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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

HEADQUARTERS

SCIENCE MISSION DIRECTORATE

300 E STREET, SW

WASHINGTON, DC 20546-0001

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES – 2010 (ROSES-2010)

NASA RESEARCH ANNOUNCEMENT (NRA)

SOLICITING BASIC AND APPLIED RESEARCH PROPOSALS

NNH10ZDA001N

CATALOG OF FEDERAL DOMESTIC ASSISTANCE (CFDA) NUMBER: 00.000

ISSUED: FEBRUARY 12, 2010

PROPOSALS DUE

STARTING NO EARLIER THAN APRIL 30, 2010

THROUGH NO LATER THAN APRIL 30, 2011

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES) – 2010

EXECUTIVE SUMMARY

This National Aeronautics and Space Administration (NASA) Research Announcement (NRA), entitled *Research Opportunities in Space and Earth Sciences (ROSES) – 2010*, solicits basic and applied research in support of NASA's Science Mission Directorate (SMD). This NRA covers all aspects of basic and applied supporting research and technology in space and Earth sciences, including, but not limited to: theory, modeling, and analysis of SMD science data; aircraft, stratospheric balloon, suborbital rocket, and commercial reusable rocket investigations; development of experiment techniques suitable for future SMD space missions; development of concepts for future SMD space missions; development of advanced technologies relevant to SMD missions; development of techniques for and the laboratory analysis of both extraterrestrial samples returned by spacecraft, as well as terrestrial samples that support or otherwise help verify observations from SMD Earth system science missions; determination of atomic and composition parameters needed to analyze space data, as well as returned samples from the Earth or space; Earth surface observations and field campaigns that support SMD science missions; development of integrated Earth system models; development of systems for applying Earth science research data to societal needs; and development of applied information systems applicable to SMD objectives and data.

Awards range from under $100K per year for focused, limited efforts (e.g., data analysis) to more than $1M per year for extensive activities (e.g., development of science experiment hardware). The funds available for awards in each program element offered in this NRA range from less than one to several million dollars, which allow selection from a few to as many as several dozen proposals depending on the program objectives and the submission of proposals of merit. Awards will be made as grants, cooperative agreements, contracts, and inter- or intra-agency transfers depending on the nature of the proposing organization and/or program requirements. The typical period of performance for an award is four years, although a few programs may specify shorter or longer (maximum of five years) periods. Organizations of every type, domestic and foreign, Government and private, for profit and not-for-profit, may submit proposals without restriction on number or teaming arrangements. Note that it is NASA policy that all investigations involving non-U.S. organizations will be conducted on the basis of no exchange of funds. Any changes or modifications to any of these guidelines will be specified in the descriptions of the relevant programs in the Appendices of this solicitation.

Details of the solicited programs are given in the Appendices of this NRA. Proposal due dates are given in Tables 2 and 3 of this NRA. Interested proposers should monitor http://nspires.nasaprs.com/ or subscribe to the SMD electronic notification system there for additional new programs or amendments to this NRA through February 2011, at which time release of a subsequent ROSES NRA is planned. A web archive (and RSS feed) for amendments, clarifications, and corrections to ROSES can be found at: http://nasascience.nasa.gov/researchers/sara/grant-solicitations/roses-2010/RSS.

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Note: Tables 2 and 3 of this NRA are posted as separate documents on the ROSES-2010 homepage located at http://nspires.nasaprs.com/ (select “Solicitations” then “Open Solicitations” then “NNH10ZDA001N”).

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Note: Any amendments to the Table of Contents for Appendices A through E may be found in Table 3 of this NRA. Table 3 of this NRA is posted as a separate document on the ROSES-2010 homepage located at http://nspires.nasaprs.com/ (select “Solicitations” then “Open Solicitations” then “NNH10ZDA001N”).

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES) – 2010

SUMMARY OF SOLICITATION

I. Funding Opportunity Description

(a) Strategic Goals of NASA's Research Program

The National Aeronautics and Space Administration (NASA) is chartered in the National Aeronautics and Space Act [Public Law No. 85-568, 2 Stat. 426 (July 29, 1958) As Amended] with, among other objectives, the expansion of human knowledge of the Earth and of phenomena in the atmosphere and space. Working from this Congressional authorization, U.S. National Space Policy directs NASA to execute a sustained and affordable human and robotic program of space exploration and develop, acquire, and use civil space systems to advance fundamental scientific knowledge of our Earth system, solar system, and universe. This direction allows the science objectives of the NASA Science Mission Directorate (SMD) to be clearly defined as the orderly pursuit of the Agency's strategic direction.

At the time of this printing, the NASA Strategic Plan is being revised. However the draft strategic goal and outcome framework is sufficiently mature to identify the following outcomes as those to be pursued by SMD:

- Advance scientific understanding of the changing Earth system to meet societal needs;
- Understand the Sun and its interactions with the Earth and the solar system;
- Advance scientific knowledge of the origin and history of the solar system, and the potential for life elsewhere;
- Discover how the universe works, explore how the universe began and evolved into its present form, and search for life elsewhere; and
- Perform basic research to understand the hazards and resources available as humans explore space.

Further valuable, in depth insight into these strategic objectives and supporting research areas may be found in the following documents:

- The latest version of *The NASA Strategic Plan*, available at http://www.nasa.gov/about/budget and/or http://nasascience.nasa.gov/about-us/science-strategy; and
- *The Science Plan for NASA's Science Mission Directorate (2007-2016)* (hereafter the *NASA Science Plan*), available at http://nasascience.nasa.gov/about-us/science-strategy.

The NASA strategic goals and research objectives for science from the *NASA Science Plan* are given in Table 1. These NASA research objectives, and their corresponding strategic outcomes, are also used to assess NASA's research progress for compliance with the *Government Performance and Results Act* (GPRA) of 1993. Each program element in this NASA Research Announcement (NRA) is explicitly relevant to these NASA strategic goals, science outcomes, and the *NASA Science Plan*. Each proposer to this NRA demonstrates relevance of the proposed research to NASA's goals and objectives by demonstrating relevance to the programmatic goals and objectives of the appropriate program element (further instructions concerning this requirement are provided in Section IV(e) below).

(b) Research Programs of NASA's Science Mission Directorate

The NASA Science Mission Directorate (SMD) pursues NASA's strategic goals using a wide variety of space flight programs that enable the execution of both remote sensing and *in situ* investigations. These investigations are carried out through flight of space missions in Earth orbit, as well as to or even beyond objects in the Solar System, and also through ground-based research activities that directly support these space missions. This ROSES NASA Research Announcement (NRA) solicits proposals for the latter of these two types of programs, in particular, ground-based supporting research and technology (SR&T) investigations that seek to understand naturally occurring space and Earth phenomena, human-induced changes in the Earth system, and Earth and space science-related technologies and to support the national goals for further robotic and human exploration of the Moon and Mars.

Proposals in response to this NRA should be submitted to the most relevant science program elements described in Appendices A, B, C, D, and E (see also the *Table of Contents* that prefaces this NRA). Table 2 lists these program elements in the order of their calendar deadlines for the submission of proposals, while Table 3 lists them in the order in which they appear in the appendices of this NRA. Questions about each specific program element should be directed to the Program Officer(s) identified in the *Summary of Key Information* section that concludes each program element description.

In order to pursue NASA's goals and objectives, SMD research activities are organized into four Research Programs:

- The *Earth Science Research Program* sponsors research to explore interactions among the major components of the Earth system — continents, oceans, atmosphere, ice, and life — to distinguish natural from human-induced causes of change and to understand and predict the consequences of change. The Earth Science Research Program is managed by the Earth Science Division.
- The *Heliophysics Research Program* sponsors research to understand the Sun as a magnetic variable star and its effects on the Earth and other planets, and the dynamics of structures in the solar system. The Heliophysics Research Program is managed by the Heliophysics Division.
- The *Planetary Science Research Program* sponsors research to explore the Solar System to study its origins and evolution, including the origins of life within it. The Planetary Science Research Program is managed by the Planetary Science Division.
- The *Astrophysics Research Program* sponsors research to explore the Universe beyond, from the search for planets and life in other solar systems to

the origin, evolution, structure, and destiny of the Universe itself. The Astrophysics Research Program is managed by the Astrophysics Division.

The program elements in Appendices A, B, C, and D describe program elements of these four science research programs, respectively, while Appendix E describes cross-division program elements relevant to two or more of these science research programs. Each of these appendices is prefaced with an *Overview* section that provides an introduction to the research program content that all interested applicants to this NRA are encouraged to read.

The program elements described in these appendices also provide any clarifications or modifications to the general guidelines contained in this *Summary of Solicitation*.

(c) Opportunities for Education and Public Outreach

(i) Overview

SMD is committed to fostering the broad involvement of the Earth and space science research communities in Education and Public Outreach (E/PO) and contributing to NASA's three education goals and outcomes:

- Strengthen NASA and the Nation's future workforce;
- Attract and retain students in science, technology, engineering, and mathematics (STEM) disciplines; and
- Engage Americans in NASA's mission.

The NASA Science Mission Directorate's vision for Education and Public Outreach is:

> *To share the story, the science, and the adventure of NASA's scientific explorations of our home planet, the solar system, and the universe beyond, through stimulating and informative activities and experiences created by experts, and delivered effectively and efficiently to learners of many backgrounds via proven conduits, thus providing a return on the public's investment in NASA's scientific research.*

Progress towards achieving these goals has become an important part of the broad justification for the public support of Earth and space science. A more detailed discussion may be found in the *NASA Education Strategic Coordination Framework* (http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Strategic_Coordination_Framework.html).

SMD sponsors a broad spectrum of educational activities ranging from kindergarten to postgraduate levels via several vehicles of solicitation. A variety of information about recent E/PO activities in Earth and space science can be found at http://nasascience.nasa.gov/researchers/education-public-outreach. This site includes *Explanatory Guides to E/PO Evaluation Factors*, strategic planning and implementation documents, catalog or directory of E/PO resources, and list or abstracts of selected E/PO awards.

(ii) E/PO Opportunities

Three opportunities to participate in SMD's E/PO programs are included in this ROSES NRA. The first is the opportunity to conduct midsized E/PO projects by participating in *Opportunities in Education and Public Outreach for Earth and Space Science* (Appendix E.4 of ROSES). The second are the opportunities for early career scientists and engineers; early career scientists and engineers in Earth science may participate in the *New Investigator Program in Earth Science* (Appendix A.28 of ROSES) and early career scientists and engineers in planetary science may participate in the *Fellowships for Early Career Researchers* (Appendix C.22 of ROSES).

The third opportunity is for Principal Investigators (PIs) of selected research investigations to receive Education or Outreach awards as supplements to their research award. Two different pathways are offered: $15K education pathway proposals and $10K outreach pathway proposals. The parent research award must have more than 12 months remaining at the time of submission of an education or outreach supplement proposal. For additional details concerning the submission of supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5 of ROSES) and Supplemental Education Awards for ROSES Investigators (Appendix E.6 of ROSES).

Other opportunities to participate in SMD's E/PO programs are not included in this ROSES NRA, but are solicited separately. These include E/PO opportunities embedded in SMD missions and programs, opportunities available through SMD's E/PO support network organizations to provide E/PO support to the scientific and educational enterprise inside and outside of NASA, and opportunities sponsored by NASA's Office of Education to develop systematic and sustainable educational efforts.

Questions and/or comments and suggestions about the SMD E/PO program are welcome and may be directed to:

Ms. Stephanie Stockman
SMD Lead for Education and Public Outreach
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
Telephone: (202) 358-0039
Email: HQ-SMD-ROSES-EPO@hq.nasa.gov

(d) NASA-Provided High-End Computing (HEC) Resources

SMD provides a specialized computational infrastructure to support its research community, managed on its behalf by NASA's High-End Computing (HEC) program (http://www.hec.nasa.gov/). Two major computing facilities are offered, namely, the NASA Center for Computational Sciences (NCCS) at Goddard Space Flight Center (GSFC), and the NASA Advanced Supercomputing (NAS) facility at Ames Research Center (ARC).

The HEC program facilities maintain a range of capacity and capability computing systems, with significant data storage resources. These offerings are summarized at http://www.hec.nasa.gov/about/overview.html. Augmentation and refreshment of these central systems occur on a periodic basis. The HEC program also provides user services in code porting, performance tuning, scientific data visualization, and data transfer.

Any need for computing time and other HEC program resources for the proposed research must be explicitly described. The proposal should include identification of the computing system and location, rationale and justification of the need, how it supports the investigation, when during the proposed period the resources will be required, and an estimate of processor hours and storage capacity needed. An aggregated computing time per year (i.e., number of runs, multiplied by the number of processors per run, multiplied by the number of hours per run) should also be included.

The box provided on the *Cover Page* for proposals submitted in response to this NRA should also be "checked" to indicate that a request for computing resources is included in the proposal. As they review the intrinsic merit of the proposed investigation, science peer review panels will be asked to consider the realism and reasonableness of the computing time request and whether it is an appropriate utilization of a highly constrained resource.

To receive an allocation of HEC resources, proposed investigations selected for funding must make annual requests. The full requested levels cannot be guaranteed. SMD will make every attempt to satisfy the needs in the context of the overall set of requirements, resource constraints, and science priorities.

The HEC website provides the mechanism for PIs to formally request full computing time allocations as identified in their funded proposals. Computing time awards are for one year and nontransferable. PIs may make large requests, greater than 100,000 aggregated computing hours, at any time during the year, but requests will be considered only twice a year (November and April). Small requests of less than 100,000 aggregated computing hours may be allocated throughout the year.

To expedite the set-up of new user accounts (especially for foreign nationals that require additional documentation and take longer to process), the HEC program will immediately award any winning proposal that has requested HEC resources a small allocation of start-up computing time. Winning PIs may then request accounts for themselves and all users on their team following the procedure at
http://www.hec.nasa.gov/request/accounts_science.html.

For further information contact either of the following:

Dr. Tsengdar J. Lee
Earth Science Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
Email: Tsengdar.J.Lee@nasa.gov
Telephone: 202-358-0860

Mr. Joseph H. Bredekamp
Heliophysics Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
Email: Joe.Bredekamp@nasa.gov
Telephone: 202-358-2348.

(e) NASA Safety Policy

Safety is the freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.

NASA's safety priority is to protect the public, astronauts and pilots, the NASA workforce (including employees working under NASA award instruments), and high-value equipment and property.

(f) Availability of Funds for Awards

Prospective proposers to this NRA are advised that funds are not in general available for awards for all of its solicited program elements at the time of its release. The Government's obligation to make awards is contingent upon the availability of sufficient appropriated funds from which payment can be made and the receipt of proposals that NASA determines are acceptable for award under this NRA.

(g) Significant Changes from ROSES-2009

Proposers should be aware of the following significant changes in this NRA from ROSES-2009.

- All team members identified on the NSPIRES proposal cover page must both acknowledge their participation in the investigation and indicate their institutional affiliation via NSPIRES (Section IV(b)(iv)).
- Proposals submitted in response to ROSES-2010 can be submitted through either NSPIRES or Grants.gov. However, certain caveats apply, see Section IV(b)(v) for details.
- The Commercial Reusable Suborbital Research (CRuSR) Program will procure reusable suborbital launch vehicle services for the conduct of NASA scientific research, education, and technology advancement. Commercial suborbital vehicles are anticipated to be operational by about 2011, and there may also be flight research opportunities as the vehicles are tested and demonstrated. The use of these commercial services may reduce the cost of suborbital flight research by leveraging private investment. Prior to the finalization of ROSES-2010 for release, sufficient technical information on vehicles for writing and evaluating proposals was not available to proposers. Once that technical information is available, ROSES-2010 will be amended to solicit proposals for investigations using CRuSR vehicles through the Commercial Reusable Suborbital Research Platforms for Earth Science program (Appendix A.27), Geospace Science program (Appendix B.3), Solar and Heliospheric Science program (Appendix B.4), Planetary Astronomy program (Appendix C.5), and the Astrophysics Research and Analysis program (Appendix D.3).
- Unless specifically allowed by an individual program element (program elements are the appendices to ROSES), multiple PIs (as described in Section 1.4.2 of the *NASA Guidebook for Proposers*[1]) are not permitted. The use of other categories of participation described in Section 1.4.2 of the *NASA Guidebook for Proposers*,

[1] The *Guidebook for Proposers Responding to a NASA Research Announcement (NRA) or Cooperative Agreements Notice (CAN)* (hereafter referred to as the *NASA Guidebook for Proposers*) is at http://www.hq.nasa.gov/office/procurement/nraguidebook; see Section IV(a) of this NRA for further information.

including Science PI, Institutional PI, and Co-PI (from a non-U.S. organization under specific circumstances), remain permitted.

In addition to the listed significant changes, this NRA and the *NASA Guidebook for Proposers* incorporate a large number of additional changes, including both policy changes and changes to proposal submission requirements. Many sections of both documents have been clarified since the release of ROSES-2009. All proposers are urged to read this NRA and the 2010 edition of the *NASA Guidebook for Proposers* carefully, since all proposals must comply with their requirements, constraints, and guidelines.

II. Award Information

(a) Funding and Award Policies

The amount of funds expected to be available for new awards for proposals submitted in response to this NRA is given in the *Summary of Key Information* that concludes each program element description in the appendices. Given the submission of proposals of merit, the number of awards that may be made for each program element is also given in this location.

In all cases, NASA's goal is to initiate new awards within 46 days after the selection of proposals is announced for each program element. However, this time period may be longer based on the workload experienced by NASA, the availability of appropriated funds, and any necessary postselection negotiations with the proposing organization(s) needed for the award(s) in question. Regarding this last item, every proposer is especially encouraged to submit full and detailed explanations of the requested budget (see Section 2.3.10 of the *NASA Guidebook for Proposers*) to help expedite the processing of the award, should their proposal be selected.

Awards made through this NRA will be in the form of grants, cooperative agreements, contracts, and intra- or interagency transfers, depending on the nature of the submitting organization and/or the specific requirements for awards given in each program element description in the appendices. The type of award to be offered to selected proposers will generally follow the policies in Section D.1 of the *NASA Guidebook for Proposers*, although in a few cases, only one type of award may be offered, as specified in the program element description. A NASA awards officer will determine the appropriate award instrument for the selections resulting from this solicitation. Grants and cooperative agreements will be subject to the provisions of the *Grants Handbook*[2] and Appendix D of the *NASA Guidebook for Proposers*. In the case of any conflict, the *Grants Handbook* takes precedence. Contract awards will be subject to the provisions of the Federal Acquisition Regulations (FAR) and the NASA FAR Supplement (see http://prod.nais.nasa.gov/cgi-bin/nais/nasa_ref.cgi).

(b) Successor Proposals and Resubmissions

Generally, PIs holding previous awards selected through any of the programs offered through earlier NRAs are welcome to submit "successor" proposals that seek to continue

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[2] The *NASA Grants and Cooperative Agreement Handbook* (hereafter referred to as the *Grants Handbook*) is at http://prod.nais.nasa.gov/pub/pub_library/grcover.htm.

a previously funded line of research (see Section 1.5 of the *NASA Guidebook for Proposers*). However, it is SMD policy that such successor proposals will be considered with neither advantage nor disadvantage along with new proposals that are submitted for that same program. Instructions regarding successor proposals may be found in Section 1.5 of the *NASA Guidebook for Proposers*.

Proposals that were submitted but not selected for any previous NASA solicitation may be submitted either in a revised or original form. Such submissions will be subjected to full peer review and considered with neither advantage nor disadvantage along with new proposals that are received by NASA.

(c) Award Period of Performance

The maximum period of performance (duration) for new awards for proposals submitted in response to this NRA is given in the *Summary of Key Information* that concludes each program element description in the appendices. The usual maximum period of performance is four years, but it can range from one year for activities of limited scope to as long as five years for extensive, comprehensive studies.

Any proposed period of performance must be justified in the proposal. The appropriateness of the proposed period of performance will be evaluated by peer review. NASA may select proposals for a shorter award duration than proposed.

III. Eligibility Information

(a) Eligibility of Applicants

Prospective investigators from any category of organizations or institutions, U.S or non-U.S., are welcome to respond to this solicitation. Specific categories of organizations and institutions that are welcome to respond include, but are not limited to, educational, industrial, and not-for-profit organizations, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), NASA Centers, the Jet Propulsion Laboratory (JPL), and other Government agencies. Historically Black Colleges and Universities (HBCUs), Other Minority Universities (OMUs), small disadvantaged businesses (SDBs), veteran-owned small businesses, service disabled veteran-owned small businesses, HUBZone small businesses, and women-owned small businesses (WOSBs) are encouraged to apply. Participation by non-U.S. organizations in this program is welcome but subject to NASA's policy of no exchange of funds, in which each government supports its own national participants and associated costs (further information on foreign participation is provided in Section 1.6 of the *NASA Guidebook for Proposers*).

(b) Number of Proposals and Teaming Arrangements

There is no restriction on the number of proposals that an organization may submit to this solicitation or on the teaming arrangements for any one proposal, including teaming with employees of NASA's Centers and the Jet Propulsion Laboratory. However, each proposal must be a separate, stand-alone, complete document for evaluation purposes.

(c) Cost Sharing or Matching

If an institution of higher education or other not-for-profit organization wants to receive a grant or cooperative agreement, cost sharing is not required, although NASA can accept cost sharing if it is voluntarily offered (see the *Grants Handbook*, Section B, §1260.123, "Cost Sharing or Matching"). If a commercial organization wants to receive a grant or cooperative agreement, cost sharing is required unless the commercial organization can demonstrate that it does not expect to receive substantial compensating benefits for performance of the work. If this demonstration is made, cost sharing is not required but may be offered voluntarily (see also the *Grants Handbook*, Section D, §1274.204, "Costs and Payments"). See also Section V(a) below.

IV. Proposal and Submission Information

(a) Proposal Instructions and Requirements

All information needed to apply to this solicitation is contained in this ROSES NRA and in the companion document, the *Guidebook for Proposers Responding to a NASA Research Announcement (NRA) or Cooperative Agreements Notice (CAN)* (hereafter referred to as the *NASA Guidebook for Proposers*), located at http://www.hq.nasa.gov/office/procurement/nraguidebook. By reference, the 2010 edition of the *NASA Guidebook for Proposers* is incorporated into this NRA. Proposers are responsible for understanding and complying with its procedures for the successful, timely preparation and submission of their proposals. Proposals that do not conform to its standards may be declared noncompliant and rejected without review.

Questions regarding this NRA or its program elements should be directed to the cognizant Program Officer identified in the *Summary of Key Information* subsection that concludes each program element description. Any clarifications or questions and answers that are published will be posted on the relevant program element's web page.

The introductory material, as well as the appendices, of the *NASA Guidebook for Proposers* provide additional information about the entire NRA process, including NASA policies for the solicitation of proposals, guidelines for writing complete and effective proposals, and NASA's general policies and procedures for the review and selection of proposals and for issuing and managing the awards to the institutions that submitted selected proposals. A group of *Frequently Asked Questions* (FAQs) provides additional miscellaneous information about a variety of the NASA proposal and award processes, policies, and procedures.

Comments and suggestions of any nature about the *NASA Guidebook for Proposers* are encouraged and welcome and may be directed at any time to the point-of-contact identified in Section VII below.

(b) Content and Form of the Proposal Submission

(i) Electronic Proposal Submission

All proposals submitted in response to this ROSES NRA must be submitted in a fully electronic form. No hard copy of the proposal is required or permitted. Electronic proposals must be submitted by one of the officials at the PI's organization who is authorized to make such a submission; electronic submission by the authorized organization representative (AOR) serves for the proposal as the required original signature by an authorized official of the proposing organization.

Proposers may opt to submit proposals in response to this ROSES NRA via either of two different electronic proposal submission systems: either via the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) (http://nspires.nasaprs.com; see Section IV(b)(iv) below) or via Grants.gov (http://www.grants.gov; see Section IV(b)(v) below).

Note carefully the following requirements for submission of an electronic proposal, regardless of the intent to submit via NSPIRES or Grants.gov.

- Every organization that intends to submit a proposal to NASA in response to this NRA, including educational institutions, industry, not-for-profit institutions, the Jet Propulsion Laboratory, NASA Centers, and other U.S. Government agencies, must be registered in NSPIRES. This applies equally for proposals submitted via Grants.gov, as well as for proposals submitted via NSPIRES. Every organization that intends to submit a proposal through Grants.gov must also be registered in Grants.gov, as well as in NSPIRES. Registration for either proposal data system must be performed by an organization's electronic business point-of-contact (EBPOC) in the Central Contractor Registry (CCR).
- Any organization requesting NASA funds through the proposed investigation must be listed on the Proposal Cover Page. NASA will not fund organizations that do not appear on the Proposal Cover Page.
- Each individual team member (e.g., PI, co-investigators, etc.), including all personnel named on the proposal's electronic cover page, must be individually registered in NSPIRES. This applies equally for proposals submitted via Grants.gov, as well as for proposals submitted via NSPIRES. Unless specifically allowed by an individual program element appendix, multiple PIs (as described in Section 1.4.2 of the *NASA Guidebook for Proposers*) are not permitted. The use of other categories of participation described in Section 1.4.2 of the *NASA Guidebook for Proposers*, including Science PI, Institutional PI, and Co-PI (from a non-U.S. organization under specific circumstances), remain permitted.
- Each individual team member (e.g., PI, co-investigators, etc.), including all personnel named on the proposal's electronic cover page, must confirm their participation on that proposal (indicating team member role) and specify an organizational affiliation. For proposals submitted via NSPIRES, this confirmation is via NSPIRES (see Section IV(b)(iv), below). For proposals submitted via Grants.gov, this confirmation is via "Letters of Commitment" included within the proposal. The organizational affiliation specified on the cover page must be the organization through which the team member would work and receive funding while participating in the proposed investigation. If the individual has multiple affiliations, then this organization may be different from the individual's primary employer or preferred mailing address. Team members are asked to ensure that their contact information is up-to-date. Changes can be made using the "Account Management" link on the "NSPIRES Options" page.

Generically, an electronic proposal consists of electronic forms and one or more attachments. The electronic forms contain data that will appear on the proposals cover pages and will be stored with the proposal in the NSPIRES database. A proposal submitted in response to this NRA must have only a single attachment. The single attachment contains all sections of the proposal, including the science/technical/ management section, the budget narrative, and all required and allowed appendices; see Section IV(b)(ii) below for further requirements.

Submission of proposals via either NSPIRES or Grants.gov is a two-step process. When the PI has completed entry of the data requested in the required electronic forms and attachment of the allowed PDF attachments, including the science/technical/management section, an official at the PI's organization who is authorized to make such a submission, referred to as the Authorized Organizational Representative (AOR), must submit the electronic proposal (forms plus attachments). Coordination between the PI and his/her AOR on the final editing and submission of the proposal materials is facilitated through their respective accounts in NSPIRES and/or Grants.gov.

(ii) Proposal Format and Contents

All proposals submitted in response to this NRA must include any specified required electronic forms available through either of two proposal submission systems, NSPIRES or Grants.gov. Submission via NSPIRES may require responding to questions on the NSPIRES submission page.

The science/technical/management section and other required sections of the proposal must be submitted as a single, searchable, unlocked PDF file that is attached to the electronic submission using one of the proposal submission systems. Proposers must comply with all format requirements specified in this NRA and in the *NASA Guidebook for Proposers* (e.g. Section 2.3 of the *NASA Guidebook for Proposers*). Only appendices that are specifically requested in either this NRA or in the *NASA Guidebook for Proposers* will be permitted; proposals containing unsolicited appendices may be declared noncompliant. Section 2 of the *NASA Guidebook for Proposers* provides detailed discussions of the content and organization of proposals suitable for all program elements in this NRA, as well as the default page limits of a proposal's constituent parts.

Note that some of the program element descriptions in Appendices A through E of this NRA may specify different page limits for the main body of the proposal; if so, these page limits will be prominently given in the *Summary of Key Information* subsection that concludes each program element description. In the event the information in this NRA is different from or contradictory to the information in the *NASA Guidebook for Proposers*, the information in this NRA takes precedence.

Proposals submitted in response to ROSES are permitted 15 characters per inch, typical of font Times New Roman 12, and consistent with our Announcements of Opportunity. This requirement applies to body text and figure captions, but it does not apply to text *within* figures and tables, which may be smaller but must still be judged by the reviewers to be readable. This more permissive standard regarding font sizes supersedes that in Section 2.2 of *NASA Guidebook for Proposers*. **[Clarified March 1, 2010]**

Important note on creating PDF files for upload: It is essential that all PDF files generated and submitted meet NASA requirements. This will ensure that the submitted files can be ingested by NSPIRES regardless of whether the proposal is submitted via NSPIRES or Grants.gov. At a minimum, it is the responsibility of the proposer to: (1) ensure that all PDF files are unlocked and that edit permission is enabled – this is necessary to allow NSPIRES to concatenate submitted files into a single PDF document; and (2) ensure that all fonts are embedded in the PDF file and that only Type 1 or TrueType fonts are used. In addition, any proposer who creates files using TeX or LaTeX is required to first create a DVI file and then convert the DVI file to Postscript and then to PDF. See http://nspires.nasaprs.com/tutorials/PDF_Guidelines.pdf for more information on creating PDF documents that are compliant with NSPIRES. PDF files that do not meet NASA requirements cannot be ingested by the NSPIRES system; such files may be declared noncompliant and not submitted to peer review for evaluation.

There is a 10 MB size limit for proposals (Section 2.3(c) of the NASA Guidebook for Proposers). Large file sizes can impact the time it takes for NASA and peer reviewers to download and access your proposal. In order to increase the ease in reviewing your proposal, you should crop and compress any embedded photos and graphic files to an appropriate size and resolution. Most electronically submitted proposals will be less than 2 MB in size.

(iii) ROSES Budget Format

In the evaluation of proposals submitted under ROSES-2010, SMD will be showing all of the budget data to peer reviewers (i.e., SMD is *not* redacting budgets). Proposers should include all relevant details in the budget justification. Proposers should *not* upload a separate second "total budget" document, but a detailed budget should be included at the end of the proposal document. Proposals submitted in response to this ROSES NRA should follow the directions for the budget section of the proposal given in Section 2.3.10 of the *NASA Guidebook for Proposers*. There are no additional requirements for ROSES proposals from non-NASA proposers.

Since NASA funding sent to NASA Centers must be obligated in the same fiscal year (FY) in which they are received, proposals submitted by NASA Centers (but not including JPL) should begin the budget section of the proposal with a breakdown of funding by NASA Center and by fiscal year, assuming the start date given in the "Summary of Key Information" table at the end of the program element (the default is six months after proposal submission). Thus, a ROSES-2010 proposal for a two-year award that starts in mid FY 2011 could phase the funds for a half year of funding in FY 2010, a full year in FY 2012, and a half year in FY 2013.

Proposers from JPL should not include the JPL award fee in the total requested amount, nor should the budgets of JPL Co-Investigators on proposals from other institutions include the JPL award fee in their total requested amount. The total requested amount is the amount which shows on the NSPIRES online (cover page) budget form or the Grants.gov standard budget form. JPL award fees are paid for and accounted for by a different mechanism than the mechanism used to fund research investigations. JPL proposers and Co-Investigators may still include the award fee for informational purposes in their budget narratives and detailed budgets.

(iv) Submission of Proposals via NSPIRES, the NASA Proposal Data System

Proposals may be submitted electronically via NASA's master proposal data base system, the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES). In order to submit a proposal via NSPIRES, this NRA requires that the proposer register key data concerning the intended submission with NSPIRES at http://nspires.nasaprs.com. Potential applicants are urged to access this site well in advance of the NOI and proposal due dates of interest to familiarize themselves with its structure and enter the requested identifier information.

It is especially important to note that every individual named on the proposal's electronic *Cover Page* form (see below) as a proposing team member in any role, including co-investigators and collaborators, must be individually registered in NSPIRES and that such individuals must perform this registration themselves; no one may register a second party, even the PI of a proposal in which that person is committed to participate. It is also important to note that every named individual must be identified with the organization through which they are participating in the proposal, regardless of their place of permanent employment or preferred mailing address. This data site is secure and all information entered is strictly for NASA's use only.

Every individual identified on the NSPIRES proposal cover page as a team member must indicate their commitment to the proposed investigation through NSPIRES prior to proposal cover page submission. Team members must additionally confirm the organization through which they are participating on this proposal. A team member will receive an email from NSPIRES indicating that he/she has been added to the proposal and should log in to NSPIRES.

- Once logged in, the team member should follow the link in the "Reminders and Notifications" section of his NSPIRES homepage, titled "Need <role> confirmation for proposal <title> for Solicitation <<solicitation number>>." On the "Team Member Participation Confirmation" page, the proposal team member should read language about the Organizational Relationship, then click the "Continue" button.
- If the contact information then displayed on the "Team Member Profile" screen is out of date, the proposal team member should update this information later using the "Account Mgmt" link in the NSPIRES navigation bar across the top. Prior to making that update, however, the team member should follow the on-screen prompts to identify the organization through which he/she is participating on this proposal. Click the "Link Relationship" button to the right side of the "Organizational Relationship" banner. Select the organization from the "Link Proposal to an Association" part of the page. If the correct organization is not displayed here, try using the "Add Association" button to add the organization to this list. Then click the "Save" button at the bottom of the page. If the team member cannot find the organization when searching in the "Add Association" area (*i.e.,* the organization is not registered), type in the formal name in the space provided (or select "Self" if appropriate). Once the organization is selected and the "Save" button is clicked, there is a confirmation page that allows the team member to edit that relationship if it was chosen incorrectly. Click "Continue".

- Note that the organization through which the proposal team member is participating in the proposal might not be the proposal team member's primary employer or primary mailing address. If the address information is accurate (or once it has been edited to be accurate), the proposal team member may log out of NSPIRES.
- NSPIRES will send an email to both the team member and the PI confirming that the commitment was made and the organization was identified. The PI may additionally monitor the status of proposal team member commitments by examining the "Relationship Confirmed" column on the Team Member page of the NSPIRES proposal cover page record. Note that the proposal cover page cannot be submitted until all identified team members have confirmed their participating organizations.

All proposals submitted via NSPIRES in response to this NRA must include a required electronic *Cover Page* form that is accessed at http://nspires.nasaprs.com/. This form is comprised of several distinct sections: a *Cover Page* that contains the identifier information for the proposing institution and personnel; a *Proposal Summary* that provides an overview of the proposed investigation that is suitable for release through a publicly accessible archive should the proposal be selected; *Business Data* that provides the proposed start and end dates, as well as other proposal characteristics; a *Budget* form that contains a budget summary of the proposed research effort; *Program Specific Data* that includes required questions specific to ROSES and that particular program element; and *Proposal Team* that provides the co-investigators and other participants in the proposal. This *Cover Page* form is available for access and submission starting about 90 days in advance of the proposal due dates given in Tables 2 and 3 of this NRA and remains open until the proposal due date for each program element. Unless specified in the program element description itself, no other forms are required for proposal submission via NSPIRES. See the *NASA Guidebook for Proposers*, Sections 2 and 3, for further details.

Although NSPIRES has the ability to accept many, separate proposal documents**,** the required elements of any proposal submitted in response to this NRA must be submitted as a single, searchable, unlocked PDF document that contains the complete proposal, including the science/technical/management section and budget justification, assembled in the order provided in the *NASA Guidebook for Proposers* (see Section 2.3) and uploaded as a single attachment using the tools in NSPIRES. The proposer is responsible for assembling the complete proposal document for peer review. All required and permitted appendices must be included in the PDF file and should not be uploaded as separate attachments, unless specified otherwise in the program element description in the appendices to this NRA. Including any part of the proposal twice creates an additional burden on the peer reviewers. Documents such as team member biographical sketches, letters of commitment, and current and pending support should <u>not</u> be uploaded to NSPIRES as separate files.

NSPIRES generates error and warning messages as part of the element check concerning possibly missing data. An error (designated by a red X) will preclude proposal submission to NASA by the AOR. A warning (indicated by an ! on a yellow field) is an indication that data may be missing; a warning can be ignored after verifying that the material is included in the single attachment containing the complete proposal. Any actions taken because of warnings are at the PI's discretion.

In addition, it is unnecessary to download the Proposal Cover Page and incorporate it into the Proposal Document. NSPIRES will automatically route the two parts of the proposal (*Cover Page* form, proposal document) to the appropriate peer or NASA reviewers.

Proposers are encouraged to begin their submission process early. Tutorials and other NSPIRES help topics may be accessed through the NSPIRES online help site at http://nspires.nasaprs.com/external/help.do. For any questions that cannot be resolved with the available online help menus, requests for assistance may be directed by email to nspires-help@nasaprs.com or by telephone to (202) 479-9376, Monday through Friday, 8:00 a.m. – 6:00 p.m. Eastern Time.

(v) Submission of Proposals via Grants.gov

In furtherance of the President's Management Agenda, NASA offers proposers the option to use Grants.gov to prepare and submit proposals in response to this ROSES NRA. Grants.gov allows organizations to electronically find and apply for competitive grant opportunities from all Federal grant-making agencies; it provides a single access point for over 1000 grant programs offered by the 26 Federal grant-making agencies. The U.S. Department of Health and Human Services is the managing partner for Grants.gov.

In order to submit a proposal via Grants.gov, Grants.gov requires that the PI download an application package from Grants.gov. Identifying the appropriate application package requires the funding opportunity number for that program element; the funding opportunity number may be found in the *Summary of Key Information* subsection that concludes each program element description in the appendices of this NRA. Proposals submitted via Grants.gov must be submitted by the AOR.

Submitting a proposal via Grants.gov requires the following steps:

- Grant researchers (PIs) do NOT need to register with Grants.gov. However, every individual named in the proposal as a proposing team member in any role, including PI, co-investigators, and collaborators, must be registered in NSPIRES (http://nspires.nasaprs.com) and such individuals must perform this registration themselves; no one may register a second party, even the PI of a proposal in which that person is committed to participate. This data site is secure and all information entered is strictly for NASA's use only.

- Follow Grants.gov instructions provided at the website to download any software tools or applications required to submit via Grants.gov.

- Download the application package from Grants.gov by selecting "Download grant application packages" under "Apply for Grants" at http://www.grants.gov. Each program element described in an appendix of ROSES requires a different application package and has a different Funding Opportunity Number; the Funding Opportunity Number may be found in the *Summary of Key Information* at the end of the program element description in each appendix of ROSES. Enter the appropriate Funding Opportunity Number to retrieve the desired application package. All NASA application packages may be found by searching on CFDA Number 00.000.

- Complete the required Grants.gov forms including the SF424 Application for Federal Assistance, research and research-related (R&R) Other Project Information, R&R Senior/Key Person Profile, and R&R Budget. Every named individual must be identified with the organization through which they are participating in the proposal, regardless of their place of permanent employment or preferred mailing address.
- Complete the required NASA specific forms including NASA Other Project Information, NASA PI and Authorized Representative Supplemental Data Sheet, and NASA Senior/Key Person Supplemental Data Sheet (this form is only required if there are Senior/Key Persons other than the PI).
- Complete any NASA program-specific form that is required for the specific program element. This form, which is usually required for all ROSES program element submissions, is included as a PDF form within the proposal application package downloaded from Grants.gov. The form, once completed, is attached to the NASA Other Project Information form.
- Create a proposal in PDF including the science/technical/management section and all other required proposal sections (see Section 2 of the *NASA Guidebook for Proposers*). Upload sections as separate PDF documents as prompted by Grants.gov.
- Because Grants.gov does not support the electronic commitment of team members, statements of commitment from all team members must be provided as letters attached to the proposal application at the place(s) specified by Grants.gov. This statement must include confirmation of both the team member role in the proposed effort (e.g., Co-Investigator, collaborator) and the identification of the organization through which the team member will be participating. Here is an example statement of commitment: "I acknowledge that I am identified by name as <<role>> to the investigation, entitled <<name of proposal>>, that is submitted by <<name of Principal Investigator>> to the NASA Research Announcement <<alpha-numeric identifier>>, and that I intend to carry out all responsibilities identified for me in this proposal. I understand that the extent and justification of my participation as stated in this proposal will be considered during peer review in determining in part the merits of this proposal. I have read the entire proposal, including the management plan and budget, and I agree that the proposal correctly describes my commitment to the proposed investigation. For the purposes of conducting work for this investigation, my participating organization is <<insert name of organization>>"
- Submit the proposal via the Authorized Organization Representative (AOR); the PI <u>may not</u> submit the application to Grants.gov unless he/she is an AOR.

Potential applicants are urged to access Grants.gov site <u>well in advance</u> of the proposal due date(s) of interest to familiarize themselves with its structure and download the appropriate application packages and tools.

Additional instructions for formatting and submitting proposals via Grants.gov may be found in Sections 2 and 3 of the *NASA Guidebook for Proposers*. Instructions for the use of Grants.gov may be found in the *Grants.gov User Guide* at http://www.grants.gov/CustomerSupport. Instructions for NASA-specific forms and NASA program-specific forms may be found in the application. For any questions that cannot be resolved with the available online help menus and documentation, requests for assistance may be directed by email to support@grants.gov or by telephone to (800) 518-4726.

(vi) Notice of Intent to Propose

For most of the program elements advertised through this solicitation, a brief Notice of Intent (NOI) to propose is encouraged, but not required, for the submission of proposals to this solicitation. The information contained in an NOI is used to help expedite the proposal review activities and, therefore, is of considerable value to both NASA and the proposer. To be of maximum value, NOIs should be submitted by the PI to NSPIRES (located at http://nspires.nasaprs.com) by the dates given in Tables 2 or 3 of this NRA for each program element in Appendices A through E. Note that NOIs may be submitted within NSPIRES directly by the PI; no action by an organization's AOR is required to submit an NOI.

Grants.gov does not provide NOI capability; therefore, NOIs must be submitted via NSPIRES regardless of whether the proposal will be submitted via NSPIRES or Grants.gov. Interested proposers must register with NSPIRES before it can be accessed for use. NSPIRES is open for the submission of NOIs for typically 30 days, starting about 90 days in advance of the due date for the proposals themselves. Since NOIs submitted after these deadlines may still be useful to NASA, late NOIs may be submitted by email as directed in Section 3.1 of the *NASA Guidebook for Proposers.*

(vii) The Two-Step Proposal Process and the Two-Phase Proposal Process

The Two-Step Proposal Process

On occasion, NASA will solicit proposals using a two-step proposal process for which the Step-1 proposal is a synopsis of the intended research. When employed, Step-1 proposals are submitted by the NOI/Step-1 due date given in Tables 2 and 3 of this NRA; this site will be open for the submission of Step-1 proposals starting ~30 days in advance of their due date. NASA will review this Step-1 proposal to determine if the anticipated research project exhibits sufficient programmatic relevance and responsiveness to the current solicitation to warrant submission of a full Step-2 proposal. All submitters of Step-1 proposals will be informed by NASA no later than eight weeks after the Step-1 due date that they are, or are not, invited to submit a full Step-2 proposal by the proposal due date established for that program element. The provision of feedback on Step-1 proposals prior to the Step-2 due date is not ensured. Note that Step-1 proposals are required. A Step-2 proposal may be submitted only if a Step-1 proposal is submitted and that Step-1 proposal results in an invitation to submit a Step-2 proposal.

The required synopsis for the Step-1 proposal is submitted as a PDF document upload; the required contents for the Step-1 proposal will be specified in the program element description. The investigation team is not considered binding for Step-1 and can be adjusted in an invited Step-2 proposal. Budget and detailed program data should not be included with the Step-1 proposal. The Step-1 proposal must be submitted by an Authorized Organizational Representative of the proposing organization. Step-2 proposals are to be submitted in full compliance with the *NASA Guidebook for Proposers* discussed in Section IV(a) above.

This ROSES-2010 NRA contains one program element that is soliciting proposals using a two-step process: Land-Cover/Land-Use Change (Appendix A.4).

The Two-Phase Proposal Process

On occasion, NASA will solicit proposals using a two-phase proposal process for which Phase-1 is an observing request for an observation to be performed by a NASA space observatory as part of a NASA guest investigator/guest observer program element. Phase-2 is a proposal for funding. An NOI is requested for a Phase-1 observing request by the NOI due date, and the Phase-1 observing request must be submitted by the proposal due date in Tables 2 and 3 of this NRA.

Grants.gov does not provide NOI or Phase-1 observing request capability; therefore, NOIs and Phase-1 observing requests cannot be submitted via Grants.gov regardless of whether the Phase-2 funding proposal will be submitted via NSPIRES or Grants.gov. The Phase-2 proposal for funding must be submitted via either NSPIRES or Grants.gov by a proposal due date that will be announced when NASA announces the disposition of the Phase-1 observing requests. The process and requirements for the submission of Phase-1 observing requests and Phase-2 proposals may differ for each program element; proposers should read carefully the relevant program element Appendix to this ROSES NRA.

This ROSES-2010 NRA contains several guest investigator/guest observer program elements using the two-phase proposal process: GALEX Guest Investigator (Appendix D.5), Swift Guest Investigator (Appendix D.6), Suzaku Guest Observer (Appendix D.7), and Fermi Guest Investigator (Appendix D.8).

(c) Proposal Submission Due Dates and Deadlines

For each program element in Appendices A through E of this NRA, the electronic proposal must be submitted in its entirety by an Authorized Organizational Representative (AOR) no later than the proposal deadline on the appropriate proposal due date given in Tables 2 or 3 of this NRA. Unless stated otherwise in the relevant appendix to this NRA, the proposal deadline is 11:59 p.m. Eastern Time. All proposals must be submitted electronically using either NSPIRES or Grants.gov (see Sections IV(b)(i–iii) above).

Proposals submitted later than the proposal due date and deadline will be considered late. Proposals that are late will be handled in accordance with NASA’s policy as given in Section (g) of Appendix B of the *NASA Guidebook for Proposers* (see also its Sections 3.2 and F.23). Proposals received after the due date may be rejected without review. If a late proposal is rejected, it is entirely at the discretion of the proposer whether or not to resubmit it in response to a subsequent appropriate solicitation. It is not possible to submit a late proposal electronically via NSPIRES unless the electronic *Cover Page* was initially created prior to the proposal due date. Late proposals may not be submitted via Grants.gov.

(d) Proposal Funding Restrictions

In addition to the funding restrictions and requirements given in the *Guidebook for Proposers* and the *Grants Handbook*, the following restrictions are applicable to this ROSES NRA.

- The estimated funding and number of proposals anticipated to be funded, as shown in the *Summary of Key Information* at the end of each program element, are subject to the availability of appropriated funds, as well as the submission of a sufficient number of proposals of adequate merit.
- As directed in the *NASA Guidebook for Proposers*, Section 2.3.10(c)(iii), other than the special cases discussed in Section 2.3.10(c)(ii) of the *NASA Guidebook for Proposers*, and unless specifically noted otherwise in the specific ROSES program element appendix, the proposing PI organization must subcontract the funding of all proposed Co-Is who reside at other non-Government organizations, even though this may result in a higher proposal cost because of subcontracting fees.
- Regardless of whether a Co-I will be funded through a subaward or through a separate award, the budget for the proposal must include all funding requested from NASA for the proposed investigation. This must be reflected in the budget totals that appear in the proposal and its budget forms. Any required budget for Co-Is or Government facilities that will be separately funded should be included in the proposal's Budget Narrative and should be listed as "Other Applicable Costs" in the required Budget Details, as well as entered in the "Other" line(s) on the NSPIRES or Grants.gov budget entry form in the "Other Direct Costs" section. This funding must be included in the total cost of the proposed work. No indirect burden should be applied to this amount. (see Section 2.3.10(c)(ii) of the *NASA Guidebook for Proposers*).
- The construction of facilities is not an allowed activity for any of the program elements solicited in this NRA unless specifically stated. For further information on what costs are permissible, refer to the cost principles cited in the *Grants Handbook*, Section B, §1260.127, "Allowable Costs."
- Travel, including foreign travel, is allowed as may be necessary for the meaningful completion of the proposed investigation, as well as for publicizing its results at appropriate professional meetings. Proposers from NASA Centers should consult the latest NASA policy document.
- In general, proposals for sponsorship of topical conferences, workshops, consortia, or symposia are not solicited by ROSES. Individual conference travel by grantees, however, is permitted and proposers from universities may include a budget for travel to conferences and workshops. Proposers from NASA Centers should consult their Center implementing policy on the latest NASA guidance on conference spending and reporting requirements.

- Profit for commercial organizations is not allowable under grant or cooperative agreement awards but is allowable under contract awards.
- U.S. research award recipients may directly purchase supplies and/or services from non-U.S. sources that do not constitute research, but award funds may not be used to fund research carried out by non-U.S. organizations. However, a foreign national may receive remuneration through a NASA award for the conduct of research while employed either full or part time by a U.S. organization (see Section 1.6 of the *NASA Guidebook for Proposers*; see also Appendix B, part (c)(8)(iv)).
- Travel by a participant in the research investigation, whether for the purpose of conducting the research, for collaboration, or for attending a conference, is considered to be a research expense. NASA conducts its collaborations with foreign institutions on a no-exchange-of-funds basis. NASA funding may not be used for research efforts by foreign organizations at any level. Therefore NASA funding may not be used for travel expenses by any participant who is not participating while employed either full time or part time by a U.S. organization (see Section 1.6 of the *NASA Guidebook for Proposers*; see also Appendix B, part (c)(8)(iv)).
- The instructions in the following paragraph clarify and supersede the *Guidebook for Proposers*, Section 2.3.10(c)(iv).

  Regardless of whether functioning as a team lead or as a team member, personnel from NASA Centers must propose budgets based on full-cost accounting and consistent with the current implementation of simplified full cost accounting for the requested year of performance. Proposal budgets from NASA Centers must include all costs that will be paid out of the resulting award. Costs that will not be paid out of the resulting award, but are paid from a separate NASA budget (e.g., center management and overhead; CM&O) and are not based on the success of this specific proposal, should not be included in the proposal budget. For example, CM&O should not be included in the proposal budget while direct civil service labor, travel, and other direct charges (including procurements and contractor labor) to the proposed research task should be included.
- Non-NASA U.S. Government organizations should propose based on full-cost accounting unless no such standards are in effect; in that case such proposers should follow the *Managerial Cost Accounting Standards for the Federal Government* as recommended by the Federal Accounting Standards Advisory Board (for further information, see http://www.hq.nasa.gov/fullcost). Proposal budgets must include all costs that will be paid out of the resulting award.

(e) Proposal Requirements for Relevance

Proposals for all NASA sponsored research programs are evaluated on three criteria: intrinsic merit, relevance to NASA's objectives, and cost realism and reasonableness (see Appendix C of the *NASA Guidebook for Proposers*).

Each program element includes a specific description of how it is relevant to the *NASA Strategic Plan* and/or the *NASA Science Plan* (see Section I(a)). Therefore, unless otherwise stated in the program element, it is not necessary for individual proposals to show relevance to NASA's broader goals and objectives. The proposal only needs to demonstrate relevance by discussing how the proposed investigation addresses the goals and objectives of the specific program element.

Note that this NRA references the strategic goals and objectives in the 2006 NASA Strategic Plan (see Section I(a) and Table 1).

V. Proposal Review Information

(a) Evaluation Criteria

Evaluation by peers of the proposing personnel will be used to assess each proposal's intrinsic scientific and technical merit, its relevance to NASA's stated objectives, and its cost realism. See Appendix C.2 of the *NASA Guidebook for Proposers* for further discussion of these criteria and their relative weights. The evaluation factors include factors evaluated by peer reviewers, as well as programmatic factors evaluated by NASA program personnel. Note the following specific points:

- Some of the program elements discussed in Appendices A through E will give specific factors, based on the solicited research objectives, which will be considered when evaluating a proposal's science and/or technical merits and/or its relevance to program objectives.
- As discussed in Section IV(e) above, relevance will be judged in part by the proposal's focus on specific strategic and science objectives for that ROSES Appendix (program element), as given in the call. This focus on relevance to the call, rather than NASA's broader goals, supersedes any instructions in the *Guidebook for Proposers.*
- Cost data for U.S. proposals will be evaluated both by peer review (for cost realism and cost reasonableness) and by NASA program personnel (for total cost and comparison to available funds). Proposers must follow the budget requirements in Section 2.3.10 of the *NASA Guidebook for Proposer*. Proposers should not redact budget data from the budget justification, nor should they upload a second "total budget" document. In evaluating the cost reasonableness of the proposals, reviewers will assess whether the proposed level of effort (i.e., labor FTEs) and the proposed other direct costs (i.e., supplies, equipment, travel) are commensurate with those required to accomplish the goals of the investigation. Salary levels, fringe benefit rates, and overhead rates are not part of that evaluation.
- Cost sharing is not part of the evaluation criteria (see Section III(c) above). However, cost sharing may become a factor at the time of selection when deciding between proposals of otherwise equal scientific and technical merit.

(b) Review and Selection Processes

Review of proposals submitted to this NRA will be consistent with the general policies and provisions given in Sections C.1 through C.4 of Appendix C of the *NASA Guidebook for Proposers*, and selection procedures will be consistent with the provisions of

Section C.5 of that document. For some of the program elements solicited in this NRA, the desire to achieve a balance of efforts across the solicited program objectives may play a role in the selections, taking into account not only the new proposals of merit that are suitable for selection, but also those that seek an extension of activities initiated through previous but now concluded selections, i.e., "successor" proposals; see Section II(b) above.

Unless otherwise specified, the SMD Division Director responsible for a research program element (or his/her delegate) is its Selection Official. Unless otherwise specified, the Associate Administrator for the Science Mission Directorate (or his/her delegate) is the Selection Official for cross-division program elements.

(c) Selection Announcement and Award Dates

SMD's goal is to announce selections within 150 days of the proposal due date and within 56 days after the conclusion of the peer review. Selections are typically announced between 150 days and 220 days after the proposal due date (see http://nasascience.nasa.gov/researchers/sara/grant-stats/progress-in-roses-selection-announcements). Although there are many reasons why selections are not announced earlier, the most common are the uncertainty in the NASA budget at the time selection decisions could be made and the time required to conduct an appropriate peer review and selection process. NASA does not usually announce new selections until the funds needed for those awards are approved through the Federal budget process. Therefore, a delay in the budget process for NASA usually results in a delay of the selection date. After 150 days have passed since the proposal due date, proposers may contact the responsible Program Officer listed at the conclusion of that program element, and on the SARA web page (see Section VII of this NRA).

In order to announce selection decisions as soon as is practical, even in the presence of budget uncertainties, the Selection Official may decide to defer selection decisions on some proposals while making selection decisions on others. If a Selection Official uses this option, then proposals will be selected, not selected, or not selected at this time. Proposals which are not selected at this time will be considered for a supplemental selection when circumstances allow. All proposers whose proposals are not selected at this time will eventually be notified whether their proposal is selected through a supplemental selection or is no longer being considered for a supplemental selection.

Those proposers not selected will be notified by postal or electronic mail and offered a debriefing consistent with the policy in Section C.6 of the *NASA Guidebook for Proposers*.

(d) Processes for Appeals

(i) Reconsideration by SMD

SMD has a process for requesting reconsideration of the declination of a proposal submitted in response to an SMD NASA Research Announcement. Reconsideration may be requested if the PI believes that the proposal was not handled correctly. This process may be found at in the "SMD Reconsideration Policy" document available in the Library section of the SARA website at http://nasascience.nasa.gov/researchers/sara/library-and-useful-links (see Section VIII(d) of this NRA for the URL of the SARA website).

(ii) Ombudsman Program

The NASA Procurement Ombudsman Program is available under this NRA as a procedure for addressing concerns and disagreements. The clause at NASA FAR Supplement (NFS) 1852.215-84 ("Ombudsman") is incorporated into this NRA.

The cognizant ombudsman is

Director, Contract Management Division
Office of Procurement
NASA Headquarters
Washington, DC 20546-0001
Telephone: 202-358-0445

(iii) Protests

Only contract awards are subject to bid protest, either at the Government Accountability Office (GAO) or with the Agency, as defined in FAR 33.101. The provisions at FAR 52.233-2 ("Service of Protest") and NFS 1852.233-70 ("Protests to NASA") are incorporated into this NRA. Under both of these provisions, the designated official for receipt of protests to the Agency and copies of protests filed with the GAO is

Assistant Administrator for Procurement
Office of Procurement
NASA Headquarters
Washington, DC 20546-0001
Telephone: 202-358-2090

(e) Service as a Peer Reviewer

The success of NASA's research program rests on the quality of peer review. NASA will contact expert investigators and ask them to serve as peer reviewers. Since those whose proposals were selected in prior competitions are highly qualified and may not be submitting a proposal to the current competition, they are highly encouraged to serve on SMD peer review panels. Potential reviewers are encouraged to volunteer to be reviewers by sending an email to sara@nasa.gov. It is good experience for young scientists, and the influx of new reviewers is healthy for the process.

VI. Award Administration Information

(a) Notice of Award

Notification of both the selected, as well as the nonselected proposers, will be consistent with the policy given in Section C.5.3 of the *NASA Guidebook for Proposers*. For selected proposers, the offeror's business office will be contacted by a NASA Awards Officer, who is the only official authorized to obligate the Government. Any costs incurred by the offeror in anticipation of an award will be subject to the policies and regulations of the *Grants Handbook* (see Section B, §1260.125(e), "Revision of Budget and Program Plans").

(b) Administrative and National Policy Requirements

This solicitation does not invoke any special administrative or national policy requirements, nor do the awards that will be made involve any special terms and conditions that differ from NASA's general terms and conditions as given in the *Grants Handbook*.

(c) Award Reporting Requirements

The reporting requirements for awards made through this NRA will be consistent with Exhibit G of the *Grants Handbook*. Any additional requirements will be specified in the program element description.

VII. Points of Contact for Further Information

General questions and comments about the policies of this NRA may be directed to:

Dr. Max Bernstein
SMD Lead for Research
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: (202) 358-0879
Email: sara@nasa.gov

Note: Proposals must not be submitted to this address. Proposals must be submitted electronically as described in Section IV above.

Specific questions about a given program element in this NRA should be directed to the Program Officer(s) listed in the *Summary of Key Information* subsection that concludes each program element description. Up-to-date contact information for program officers can also be found online at the SARA web page's Program Officers List at http://nasascience.nasa.gov/researchers/sara/program-officers-list.

Inquiries about accessing or using the NASA proposal data base located at http://nspires.nasaprs.com should be directed by an email that includes a telephone number to nspires-help@nasaprs.com or by calling (202) 479-9376. This help center is staffed Monday through Friday, 8:00 a.m. – 6:00 p.m. Eastern Time.

Inquiries about accessing or using Grants.gov located at http://www.grants.gov should be directed by an email to support@grants.gov or by calling (800) 518-4726. This customer support contact center is staffed Monday through Friday, 7:00 a.m. – 9:00 p.m. Eastern Time.

VIII. Ancillary Information

(a) Announcement of Updates/Amendments to Solicitation

Because this NRA is released far in advance of many of the deadlines given in Tables 2 and 3, additional programmatic information for any of its programs may develop before their proposal due dates. If so, such information will be added as a formal amendment to this NRA as posted at its homepage at http://nspires.nasaprs.com (select "Solicitations" then "Open Solicitations" then "NNH10ZDA001N") no later than 30 days before the proposal due date, or, if this is not possible, the proposal due date will be extended to allow 30 days for proposal submission from the date of the amendment. Although NASA SMD will also send an electronic notification of any such amendments to all subscribers of its electronic notification system (see Section VIII(c) below), it is the responsibility of the prospective proposer to check this NRA's homepage for updates concerning the program(s) of interest.

Any clarifications or questions and answers that are published will be posted on the relevant program element's web page at http://nspires.nasaprs.com (select "Solicitations" then "Open Solicitations" then "NNH10ZDA001N" then "List of Program Elements" then the relevant program element). All such clarifications will be posted no later than 30 days before the proposal due date.

A single list of amendments, clarifications, and corrections to ROSES will be maintained on the SARA web page at http://nasascience.nasa.gov/researchers/sara/grant-solicitations/roses-2010/, where an RSS feed is also available.

(b) Electronic Submission of Proposal Information

On-time electronic submission over the Internet is required for every proposal. While every effort is made to ensure the reliability and accessibility of the electronic proposal submission systems (NSPIRES and Grants.gov) and to maintain help centers via email and telephone, difficulty may arise at any point, including the user's own equipment. Therefore, prospective proposers are urged to familiarize themselves with the submission system(s) and to submit the required proposal materials well in advance of the deadline of the program of interest. Difficulty in registering with or using a proposal submission system is not, in and of itself, a sufficient reason for NASA to consider a proposal that is submitted after the proposal due date (see Section IV(c) above). After submission via NSPIRES, proposers can verify proposal delivery by logging into NSPIRES and selecting "proposals" and "Submitted Proposals/NOIs."

(c) Electronic Notification of SMD Research Solicitations

SMD maintains an electronic notification system to alert interested researchers of its research program announcements. Subscription to this service is free to all registered users of the NASA proposal data base system at http://nspires.nasaprs.com. To add or change a subscription to the electronic notification system, users should login to the data base system and select "Account Management" then "Email Subscriptions." Owing to the increasingly multidisciplinary nature of SMD programs, this email service will notify all subscribers of (i) all NASA SMD research program solicitations regardless of their type or science objectives; (ii) amendments to all SMD solicitations that have been released for which the proposal due dates have not passed; and (iii) special information that SMD wishes to communicate to those interested in proposing to its sponsored research programs. Altogether, a subscriber may receive 50–75 notifications per year. SMD maintains this subscription list in confidence and does not attempt to discern the identity of its subscribers. Regardless of whether or not this service is used, all SMD research announcements may be accessed at http://nspires.nasaprs.com (select "Solicitations" then "Open Solicitations") as soon as they are posted (typically by ~9:00 a.m. Eastern Time on their release date).

Note: Automated spam filtering software may identify SMD's electronic notifications as spam or junk mail. Subscribers are advised to ensure that email received from "NSPIRES-help@nasaprs.com" is not identified by any automated email filtering system as unwanted email.

NRAs issued by SMD are synopsized on Grants.gov (http://www.grants.gov) at the time they are released. This ROSES-2010 NRA will be synopsized upon its release. Amendments to this NRA that create new proposal opportunities will also be synopsized on Grants.gov at the time of their release.

(d) Further Information on SMD Research and Analysis Programs

SMD maintains a website for improving communication with the research community. This site is maintained by the SMD Research Lead, is referred to as the SARA website, and is located at http://sara.nasa.gov. The SARA website contains information related to NASA's Science Research Programs, including the solicitations, selections, an RSS feed for changes to ROSES, and contact information for program officers.

(e) Archives of Past Selections

For more information about the types of research supported by the program elements solicited in previous editions of this NRA and other predecessor NRAs, the titles and abstracts of investigations selected through previous solicitations (issued after January 1, 2005) are available at http://nspires.nasaprs.com (click "Selected Proposals, choose the year from the pop-down menu, and click the find button. "). Selection statistics and links to winning abstracts can also be found at http://nasascience.nasa.gov/researchers/sara/grant-stats.

(f) Meeting Geospatial Standards

NASA pioneered the development of metadata and the accessibility and interoperability of space and Earth science data. When grants result in the development of data that NASA both identifies as geospatial and intends to distribute, then NASA awards will require that documentation (metadata) meet Federal Geographic Data Committee standards. NASA will assure that this documentation is electronically accessible to the Clearinghouse network (http://www.fgdc.gov/dataandservices/) and discoverable through Geospatial One Stop (http://www.GeoData.gov).

IX. CONCLUDING STATEMENT

Through this ROSES NRA, NASA encourages the participation of the space and Earth science communities in its Science Mission Directorate research and technology programs. These programs, while quite diverse in objectives and types, in fact form the foundation of both the basic and applied research that allows NASA's space and Earth science programs to be properly planned and carried through to the successful interpretation of data and its application to the needs of end users. Comments about this NRA are welcome and may be directed to the point of contact for general questions and comments identified in Section VII above.

Michael H. Freilich
Director
Earth Science Division

Richard R. Fisher
Director
Heliophysics Division

James L. Green
Director
Planetary Science Division

Jon A. Morse
Director
Astrophysics Division

Edward J. Weiler
Associate Administrator
for Science Mission Directorate

TABLE 1. NASA STRATEGIC GOALS AND SCIENCE OUTCOMES[3]

Strategic Goal 1: Advance technology and aeronautics research for societal benefit.

Strategic Goal 2: Expand scientific understanding of the Earth and the universe in which we live.

Outcomes:

- Advance scientific understanding of the changing Earth system to meet societal needs.
- Understand the Sun and its interactions with the Earth and the solar system.
- Advance scientific knowledge of the origin and history of the solar system, and the potential for life elsewhere.
- Discover how the universe works, explore how the universe began and evolved into its present form, and search for life elsewhere.
- Perform basic research to understand the hazards and resources available as humans explore space.

Strategic Goal 3: Extend and sustain robotic and human presence across the solar system.

Strategic Goal 4: Enable program and institutional capabilities to conduct NASA's aeronautics and space missions.

Strategic Goal 5: Share the challenges and results of NASA missions to inspire the American public, to encourage scientific literacy, and to foster innovation and a strong national economy.

[3] From *The 2010 NASA Strategic Plan*; see Section I(a) for reference

TABLE 2: SOLICITED RESEARCH PROGRAMS (IN ORDER OF PROPOSAL DUE DATES) [1]

APPENDIX	PROGRAM	NOI/Step 1 DUE DATE [2]	PROPOSAL DUE DATE
C.10	Cassini Data Analysis	3/26/10	4/30/10
A.6	Cryospheric Science	N/A	4/30/10
A.32	Earth System Data Records Uncertainty Analysis	3/15/10	4/30/10
A.22	NPP Science Team for Climate Data Records	4/1/10	5/14/10
C.2	Cosmochemistry [3] [4]	4/2/10	5/14/10
D.2	Astrophysics Data Analysis	3/19/10	5/14/10
A.25	HyspIRI Preparatory Activities Using Existing Imagery	4/2/10	5/20/10
C.21	In Space Propulsion	3/19/10	5/21/10
A.11	Ocean Salinity Field Campaign	3/29/10	5/28/10
A.31	Earth Science Applications Feasibility Studies: Public Health	N/A	5/28/10
C.22	Fellowships for Early Career Researchers (current fellows) (first opportunity)	N/A	5/28/10
E.3	Origins of Solar Systems [4]	3/26/10	5/28/10
A.12	Modeling, Analysis, and Prediction	4/1/10	6/1/10
E.4	Opportunities in Education and Public Outreach for Earth and Space Sciences	4/2/10	6/3/10
A.5	Carbon Cycle Science	4/9/10	6/4/10
C.4	Planetary Geology and Geophysics [3] [4]	4/30/10	6/4/10
D.4	Astrophysics Theory	4/9/10	6/4/10
C.3	Laboratory Analysis of Returned Samples [4]	4/16/10	6/11/10
C.5	Planetary Astronomy [3] [4]	4/16/10	6/11/10
C.9	Near Earth Object Observations [3] [4]	4/16/10	6/11/10
A.16	Terrestrial Hydrology	4/21/10	6/15/10
B.3	Heliophysics Research: Geospace Science	4/16/10	6/18/10
C.6	Planetary Atmospheres [3] [4]	4/23/10	6/18/10
C.19	Astrobiology Science and Technology for Instrument Development [3]	4/23/10	6/25/10
B.2	Heliophysics Theory	4/20/10	6/29/10
A.7	Physical Oceanography	4/30/10	6/30/10
A.26	Earth Science U.S. Participating Investigator	5/3/10	7/1/10

A.38	**CLARREO Science Team**	**N/A**	**7/1/10**
C.13	Mars Fundamental Research [3] [4]	5/7/10	7/9/10
B.8	Heliophysics Data Environment Enhancements	5/14/10	7/16/10
C.20	Astrobiology Science and Technology for Exploring Planets [3]	**4/2/10**	**7/16/10**
A.30	Climate and Biological Response: Research and Applications	6/11/10	7/20/10
A.35	Instrument Incubator	4/21/10	7/21/10
D.5	GALEX Guest Investigator – Cycle 7	N/A	7/30/10
A.15	Atmospheric Composition: Aura Science Team	N/A	8/2/10
C.25	**Venus Climate Orbiter Participating Scientist Program**	**6/11/10**	**8/6/10**
A.3	Ocean Biology and Biogeochemistry	6/11/10	8/13/10
C.16	Planetary Instrument Definition and Development	6/11/10	8/13/10
C.24	Moon and Mars Analog Missions Activities	6/30/10	8/25/10
A.17	NASA Energy and Water Cycle Study	7/1/10	9/1/10
E.5	Supplemental Outreach Awards for ROSES Investigators (first opportunity)	8/4/10	9/1/10
E.6	Supplemental Education Awards for ROSES Investigators (first opportunity)	8/4/10	9/1/10
C.18	Planetary Protection Research	7/2/10	9/3/10
A.24	Enhancing the Capability of Computational Earth System Models and NASA Data	7/15/10	9/17/10
C.12	Mars Data Analysis [3]	7/20/10	9/21/10
A.23	Recompetition of the GRACE Science Team	7/23/10	9/24/10
C.17	Astrobiology: Exobiology and Evolutionary Biology [3] [4]	7/23/10	9/24/10
D.6	Swift Guest Investigator – Cycle 7	N/A	9/29/10
A.14	Atmospheric Composition: Modeling and Analysis	N/A	10/1/10
A.19	Earth Surface and Interior	8/2/10	10/1/10
D.10	MOST U.S. Guest Observer – Cycle 3	8/13/10	10/8/10
B.6	Living with a Star Targeted Research and Technology	8/20/10	10/15/10
B.7	Living with a Star Targeted Research and Technology: Strategic Capability	8/20/10	10/15/10
C.11	Planetary Mission Data Analysis [3]	8/20/10	10/15/10
C.7	Outer Planets Research [3] [4]	8/27/10	10/22/10

A.8	Ocean Salinity Science Team	8/30/10	10/29/10
C.22	Fellowships for Early Career Researchers (current fellows) (second opportunity)	N/A	10/29/10
A.21	Applications of Geodetic Imaging	9/1/10	11/1/10
D.7	Suzaku Guest Observer – Cycle 6	N/A	11/19/10
A.20	Advanced Concepts in Space Geodesy	10/1/10	12/1/10
D.9	Kepler Guest Observer – Cycle 3	N/A	1/21/11
C.8	Lunar Advanced Science and Exploration Research [3] [4]	11/26/10	1/28/11
D.8	Fermi Guest Investigator – Cycle 4	N/A	2/4/11
E.5	Supplemental Outreach Awards for ROSES Investigators (second opportunity)	2/9/11	3/2/11
E.6	Supplemental Education Awards for ROSES Investigators (second opportunity)	2/9/11	3/2/11
B.4	Heliophysics Research: Solar and Heliospheric Science	1/21/11	3/18/11
D.3	Astrophysics Research and Analysis	1/28/11	3/25/11
D.11	Strategic Astrophysics Technology	1/28/11	3/25/11
A.4	Land Cover/Land Use Change	12/1/10	6/1/11
A.13	Atmospheric Composition: Atmospheric Composition, Cloud, and Climate Experiment	TBD	TBD
A.27	Commercial Reusable Suborbital Research Platforms for Earth Science	See Program of Interest	
A.29	Applied Sciences Program: Decision Support	See Program of Interest	
C.22	Fellowships for Early Career Researchers (new applicants) [3]	See Program of Interest [3]	
C.23	Planetary Major Equipment [4]	See Program of Interest [4]	
A.2	Terrestrial Ecology	Not solicited this year	
A.9	Ocean Vector Winds Science Team	Not solicited this year	
A.10	Ocean Surface Topography Science Team	Not solicited this year	
A.18	Precipitation Measurement Missions Science	Not solicited this year	
A.28	New Investigator Program in Earth Science	Not solicited this year	
A.33	Making Earth System Data Records for Use in Research Environments	Not solicited this year	
A.34	Advancing Collaborative Connections for Earth System Science	Not solicited this year	

A.36	Advanced Component Technology	Not solicited this year
A.37	Advanced Information Systems Technology	Not solicited this year
B.5	Heliophysics Guest Investigators	Not solicited this year
C.14	Mars Instrument Development Project	Solicitation pending decision
C.15	Mars Technology Project	Solicitation pending decision
E.2	Applied Information Systems Research	Solicitation pending decision
A.1	Earth Science Overview	N/A
B.1	Heliophysics Overview	N/A
C.1	Planetary Science Overview	N/A
D.1	Astrophysics Overview	N/A
E.1	Cross-Division Overview	N/A

Notes:
[1] Amended due dates and new program elements will be indicated with bold red text as ROSES-2010 is amended through the 2010 calendar year.
[2] See Sections IV(b)(vi) and IV(b)(vii) for a discussion of Notice of Intent (NOI) vs. a Step-1 proposal.
[3] The proposals for program element Fellowships for Early Career Researchers (C.22) may be submitted only in conjunction with program elements Cosmochemistry (Appendix C.2); Planetary Geology and Geophysics (Appendix C.4); Planetary Astronomy (Appendix C.5); Planetary Atmospheres (Appendix C.6); Outer Planets Research (Appendix C.7); Lunar Advanced Science and Exploration Research (Appendix C.8), Near Earth Object Observations (Appendix C.9); Planetary Mission Data Analysis (Appendix C.11), Mars Data Analysis (Appendix C.12), Mars Fundamental Research (Appendix C.13); Astrobiology: Exobiology and Evolutionary Biology (Appendix C.17); Astrobiology Science and Technology for Instrument Development (Appendix C.19); and Astrobiology Science and Technology for Exploring Planets (Appendix C.20).
[4] The proposals for program element Planetary Major Equipment (C.23) may be submitted only in conjunction with program elements Cosmochemistry (Appendix C.2); Laboratory Analysis of Returned Samples (Appendix C.3); Planetary Geology and Geophysics (Appendix C.4); Planetary Astronomy (Appendix C.5); Planetary Atmospheres (Appendix C.6); Outer Planets Research (Appendix C.7); Lunar Advanced Science and Exploration Research (Appendix C.8), Near Earth Object Observations (Appendix C.9), Mars Fundamental Research (Appendix C.13); Astrobiology: Exobiology and Evolutionary Biology (Appendix C.17); and Origins of Solar Systems (Appendix E.3).

TABLE 3: SOLICITED RESEARCH PROGRAMS (IN ORDER OF APPENDICES A–E) [1]

APPENDIX	PROGRAM	NOI/Step 1 DUE DATE [2]	PROPOSAL DUE DATE
A.1	Earth Science Overview	N/A	
A.2	Terrestrial Ecology	Not solicited this year	
A.3	Ocean Biology and Biogeochemistry	6/11/10	8/13/10
A.4	Land Cover/Land Use Change	12/1/10	6/1/11
A.5	Carbon Cycle Science	4/9/10	6/4/10
A.6	Cryospheric Science	N/A	4/30/10
A.7	Physical Oceanography	4/30/10	6/30/10
A.8	Ocean Salinity Science Team	8/30/10	10/29/10
A.9	Ocean Vector Winds Science Team	Not solicited this year	
A.10	Ocean Surface Topography Science Team	Not solicited this year	
A.11	Ocean Salinity Field Campaign	3/29/10	5/28/10
A.12	Modeling, Analysis, and Prediction	4/1/10	6/1/10
A.13	Atmospheric Composition: Atmospheric Composition, Cloud, and Climate Experiment	TBD	TBD
A.14	Atmospheric Composition: Modeling and Analysis	N/A	10/1/10
A.15	Atmospheric Composition: Aura Science Team	N/A	8/2/10
A.16	Terrestrial Hydrology	4/21/10	6/15/10
A.17	NASA Energy and Water Cycle Study	7/1/10	9/1/10
A.18	Precipitation Measurement Missions Science	Not solicited this year	
A.19	Earth Surface and Interior	8/2/10	10/1/10
A.20	Advanced Concepts in Space Geodesy	10/1/10	12/1/10
A.21	Applications of Geodetic Imaging	9/1/10	11/1/10
A.22	NPP Science Team for Climate Data Records	4/1/10	5/14/10
A.23	Recompetition of the GRACE Science Team	7/23/10	9/24/10
A.24	Enhancing the Capability of Computational Earth System Models and NASA Data	7/15/10	9/17/10
A.25	HyspIRI Preparatory Activities Using Existing Imagery	4/2/10	5/20/10
A.26	Earth Science U.S. Participating Investigator	5/3/10	7/1/10
A.27	Commercial Reusable Suborbital Research Platforms for Earth Science	See Program of Interest	
A.28	New Investigator Program in Earth Science	Not solicited this year	
A.29	Applied Sciences Program: Decision Support	See Program of Interest	

A.30	Climate and Biological Response: Research and Applications	6/11/10	7/20/10
A.31	Earth Science Applications Feasibility Studies: Public Health	N/A	5/28/10
A.32	Earth System Data Records Uncertainty Analysis	3/15/10	4/30/10
A.33	Making Earth System Data Records for Use in Research Environments	Not solicited this year	
A.34	Advancing Collaborative Connections for Earth System Science	Not solicited this year	
A.35	Instrument Incubator	4/21/10	7/21/10
A.36	Advanced Component Technology	Not solicited this year	
A.37	Advanced Information Systems Technology	Not solicited this year	
A.38	**CLARREO Science Team**	**N/A**	**7/1/10**
B.1	Heliophysics Overview	N/A	
B.2	Heliophysics Theory	4/20/10	6/29/10
B.3	Heliophysics Research: Geospace Science	4/16/10	6/18/10
B.4	Heliophysics Research: Solar and Heliospheric Science	1/21/11	3/18/11
B.5	Heliophysics Guest Investigators	Not solicited this year	
B.6	Living with a Star Targeted Research and Technology	8/20/10	10/15/10
B.7	Living with a Star Targeted Research and Technology: Strategic Capability	8/20/10	10/15/10
B.8	Heliophysics Data Environment Enhancements	5/14/10	7/16/10
C.1	Planetary Science Overview	N/A	
C.2	Cosmochemistry [3] [4]	4/2/10	5/14/10
C.3	Laboratory Analysis of Returned Samples [4]	4/16/10	6/11/10
C.4	Planetary Geology and Geophysics [3] [4]	4/30/10	6/4/10
C.5	Planetary Astronomy [3] [4]	4/16/10	6/11/10
C.6	Planetary Atmospheres [3] [4]	4/23/10	6/18/10
C.7	Outer Planets Research [3] [4]	8/27/10	10/22/10
C.8	Lunar Advanced Science and Exploration Research [3] [4]	11/26/10	1/28/11
C.9	Near Earth Object Observations [3] [4]	4/16/10	6/11/10
C.10	Cassini Data Analysis	3/26/10	4/30/10
C.11	Planetary Mission Data Analysis [3]	8/20/10	10/15/10
C.12	Mars Data Analysis [3]	7/20/10	9/21/10
C.13	Mars Fundamental Research [3] [4]	5/7/10	7/9/10

C.14	Mars Instrument Development Project	Solicitation pending decision	
C.15	Mars Technology Project	Solicitation pending decision	
C.16	Planetary Instrument Definition and Development	6/11/10	8/13/10
C.17	Astrobiology: Exobiology and Evolutionary Biology [3] [4]	7/23/10	9/24/10
C.18	Planetary Protection Research	7/2/10	9/3/10
C.19	Astrobiology Science and Technology for Instrument Development [3]	4/23/10	6/25/10
C.20	Astrobiology Science and Technology for Exploring Planets [3]	**4/2/10**	**7/16/10**
C.21	In Space Propulsion	3/19/10	5/21/10
C.22	Fellowships for Early Career Researchers (new applicants) [3]	See Program of Interest [3]	
	Fellowships for Early Career Researchers (current fellows)	N/A	5/28/10 or 10/29/10
C.23	Planetary Major Equipment [4]	See Program of Interest	
C.24	Moon and Mars Analog Missions Activities	6/30/10	8/25/10
C.25	**Venus Climate Orbiter Participating Scientist Program**	**6/11/10**	**8/6/10**
D.1	Astrophysics Overview	N/A	
D.2	Astrophysics Data Analysis	3/19/10	5/14/10
D.3	Astrophysics Research and Analysis	1/28/11	3/25/11
D.4	Astrophysics Theory	4/9/10	6/4/10
D.5	GALEX Guest Investigator – Cycle 7	N/A	7/30/10
D.6	Swift Guest Investigator – Cycle 7	N/A	9/29/10
D.7	Suzaku Guest Observer – Cycle 6	N/A	11/19/10
D.8	Fermi Guest Investigator – Cycle 4	N/A	2/4/11
D.9	Kepler Guest Observer – Cycle 3	N/A	1/21/11
D.10	MOST U.S. Guest Observer – Cycle 3	8/13/10	10/8/10
D.11	Strategic Astrophysics Technology	1/28/11	3/25/11
E.1	Cross-Division Overview	N/A	
E.2	Applied Information Systems Research	Solicitation pending decision	
E.3	Origins of Solar Systems [4]	3/26/10	5/28/10
E.4	Opportunities in Education and Public Outreach for Earth and Space Sciences	4/2/10	6/3/10
E.5	Supplemental Outreach Awards for ROSES Investigators (first opportunity)	8/4/10	9/1/10

	Supplemental Outreach Awards for ROSES Investigators (second opportunity)	2/9/11	3/2/11
E.6	Supplemental Education Awards for ROSES Investigators (first opportunity)	8/4/10	9/1/10
	Supplemental Education Awards for ROSES Investigators (second opportunity)	2/9/11	3/2/11

Notes:
[1] Amended due dates and new program elements will be indicated with bold red text as ROSES-2010 is amended through the 2010 calendar year.
[2] See Sections IV(b)(vi) and IV(b)(vii) for a discussion of Notice of Intent (NOI) vs. a Step-1 proposal.
[3] The proposals for program element Fellowships for Early Career Researchers (C.22) may be submitted only in conjunction with program elements Cosmochemistry (Appendix C.2); Planetary Geology and Geophysics (Appendix C.4); Planetary Astronomy (Appendix C.5); Planetary Atmospheres (Appendix C.6); Outer Planets Research (Appendix C.7); Lunar Advanced Science and Exploration Research (Appendix C.8), Near Earth Object Observations (Appendix C.9); Planetary Mission Data Analysis (Appendix C.11), Mars Data Analysis (Appendix C.12), Mars Fundamental Research (Appendix C.13); Astrobiology: Exobiology and Evolutionary Biology (Appendix C.17); Astrobiology Science and Technology for Instrument Development (Appendix C.19); and Astrobiology Science and Technology for Exploring Planets (Appendix C.20).
.
[4] The proposals for program element Planetary Major Equipment (C.23) may be submitted only in conjunction with program elements Cosmochemistry (Appendix C.2); Laboratory Analysis of Returned Samples (Appendix C.3); Planetary Geology and Geophysics (Appendix C.4); Planetary Astronomy (Appendix C.5); Planetary Atmospheres (Appendix C.6); Outer Planets Research (Appendix C.7); Lunar Advanced Science and Exploration Research (Appendix C.8), Near Earth Object Observations (Appendix C.9), Mars Fundamental Research (Appendix C.13); Astrobiology: Exobiology and Evolutionary Biology (Appendix C.17); and Origins of Solar Systems (Appendix E.3).

APPENDIX A. EARTH SCIENCE RESEARCH PROGRAM

A.1 OVERVIEW

1. Introduction

NASA's Earth Science Research Program supports research activities that address the Earth system to characterize its properties on a broad range of spatial and temporal scales, to understand the naturally occurring and human-induced processes that drive them, and to improve our capability for predicting its future evolution. The focus of the Earth Science Research Program is the use of space-based measurements to provide information not available by other means. NASA's program is an end-to-end one that starts with the development of observational techniques and the instrument technology needed to implement them; tests them in the laboratory and from an appropriate set of surface-, balloon-, aircraft-, and/or space-based platforms; uses the results to increase basic process knowledge; incorporates results into complex computational models that can be used to more fully characterize the present state and future evolution of the Earth system; and develops partnerships with other national and international organizations that can use the generated information in environmental forecasting and in policy, business, and management decisions. The Earth Science Research Program is designed to leverage NASA's unique capabilities in the context of related research carried out by other Federal agencies, especially that conducted as part of organized interagency activities (including those coordinated through the Committee on Environment and Natural Resources under the National Science and Technology Council), such as the U.S. Global Change Research Program, the U.S. Group on Earth Observations, the Ocean Action Plan, the EarthScope Program, and NASA-National Oceanic and Atmospheric Administration (NOAA) efforts to support the transition between research and operations.

The scientific documentation underlying the Earth Science Research Program provides a comprehensive background for the science addressing its objectives. The science carried out addresses NASA's Strategic Goal 4A to study planet Earth from space to advance scientific understanding and meet societal needs (see the *2009 NASA Strategic Plan*)**.** In particular, it addresses the more specific Science Outcomes (see the *NASA Science Plan*), which are to achieve:

- Progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition;
- Progress in enabling improved predictive capability for weather and extreme weather events;
- Progress in quantifying global land cover change and terrestrial and marine productivity and in improving carbon cycle and ecosystem models;
- Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability;
- Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution;

- Progress in characterizing and understanding Earth surface changes and variability of the Earth's gravitational and magnetic fields; and
- Progress in expanding and accelerating the realization of societal benefits from Earth system science.

The most recent comprehensive description of the research goals of NASA's Earth Science Research Program was in the *2003 Earth Science Enterprise Strategy* at http://nasascience.nasa.gov/about-us/science-strategy. The most up-to-date description of the Earth Science Research Program may be found in Chapter 4 of the *NASA Science Plan* at http://nasascience.nasa.gov/about-us/science-strategy. A decadal survey for the satellite component of NASA's Earth science activities has been carried out by the National Academy of Sciences (NAS); the report *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* is available at http://www.nap.edu/catalog.php?record_id=11820. A study by the NAS documenting the advances in the study of Earth from space, which draws significantly on NASA-produced results, was also released recently and is available at http://dels.nas.edu/dels/viewreport.cgi?id=4675.

Research is solicited in four major areas for the Earth Science Research Program: research and analysis, decadal survey missions, applied sciences, and enabling capabilities, with the bulk of the solicited research coming in the first of these. Research and analysis (R&A) emphasizes the development of new scientific knowledge, including the analysis of data from NASA satellite missions and the development and application of complex models that assimilate these science data products and/or use them for improving predictive capabilities. Within the Earth Science Research Program, the research and analysis activities include those historically coming under R&A, mission science team, interdisciplinary science, and calibration/validation activities. The applied sciences area develops and demonstrates innovative and practicable applications of NASA Earth science observations and research through demonstration projects carried out in partnership with end user organizations. Applied sciences thus serves as a bridge between the knowledge generated by R&A (and research satellite measurements) and the information required by mission agencies, companies, and organizations to improve their products, services, and decision making. A separate appendix describing the Applied Sciences Program is included as Appendix A.29.

Enabling capabilities include those programmatic elements with sufficient breadth to contribute to a broad range of activities within the Earth Science Research Program and typically involve the development of some kind of capability whose sustained availability is considered to be important for the Program's future. These include focused activities in support of education; data, information, and management; and airborne science, as well as some broadly based technology-related elements (others which are very focused towards a single scientific area of the Earth Science Research Program will be solicited through the research and analysis area).

2. Earth Science Research and Analysis Focus Areas

The Earth Science R&A activity is built around the creation of new scientific knowledge about the Earth system. The analysis and interpretation of data from NASA's satellites form the heart of the R&A program in the Earth Science Research Program, although a full range of underlying scientific activity needed to establish a rigorous base for the satellite data and their use in computational models, including those for assimilation and forecasting, is also included. The complexity of the Earth system, in which spatial and temporal variability exists on a range of scales, requires that an organized scientific approach be developed for addressing the complex, interdisciplinary problems that exist, taking good care that in doing so there is a recognition of the objective to integrate science across the programmatic elements towards a comprehensive understanding of the Earth system.

In the Earth system, these elements may be built around aspects of the Earth that emphasize the particular attributes that make it stand out among known planetary bodies. These include the presence of carbon-based life; water in multiple, interacting phases; a fluid atmosphere and ocean that redistribute heat over the planetary surface; an oxidizing and protective atmosphere, albeit one subject to a wide range of fluctuations in its physical properties (especially temperature, moisture, and winds); a solid but dynamically active surface that makes up a significant fraction of the planet's surface; and an external environment driven by a large and varying star whose magnetic field also serves to shield the Earth from the broader astronomical environment. The resulting structure is comprised of six interdisciplinary science Focus Areas:

- Carbon Cycle and Ecosystems,
- Water and Energy Cycle,
- Climate Variability and Change,
- Atmospheric Composition,
- Weather, and
- Earth Surface and Interior.

These Focus Areas form the basis around which R&A activity is solicited for the Earth Science Research Program. Given the interconnectedness of these science Focus Areas, research that crosses individual Focus Areas is sought after, and a number of specific cases of such connectivity will be identified in the specific research opportunities identified below. In particular, several instrument science teams for NASA satellite missions are solicited through ROSES. Science team investigations can contribute to scientific advances in several science Focus Areas, and potential investigators may want to look carefully at all such teams for opportunities that may be relevant to them. In addition, there are several cross-cutting elements included within this appendix. They involve two mission science teams as described in the previous sentence (NPOESS Preparatory Project and Gravity Recovery and Climate Experiment – Appendices A.22 and A.23, respectively), one that addresses the development of approaches for enhancing use of NASA data through incorporation of advances in computational science and by accelerating its operational use (Appendix A.24), one that solicits use of existing imagery as preparatory research towards the Hyperspectral Infrared Imager (HysPIRI) mission identified in the Decadal Survey (Appendix A.25), one that allows for the participation of U.S. scientists in satellite missions carried out by NASA's international partners (Appendix A.26), one that supports the use of commercially-implemented reusable suborbital research platforms to address NASA's Earth System Science goals (Appendix A.27), and one that addresses the connection of drivers and impacts of global change as documented in NASA-produced data sets (Appendix A.30).

2.1 Carbon Cycle and Ecosystems

The carbon cycle is the basis for the food, fiber, and energy that sustain life on planet Earth. The cycling of carbon dioxide and methane into the atmosphere contributes to the planetary greenhouse effect and global climate. Ecosystems provide a wide variety of essential goods and services to humans and also affect the climate system by exchanging energy, momentum, trace gases, and aerosols with the atmosphere. Earth's carbon cycle and ecosystems are being subjected to human intervention and environmental changes on an unprecedented scale, in both rate and geographical extent. Our ability to ameliorate, adapt to, or benefit from these rapid changes requires fundamental knowledge of the responses of the carbon cycle and terrestrial and marine ecosystems to global change. Also required is an understanding of the implications of these changes for food production, biodiversity, sustainable resource management, and the maintenance of a healthy, productive environment.

The Carbon Cycle and Ecosystems Focus Area addresses: (i) the distribution and cycling of carbon among the active terrestrial, oceanic, and atmospheric reservoirs and (ii) ecosystems as they are affected by human activity, as they change due to their own intrinsic biogeochemical dynamics, and as they respond to climatic variations and, in turn, affect climate. Research activities focus on providing data and information derived from remote sensing systems to answer the following science questions:

- How are global ecosystems changing?
- What changes are occurring in global land cover and land use, and what are their causes?
- How do ecosystems, land cover, and biogeochemical cycles respond to and affect global environmental change?
- What are the consequences of land cover and land use change for human societies and the sustainability of ecosystems?
- What are the consequences of climate change and increased human activities for coastal regions?
- How will carbon cycle dynamics and terrestrial and marine ecosystems change in the future?

Frequent, repeat observations from space, at both moderate and high spatial resolutions, are required to address the heterogeneity of living systems. Complementary airborne and *in situ* observations, intensive field campaigns and related process studies, fundamental research, data and information systems, and modeling are employed to interpret the satellite observations and answer the science questions.

The goals of the Carbon Cycle and Ecosystems Focus Area are to:

- Document and understand how the global carbon cycle, terrestrial and marine ecosystems, and land cover and use are changing;
- Quantify global productivity, biomass, carbon fluxes, and changes in land cover; and

- Provide useful projections of future changes in global carbon cycling, land cover and use, and terrestrial and marine ecosystems for use in ecological forecasting and in improving climate change predictions.

Anticipated products and payoffs include:

- Assessments of ecosystem response to climatic and other environmental changes and the effects on food, fiber, biodiversity, primary productivity, and other ecological goods and services;
- Quantitative carbon budgets for key ecosystems along with the identification of sources and sinks of carbon dioxide and other greenhouse gases;
- Documentation and prediction of land cover and land use change, as well as assessments of consequences to society and for resource sustainability;
- Understanding of ecosystem interactions with the atmosphere and hydrosphere leading to comprehensive modeling of the exchange of gases, aerosols, water, and energy among the components of the Earth system; and
- Improved representations of ecosystem and carbon cycling processes within global climate models leading to more credible predictions of climate and other Earth system functions.

Interdisciplinary collaborations with other Earth Science Research Program Focus Areas include:

- Work with the Water and Energy Cycle Focus Area on land-atmosphere exchanges of water and energy and the effects of land cover and land use change on water resources;
- Work with the Atmospheric Composition Focus Area on surface emissions and atmospheric transport of trace gases and aerosols and on measurement of carbon-containing greenhouse gases;
- Work with the Climate Variability and Change and Weather Focus Areas on air-sea CO_2 exchange and to share the observations of climate, weather, ecosystems, and land cover that are needed to drive Earth system models; and
- Coordinate with the Earth Surface and Interior Focus Area to advance and/or exploit radar, lidar, and hyperspectral remote sensing technologies for surface properties.

The ROSES elements most closely directed towards the Carbon Cycle and Ecosystems Focus Area are (* indicates program elements soliciting proposals in ROSES-2010):

- Terrestrial Ecology (Appendix A.2);
- Ocean Biology and Biogeochemistry * (Appendix A.3);
- Land Cover / Land Use Change * (Appendix A.4);
- Carbon Cycle Science * (Appendix A.5); and
- Climate and Biological Response: Research and Applications * (Appendix A.30).

Topics relevant to the Carbon Cycle and Ecosystems Focus Area are included in the following program elements (* indicates program elements soliciting proposals in ROSES-2010):

- NPP Science Team for Climate Data Records * (Appendix A.22);
- Computing and Operational Use of NASA Data * (Appendix A.24);
- HyspIRI Preparatory Activities Using Existing Imagery * (Appendix A.25); and
- Earth Science U.S. Participating Investigator * (Appendix A.26).

2.2 Climate Variability and Change

Climate change is one of the major themes guiding Earth System Science today. NASA is at the forefront of quantifying forcings and feedbacks of recent and future climate change. Our comprehensive end-to-end program ranges from global high-resolution observations to data assimilation and model predictions. Recently, the Climate Variability and Change Focus Area has directed its research toward addressing five specific questions:

- How is global ocean circulation varying on interannual, decadal, and longer time scales?
- What changes are occurring in the mass of the Earth's ice cover?
- How can climate variations induce changes in the global ocean circulation?
- How is global sea level affected by natural variability and human-induced change in the Earth system?
- How can predictions of climate variability and change be improved?

Climate-variability and change research is now not just a global issue, but also a research problem that directly impacts regional to local environments. In fact, local-to-regional anthropogenic-induced changes are having global impacts whose magnitudes are expected to increase in the future. Climate models have moved toward higher and higher spatial resolution as computer resources have improved. During the next decade, climate models are expected to approach the spatial resolution of weather and regional models as more details of Earth System processes are incorporated.

The oceans are a major part of the climate system, and a unique NASA contribution to climate science is the near-global coverage of observations from space of selected ocean properties every two to ten days. Additionally, NASA provides observations of the vast expanses of polar ice, including both ice sheets and sea ice, on the temporal and spatial scales necessary to detect change and sampling of the other critical elements of the climate system that link climate to other Focus Areas, such as cloud distribution, snow cover, surface temperatures, humidity characteristics, etc.

NASA makes substantial investments to characterize and understand the nature and variability of the climate system. As part of those investments, NASA maintains an active research program to utilize data from satellites to both improve our understanding of these components of the Earth system and the interactions between them and to assess how satellite observations can be used to improve predictive capability. Current capabilities include global measurements of sea-surface topography, ocean-vector winds, ice topography and motion, and mass movements of the Earth's fluid envelope and cryosphere.

Understanding interactions within the climate system also requires strong modeling and analysis efforts. The climate system is dynamic and complex, and modeling is the only way we can effectively integrate the observations and current knowledge of individual components fully to characterize current conditions and underlying mechanisms, as well as to project the future states of the climate system. This modeling requires a concerted effort both to improve the representation of physical, chemical, and biological processes and to incorporate observations into climate models through data assimilation and other techniques. The ultimate objective is to enable a predictive capability of climate change on time scales ranging from seasonal to multidecadal.

The ROSES elements most closely directed towards the Climate Variability and Change Focus Area are (* indicates program elements soliciting proposals in ROSES-2010):

- Cryospheric Science *(Appendix A.6);
- Physical Oceanography * (Appendix A.7);
- Ocean Salinity Science Team * (Appendix A.8);
- Ocean Vector Winds Science Team (Appendix A.9);
- Ocean Surface Topography Science Team (Appendix A.10);
- Ocean Salinity Field Campaign * (Appendix A.11); and
- Modeling, Analysis, and Prediction * (Appendix A.12).

Topics relevant to the Climate Variability and Change Focus Area are included in the following program elements (* indicates program elements soliciting proposals in ROSES-2010):

- Carbon Cycle Science * (Appendix A.5);
- Atmospheric Composition: Modeling and Analysis * (Appendix A.14);
- NPP Science Team for Climate Data Records * (Appendix A.22);
- Recompetition of the GRACE Science Team* (Appendix A.23);
- Computing and Operational Use of NASA Data* (Appendix A.24);
- Earth Science U.S. Participating Investigator * (Appendix A.26); and
- Climate and Biological Response: Research and Applications* (Appendix A.30).

2.3 Atmospheric Composition

Atmospheric composition changes affect air quality, weather, climate, and critical constituents such as ozone. Atmospheric exchange links terrestrial and oceanic pools within the carbon cycle and other biogeochemical cycles. Solar radiation affects atmospheric chemistry and is thus a critical factor in atmospheric composition. Atmospheric composition is central to Earth system dynamics, since the atmosphere integrates surface emissions globally on time scales from weeks to years and couples several environmental issues. NASA’s research for furthering our understanding of atmospheric composition is geared to providing an improved prognostic capability for such issues (e.g., the recovery of stratospheric ozone and its impacts on surface ultraviolet radiation, the evolution of greenhouse gases and their impacts on climate, and the evolution of tropospheric ozone and aerosols and their impacts on climate and air quality). Toward this end, research within the Atmospheric Composition Focus Area addresses the following science questions:

- How is atmospheric composition changing?
- What trends in atmospheric composition and solar radiation are driving global climate?
- How does atmospheric composition respond to and affect global environmental change?
- What are the effects of global atmospheric composition and climate changes on regional air quality?
- How will future changes in atmospheric composition affect ozone, climate, and global air quality?

NASA expects to provide the necessary monitoring and evaluation tools to assess the effects of climate change on ozone recovery and future atmospheric composition, improved climate forecasts based on our understanding of the forcings of global environmental change, and air quality forecasts that take into account the feedbacks between regional air quality and global climate change. Achievements in these areas via advances in observations, data assimilation, and modeling enable improved predictive capabilities for describing how future changes in atmospheric composition affect ozone, climate, and air quality. Drawing on global observations from space, augmented by suborbital and ground-based measurements, NASA is uniquely poised to address these issues. This integrated observational strategy is furthered via studies of atmospheric processes using unique suborbital platform-sensor combinations to investigate, for example: (1) the processes responsible for the emission, uptake, transport, and chemical transformation of ozone and precursor molecules associated with its production in the troposphere and its destruction in the stratosphere and (2) the formation, properties, and transport of aerosols in the Earth's troposphere and stratosphere, as well as aerosol interaction with clouds. NASA's research strategy for atmospheric composition encompasses an end-to-end approach for instrument design, data collection, analysis, interpretation, and prognostic studies.

The ROSES elements most closely directed towards the Atmospheric Composition Focus Area are (* indicates program elements soliciting proposals in ROSES-2010):

- Atmospheric Composition: Atmospheric Composition, Cloud, and Climate Experiment * (Appendix A.13);
- Atmospheric Composition: Modeling and Analysis * (Appendix A.14); and
- Atmospheric Composition: Aura Science Team * (Appendix A.15).

Topics relevant to the Atmospheric Composition Focus Area are also included in the following program elements (* indicates program elements soliciting proposals in ROSES-2010):

- Carbon Cycle Science * (Appendix A.5);
- NPP Science Team for Climate Data Records * (Appendix A.22);
- Computing and Operational Use of NASA Data * (Appendix A.24); and
- Earth Science U.S. Participating Investigator * (Appendix A.26).

2.4 Water and Energy Cycle

Earth is a unique, living planet in our Solar System due to the abundance of water and the vigorous cycling and replenishing of that water throughout its global environment. The global water cycle represents the transport and transformation of water within the Earth system, and, as such, distributes fresh water over the Earth's surface. The water cycle operates on a continuum of time and space scales and exchanges large amounts of energy as water undergoes phase changes and is moved from one part of the Earth system to another. Through latent heat release from condensation and sublimation, the water cycle is a major driving agent of global atmospheric circulation. Clouds play a critical role in modulating the flow of energy into and out of the Earth system, while at the same time modulating the continuous supply of solar energy that keeps the water cycle in motion. So while the water cycle delivers the hydrologic consequences of climate changes, the global water cycle is both a consequence of, and influence on, the global energy cycle. The global water and energy cycles are intimately entwined.

The global water and energy cycles maintain a considerable influence upon the global pathways of biogeochemical cycles. The cycling of water and energy and nutrient exchanges among the atmosphere, ocean, and land help determine the Earth's climate and cause much of the climate's natural variability. Natural and human-induced changes to the water and energy cycle have major impacts on industry, agriculture, and other human activities. Increased exposure and density of human settlements in flood plains and coastal regions amplify the potential loss of life, property, and commodities that are at risk from intense precipitation events. Improved monitoring and prediction of the global water and energy cycle enable improved knowledge of the Earth system that must be nurtured to proactively mitigate future adversities. Current and forthcoming projections of such impacts will remain speculative unless fundamental understanding is assimilated into effective global prediction systems and effective decision-support tools applicable to local conditions. Predicting the consequences of global change — whether natural or human induced — and developing useful science-based applications of climate, weather, and hydrologic prediction systems are paramount challenges of NASA's Earth Science Research Program and specifically for its Water and Energy Cycle Focus Area.

Additional information on the Water and Energy Cycle Focus Area can be found at http://watercycle.gsfc.nasa.gov/. Within this Focus Area are the following R&A programs: Precipitation and Atmospheric Dynamics and Terrestrial Hydrology. Also, the Radiation Sciences and Land Cover Land Use Change programs are shared with, respectively, the Atmospheric Composition and Carbon Cycle and Ecosystems Focus Areas. In brief, the Water and Energy Cycle Focus Area seeks to address the topics discussed above by enhancing our understanding of the transfer and storage of water and energy in the Earth system. For the water cycle, the emphasis is on atmospheric and terrestrial stores, including seasonal snow cover. Permanent snow and ice, as well as ocean dynamics, are studied within the Climate Variability and Change Focus Area. The Water and Energy Cycle Focus Area aims to resolve all fluxes of water and the corresponding energy fluxes involved with the water changing phase. High priority is placed on understanding, observing, and modeling clouds and their interaction with energy fluxes, though this is done along with activities of three other Focus Areas (Atmospheric Composition, Climate, and Weather).

In addition to the study of the individual components of the water and energy cycle, this Focus Area places a high priority on integrating these components in a coherent fashion as is pursued by the NASA Energy and Water Cycle Study (NEWS), for which more information can be found at http://gwec.gsfc.nasa.gov/. NEWS has been established to create a mechanism to export and import information, results, and technology to and from other U.S. agencies and international partners concerned with the study and observation of water and energy cycle.

All of the Focus Area's activities should enhance the community's ability to answer these research questions:

- How are global precipitation, evaporation, and the cycling of water changing?
- What are the effects of clouds and surface hydrologic processes on Earth's climate?
- How are variations in local weather, precipitation, and water resources related to global climate variation?
- What are the consequences of land cover and land use change for human societies and the sustainability of ecosystems?
- How can weather forecast duration and reliability be improved?
- How can predication of climate variability and change be improved?
- How will water cycle dynamics change in the future?

Pursuit of answers to these questions should lead to research products, such as satellite data and model outputs, that are useful to activities sponsored by the Applied Sciences Program, in particular, the Applications areas of Water Resources, Disaster Management, and Agriculture. Ultimately, Water and Energy Cycle Focus Area-sponsored activities will lead to the fulfillment of its goal: "Models capable of predicting the water cycle, including floods and droughts, down to tens of kilometers resolution."

The ROSES elements most closely directed towards the Water and Energy Cycle Focus Area are (* indicates program elements soliciting proposals in ROSES-2010):

- Terrestrial Hydrology * (Appendix A.16); and
- NASA Energy and Water Cycle Study * (Appendix A.17).

Topics relevant to the Water and Energy Cycle Focus Area are included in the following program elements (* indicates program elements soliciting proposals in ROSES-2010):

- NPP Science Team for Climate Data Records * (Appendix A.22);
- Recompetition of the GRACE Science Team* (Appendix A.23);
- Computing and Operational Use of NASA Data * (Appendix A.24);
- HyspIRI Preparatory Activities Using Existing Imagery * (Appendix A.25);
- Earth Science U.S. Participating Investigator * (Appendix A.26);
- Climate and Biological Response: Research and Applications * (Appendix A.30); and
- Earth Science Applications Feasibility Studies: Public Health * (Appendix A.31).

2.5 Weather

The Weather Focus Area represents the cooperation among NASA programs for Atmospheric Dynamics, Weather Forecast Improvement, and Ocean and Land Remote Sensing. It has strong ties to other Focus Areas, especially Climate Variability and Change and Water and Energy

Cycle, and it has a supporting role in Carbon Cycle and Ecosystems and the Atmospheric Composition Focus Areas.

The Weather Focus Area is primarily designed to apply NASA scientific remote sensing expertise to the problem of obtaining accurate and globally distributed measurements of the atmosphere and the assimilation of these measurements into research and operational weather forecast models in order to improve and extend U.S. and global weather prediction. This Focus Area is implemented in close coordination with other U.S. agencies' programs under the U.S. Weather Research Program (USWRP), and it is guided by the question from the 2003 Earth Science Enterprise Strategy:

- How can weather forecast duration and reliability be improved?

A large effort in this Focus Area is concerned with the detection and quantification of rainfall rate, generally measured using microwave radiation. The first weather radar in space, on board the Tropical Rainfall Measuring Mission (TRMM) satellite, has enabled the global mapping of rainfall in the tropics and has contributed to the increased physical understanding of storm cloud characteristics accompanying various forms and levels of rainfall rates. Future planning involves the extension of the TRMM concept to a global constellation of active and passive sensors in the form of a Global Precipitation Measurement (GPM) mission.

Another key component of the current Weather Focus Area is a set of core efforts to assimilate new NASA satellite data into numerical forecast models and to assess the amount of forecast improvement. Two groups are currently working on this problem: the Joint Center for Satellite Data Assimilation (JCSDA), involving the NASA Goddard Space Flight Center (GSFC) and the National Center for Environmental Prediction (NCEP) at NOAA, and now including other agency participation; and NASA's Short-term Prediction Research and Transition Center (SPoRT). As NASA continues to implement NPP and decadal survey missions, the weather focus area will contribute to the algorithm development to accelerate the use of the relevant decadal survey measurements in operational weather forecasting. These centers will allow studies of the most effective ways of assimilating new satellite data into global and regional numerical models.

NASA-funded researchers are working to use the many forms of new data from Earth Observing System sensors related to the atmosphere. The Moderate Resolution Imaging Spectroradiometer (MODIS), Atmospheric Infrared Sounder (AIRS), Multiangle Imaging Spectroradiometer (MISR), and Advanced Microwave Scanning Radiometer (AMSR-E) sensors on the Earth Observing System (EOS) satellites Terra and Aqua all contribute valuable information, such as land and sea surface temperatures, cloud characteristics, bidirectional reflectance for interpreting air pollution concentrations, surface wetness, and polar winds.

The weather forecast area has also contributed to a number of field programs, such as the Tropospheric Cloud System and Processes (TCSP) and the NASA contribution to the Amazon Multidisciplinary Monsoon Analysis (AMMA) that serve to both improve our understanding of atmospheric processes and provide calibration and validation instruments for NASA's Earth-observing satellites. Not all of the satellite and airborne measurements are currently being assimilated into numerical forecast models to determine their potential forecast impacts.

Research work will continue for improved modeling and computing, the development of Doppler wind lidars, and the development of geosynchronous and active sounding to meet the future objectives of the Weather Focus Area.

The ROSES element most closely directed towards the Weather Focus Area (which is not being solicited this year) is:

- Precipitation Measurement Missions Science (Appendix A.18).

Topics relevant to the Weather Focus Area are included in the following program elements (* indicates program elements soliciting proposals in ROSES-2010):

- NPP Science Team for Climate Data Records * (Appendix A.22);
- Computing and Operational Use of NASA Data * (Appendix A.24);
- Earth Science U.S. Participating Investigator * (Appendix A.26); and
- Earth Science Applications Feasibility Studies: Public Health * (Appendix A.31).

2.6 Earth Surface and Interior

The Earth Surface and Interior Focus Area promotes the development and application of remote sensing to address the questions:

- How is the Earth's surface being transformed by naturally occurring tectonic and climatic processes?
- What are the motions of the Earth's interior, and how do they directly impact our environment?
- How can our knowledge of Earth surface change be used to predict and mitigate natural hazards?
- How is global sea level affected by natural variability and human induced change in the Earth System?

The overarching goal of the Focus Area is to assess, mitigate, and forecast natural hazards that affect society, including such phenomena as earthquakes, landslides, coastal and interior erosion, floods, and volcanic eruptions. The path to prediction includes comprehensively recording and understanding the variability of surface changes controlled by two types of forces: external forces, such as climate, and internal forces that are in turn driven by the dynamics of the Earth's interior. In order to develop a predictive capability, these observations of the Earth's transformation must be modeled, interpreted, and understood. Space-based remote sensing is vital to forecasting in the solid Earth sciences, providing a truly comprehensive perspective for monitoring the entire solid Earth system.

Modeling, calibration, and validation are essential components in the development of accurate forecasting capabilities. The Earth Surface and Interior Focus Area views natural laboratories as a critical component for the validation and verification of remote sensing algorithms. NASA joins with the National Science Foundation (NSF) and U.S. Geologic Survey (USGS) in support of the EarthScope initiative to apply modern observational, analytical, and telecommunications technologies to investigate the structure and evolution of the North American continent and the physical processes controlling Earthquakes and volcanic eruptions.

Among the many activities supported by the Earth Surface and Interior Focus Area are the following:

- Geodetic and thermal imaging of the precise metrology of Earth's surface and its changes through lidar, radar constellations, and optical arrays, coupled with geopotential field measurements to understand the dynamics of the Earth's surface and interior;
- Development of a stable terrestrial reference frame, highly precise realization of topography and topographic change, and understanding of changes in the Earth's angular momentum and gravity fields, which can be applied to issues such as sea-level change, polar mass balance, and land subsidence;
- Use of gravitational and magnetic observables for studying the inner dynamics of the Earth, as well as for studies of how the ionosphere responds to changes in the Earth's surface; and
- Improved predictions of Earthquakes and volcanic eruptions through the use of a broad range of Earth surface remote sensing and space geodesy approaches.

The ROSES elements most closely directed towards the Earth Surface and Interior Focus Area are (* indicates program elements soliciting proposals in ROSES-2010):

- Earth Surface and Interior * (Appendix A.19);
- Advance Concepts in Space Geodesy * (Appendix A.20); and
- Applications of Geodetic Imaging * (Appendix A.21).

Topics relevant to the Earth Surface and Interior Focus Area are included in the following program elements (* indicates program elements soliciting proposals in ROSES-2010):

- Recompetition of the GRACE Science Team * (Appendix A.23);
- Computing and Operational Use of NASA Data * (Appendix A.24);
- HyspIRI Preparatory Activities Using Existing Imagery * (Appendix A.25); and
- Earth Science U.S. Participating Investigator * (Appendix A.26).

2.7 Cross-Cutting and Interdisciplinary

There are several cross-cutting and interdisciplinary elements in ROSES-2010, most of which have been identified as related elements to specific research focus areas in Sections 2.1 through 2.6 (and also briefly summarized in the overview to Section 2). These elements, all of which are solicited proposals in ROSES-2010 (* indicates program elements soliciting proposals in ROSES-2010), are:

- NPP Science Team for Climate Data Records * (Appendix A.22) – This program element is a recompetition of the previous NPP Science Team selected as part of an integrated Terra/Aqua/NPP program element from ROSES-2006 (available at http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={D052

AD26-7845-AF0F-1B6A-C5C7BE94046C}&path=past; click on "A.15 Earth System Science Research using Data and Products from the Terra, Aqua, and ACRIMSAT Satellites as amended"). Given its breadth, this is relevant to most NASA Earth science research and applied science areas.

- Recompetition of the GRACE Science Team * (Appendix A.23) – This program element is a recompetition of the science team for the GRACE mission, last competed as part of ROSES-2006 (available at http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={AFCACB82-FA25-DED6-21FC-01D883868C3A}&path=past; click on "A.12 Recompetition of the GRACE Science Team"). This is most relevant to NASA's Climate Variability and Change, Global Water and Energy Cycle, and Earth Surface and Interior focus areas and may have applications in several areas, most notably water resources.
- Computing and Operational Use of NASA Data * (Appendix A.24) – This program element provides a new opportunity for proposals that can enhance the capability and usefulness of NASA models and data through incorporating new advances in computational science and capability and that can better transition research results deriving from them into the operational sector. The latter portion represents an evolution of the element from ROSES-2007, Accelerating Operational Use of Research Data (available at http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={01C61E75-EF9D-BCD2-AA74-947E48888A71}&path=past, click on "A.15 Accelerating Operational Use of Research Data as clarified"). Given its breadth, this may be applicable to any of the research focus areas.
- HyspIRI Preparatory Activities Using Existing Imagery * (Appendix A.25) – This program element provides an opportunity for proposals to use existing imagery in support of early planning towards the Hyperspectral Infrared Imager (HysPIRI) instrument identified by the NRC Decadal Survey. This element was also included in ROSES-2009 (available at http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={DAFC4BF9-606A-4869-D6C0-806F77BC6B3E}&path=past, click on "A.29 HyspIRI Preparatory Activities Using Existing Imagery as clarified"). This is most relevant to the Carbon Cycle and Ecosystems, Global Water and Energy Cycle, and Earth Surface and Interior focus areas, and may be useful for a very broad range of applications.
- Earth Science U.S. Participating Investigator * (Appendix A.26) – This program element provides an opportunity for U.S. scientists to propose to have a formal role in satellite missions being planned by NASA's international partners. This is a recompetition of a program element first included in ROSES-2008 (available at http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={D7239FC6-63F0-37B0-4066-8BE664BF7723}&path=past, click on "A.29 Earth Science U.S. Participating Investigator").
- Commercial Reusable Suborbital Research Platforms for Earth Science * (Appendix A.27) – This program element describes the opportunity to propose suborbital investigations that can take advantage of commercial reusable suborbital research platforms to advance NASA's Earth science objectives. This opportunity can be applied to any area of NASA's Earth science and applications research program for which suborbital investigations are appropriate.

3. Applied Sciences

The overarching purpose of the Applied Sciences Program is to discover and demonstrate innovative and practical applications of NASA Earth science research, technology, and observations. The program seeks to increase the benefits to society of the nation's investments in the NASA Earth science research program. To this end, the program develops and demonstrates foundational applied knowledge and enables practical applications of NASA Earth science products through projects carried out in partnership with operational or end-user organizations. The Applied Sciences Program supports projects that address topics that are of international, national, or regional importance in eight application areas -- Agriculture, Air Quality, Climate, Disaster Management, Ecosystems, Public Health, Water Resources, and Weather. Applied Science projects leverage products, knowledge, and outcomes of Research and Analysis activities described in Section 2.

The Applied Sciences Program employs an "end-to-end" approach to extend Earth science research results as inputs to decision-making activities. The Program works in partnership with organizations that develop, own, and employ decision support tools, systems, assessments, etc. to support their management, business, and policy-making decisions. These organizations include Government agencies, business, and not-for-profit organizations. The program also works with international, national, and regional associations, such as the World Health Organization, United Nations Food and Agriculture Organization, the American Water Resources Association, and the Western Governors Association.

A summary of the Applied Science Program is provided in Appendix A.29, Applied Sciences Program: Decision Support.

The Applied Sciences Program directly solicits proposals through the following ROSES elements (* indicates program elements soliciting proposals in ROSES-2010):

- Climate and Biological Response: Research and Applications * (Appendix A.30); and
- Earth Science Applications Feasibility Studies: Public Health * (Appendix A.31).

The Program is also funding proposals for applications-related activities in ROSES-2010 program elements managed by Earth Science Research Programs. Appendix A.29 lists the specific program elements with Applied Science funding for applications-oriented activities. In general, topics relevant to the Applied Science Program are also included in the following program elements (* indicates program elements soliciting proposals in ROSES-2010):

- Carbon Cycle Science* (Appendix A.5);
- Atmospheric Composition: Modeling and Analysis* (Appendix A.14);
- Aura Science Team* (Appendix A.15);
- Terrestrial Hydrology* (Appendix A.16);
- Applications of Geodetic Imaging* (Appendix A.21); and
- NPP Science Team for Climate Data Records * (Appendix A.22).

4. Enabling Capability

Enabling capabilities include those programmatic elements that are of sufficient breadth that they contribute to a broad range of activities within the Earth Science Research Program. They typically involve the development of some kind of capability whose sustained availability is considered to be important for the Earth Science Research Program's future. These include focused activities in support of education; data, information, and management; and airborne science, as well as some broadly based technology-related elements (others which are very focused towards a single scientific area of the Earth Science Research Program will be solicited through the research and analysis area).

4.1 Education

The Earth Science Research Program also recognizes its essential role in NASA's mission to inspire the scientists and engineers of tomorrow. The Earth system science concept pioneered by NASA is changing not only how science research is conducted, but also the way Earth and space science education is taught at elementary through postgraduate levels, as well as the way space exploration is presented to the public by the media and informal learning communities.

In addition to the education and outreach opportunities that are embedded in and competitively selected as part of the Earth Science flight and research programs, other program announcements are issued periodically to focus on continued workforce enrichment. The Earth Science component of the NASA Earth and Space Science Fellowship (NESSF) program, which supports the training of graduate students in Earth system science and/or remote sensing, is solicited outside of ROSES with new applications due February 1 of each year (NESSF is posted at http://nspires.nasaprs.com/ in November). The New Investigator Program in Earth Science (Appendix A.28), which is directed towards scientists and/or engineers within five years of their receipt of a terminal degree, is solicited every two years. It was solicited as part of ROSES-2009 and thus is not solicited in ROSES-2010.

4.2 Data and Information Management

NASA's space observation capabilities are a central part of the Agency's contribution to Earth system science, along with the science information systems that compile and organize observations and related data for research purposes. The Earth Science Research Program has established a number of strategic principles for the development and deployment of its observing and information systems, recognizing the importance of providing active and informed stewardship for the large volume of data that are returned to Earth every day. The broad range of uses to which the data are put and the large and diverse user community require multiple temporal and spatial scales, emphasize the need for having a range of data products, and place stringent requirements on NASA for its data processing, archival, and data dissemination activities. These products and services will be variously useful to multiple classes of users, from sophisticated scientific users to other Government and private sector entities that use NASA's information for policy and resource management decisions and including scientifically attentive members of the public who utilize data and information for general information and recreation.

NASA's data and information management activities are described in NASA's *2003 Earth Science Strategy* at http://nasascience.nasa.gov/about-us/science-strategy/past-strategy-documents/earth-science-enterprise-plans.

Three program elements in the area of data and information management are included in this NRA, only one of which is being solicited this year. The active element is Earth System Data Records Uncertainty Analysis (Appendix A.32). This program, solicited for the first time this year, provides support for in-depth analysis of the properties of long-term data sets, with a focus on detecting systematic error, better quantifying error, and properly attributing uncertainty sources. A second focus is to resolve known issues of such data sets. Resultant tool development is a third focus of the program. The two not being solicited are Making Earth System data records for Use in Research Environments (MEaSUREs) program (Appendix A.33); and the Advancing Collaborative Connections for Earth System Science (ACCESS) program (Appendix A.34).

4.3 High-End Computing, Networking, and Storage

High-end computing, networking, and storage are critical enabling capabilities for Earth system science. Satellite observations must be converted into scientific data products through retrieval and/or data assimilation processes. Long-term data sets must be synthesized together and become a physically consistent climate-research quality data set through reanalysis. These data products, in turn, provide initial and boundary conditions, validation and verification references, and internal and external constraints to the models that describe the behavior of the Earth system. None of the above will be possible without advanced techniques in high-end computing, networking, and storage.

SMD recognizes the need of such an enabling capability and maintains the high-end computing, networking, and storage within its programs. Computing resources are provided through various program elements. Proposers to ROSES must follow the instructions in Section I(d) of the *Summary of Solicitation* of ROSES to request computing resources.

NASA also supports computational science research and development, including parallelization of codes to an advanced computing architecture for the advancement of Earth system modeling and data assimilation. There is a relevant subsection of Appendix A.24, Computing and Operational Use of NASA Data, which provides an opportunity for this type of research to be proposed this year.

4.4 Airborne and Suborbital Science

The Earth Science Research Program airborne science program provides access to airborne and balloon-based platforms that can be used to obtain measurements of the Earth. Airborne and balloon-based platforms may be used to test new measurement approaches, collect detailed *in situ* and remote-sensing observations that are needed to better document and test models of Earth system processes, and/or provide calibration/validation information for satellites. Airborne and balloon-based platforms can also be an important part of training the next generation of scientists because of the fact that students can be engaged in all aspects of science, from sensor development, through utilization, to completing analysis of data obtained.

Aircraft have proven to be of significant value in Earth system science research, particularly for investigation into atmospheric processes. NASA makes use of several existing aircraft through an annual Call Letter process, most notably the NASA-owned DC-8, WB-57F, ER-2, P-3B, and Global Hawk as well as several independently owned aircraft, including but not limited to those operated by other Federal agencies. By working with the NASA Aeronautics Research Mission Directorate, SMD hopes to pioneer new types of airborne missions that capitalize on NASA's unique expertise in platforms, sensors, and aeronautical operations.

The FY 2011 Call Letter for Flight Requests supporting approved investigations is expected to be released in April 2010. ROSES-2010 program elements that solicit airborne-platform-based research include (* indicates program elements soliciting proposals in ROSES-2010):

- Ocean Salinity Field Campaign* (Appendix A.11); and
- Atmospheric Composition: Atmospheric Composition, Cloud, and Climate Experiment * (Appendix A.13).

SMD recognizes that in certain cases Earth science research may be best accomplished by use of commercial reusable suborbital platforms. The Commercial Reusable Suborbital Research (CRuSR) Program (http://suborbitalex.arc.nasa.gov/node/61) at NASA Ames Research Center manages NASA's use of these platforms. The CRuSR program is described more fully in Appendix A.27, Commercial Reusable Suborbital Research Platforms for Earth Science. Proposals seeking to use CRuSR platforms for Earth science research must make a clear and convincing scientific and/or technical case that use of a CRuSR platform is required to produce the needed results in ways that could not be accomplished as effectively or as efficiently as through use of other suborbital platforms including aircraft (piloted or uninhabited), balloons, and sounding rockets.

4.5 Technology

The Earth Science Technology Program is designed to foster the creation and infusion of new technologies into space missions in order to enable new science observations or reduce the cost of current observations. Needs for advanced technology development are based on Earth science measurement and system requirements articulated in chapter 4 of the *Science Plan For NASA's Science Mission Directorate 2007-2016*, available at http://nasascience.nasa.gov/about-us/science-strategy, and also the National Research Council (NRC) report *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*, available at http://www.nap.edu/catalog.php?record_id=11820.

The key components of the technology infusion process are dialog among experts and the programs spanning the technology readiness scale for remote sensing, computing, and communications. Open solicitations are used to attract the best ideas from universities, industry, and Government laboratories. Conferences and workshops are held to establish connections between developers of maturing technologies and scientific investigators proposing new observing or modeling approaches. Principal investigators and others responding to mission solicitations can then adopt these technologies, whose maturation and readiness is well documented, in their proposals.

The Earth Science Technology Office (http://esto.nasa.gov) maintains several program lines through which technology investments are competed and that cover a range of technology readiness levels (TRLs) (* indicates program elements soliciting proposals in ROSES-2010):

- Instrument Incubator Program * (Appendix A.35);
- Advanced Component Technology (Appendix A.36); and
- Advanced Information Systems Technology Program (Appendix A.37).

A.2 TERRESTRIAL ECOLOGY

NOTICE: The Terrestrial Ecology program will not be competed in 2010. The Terrestrial Ecology program is tentatively scheduled to next solicit proposals in ROSES 2011.

NASA expects to solicit research relevant to the goals and objectives of the Terrestrial Ecology program through the Science of Terra and Aqua program (ROSES-2009, Appendix A.41), Carbon Cycle Science program (ROSES-2010, Appendix A.5), and NPP Science Team for Climate Data Records (ROSES-2010, Appendix A.22). Any funds becoming available under the Terrestrial Ecology program may be used to support relevant research in these programs. Interested researchers are encouraged to consult these other program elements for descriptions of those funding opportunities.

1. Scope of Program

NASA Terrestrial Ecology research addresses changes in Earth's carbon cycle and ecosystems using space-based observations. The goals of NASA's Terrestrial Ecology research are to improve understanding of the structure and function of global terrestrial ecosystems, their interactions with the atmosphere and hydrosphere, and their role in the cycling of the major biogeochemical elements and water. This program of research addresses variability in terrestrial ecosystems, how terrestrial ecosystems and biogeochemical cycles respond to and affect global environmental change, and future changes in carbon cycle dynamics and terrestrial ecosystems. The research approach combines (i) use of remote sensing to observe terrestrial ecosystems and their responses; (ii) field campaigns and related process studies to elucidate ecosystem function; and (iii) ecosystem and biogeochemical cycle modeling to analyze and predict responses. Research to establish a theoretical and scientific basis for measuring Earth surface properties using reflected, emitted, and scattered electromagnetic radiation and to develop the methodologies and technical approaches to analyze and interpret such measurements is an important component of the Terrestrial Ecology research program.

2. Point of Contact for Further Information

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A.3 OCEAN BIOLOGY AND BIOGEOCHEMISTRY

1. Scope of Program

The Ocean Biology and Biogeochemistry (OB&B) program supports a number of Presidential mandates and associated Federal research objectives, e.g., the U.S. Climate Change Science Program (http://www.climatescience.gov/) and its strategic plan (http://www.climatescience.gov/Library/stratplan2003), which address aspects of Carbon Cycle and Ecosystem research from space, with a focus on understanding Earth's aquatic environment and its role within the Earth System. The program is also responsive to the U.S. Ocean Action Plan objectives and, in particular, the Ocean Research Priorities Plan.

NASA's Ocean Biology and Biogeochemistry program focuses on describing, understanding, and predicting the biological and biogeochemical regimes of the upper ocean, as determined by observation of aquatic optical properties using remote sensing data, including those from space, aircraft, and other suborbital platforms.

Overarching programmatic goals include:

1. Understanding and quantifying the impacts and feedbacks of Earth System processes, particularly oceanographic mechanisms, on the global and regional spatial and temporal variability of ocean biology, including phytoplankton and organisms from other trophic levels;

2. Understanding and quantifying the impacts and feedbacks of Earth System processes, particularly oceanographic mechanisms, on the global and regional spatial and temporal variability of ocean biogeochemistry, including carbon sources and sinks and the fate of other chemical species or components in the ocean;

3. Exploring the development of new biological and biogeochemical observations beyond traditional ocean color (e.g., phytoplankton chlorophyll *a*) from space-based assets, as well as furthering the climate research enabled by existing time series of climate observations (Earth System Data Records); and

4. Improving future climate predictions (impacts and feedbacks) by incorporating a dynamic understanding of ocean biology and biogeochemistry into global biogeochemical and ecological models to understand the ocean's role in the Earth System.

Ocean Biology and Biogeochemistry research mainly supports the Carbon Cycle and Ecosystem Focus Area (http://nasascience.nasa.gov/earth-science/carbon-cycle-and-ecosystems). Each of the Earth Science Focus Areas portray a strategy for a decade of progress through 2015 based on a suite of systematic observations, novel new Earth Science observations, and specific programmatic elements. NASA's Ocean Biology and Biogeochemistry program utilizes remotely sensed observations from land, ocean, and atmosphere, as well as field studies and campaigns, and interdisciplinary data assimilation and modeling efforts to better understand the ocean's role in the Earth System, and to predict future causes of change and feedbacks on ocean biology and biogeochemistry within the Earth System.

In support of the Carbon Cycle and Ecosystems Roadmap, scientific questions of interest to the Ocean Biology and Biogeochemistry Program include (but are not limited to):

1. How are ocean ecosystems and the biodiversity they support influenced by climate and environmental variability and change, and how will these changes occur over time?

2. How do carbon and other elements transition between ocean pools and pass through the Earth System, and how do biogeochemical fluxes impact the ocean and Earth's climate over time?

3. How (and why) are the diversity and geographical distribution of coastal marine habitats changing, and what are the implications for the well-being of human society?

4. How do hazards and pollutants impact the hydrography and biology of the coastal zone? How do they affect us, and can we mitigate their effects?

Appendix A.1 of ROSES ("Earth Science Research Program") provides an overview of how the Ocean Biology and Biogeochemistry program fits into the Earth Science Division within NASA's Science Mission Directorate. Program goals and objectives for the coming decades can be found in the Ocean Biology and Biogeochemistry program's advance plan (http://oceancolor.gsfc.nasa.gov/DOCS/OBB_Report_5.12.2008.pdf).

2. Description of Solicited Research

The subject of this solicitation is to establish a satellite data calibration and validation office for ocean biological, biogeochemical, and interdisciplinary ocean research.

2.1 Background

NASA's ocean research and modeling activities span from global and coastal ocean scales, to the Great Lakes, and down to smaller lakes and rivers. Calibration and validation activities based on *in situ* and laboratory observations, as well as focused oceanographic field studies ensure the quality and utility of climate and Earth System data records. Although many challenges to remote sensing have been addressed during thirty years of ocean color remote sensing, including the success of the SIMBIOS program (Sensor Intercomparison for Marine Biological and Interdisciplinary Ocean Studies) conceived in 1994, there remain many challenges in *in situ* calibration and validation science to further improve our retrievals of space-based ocean properties.

Historically, NASA's focus in oceanography has been in open ocean waters. While there remains significant work to be done in improving characterization, uncertainties, and errors associated with *in situ* sampling to support ocean color remote sensing calibration and validation in blue water, calibration and validation efforts in coastal waters have lagged behind those for the ocean.

An expanded effort in calibration and validation of data in optically complex coastal zones is now necessary to improve our ability to understand processes along the terrestrial margins. Understanding the ice-covered polar regions, which are highly vulnerable to changes in climate, is also a high priority of NASA's research activities. A strong, unified *in situ* observational capability must accompany any coastal or high latitude oceanographic research priority because the former is highly dynamic and variable, and the latter is remote and difficult to sample.

2.2 Implementation

In this solicitation, "calibration" is associated with those activities needed to ensure a proper prelaunch characterization of the satellite sensor, to track the post-launch sensor performance over time, and to vicariously adjust the sensor's prelaunch calibration to match properly collected ground-truth observations. "Validation" encompasses the breadth of tasks required to establish the accuracy and precision of data products derived from an algorithm applied to the observations recorded by a properly calibrated sensor. Generally, these activities are simply referred to as "vicarious calibration and algorithm validation," and, ultimately, "calibration and validation."

For this solicitation, one proposal will be selected to execute the following research activities, to conduct a thorough analysis of the data, and to disseminate the research results widely through peer-reviewed publication(s). The team selected for coordinating the research within a calibration and validation data office for NASA must address these principal areas of research:

1) Quantify uncertainty and conduct error analyses for *in situ* ocean biological and biogeochemical observations in support of ocean color remote sensing,
2) Conduct *in situ* sampling, develop laboratory protocols for calibration of new and existing instrumentation, and
3) Collect appropriate field data in support of calibration and validation measurements for ocean color.

The proposal must provide a detailed plan for participating in field data collection during NASA research efforts, field campaigns, and international cruises of opportunities, and where opportunity exists to expand the breadth of optical water masses that are undersampled and that can improve ocean color satellite retrievals. The investigators and their technical team should be demonstrated and recognized experts in the collection of *in situ* apparent optical properties, inherent optical properties, and other ocean biological and biogeochemical properties of scientific interest to NASA's OB&B program. There must be a demonstrated history of submission of *in situ* data to NASA's SeaBASS archive in a timely fashion. There must be a plan for analysis of field and laboratory data, and of associated *in situ* and laboratory protocols, and for instrument calibration for existing *in situ* and laboratory instrumentation. Assessment of existing and new *in situ* and laboratory instrumentation should include protocol review and comparison to other existing technology. The team will be expected to work closely with the NASA Ocean Biology Processing Group, located at NASA's Goddard Space Flight Center, which is responsible for processing and analysis of NASA and other ocean color satellite data. The team will also be expected to coordinate dissemination of their expertise to the research community to ensure the accuracy and precision of data collected by NASA OB&B-supported

research PIs. This can be through a mechanism of choice, e.g., round-robin activities, workshops, scientific meetings, field certification, etc., and this mechanism will have to be thoroughly delineated in the proposal. The team will be subject to an external peer-review board on an annual or biannual basis, as appropriate.

3. Programmatic Requirements

All proposals that respond to the Ocean Biology and Biogeochemistry program elements must either utilize remotely sensed (e.g., ocean color) observations as a primary research tool, or seek to improve existing ocean color observations, or explore the development of new biological and biogeochemical properties from space-based assets beyond traditional ocean color in support of the project objectives.

Research supported under this subelement is required to address uncertainties and quantify errors.

Individual activities or projects may be linked with other projects, but such coordinated or linked projects should be proposed separately. These linkages must clearly and explicitly be called out by all involved proposals and investigators.

Investigators should make clear any special requirements or platform needs, i.e., ship modifications, additional boats, specific sampling requirements, aircraft support (see http://www.nasa.gov/centers/dryden/research/AirSci/), high-end computing requirements (see Section I(d) of the *ROSES Summary of Solicitation*), in a separate section.

Funding for these tasks will begin in Fiscal Year 2011.

All data collected will be subject to the standard NASA Earth Science data policy (http://nasascience.nasa.gov/earth-science/earth-science-data-centers/data-and-information-policy/). Proposals planning to collect field data should contain a table that, to the extent possible, details cruises to be undertaken, region, dates, expected stations, measured variables, sampling frequency, platform and instrument, calibration strategy, and co-investigators. Data collected are requested to be submitted to the NASA SeaBASS archive (http://seabass.gsfc.nasa.gov/) within one year of collection.

Investigators selected under this call will be required to participate in any meetings and coordination workshops sponsored or co-sponsored by NASA (e.g., post-cruise data workshops, pre-cruise planning meetings, etc.). PIs will also be encouraged to attend annual NASA co-sponsored science coordination meetings with international research programs, as needed. Investigators selected by the Ocean Biology and Biogeochemistry program are strongly encouraged to attend the annual NASA Ocean Color Research Team meeting or equivalent within the United States (e.g., PIs should budget a four day trip to the farthest coast once per year, unless specified otherwise).

4. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

5. Summary of Key Information

Expected program budget for first year of new award	Up to $1.5M
Number of new awards pending adequate proposals of merit	1
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	October 1, 2010
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-OBB
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A.4 LAND-COVER / LAND-USE CHANGE

Amendment 5 on May 18, 2010. This program element has been modified to focus the VIA theme on a single land-cover type – wetlands, and put a greater emphasis on inclusion of the social science component, such as the use of socioeconomic data associated with a land-use or socioeconomic model. New text appears as bold, deleted text as strikethrough.

1. Solicited Research

1.1 Background and linkages to USCCSP/USGCRP and NASA Strategic Goals

This solicitation will contribute to a strategic research question identified in the Land-Use and Land-Cover Change theme of the 2003 U.S. Climate Change Science Program (USCCSP) Strategic Plan: "What are the environmental, social, economic, and human health consequences of current and potential land-use and land-cover change over the next 5 to 50 years?" (The new site is at http://www.globalchange.gov/; the old U.S. Global Change Research Program (USGCRP) site at http://www.climatescience.gov/ is still accessible and has some useful information.) This question is aligned with NASA's strategic subgoal to "Study Earth from space to advance scientific understanding and meet societal needs" (see Table 1 of the *ROSES Summary of Solicitation*).

Specifically, this solicitation is focused on two major themes: 1) Synthesis of prior Land Use and Land Cover Change studies and 2) Vulnerability, Impacts, and Adaptation (VIA), as related to climate interactions with land-use changes around the world, for example addressing the vulnerability of current land use systems and related social systems and their adaptability to climate variability and change and other major global stressors.

Participation by social scientists in this program is strongly encouraged. **For a proposal to be competitive, it must include a social science component, such as the use of socioeconomic data associated with a land-use or socioeconomic model as an integral part of the study, preferably based on available data or data being collected by an ongoing study funded by another agency.** Guidance on preferred areas of research and geographic regions is provided below, to help develop a thematically and geographically balanced program of research. Rapid land-cover changes have been quantified and characterized using different types of satellite-based remote sensing. The NASA Land Cover/Land-Use Change (LCLUC) program has been supporting such studies for the last 14 years. The current solicitation is calling for synthesis of regional results from this or related programs. The results of past LCLUC process studies, combined with various modeling approaches could be a basis for analyses of VIA, as emphasized in the National Research Council report, *New Directions in Climate Change Vulnerability, Impacts, and Adaptation Assessment* (http://www.nap.edu/catalog.php?record_id=12545).

1.2 Solicitation Components

This solicitation consists of two major components:

The first component (Synthesis) calls for proposals on synthesizing the LCLUC research results from this or related programs. Understanding LCLUC processes often requires local scale studies, yet it is hard to develop general principles from individual local studies. Synthesis of results from several studies may provide an opportunity to test and establish such general principles. **This component of the solicitation is directed at developing synthesis of analyses obtained from various LCLUC projects and case studies from the period of satellite observations, i.e. the last 30 years.** For example, proposals to this solicitation might generate a synthesis of methods and results on detecting and quantifying land-cover and land-use changes and their impacts in rapidly changing regions of the globe ("hot spots"), or a synthesis of local land cover /land use process studies previously undertaken in various regions of the globe, such as the Arctic, the tropics, the boreal forests, the drylands, the coastal zone or mountains, temperate forests or agriculture. ~~Other topics are welcome. Individual local scale studies will not be of interest. However, synthesis of several local scale studies could be a potential topic for a proposal.~~

Proposals could include the synthesis of studies addressing the landcover and land-use impacts of large-scale institutional changes; changes caused by periods of economic growth or downturn, or land use changes resulting from climate variability or change. Studies could also include the synthesis of future projections of land use change. For example, proposals might address rapid changes in land cover and land use on a regional to continental basis caused by institutional changes due to the break-up of the Soviet Union, or the move of the former socialist countries into the European Union, or the fast economic development in Asia or South America. Proposals are expected to be on synthesis for large regions or a thematic topic, for example, within a particular agro-ecological zone or biome, preferably on a continental scale or addressing a particular land-use topic such as agricultural expansion or abandonment, large-scale deforestation or urbanization. Integration across scales from local to regional to continental is of interest. Individual local scale studies will not be of interest, however, synthesis of several local scale studies would be appropriate for this solicitation.

The second component (VIA) is directed at addressing vulnerability, impacts, and adaptation of land use to climate and global change. Of particular interest are studies, which address linkages across spatial and temporal scales, or studies, which address feedbacks between land use change, economic development and policies. Global scale climate model projections need to be translated to finer scales for VIA studies. Regional integrated studies studying the impacts and feedbacks of regional processes with local ecosystems and land uses are of particular interest.

In general, the vulnerability, impacts, and adaptation (VIA) component of the LCLUC program is focused on changes in land cover and land use and the role of multiple stressors and their impact on land-cover and land-use systems.

The VIA component of the current solicitation focuses on wetlands - a biome that to-date has received relatively little attention in the program. Proposals should focus on changes in wetlands areas in response to changes in climate, economic development, policies, and their interactions. Studies on VIA for both coastal and inland wetlands can be proposed.

According to definitions commonly used by the U.S. Environmental Protection Agency, wetlands are lands where saturation with water is the dominant factor determining the types of species living in that ecosystem. In other words, wetlands are areas where water covers the soil, or is present at the surface for varying periods of time during the year (or throughout the whole year). Wetlands generally include swamps, marshes, bogs, and similar areas and may support both aquatic and terrestrial species. Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance.

Wetlands play an important function in terms of biodiversity and nutrient cycling and in some cases human health, but are being lost worldwide due to a number of factors. The importance of wetlands is recognized by the international community. In 1971, the 'Ramsar Convention on Wetlands' was adopted, providing the framework for national action and international cooperation for the conservation and wise use of wetlands. The Convention's 138 national signatories report on the state of their listed wetlands. The Ramsar Convention on Wetlands stresses that targeted assessment and monitoring information is vital for ensuring effective management planning for wetlands.

Wetlands are often associated with inaccessible terrain, therefore, remote sensing from satellites is a critical tool providing synoptic information on the types of wetland vegetation, land cover, water dynamics, and land-management impacts. The LCLUC program encourages use and fusion of remote sensing data from various spectral ranges, passive and active optical and microwave, and from different spatial and temporal resolutions. Satellite observations can be used in an analysis of the past changes. Results of such an analysis, together with models may indicate where we will see major changes and adaptation in the future and which places are vulnerable to different stressors. The LCLUC Program encourages large area studies, including comparisons of human disturbances in wetlands on one continent or different continents. Proposals on small, individual watersheds are of a lesser interest to the program.

In general, the LCLUC program encourages linkages to large international projects (see below). For this particular amendment, the European Space Agency's GlobWetland II project, launched in January 2010

(http://www.esa.int/esaCP/SEM2MMUJ15G_Protecting_0.html) could be used as a good linkage.

Proposals are solicited on either or both components listed above. Carbon cycle studies are solicited in the Carbon Cycle Science program (Appendix A.5 of ROSES-2010), hence they will be of a lesser priority in this particular LCLUC solicitation.

1.3 Regions of Interest

The LCLUC Program is global, and research proposals can be submitted on any region of the globe. Proposals on the United States are always welcome in the program but they should be on large regions, for example, within a particular agro-ecological zone, biome, or conurbation, or at a national to continental scale. Local studies of an individual watershed or city are discouraged. The LCLUC program welcomes studies on coastal or mountainous regions, which to date have received less attention within the program.

1.4 International Program Linkages

As a global-scale program, we recognize the multiple and mutual benefits of international cooperation: to focus international expertise, assets and resources, to strengthen the research and involve scientists with in-depth regional knowledge. To this end, the LCLUC program is a contributor to the Global Observation of Forest and Land Cover Dynamics (GOFC/GOLD; http://www.fao.org/gtos/gofc-gold/) Program and the Global Earth Observation System of Systems (GEOSS; http://www.earthobservations.org/) framework, offering opportunities for international cooperation and collaboration on land-use and land-cover related research and applications. It is desirable that LCLUC proposals contribute to these or related international programs.

Proposals focused on Asia will be expected to contribute to the international Monsoon Area Integrated Regional Study (MAIRS) Program (http://www.mairs-essp.org/). Urban land-use change projects addressing air quality issues will be expected to develop linkages to the ongoing multi-institutional, multinational project MEGAPOLI (http://web.dmi.dk/pub/megapoli/).

1.5 Remote Sensing Component

The NASA LCLUC program will only support proposals with a strong remote sensing component. The use of data from U.S. Earth-observing satellites in general, and those of NASA in particular, is encouraged. However, the use of non-U.S. and commercial satellites having relevant data holdings is of interest to the program. Proposals that undertake fusion of data from various sources of Landsat-type data (e.g., Landsat, AWiFS, CBERS, SPOT), as well as radar observations, are most welcome. This latter approach may provide better temporal and spatial coverage and pave the way to a Land Surface Imaging constellation paradigm for future systems (http://www.ceos.org/index.php?option=com_content&view=category&layout=blog&id=47&Itemid=38). Special attention should be given to the dissemination of data and products associated with the proposed research. The LCLUC program encourages analysis of the available long-term time-series of Landsat data, e.g., as provided by the Global Land Survey (GLS) datasets (http://gls.umd.edu/), to detect trends in land use as an adaptation to climatic, social, economic, or demographic changes.

2. Programmatic Information

2.1 Period of Performance for Selected Proposals

Research awards for the LCLUC Program are typically for three-year periods of performance (or less) with annual funding contingent upon satisfactory progress reporting and available funding.

2.2 Funding Available for Support of Selected Proposals

About $2M per year from the NASA LCLUC program is expected to be available for this solicitation. Support can be anticipated for about 1-2 investigations from larger, multi-institutional teams of up to $500K per year, 2-3 investigations for average size proposals of about $200-300K per year, and 2-5 investigations from smaller project proposals of about $100-200K per year.

PLEASE NOTE: This program uses the Two-Step Proposal Process (see Section IV(b)(vi) of the *ROSES Summary of Solicitation*). The Two-Step Proposal Process for this announcement will start in 2010. Pending the availability of funds through the Federal budget process for Fiscal Year 2012, NASA expects to make final selections for this announcement in late 2011. Anticipated starting date for selected projects is January 1, 2012.

A budget for travel to at least one LCLUC Science Team Meeting per year is required in the proposal. In addition, international travel should be included in the proposal budget if the region of investigation is outside of the U.S. Involvement of local scientists from the selected region is strongly encouraged and letters of endorsement from foreign partners, although not needed at Step-1, will be required at Step-2. Note that direct support of research by foreign investigators is not allowed (see the *NASA Guidebook for Proposers*, Sections 1.6 and 2.3.11(b)(vi)). However, supplies and services can be purchased from foreign investigators to facilitate the research activities of U.S. investigators, provided that the purchased supplies or services do not constitute research.

2.3 The Two-Step Proposal Procedure

To streamline the proposal process and relieve the work load on the community of interested applicants and those that help NASA in reviewing proposals, the LCLUC program is using a two-step procedure (see also Section IV(b)(vi) of the *ROSES Summary of Solicitation*). Proposals solicited for LCLUC will use a two-step proposal process in which the Notice of Intent (NOI) is replaced by a required Step-1 Proposal. Step-1 Proposals must be submitted electronically by the NOI/Step-1 Due Date (see

Tables 2 and 3 in the *ROSES Summary of Solicitation*). Unlike a NOI, Step-1 Proposals must be submitted by one of the officials at the PI's organization who is authorized to make such a submission.

NSPIRES will be open for the submission of Step-1 Proposals starting ~30 days in advance of the Step-1 Due Date. NASA will then review each Step-1 Proposal to determine whether or not the anticipated research project is considered of sufficient merit, responsiveness, and relevance to warrant submission of a full Step-2 Proposal. All submitters of Step-1 Proposals will be informed by NASA, no later than eight weeks after the Step-1 Due Date, whether they are, or are not, invited to submit a full Step-2 Proposal.

A separate Step-1 Proposal must be submitted for each intended (and thus corresponding) Step-2 Proposal.

Only proposers who submit a Step-1 Proposal and are invited to submit a Step-2 Proposal are eligible to submit a Step-2 Proposal. Submission of a Step-1 Proposal is therefore required in order to submit a Step-2 Proposal. Step-2 Proposals must contain the same scientific goals proposed in Step-1, but the proposal team identified at Step-1 is not considered binding and can be adjusted in an invited Step-2 Proposal. However, the submission of a Step-1 Proposal is not a commitment to submit a Step-2 Proposal.

The NSPIRES system will guide proposers through submission of all required proposal information. Please note that the Proposal Summary, Business Data, Program Specific Data, and Proposal Team are required Cover Page Elements for a Step-1 Proposal. A budget should <u>not</u> be included with the Step-1 Proposal, but will be needed with a budget explanation at Stage 2.

To facilitate the work by reviewers on Step-1 Proposals, the following abbreviated template is suggested for use. Step-1 Proposals should be provided as a PDF proposal document-upload not to exceed five pages. The five-page, Step-1 Proposal should:

- Emphasize responsiveness, i.e., identify to which component(s) of the solicitation the proposal is responding, clearly indicating how it addresses the call, which remote sensing assets are to be used.
- Describe the proposed research, showing knowledge of previous research carried out by the scientific community in the subject area. Identify what <u>new</u> research aspects are being proposed, as compared to the latest achievements or capabilities on the proposed topic.
- Indicate whether the research builds on previous research experience by the team or whether it is a new topic for the proposing team. Proposers may refer to a Web site with more detailed information on previous research.
- Outline the expected outcomes of the research, identify any proposed deliverables, provide an outlined schedule, and identify the roles and responsibilities of the proposed research team.

The five-page limit for Step 1 Proposals must include all information necessary to evaluate the Step 1 Proposal. That specifically includes any references or citations included in the Step 1 Proposal. Step 1 Proposals may also be submitted via Grants.gov

Step-2 Proposals should provide more detail on the state of the science in the particular topic area and the proposed research, the methodology, anticipated results and deliverables, and schedule. Step-2 proposals should include a budget and the associated explanation. For consistency and to ease the burden of reviewing, it is preferable that Step-2 Proposals follow approximately the same structure as outlined for the Step-1 Proposals.

Step-2 Proposals must be submitted electronically by the Proposal Due Date (see Tables 2 and 3 in the *ROSES Summary of Solicitation*) in full compliance with the requirements specified in the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers* (see Section 3 below).

2.4 Evaluation of Proposals

All proposals will be submitted to the NASA peer review process in accordance with the guidelines provided in this NRA and the *NASA Guidebook for Proposers*. This peer review will be followed by a programmatic review in which NASA will assess program balance across the competitive range of proposals, evaluate any logistical, implementation, cost, and/or management concerns. The funding recommendations will then be forwarded to a Selection Official for confirmation. NASA then will announce the official selection of proposals for award.

Reviews of Step-1 proposals and any other feedback from NASA management can be obtained from the NASA point-of-contact listed below only after the full two-step procedure is complete. Proposers will receive written notification no later than eight weeks after the submission of their Step-1 proposals, whether they are, or are not, invited to submit Step-2 full proposals, based on reviews of their Step-1 proposals.

Panel review summaries on the Step-2 Proposals will be sent to the proposers together with their letters of acceptance/rejection.

3. Summary of Key Information

Expected program budget for first year of new awards	~ $2M
Number of new awards pending adequate proposals of merit	5-10
Maximum duration of awards	3 years
Due date for Step-1 Proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.

Due date for Step-2 Proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2012
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-LCLUC
NASA point of contact concerning this program	Dr. Garik Gutman Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Tel: 202-358-0276 Email: ggutman@nasa.gov

A.5 CARBON CYCLE SCIENCE

1. Scope of Program

This announcement offers opportunities for Carbon Cycle Science investigations within the NASA Earth Science Program, the U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA) Agriculture and Food Research Initiative Competitive Grants Program (AFRI), and the USDA Forest Service Program (working through the USDA-NIFA-AFRI program). NASA and USDA-NIFA seek proposals to improve understanding of changes in the distribution and cycling of carbon among the active land, ocean, and atmospheric reservoirs and how that understanding can be used to establish a scientific foundation for societal responses to global environmental change. Of particular interest are studies that respond to the National Research Council (NRC) report, *Restructuring Federal Climate Research to Meet the Challenges of Climate Change* (NRC, 2009, available at http://www.nap.edu/catalog.php?record_id=12595), and its call for "research on the end-to-end climate change problem, from understanding causes and processes to supporting actions needed to cope with impending societal problems of climate change."

The goals of the NASA Earth Science Research Program for carbon cycle science are to improve understanding of the global carbon cycle and to quantify changes in atmospheric CO_2 and CH_4 concentrations as well as terrestrial and aquatic carbon storage in response to fossil fuel combustion, land use and land cover change, and other human activities and natural events. NASA carbon cycle research encompasses multiple temporal and spatial scales and addresses atmospheric, terrestrial, and aquatic carbon reservoirs, their coupling within the global carbon cycle, and interactions with climate and other aspects of the Earth system. A focus on observations from space pervades carbon cycle research by NASA and is a basis for partnerships with other U.S. Government agencies and institutions. NASA carbon cycle research contributes toward the goals of major U.S. Global Change Research Program (USGCRP) activities, including the Carbon Cycle Science Program's U.S. North American Carbon Program (NACP) and the Ocean Carbon and Climate Change Program (OCCC) (http://www.globalchange.gov/ and http://www.carboncyclescience.gov/). NASA carbon cycle research also contributes toward the goals of the U.S. Ocean Action Plan (http://www.whitehouse.gov/assets/documents/09_17_09_Interim_Report_of_Task_Force_FINAL2.pdf).

The mission of the NASA Earth Science Applied Sciences Program is to advance the realization of societal and economic benefits from NASA Earth Science by identifying societal needs, conducting applied research and development, and collaborating with application developers and users (http://nasascience.nasa.gov/earth-science/applied-sciences). The program's carbon cycle applications leverage NASA's investments in carbon cycle science to discover and demonstrate applications that inform resource management, policy development, and decision making. Applied sciences carbon cycle research is directed toward enhancing decision making within operational agencies responsible for resource management and policy decisions that affect carbon emissions, sequestration, and fluxes among terrestrial, aquatic, and atmospheric environments.

The USDA-NIFA mission is to advance knowledge for agriculture, the environment, human health and well-being, and communities. The purpose of the AFRI is to support research, education, and extension grants that address key problems of national, regional, and multistate importance in sustaining all components of agriculture. USDA research seeks to determine the significance of agricultural systems (including farm, crop, forest, and range lands) in the global carbon cycle and to identify agricultural and forestry activities that can contribute toward reducing atmospheric concentrations of greenhouse gases. This carbon cycle science program falls within the USDA-NIFA Global and Climate Change program which seeks both fundamental and applied interdisciplinary research on impacts and feedbacks to global change and potential adaptation and mitigation strategies, as well as discovery and demonstration of decision support tools for land, ecosystem and water resource managers to mitigate carbon and greenhouse gas emissions (i.e., increase carbon sequestration and storage) while maintaining or enhancing productivity and associated ecosystem products, services, and structure; identify vulnerable ecosystems (including production and management systems) and their thresholds; and adapt to global change and its drivers.

2. Background

In 2009 the National Research Council (NRC) issued a report, *Restructuring Federal Climate Research to Meet the Challenges of Climate Change,* calling for a new framework to meet the challenges of climate change. The NRC noted that the "paucity of social science research and the separation of natural and social science research within the CCSP [now the USGCRP], as well as the insufficient engagement of policy makers, resource managers, and other stakeholders in the program are hindering our ability to address the problems that face society." The report called for "research on the end-to-end climate change problem, from understanding causes and processes to supporting actions needed to cope with the impending societal problems of climate change." Among their top six priority recommendations, three are pertinent to and could at least partially be addressed in future carbon cycle research. These are:

- Establish a U.S. climate observing system, defined as including physical, biological and social observations, to ensure that data needed to address climate change are collected or continued.
- Develop the science base and infrastructure to support a new generation of coupled Earth system models to improve attribution and prediction of high-impact regional weather and climate, to initialize seasonal-to-decadal climate forecasting, and to provide predictions of impacts affecting adaptive capacities and vulnerabilities of environmental and human systems.
- Strengthen research on adaptation, mitigation, and vulnerability.

The NRC also recommended a program organized around "integrated scientific-societal issues to facilitate crosscutting research focused on understanding the interactions among the climate, human, and environmental systems and on supporting societal responses to climate change." This solicitation encourages proposers to address integrated scientific-societal issues in the carbon-oriented research proposed. Current, important scientific-societal issues relevant to carbon cycle science include:

- The potential for large abrupt release of carbon dioxide and other greenhouse gases;
- Competing demands for land and water and associated trade-offs among food/fiber, energy, biodiversity, and other ecosystem services;
- The increasing risk of disturbance (fire, floods, landslides, pests and diseases, invasive species/weeds);
- Ecosystems services under threat from global change related to water deficits or excesses, changing ranges of pests and diseases, and/or invasive species;
- Sustainability of production and management systems under a changing and increasingly variable climate;
- Monitoring and verification of mitigation effects for carbon, greenhouse gas, and other environmental markets;
- Biofuels and energy needs versus food, quality of life, and other ecosystem services;
- Land cover patterns, fragmentation and urban encroachment;
- Leakage/offsets in one region caused by carbon management in other regions -- global connections; and
- How mitigation and adaptation efforts interact with each other and with climatic and ecological changes in determining risks, vulnerabilities, and response challenges associated with climate change.

Interactions between the scientific community and existing or emerging carbon information stakeholders will be essential in addressing these scientific-societal issues in an integrated, end-to-end manner. Stakeholders should have specific mandates or leverage on critical carbon issues with information needs that the science community can affect rapidly and effectively. Examples of relevant stakeholder types include land use and resource managers; international organizations responsible for coordinating scientific research, assessments, and/or observations; carbon monitoring and/or reporting businesses; and climate policy makers.

3. Carbon Cycle Research Solicited

Current NASA and USDA-NIFA carbon cycle research contributes toward the goals of the USGCRP and the U.S. Ocean Action Plan by providing critical scientific information about the movement of carbon in the environment and potential near- and long-term changes in the carbon cycle, including the role of and implications for societal actions. U.S. carbon cycle research addresses two broad questions:

- How large and variable are the dynamic reservoirs and fluxes of carbon within the Earth system and how might carbon cycling change and be managed in future years, decades, and centuries?
- What are our options for managing carbon sources and sinks to achieve an appropriate balance of risk, cost, and benefit to society?

In this solicitation, NASA and USDA-NIFA request proposals for research and/or applied science investigations to address these questions in a manner that is responsive to the NRC's call for end-to-end research focused on integrated scientific-societal issues. Proposals within five research themes are requested. Each agency participating in this solicitation will be able to support research only in a subset of these themes, and the participating agencies are noted in parentheses for each theme listed below. The five research themes are:

1. Interactions between land management and land change and the carbon cycle (NASA, USDA);
2. Ocean acidification (NASA);
3. Advancing the scientific basis for space-based measurements of atmospheric carbon dioxide and/or methane (NASA);
4. Adaptation, mitigation, and vulnerability within the Earth system (land, ocean, and atmosphere) (NASA, USDA); and
5. Synthetic and integrative research to advance the carbon-related goals of ongoing research activities under the U.S. Carbon Cycle Science Program and the carbon-related goals and objectives of related national and international programs. (NASA, USDA).

3.1 <u>Interactions between land management and land change and the carbon cycle</u> (NASA, USDA)

Land use and land management decisions have historically centered on production and/or other ecosystem products and services (water storage/quality, habitat, etc.) but can have a profound impact on the carbon cycle and climate. Much of this impact relates directly to the effects of these decisions on carbon stocks and greenhouse gas fluxes, both above- and below-ground (soils), and in both terrestrial and aquatic systems. Carbon cycle research under this theme is expected to address the effects of land management and land use on carbon and greenhouse gas fluxes, both above and below ground, and the tradeoffs between greenhouse gases and other products and services provided by terrestrial and aquatic ecosystems. Priority will be given to projects investigating vulnerable systems of high potential flux that affect food and fiber production systems, both terrestrial and aquatic.

Research may include assessment/synthesis of resilience and vulnerability of land carbon stocks potentially affected by land change and disturbance. Facets of this may include natural and direct or indirect human impacts; urban, exurban, agricultural, natural and managed forest, shrub, grassland, and range ecosystems; and agricultural production systems coupled to natural or urban systems. Land use changes may include, for example, deforestation and afforestation, urban encroachment, land conversions to and from agricultural uses, changes related to renewable energy production, changes in crop, range, pasture, or forest management systems, and fragmentation of land cover types. This theme could also include changes brought about through disturbance as well as intentional and natural responses to climate change. Within land use types, there are many management options. Intentional management responses to climate change in forests, rangelands, grasslands, croplands, and watersheds include such things as harvest practices, clearing, burning and fire management, road construction, fertilization, irrigation and drainage, stocking rates, crop/species choices, manure and fertilizer management, tillage, weed and pest control, and water management.

Assessing and understanding the resilience and vulnerability of important carbon stocks or sinks to land use change and disturbance is needed to prioritize adaptation and mitigation strategies. Projects that integrate research with outreach and/or education for various types of decision makers may be proposed under this theme. Such integrated projects should involve stakeholders from the beginning and throughout the project. Research may include assessing sustainable land change methodologies and technologies that can be implemented by stakeholders to provide information that is essential for efficient markets and effective programs and oversight. Development of decision support tools, educational materials, and outreach strategies related to carbon management and policies, including carbon markets and verification, are also solicited under this theme. Research may include educational materials directed toward carbon stakeholders (e.g., carbon trade markets, environmental industry) that link science-based information and processes to their requirements for transparency, latency, objectivity, and spatial coverage. Projects of this type should lead to measurable changes in learning or conditions, or adoption of technology in an identified audience or stakeholder group. These projects should also include a review of science results from carbon cycle research to identify outcomes with potential impact on specific decision-making processes, and should further include strategies for stakeholder input into the development of the product.

3.2 Ocean acidification (NASA)

The oceans play a critical role in the global carbon cycle and in Earth's climate. A variety of processes interact among land, ocean, and atmosphere within the Earth System, and the interplay of those processes impact and feedback to ocean chemistry. Changes in ocean chemistry, as a result of both natural and anthropogenic factors, affect ocean biological processes and ocean ecosystems. Oceanic uptake of CO_2 is altering the chemistry of the world's oceans, which has consequences for ocean biology, ecology, and biogeochemistry. Understanding these impacts requires integrative approaches to understand the linkages among ecosystem components and feedbacks to climate. As concentrations of CO_2 increase in the atmosphere, the oceans take up more CO_2. Increased oceanic CO_2 uptake leads to pH reductions and changes in seawater chemistry that are commonly referred to as ocean acidification. Ocean acidification is a poorly understood area, and its drivers, impacts, and feedbacks are in need of further study. The long-reaching impacts involve future carbon management strategies, requiring our understanding of how aquatic biota partition carbon, and how ocean processes affect and constrain where in the ocean CO_2 may be sequestered.

NASA welcomes proposals for studies that address our understanding of ocean acidification and the impacts and feedbacks on ocean chemistry, ecology, and biology. These may include but are not limited to: 1) the impact of increasing or high CO_2 concentrations on ocean chemistry, 2) the evolving ability of the oceans to take up $CO_{2,}$ and 3) the characterization and delineation of possible interactions between the effects of increasing $p(CO_2)$ and effects due to climate-induced changes in variables such as temperature and nutrients. To the extent possible, predictions of changes and quantification and characterization of impacts and feedbacks of ocean acidification on the broad ocean system, especially carbon dynamics, with the associated errors, are encouraged. Proposed studies should address the recommendations and priorities as outlined in numerous national and international reports, including the "Present and future impacts of ocean acidification on marine ecosystems and biogeochemical cycles" and the report of the Ocean Carbon and Biogeochemistry scoping workshop on ocean acidification research (http://www.us-ocb.org/publications/OCB_OA_rept.pdf).

Development of educational materials and outreach strategies related to ocean acidification and associated policies are encouraged as part of the research solicited under this theme. Educational materials may be directed toward managers and stakeholders, and should link science-based information and processes to stakeholder requirements. Research should lead to measurable changes in learning or management capacity, or adoption of the research by a stakeholder group. Projects should also include a review of science results from ocean acidification research to identify outcomes with a potential impact on specific decision-making processes.

3.3 Advancing the scientific basis for space-based measurements of atmospheric carbon dioxide and/or methane (NASA)

In NASA's 2007 carbon cycle science solicitation (see Appendix A.3 of ROSES-2007 at http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={968D6A15-5392-0610-805F-CEF833111BBF}&path=past), NASA called for research to prepare the scientific community for analysis of data from the Orbiting Carbon Observatory (OCO). This mission was designed to obtain highly precise and accurate column average abundances of atmospheric CO_2 on a global basis. The goal for OCO was to make much improved inferences of the sources and sinks of atmospheric CO_2 compared to what is available with current data sets. The OCO satellite failed to reach orbit during its launch in February 2009. NASA remains committed to advancing the science behind the design of OCO in order to be prepared to maximize the use of data from a potential OCO re-flight or other satellite missions with similar scientific goals. NASA has recently solicited research to utilize global satellite and *in situ* observational data sets to improve understanding of the carbon cycle; assess the validity of inferring CO_2 sources, sinks, and fluxes from atmospheric measurements; and assess the quality of the various data sets (see Appendix A.5 of ROSES-2009 at http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId=%7bE95BFF05-865B-5DB9-AE0C-E74B0D5B5D19%7d&path=open).

In this solicitation, NASA is interested in proposals that will complement these studies to further enhance community preparedness for future CO_2 observing missions. Specifically, research is solicited to continue improving atmospheric transport and inversion models and/or developing data assimilation and data fusion approaches tailored specifically to the characterization of carbon sources and sinks using atmospheric measurements. Validation of satellite data products remains a strong interest, and research to utilize existing suborbital observations and infrastructure to evaluate current greenhouse gas data products would be welcome. Research to establish a stronger scientific foundation for future greenhouse gas monitoring systems or decision support capabilities utilizing satellite observations is also of potential interest.

3.4 Research on adaptation, mitigation, and/or vulnerability to climate change (land-ocean-atmosphere) (NASA, USDA)

Carbon cycle-oriented research under this theme is expected to address the role of humans in mitigating and adapting to the impacts of climate change and/or adaptation and vulnerability in ecosystems.

The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as "the adjustment of a human or natural system in response to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences." Research on adaptation might include study of the effects of human actions on land and energy use, carbon fluxes, and ecosystem services, products and/or structure; development of indicators of adaptive capacity; assessment of adaptation options in terms of their ability to reduce unwanted consequences while maintaining ecosystem services; or assessment of barriers/constraints to adaptation.

The IPCC defines mitigation as "purposeful (anthropogenic) intervention to reduce anthropogenic forcing of the climate system, including reducing greenhouse gas emissions or enhancing greenhouse gas sinks." Research on mitigation might include development/evaluation of monitoring strategies for assessing the efficacy of or verifying reporting on mitigation actions, studies of the effects/efficacy of incentives and regulations, or evaluation of the environmental impacts associated with the mitigation action. Research that addresses the scientific foundation for measurement and analytical approaches to monitoring and/or verification of mitigation and adaptation effects is of interest. This research may include integration of science-based products and processes into actual decision support systems to provide essential information for decision makers and provide critical feedback on the efficacy of science results in meeting carbon stakeholder requirements. Such work may include the development of better estimation tools and procedures.

The IPCC defines vulnerability as "the degree to which a system (human or natural) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes." It is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. Research on vulnerability might include development of scenarios, vulnerability maps, and adaptive capacity metrics; modeling feedbacks and nonlinearity between adaptation and mitigation; or examining vulnerability, adaptive capacity, and adaptation options in terms of type of event, location and scale, socioeconomic characteristics of affected populations, sector, and/or constraints and opportunities for governance and policy implementation.

Most of the examples of relevant research provided in this section have been extracted from the NRC's 2009 report as illustrative of the types of studies that might be proposed, but other types of studies are not precluded. This opportunity is open to research that addresses adaptation, mitigation, and vulnerability in oceanic, coastal, freshwater aquatic, terrestrial, and human systems. Studies focused on the scientific-societal issues identified in section 2 are of strong interest.

3.5 <u>Synthesis and integrative research</u> (NASA, USDA)

Integrative studies that build upon the results of past carbon cycle research and create a new synthesis are a current priority within the U.S. Carbon Cycle Science Program. Of particular interest are 1) integrative studies to significantly advance the results of prior research toward new scientific insights and meaningful answers to the USGCRP's carbon cycle science questions (see Section 3) and 2) application of these results to new decision support uses. Studies are solicited to advance the goals and objectives of and/or support the integrative analysis infrastructure of the following U.S. carbon cycle science programs and projects: the North American Carbon Program (NACP), the Ocean Carbon and Climate Change (OCCC) program, Greenhouse Gas Reduction through Agricultural Carbon Enhancement Network (GRACEnet), the AmeriFlux network, Sustainable Agroecosystems Science Long-Term Agroecosystem Program **(**LTAP), and related long-term carbon cycle related projects. Studies are also solicited to advance the carbon-related goals and objectives of major international programs and projects, including the Northern Eurasia Earth Science Partnership Initiative (NEESPI) and the Monsoon Integrated Regional Study (MAIRS), both under the International Geosphere-Biosphere Programme (IGBP) and World Climate Research Programme (WCRP). During the last few years many carbon-related studies have been supported under NEESPI and MAIRS for their respective geographic regions, so it is appropriate that this solicitation calls for synthesis and integrative analyses for these programs.

3.6 Additional Requirements for Proposals

Proposers are advised to take care to match their proposed activities to the research themes solicited (see Section 3) and the scientific goals (see Section 1) and programmatic considerations (see Sections 4.2 and 4.3) of each agency. Proposers are encouraged to contact the relevant agency point of contact listed in Section 5 if they have any questions regarding the appropriateness of or requirements for a particular type of study.

In addition to the requirements specified under each research theme in Sections 3.1-3.5 above, all proposals must adhere to the requirements detailed below.

All proposals must address how error and uncertainty will be dealt with in the study and describe how an understanding of the errors associated with measurement, quantification, and/or interpretation will be conveyed along with the research results.

All proposals must explain how the research proposed addresses the end-to-end climate change problem (see Section 2 and *Restructuring Federal Climate Research to Meet the Challenges of Climate Change*). Proposals should identify key stakeholder groups and, if appropriate, describe how they will be involved in the study. Proposals that address causes and consequences that involve human actions or responses must include appropriate social science expertise on their research teams.

To be eligible for NASA funding, the proposed research must make substantial use of remotely sensed data from satellites or airborne platforms.

To be eligible for USDA-NIFA funding, the proposed budget plan must comply with USDA-NIFA restrictions on indirect costs and allowable expenses (see Sections 4.3.4 and 4.3.5) or be willing to adjust budgets to comply with these restrictions upon being recommended for an award.

4. Programmatic Information

4.1 Evaluation and Selection of Proposals

4.1.1 *NASA and USDA-NIFA Cooperation*

All proposals will be submitted to a NASA-led peer review process in accordance with the guidelines provided in this solicitation and the *NASA Guidebook for Proposers*. NASA and USDA-NIFA will collaborate in the planning and conduct of the peer review. This peer review will be followed by a programmatic review in which NASA and USDA-NIFA program officers will assess program balance across the highly rated proposals and evaluate any logistical, implementation, cost, or management concerns. The NASA and USDA-NIFA program officers will recommend for selection the proposals that best address the objectives of this solicitation within resource constraints. The program officers will also recommend the division of funding responsibilities between the agencies consistent with each agency's mission (see Section 4.1.2 on evaluation criteria below). Co-funding is possible, and NASA and USDA-NIFA reserve the option of funding co-investigator institutions either as subawards of the principal investigator institution's award or as separate awards directly to the co-investigator institutions. The funding recommendations will be forwarded to each participating agency's Selection Official for confirmation. The Selection Official for USDA-NIFA will be the Research Director, Competitive Programs. The Selection Official for NASA will be the Director, Earth Science Division. NASA will announce the official selection of proposals for award, recognizing the agency or agencies that have agreed to be responsible for funding.

Proposals that USDA-NIFA has agreed to be responsible for will be forwarded to USDA-NIFA for final negotiations and implementation of awards. Respondents selected for funding by USDA-NIFA will be required to submit additional documentation. Further information will be provided to applicants selected for USDA-NIFA funding.

4.1.2 *Evaluation Criteria*

Proposals will be evaluated according to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*. In addition to the factors given there, the evaluation of intrinsic merit for a proposal shall consider the experience of the offeror (investigators and their institutions) in engaging in data sharing and providing timely access to data and research products on related and relevant projects.

In addition to the factors given in the *NASA Guidebook for Proposers*, evaluation of a proposal's relevance also will consider the potential contribution to the mission of USDA-NIFA as well as its contribution to the NASA mission.

4.2 Programmatic Information Specific to NASA

4.2.1 *High-End Computing Resources*

Those investigators whose research requires high-performance computing should refer to the *ROSES Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to apply for computing time on either of two NASA computing facilities at Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at Ames Research Center's Advanced Supercomputing Division.

4.2.2 *Education and Public Outreach Opportunities*

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. Proposers may be eligible to propose a supplemental Education or Outreach effort if their research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4.3 Programmatic Information Specific to USDA-NIFA

4.3.1 *Eligibility*

For *research projects*, the eligibility requirements for the AFRI are as follows: Eligible applicants for the grant program implemented under this subpart include: (1) State agricultural experiment stations; (2) colleges and universities (including junior colleges offering associate degrees or higher); (3) university research foundations; (4) other research institutions and organizations; (5) Federal agencies, (6) national laboratories; (7) private organizations or corporations; (8) individuals who are U.S. citizens, nations, or permanent residents; and (9) any group consisting of 2 or more entities identified in (1) through (8). Eligible institutions do not include foreign and international organizations, unless otherwise provided in this research announcement.

For *integrated projects (those that request funding for outreach and/or education activities)*: Colleges and universities (as defined in section 1404 of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (NARETPA), 7 U.S.C. 3103) are eligible to submit applications to the AFRI program. For the purposes of this program, the terms "college" and "university" mean an educational institution in any state which (1) admits as regular students only persons having a certificate of graduation from a school providing secondary education, or the recognized equivalent of such a certificate; (2) is legally authorized within such state to provide a program of education beyond secondary education; (3) provides an educational program for which a bachelor's degree or any other higher degree is awarded; (4) is a public or other nonprofit institution; and (5) is accredited by a nationally recognized accrediting agency or association. Applications also may be submitted by 1994 Land-Grant Institutions and Hispanic-serving agricultural colleges and universities (as defined in section 1404 of NARETPA, 7 U.S.C. 3103). A research foundation maintained by a college or university is eligible to receive an award under this program. For a definition of USDA-NIFA integrated projects, please see page 15 of the 2009 AFRI Request for applications at http://www.nifa.usda.gov/funding/rfas/pdfs/09_afri_ext_4-24-09.pdf.

4.3.2 *Legislative Authority*

Section 7406 of the Food, Conservation, and Energy Act of 2008 (FCEA) (Pub. L. 110-246) amends section 2(b) of the Competitive, Special, and Facilities Research Grant Act (7 U.S.C. 450i(b)) to authorize the Secretary of Agriculture to establish the Agriculture and Food Research Initiative (AFRI); a competitive grant program to provide funding for fundamental and applied research, extension, and education to address food and agricultural sciences. Grants shall be awarded to address priorities in United States agriculture in the following areas:

1. Plant health and production and plant products;
2. Animal health and production and animal products;
3. Food safety, nutrition, and health;
4. Renewable energy, natural resources, and environment;
5. Agriculture systems and technology; and
6. Agriculture economics and rural communities.

Section 7406 of the FCEA also authorizes support for integrated programs under section 406 of the Agricultural Research, Extension, and Education Reform Act of 1998 (7 U.S.C. 7626). Eligible applicants for the integrated programs include: (1) colleges and universities (as defined in section 1404 of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (7 U.S.C. 3103)); (2) 1994 Institutions (as defined in section 532 of the Equity in Educational Land-Grant Status Act of 1994 (Public Law 103–382; 7 U.S.C. 301 note)); and (3) Hispanic-serving agricultural colleges and universities (as defined in section 1404 of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (7 U.S.C. 3103), as amended).

To the maximum extent practicable, the National Institute of Food and Agriculture (NIFA), in coordination with the Under Secretary for Research, Education, and Economics (REE), will make grants for high priority research, education, and extension, taking into consideration, when available, the determinations made by National Agricultural Research, Extension, Education, and Economics Advisory Board (NAREEEAB) pursuant to section 2(b)(10) of the Competitive, Special, and Facilities Research Grant Act (7 U.S.C. 450i(b)(10)), as amended. The authority to carry out this program has been delegated to NIFA through the Under Secretary for REE.

STAKEHOLDER INPUT: The National Institute of Food and Agriculture (NIFA) is requesting comments regarding Appendix A.5 of this research announcement from any interested party. These comments will be considered in the development of the next research announcement for the program, if applicable, and will be used to meet the requirements of section 103(c)(2) of the Agricultural Research, Extension, and Education Reform Act of 1998 (7 U.S.C. 7613(c)(2)). This section requires the Secretary to solicit and consider input on a current research announcement from persons who conduct or use agricultural research, education, and extension for use in formulating future research announcements for competitive programs. Written stakeholder comments directed toward Appendix A.5 of this research announcement should be submitted in accordance with the guidelines set forth below.

Written stakeholder comments should be submitted by mail to: Policy and Oversight Branch; Office of Extramural Programs; National Institute of Food and Agriculture; USDA; STOP 2299; 1400 Independence Avenue, SW; Washington, DC 20250-2299; or via e-mail to: RFP-OEP@nifa.usda.gov. (This e-mail address is intended only for receiving comments regarding this research announcement and not for requesting information or forms.) In your comments, please state that you are responding to the Agriculture and Food Research Initiative Joint Carbon Cycle Science research announcement. Comments regarding this research announcement are requested within six months from the issuance of this announcement. Comments received after this date will be considered to the extent practicable.

4.3.3 *Current and Pending Support*

For proposals funded by USDA, the agency requires that the Current and Pending Support information be submitted for all Project Directors (PDs) and Senior/Key Persons regardless of percentage of effort.

4.3.4 *Limit on Indirect Costs for USDA-NIFA Awards*

Section 7132 of the Food, Conservation, and Energy Act amended section 1462(a) of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (7 U.S.C. 3310(a)) regarding recovery of indirect costs. The recovery of indirect costs on awards made by NIFA under this program area may not exceed the lesser of the institution's official negotiated indirect cost rate or the equivalent of 22 percent of total Federal funds awarded. 22 percent of total Federal funds is equivalent to 28.205 percent of total direct costs. If a project is chosen for funding by USDA the applicant will be required to adjust the budget if it does not comply with this limitation.

4.3.5 *Allowable Expenses*

Funds made available for grants under the AFRI program shall not be used for the construction of a new building or facility or the acquisition, expansion, remodeling, or alteration of an existing building or facility (including site grading and improvement, and architect fees).

5. Summary of Key Information

Expected program budget for first year of new awards	NASA: $7.5 M; USDA: $1.67 M
Number of new awards pending adequate proposals of merit	NASA: 30-45; USDA: 6-8
Maximum duration of awards	3 years

Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2011
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA and/or USDA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA. Proposals for USDA funding must address one or more of the USDA objectives listed in Section 3 of this Appendix.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-CARBON
Lead and NASA Research Program point of contact concerning this program	Dr. Diane E. Wickland Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0245 E-mail: Diane.E.Wickland@nasa.gov
NASA Applied Sciences Program point of contact concerning this program	Dr. Bradley Doorn Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-2187 E-mail: Bradley.Doorn@nasa.gov

USDA point of contact concerning this program	Dr. Nancy Cavallaro Soils and Global Change Programs U.S. Department of Agriculture National Institute of Food and Agriculture Washington, DC 20250-2241 Telephone: (202) 401-5176 E-mail: ncavallaro@nifa.usda.gov

A.6 CRYOSPHERIC SCIENCE

1. Program Overview

1.1 Background

NASA's Cryospheric Sciences Program supports basic research on the Earth's sea- and land-based ice to understand its connections to the global system. Recent satellite observations show dramatic changes in the Earth's polar ice sheets, especially in the thickness and extent of Arctic and Antarctic sea ice, and thinning of the outlet glaciers draining the ice sheets covering Greenland and Antarctica. Given the tremendous areas that must be studied to characterize this change, space-based and other remote sensing techniques are required.

1.2 Scope of Program

This solicitation calls for proposals to understand the mechanisms of change in polar regions and their implications for global climate, sea level, and the polar environment. Proposed studies should use space-based and other remote sensing techniques to understand the factors controlling the retreat and growth of the world's major sea- and land-based ice sheets and their interactions with the ocean, atmosphere, solid earth, and solar radiation. Field studies are considered if closely tied to remote sensing efforts.

Specific goals of the program are to improve our understanding of the following:

- Mechanisms controlling mass balance and dynamics of the ice sheets of Greenland and Antarctica; including studies aimed at improving fundamental understanding of ice flow, ice shelves, grounding lines, bed, melt water formation and role, and connections to the ocean, sea ice cover, and atmosphere;
- Use of remote sensing data to develop, validate, and improve predictive models of the contribution of land-based ice to sea level change, especially in the coming century;
- Mechanisms controlling sea ice cover, including quantification of the connections between sea ice and the ocean and atmosphere, and determining the effects of changing sea ice cover;
- Use of remote sensing data to validate and improve predictive models of changes in sea ice cover, especially in the coming century, and the implications of these changes to the ocean, atmosphere, surrounding land areas, and global system;
- Improvements to the use of remote sensing techniques to estimate snow accumulation on sea- and land-based ice; and
- Utilization of surface roughness measurements to characterize critical unknowns for sea- and land-based ice.

To this end, NASA is soliciting studies of (a) the northern and southern hemisphere ice-covered oceans to determine their response to climate change and (b) the Greenland and Antarctic ice sheets to understand the controls on their mass balance. Studies of polar and non polar mountain glaciers will be considered if such studies cover broad geographical areas; and are of consequence to understanding systemic impacts of global climate change, sea level change, or elucidating fundamental processes that control glacier dynamics that may have applications to polar ice sheets.

In addition, NASA expects synergy among observations, modeling, and field campaigns and strongly encourages all Arctic projects to connect with the Study of Environmental Arctic Change (SEARCH; http://www.arcus.org/SEARCH/index.php), the interagency effort to understand the nature, extent, and future development of the system-scale change presently seen in the Arctic.

Use of the extensive data sets collected by NASA and other satellite and airborne remote sensing campaigns is strongly encouraged, and all projects should consider utilizing the data collected under NASA's IceBridge mission (http://www.espo.nasa.gov/oib/), an airborne remote sensing mission collecting altimetry, radar, gravity and other data in both polar regions. Data is available at the National Snow and Ice Data Center (NSIDC; http://nsidc.org/).

The program's focus is on the use of remote sensing data to study the Earth's cryosphere. Field projects will be considered, but must be intimately tied to remote sensing work or improving the utility of remote sensing techniques. As well, projects developing numerical models of cryospheric processes will be considered, but must use remote sensing datasets for development and validation.

1.3 Arctic Studies

For Arctic sea ice, the program's focus is to understand the observed changes — in extent, concentration, thickness, and dynamics — in the context of ocean circulation and northern hemisphere climate. Understanding the feedback mechanisms associated with sea ice cover and the surrounding land, ocean, atmosphere, and sunlight is intended to both improve predictive models for the Arctic and establish links between high-latitude and low-latitude climates. Among the data sets available to support such efforts are those stored at the Distributed Active Archive Center (DAAC) at the National Snow and Ice Data Center (http://nsidc.org/), such as ICESat.

For Arctic land ice, understanding the changes in the mass balance of the Greenland and other northern hemisphere glaciers is essential to understanding and modeling their dynamics and contributions to sea level. Since 1995, NASA's Program for Arctic Regional Climate Assessment (PARCA; http://nsidc.org/data/parca/) has focused a coordinated effort on determining the dynamics and mass balance of the Greenland ice sheet through a combination of targeted field campaigns, satellite data analysis, aircraft observations, and process modeling. Given the crucial role of certain northern hemisphere glaciers and the Greenland ice sheet to sea level rise, the program's focus is to advance understanding of land-ice processes, especially connections between the warming ocean and increases in glacial flow rates; determining how the ice sheet interior is tapped by outlet glaciers; and determining the connections between glacial dynamics, bed characteristics, and melt water. The program is also focused on determining accumulation rates to mass balance estimates. Some unique data resources available to support this work include the altimetry data collected by NASA's Airborne Topographic Mapper (ATM) archived at http://science.wff.nasa.gov/page/2.html%3F&MMN_position=2:2.html as well as ICESat, IceBridge, GRACE, and various radar satellites.

For proposals requiring Arctic fieldwork in Greenland utilizing NSF's Arctic Program resources, proposers will be required to obtain a cost estimate for the proposed fieldwork as discussed in NSF's Arctic Sciences research solicitation (http://www.nsf.gov/div/index.jsp?div=ARC). A copy of the summary costs must be included with the proposal.

1.4 Antarctic Studies

For the Southern Ocean and the Antarctic ice sheet, the program is focused on the dynamics and mass balance of the overall ice sheet; the potential instability of the West Antarctic ice sheet; the interaction of the warming ocean with ice shelves; characteristics and changes of the glacial grounding lines; sub-ice hydrology; and changes in the extent of sea ice. There is also a need to assess the likelihood of rapid ice sheet response to the large changes in elevation and mass loss observed in some outlet glaciers — by ICESat, GRACE, the IceBridge airborne campaigns, and radar satellites — and how changes in these outlet glaciers may affect the stability of the interior ice sheet.

For proposals requiring Antarctic fieldwork, proposers must contact the Cryosphere program manager at NASA headquarters and the Glaciology Program Manager at NSF's Antarctic Sciences Program (http://www.nsf.gov/div/index.jsp?div=ANT) prior to submitting the proposal. Proposers are required to complete an Operational Requirements Worksheet (ORW) as discussed in NSF's Antarctic Science research solicitation (http://www.nsf.gov/div/index.jsp?div=ANT). A copy of the summary ORW must be included with your proposal.

2. Programmatic Information

Results from investigations supported under this solicitation are expected to advance the goals that are articulated in one or more of the Science Mission Directorate's Science Focus Area roadmaps (see http://nasascience.nasa.gov/about-us/science-strategy/), as well as a number of Presidential Mandates and associated Federal research objectives, e.g., the U.S. Global Climate Change Science Program (see http://www.globalchange.gov/) and its strategic plan, which address aspects on understanding the role of glaciers, ice sheets and sea ice within the Earth system.

3. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $3M
Number of new awards pending adequate proposals of merit	~ 12
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	Not Requested.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-CRYO
NASA point of contact concerning this program	Dr. Thomas Wagner Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-4682 E-mail: thomas.wagner@nasa.gov

A.7 PHYSICAL OCEANOGRAPHY

1. Scope of Program

NASA's Physical Oceanography program supports basic research and analysis activities that enable development of NASA's current and future physical oceanography satellite missions and the scientific interpretation of data from them. The primary centers of support for the Physical Oceanography program are at the NASA Goddard Space Flight Center Laboratory for Hydrospheric Processes, the NASA Jet Propulsion Laboratory Earth Science Directorate, and the external (non-NASA) scientific community. This announcement serves as the vehicle for participation in the Physical Oceanography program for all institutions.

The primary scientific thrust for physical oceanography at NASA is toward understanding the ocean's role in climate variability and its prediction. Since the general ocean circulation plays a critical role in the global heat balance and materially changes atmospheric properties through air-sea exchange, understanding and modeling the state of the coupled ocean-atmosphere system are fundamental to climate studies. NASA utilizes the unique vantage point of space to enable rapid collection of global ocean data sets and intends to contribute significantly to the World Climate Research Program's Climate Variability and Predictability (CLIVAR) Program.

An emerging area of increased emphasis in NASA's Physical Oceanography program is research on the coastal ocean. While NASA's focus will remain global in nature, it is recognized that many of the practical problems with respect to human interaction with the ocean lie within the coastal seas.

Two research themes are identified in the Physical Oceanography program and represent priority areas for proposals solicited through this announcement.

- *Analysis and interpretation of the ocean circulation using satellite and in situ data.* NASA will support modest proposals undertaking analysis of satellite altimetry, surface wind stress, and other relevant data in support of the U.S. CLIVAR Program (http://www.usclivar.org).

- *Exploitation of sea-surface temperature products.* NASA is playing a central role in providing the next generation of data products for sea surface temperature through the Group on High-Resolution Sea Surface Temperature (GHRSST) (http://www.ghrsst-pp.org). Proposals are sought which utilize or exploit these data products for innovative physical oceanographic science.

2. Programmatic Information

Total funds available for work selected under this solicitation are approximately $2.0M per year for 3 years.

Programmatic priority will be given to those proposals making the strongest links to analysis of satellite data and addressing oceanographic problems at basin or global scale.

Based on the quality of proposals received, awards will be distributed across the two research themes identified in Section 1. Proposals outside these research themes may be considered but must be highly meritorious.

2.1 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $2M
Number of new awards pending adequate proposals of merit	~ 10-15
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	1 January 2011
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.

Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-PO
NASA point of contact concerning this program	Dr. Eric Lindstrom Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-4540 E-mail: eric.j.lindstrom@nasa.gov

A.8 Ocean Salinity Science Team

The objective of this program element is to select additional members for the U.S. Ocean Salinity Science Team to support and participate in the U.S./CONAE Aquarius/SAC-D mission and joint Aquarius/SAC-D Science Team. The initial Ocean Salinity Science Team was competed in ROSES 2008. Proposals exploiting the Aquarius data for ocean science investigations are the theme of this announcement. It is the "Phase 2" competition promised in ROSES 2008.

1. Background Information

The Aquarius SAC-D Observatory comprises the SAC-D spacecraft provided by CONAE, the NASA-provided Aquarius instrument, several CONAE-provided instruments, including the New Infra-Red Sensor Technology (NIRST) camera, a K-band radiometer for measurements of surface temperature, surface wind, sea ice, and rain, the High Sensitivity Optical Camera, and the Data Collection Tranceiver, and other third party instruments. A full description of the observatory may be found online at http://www.esr.org/aquarius.html.

The objective of Aquarius instrument is to contribute to a better understanding of ocean circulation, the prediction of changes in this circulation, and its impact on Earth's climate and water cycle. Aquarius is described fully at http://aquarius.gsfc.nasa.gov/.

The NASA Ocean Salinity Science Team (OSST) supports basic research and analysis activities associated with the salinity measurement objectives of the Aquarius/SAC-D Mission. Selected investigators will become members of a larger international Aquarius/SAC-D Science Team supporting the overall Aquarius/SAC-D mission. A similar announcement will be made by the CONAE for Argentine and International proposals, and a joint selection and announcement will be coordinated by the two agencies in 2010.

The goals of the OSST are to provide the scientific underpinning for production of the best possible satellite-derived ocean salinity data sets and to demonstrate the Earth science and applications arising from analyses of the ocean surface salinity data. Specifically, this program element seeks proposals addressing the following objective:

- *Conduct ocean science investigations that are possible only through exploitation of Aquarius data.*

Proposals addressing this objective must use Aquarius data in a fundamental way to further ocean science. Selected investigations will become part of the Ocean Salinity Science Team supporting the Aquarius/SAC-D mission. Therefore it is also expected that proposed applications of Aquarius data conceive of means to provide input to the overall evaluation of the sea surface salinity uncertainty in the Aquarius products.

2. Programmatic Information

Proposals outside this research theme will be considered but must be highly meritorious.

3. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $2M
Number of new awards pending adequate proposals of merit	~ 10-15
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	April 1, 2011
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-OSST
NASA point of contact concerning this program	Dr. Eric Lindstrom Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-4540 E-mail: Eric.J.Lindstrom@nasa.gov

A.9 OCEAN VECTOR WINDS SCIENCE TEAM

NOTICE: Ocean Vector Winds Science Team will not be competed in 2010. The Ocean Vector Winds Science Team is tentatively scheduled to next solicit proposals in ROSES 2013.

The Ocean Vector Wind Science Team (OVWST) supports the analysis and interpretation of ocean vector winds and other applications derived from Earth-observing missions carrying scatterometers and polarimetric radiometers. Every four years this program element solicits scientific investigations that require the accurate and extensive vector wind and backscatter measurements. This element was last competed in 2009 and is anticipated to be open again in ROSES 2013.

Extensive background on NASA's ocean vector wind science program and missions is available at http://winds.jpl.nasa.gov/.

For information on this program, contact:

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A.10 Ocean Surface Topography Science Team

NOTICE: Ocean Surface Topography Science Team will not be competed in 2010. The Ocean Surface Topography Science Team is tentatively scheduled to next solicit proposals in ROSES 2011.

The joint NASA/CNES Ocean Surface Topography Science Team (OSTST) supports basic research and analysis activities associated with joint satellite altimetry missions (TOPEX/Poseidon (TP), Jason-1, and Ocean Surface Topography Mission) and other ocean altimetry data sets. The team is recompeted every four years. Proposals were last received in October 2007, and it is anticipated that proposals will be solicited again in ROSES 2011.

The goals of the OSTST are to provide the scientific underpinning for production of the best possible satellite-derived ocean surface topography data sets and to demonstrate the Earth science and applications arising from analyses of the ocean surface topography data. The team is also involved in the calibration and validation for the Ocean Surface Topography Mission (OSTM), a cooperative mission between NASA, CNES, the National Oceanic and Atmospheric Administration (NOAA), and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) which successfully launched in June 2008.

For information on this program, contact:

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National Aeronautics and Space Administration
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A.11 OCEAN SALINITY FIELD CAMPAIGN

The objective of this program element is to select additional members to the NASA Ocean Salinity Science Team for a 2012 Ocean Salinity Field Campaign in support of the science of the U.S./CONAE Aquarius/SAC-D mission and joint Aquarius/SAC-D Science Team**.** This field campaign, together with its associated modeling and data management, will be known as the Salinity Processes in the Upper-Ocean Regional Study (SPURS). The planned work coincides with the U.S.-Argentine Aquarius/SAC-D and European SMOS surface salinity satellite missions (planned for launch in 2010 and launched in 2009 respectively) as well as the continuing, global array of Argo profiling floats, all of which provide excellent new tools to monitor ocean salinity.

1. Background Information

As articulated in the report of the U.S. CLIVAR Salinity Working Group (2007), no part of the climate system is as important to society as the global hydrological cycle; yet we lack key understanding of its major element, the ocean. Thus, it is of great importance to improve our abilities to monitor, understand, and model the water cycle over and within the oceans. As upper ocean salinity (UOS) is an important variable that indicates the intensity of water exchange between ocean and atmosphere and has direct impact on the ocean's mass distribution, mixing rates, and associated interior circulation, improved observation systems for salinity and better understanding of the processes that control it are needed for progress in understanding the oceanic water cycle.

A workshop in December 2009 has laid out the framework for a study of UOS in the subtropical North Atlantic in 2012. A report of the workshop is available at http://SPURS.jpl.nasa.gov/. The report, describing the SPURS concept and associated field campaign, serves as the guide for submission of responsive proposals to this announcement. The web site also provides other useful background material – such as the 2007 report of the U.S. CLIVAR Salinity Working Group.

Research questions to be addressed in SPURS are:

1. What are the physical processes responsible for the location, magnitude and maintenance of the subtropical Atlantic sea surface and subsurface salinity maximum?
2. How will the ocean respond to changes in thermal and freshwater forcing associated with a changing climate?
3. What is the nature of the cascade of salinity variance from the largest (climate) scales down to dissipation scales of a few millimeters?
4. What new information must be supplied to ocean models in order for these questions to be adequately examined?

To address these questions, an observational and modeling program will be carried out throughout an annual cycle, beginning in early 2012, when the Aquarius/SAC-D satellite will provide near synoptic coverage of sea surface salinity (SSS). The satellite measurements of Aquarius/SAC-D and SMOS, with resolution scales of 150-200 km and 7-30 days, will provide the large-scale SSS fields surrounding the study region. In combination with surface currents derived from satellite sea surface height and vector wind data (see http://www.oscar.noaa.gov/ for information on the surface current analyses), the satellite SSS data will be used to compute the advective terms in the salinity balance as well as the large scale temporal evolution of SSS.

In addition to the satellite capabilities, a number of hardware elements of a potential field program in this region can be identified, including: underway ship-based observations such as sea surface temperature (SST), SSS, Chlorophyll-a and hull mounted acoustic Doppler current profiler (ADCP); shipboard conductivity/temperature/depth (CTD) stations, surface flux measurements, microstructure profilers, and towed SeaSoar capabilities; profiling floats equipped with surface salinity sensors (some with wind speed and rainfall capability, some with microstructure sensors); surface drifters equipped with salinity sensors; gliders (some equipped with microstructure sensors); and at least one mooring heavily instrumented with upper ocean velocity, temperature, and salinity sensors, plus the capability of measuring surface air-sea fluxes. Such field measurements should be complemented by numerical modeling and data assimilation studies in order to best interpret the data collected.

An additional objective of SPURS is to learn how to use a diverse array of modern and novel salinity measurements technologies described above to map upper ocean salinity fields. This capability, once matured, will expand our ability to study and understand the ocean's role in the global hydrological cycle.

SPURS, in concept, will consist of a set of nested experiments, with investigations sponsored by multiple U.S. agencies and with international contributions, designed to sample the characteristics of the salinity maximum region on large scales (2000 km or larger) and scales associated with eddy variability (~200 km and smaller) during the 2012 observational period. It will also support a robust modeling component and data management activity. The main components, by scale, are as follows:

<u>Large Scale</u>: This scale covers the entire subtropical ocean regime, with a focus on the region where SSS > 37 psu, where this isohaline surface forms the unique subtropical high salinity bowl. The large-scale assessment of this region would rely chiefly on the present coverage of satellites, ship-based sections, floats, and drifters, but with enhancements to expendable temperature and temperature/conductivity profiler (XBT/XCTD) lines and Argo float coverage for improved resolution to provide context to the observations within the mesoscale boxes described below.

A comparative study (North Atlantic SSS-maximum versus other subtropical SSS-maxima regions) using existing observing systems and global models must be carried out in order to provide a global scale context and linkage to the global water cycle.

<u>Mesoscale</u>: The highest resolution is within two 200-km boxes, one centered on the salinity maximum in the North Atlantic (the outcropping region) and one centered approximately 10° of latutude to the south of the maximum (the edge of the SSS > 37-psu region that marks the high salinity bowl), where the surface salinity gradients are large and evaporation minus precipitation (E−P) is a maximum. Within the mesoscale box, observations will resolve horizontal scales from

<10 km to the full 200 km scope of the box. The observational program may include a range of shipboard and autonomous platforms.

Small-scale: Focusing on scales of less than 10 km and time scales less than a day, these observations would be dedicated to estimation of the microscale dissipation parameters for energy (ε) and for temperature and salinity (χ) in as many places as possible using enhanced gliders, profiling floats, and shipboard measurements. The focus would be on sub-mesoscale and internal/inertial-wave induced mixing and processes such as salt fingers. The surface skin can be studied with upward-going profilers. The data will be used to make estimates of turbulent mixing at scales from several hundred kilometers down to the dissipation scale of millimeters.

Modeling Component: SPURS is conceived to be a fully-integrated observing and modeling program. Before the field experiment, SPURS will use models to perform Observing System Simulation Experiments (OSSEs) to aid the observing system design. During the field experiment, SPURS investigators will have access to real-time assimilative/forecasting models at the spatial scales of observational data being collected. After the field experiment, models will be used to produce reanalyses to further address the SPURS science questions.

Data Management: A SPURS data management system will be required to provide coherent and easy access to all the data and model products described above.

2. Programmatic Information

Significant interagency and international contributions to SPURS are being planned, but are not yet fully committed. Many of the existing large-scale in situ observing components are part of the Global Ocean Observing System and are coordinated by the NOAA Climate Program Office. In the past, oceanographic investigations of microstructure and turbulent mixing during process studies have been supported by the NSF and ONR. Also, significant contributions to SPURS are being planned in Europe. Given these developing interests, NASA is planning to emphasize support of SPURS proposals for the mesoscale, modeling, and data management components described above, while coordinating and supplementing contributions from other agencies for other aspects of the field program. Field program planning will incorporate all the components and leverage contributions from other nations and agencies.

Proposals responding to this program element should involve observation, modeling, or data management for the SPURS campaign. In addition to the particular scientific rationale for the specific observing or modeling proposal, justication and detailed description of instrumentation and ship-resource requirements should be specified. Personel requirements for shipboard work should be described. Lead time requirements for purchase and preparation of new equipment should be highlighted. Ship resources and schedule will be negotiated once a suite of investigations is selected.

This program element seeks only proposals supporting the salinity field campaign of 2012 centered on the subtropical North Atlantic Ocean. Other proposals related to analyis and exploitation of Aquarius salinity data for ocean science should respond to Appendix A.8 Ocean

Salinity Science Team (OSST). However, those investigations selected under this Ocean Salinity Field Campaign announcement will be incorporated into OSST meetings and activities.

2.1 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $2M
Number of new awards pending adequate proposals of merit	~ 10
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2011
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-OSFC
NASA point of contact concerning this program	Dr. Eric Lindstrom Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-4540 E-mail: Eric.J.Lindstrom@nasa.gov

A.12 MODELING, ANALYSIS, AND PREDICTION

1. Scope of Program

1.1 Overview

NASA's Science Mission Directorate (SMD) supports a broad portfolio of research in the Earth Science Research Program. Within the Earth Science Research Program, the Modeling, Analysis, and Prediction (MAP) program seeks an understanding of the Earth as a complete, dynamic system, with particular emphasis on climate and weather. Key questions that drive the core research efforts include:

- How is the Earth system changing?
- What are the forcing mechanisms driving observed changes?
- How does the Earth system respond to natural and human-induced changes?
- What are the consequences of Earth system change to society?
- What further changes can be anticipated, and what can be done to improve our ability to predict such changes through improved remote sensing, data assimilation, and modeling?

The MAP program supports observation-driven modeling that integrates across all the research activities in NASA's Earth Science Research Program. The research is distinguished by rigorous examination and incorporation of satellite-based observations, using models to bridge the spatial and temporal scales between satellite observations and observations from ground and air based campaigns. This contributes to the validation of the satellite observations and to observationally based improvements of Earth system model components. MAP strives to generate models and model components that are documented, evaluated, interoperable, and consistent with current coding standards and practices. An overview of the current program may be found at http://map.nasa.gov/.

1.2 Background

MAP funds several large projects and/or functional organizations that comprise the core activities of the program. These efforts include:

Goddard Institute for Space Studies (http://www.giss.nasa.gov/research/modeling/). GISS supports research on natural and man-made global climate change that may occur on the scale of decades to millennia. GISS makes use of analyses of comprehensive global datasets and planetary models of the atmosphere, the land surface, and the oceans. The research includes the study of paleoclimate and the study of other planets as an aid to prediction of future evolution of Earth on a planetary scale. The primary GISS modeling tool supported by the MAP program is the GISS Model E (http://www.giss.nasa.gov/tools/modelE/), a coupled atmosphere-ocean general circulation model (GCM).

NASA Goddard Global Modeling and Assimilation Office (http://gmao.gsfc.nasa.gov). GMAO addresses the optimal use of satellite and *in situ* observations to generate research quality data sets for climate analyses and also for weather, climate, and air quality forecasts. The modeling and assimilation research includes coupling to and assimilation of atmospheric chemistry and ocean biology and carbon. GMAO is focused on developing and maintaining world-class data assimilation systems for purposes associated with maximizing satellite data utility and serving as a centralized resource for testing and validating as wide a range of modeling and observational efforts as possible. The goal is to undertake modeling and assimilation as components of an end-to-end process, from defining an instrument, characterizing its in-flight performance, through to the development of algorithms and forward models for data assimilation, integrating the data into assimilation products, and finally assessing the impact of the data on the products of the assimilation system. GMAO is supported by MAP to develop and utilizes the Goddard Earth Observing System, version 5 (GEOS 5). GEOS 5 includes both a coupled atmosphere-ocean GCM and a data assimilation system (DAS). More information is available at: http://gmao.gsfc.nasa.gov/systems/geos5/.

1.3 Modeling, Analysis, and Prediction Research Themes

The specific research themes included in this Modeling, Analysis, and Prediction solicitation are as follows:

1.3.1 Ocean Modeling and Data Assimilation

A long-term goal of the MAP program is the development of an Integrated Earth System Analysis (IESA) capability. IESA is the process of consistently combining all available observations of the Earth System (atmosphere, ocean, land surface, sea-ice, and biogeochemistry) at some time with a model of the Earth System in such a way to produce a best estimate of the state of the Earth System at that time. This capability is not currently available given the start-of-the-art in modeling the global Earth System and the high computational requirements necessary for such a task.

At the present time, MAP is funding efforts to produce atmospheric analyses and reanalyses, and funds a related effort aimed at developing a best estimate of the evolution of the ocean state and ice sheets over the time period when significant ocean observations are available.

In this solicitation, MAP seeks proposals aimed at furthering NASA's capabilities in the area of ocean modeling and data assimilation, with a particular focus on development toward an integrated Earth System analysis. Issues MAP is interested in addressing in the area of ocean modeling and data assimilation include:

- Improvements in coupled ocean/atmosphere GCMs which include ice sheets.
- Generating improved initial conditions of the ocean state for seasonal to decadal prediction.
- Improved understanding of atmosphere/ocean interaction, including exchanges of heat, momentum, and carbon dioxide.
- Improved understanding of ocean/ice sheet interactions.
- Combined ocean/atmosphere analysis.

Proposals funded under the ocean modeling and data assimilation research theme must demonstrate a tie to either the GISS Model E or GMAO GEOS5 GCM/Data Assimilation System.

1.3.2 Earth System Modeling Framework for MAP-supported modeling efforts

The MAP program has developed and implemented the philosophy of a shared "modeling environment," or MAP-ME, which includes a community pool of Earth modeling code that is available to MAP-funded scientists to utilize in pursuit of their scientific efforts. In addition, code that is developed using MAP funding is made available to the MAP community through the software repository. A goal of the program is that the code contained in the repository be written using standardized software tools that increase code interoperability and utility. The Earth System Modeling Framework (ESMF) is a software package designed to facilitate the development of Earth Science codes with increased interoperability, reuse, ease of use, and portability (see http://www.esmf.ucar.edu/) for a full description of the software.

The NASA MAP program is interested in continuing the process of developing ESMF-compliance in MAP-supported codes, as well as in supporting continued development of the ESMF. The MAP program is therefore soliciting proposals that contribute to increased utilization of ESMF software within MAP-supported code, and work to further development of ESMF software in directions which are of benefit to NASA's modeling interests. Specific efforts of interest to NASA include:

1. Efforts to further develop the base ESMF implementation, for instance to develop a broader ESMF toolkit or improved grid conversion routines;
2. Development of "plug-ins" to the base ESMF implementation that expand its utility in ways that are demonstrably advantageous to codes currently or potentially within the MAP software repository;
3. Efforts to create or enhance the ESMF compliance of code whose development has been or is being supported by the MAP program; and
4. Efforts to utilize ESMF-compliant codes contained within the MAP software repository to expand the capabilities of the GEOS 5 or GISS Model E modeling systems to address scientific questions that cannot be currently approached with standard versions of the code.

2. Programmatic Information

2.1 Programmatic Priorities

Characterizing the limits of validity of models and model components and identifying the sources of uncertainties is important to realizing the goal of enabling whole Earth System Models. Therefore, preference will be given to proposals that; 1) characterize and/or help reduce uncertainties in the models and products; 2) extend the range of model or product validity by using new components; 3) exploit these products to address NASA Earth Science Division (ESD) research questions; 4) are in alignment with the goals and objectives of the core MAP elements described above; and 5) enable independent community validation and characterization of the core MAP elements leading to improvement of the models or products.

Proposals for new model component capabilities must include an evaluation activity that characterizes their limits of validity by comparing to observational data. In all cases, the proposer must explain how the validation methodology will help identify the source of uncertainty within the model or analysis product.

2.2 MAP Infrastructure

Adherence to the multiagency Earth System Modeling Framework (http://www.esmf.ucar.edu/), which provides a robust software infrastructure for coupling model elements, is desired by the program. Independent resources have been allocated to provide software engineering and interface support to successful proposals of this announcement to assure that the final product meets ESMF standards and investigator verification that the ESMF-compatible product yields desired results. Additional infrastructure support will be provided to the selected PIs as aids to increase productivity and to increase integration. There are three key types of support available:

- High-end computing (HEC) support from NASA Center for Computational Sciences (NCCS, https://nccs.nasa.gov/) and the NASA Advanced Supercomputing facility (NAS, http://www.nas.nasa.gov/) (see Section I(d) of the ROSES *Summary of Solicitation*);
- Expert assistance from computational scientists for optimization, porting, ESMF implementation, refactoring, testing, and other techniques to improve software; and
- Assistance with ancillary tools, including GUI-based workflow tools to assist in the set up and execution of model experiments with selected experiments preconfigured, assistance with visualization tools, support for access to modeling software, and an active collective learning repository of modeling development knowledge. A full list of services is available at the MAP Program web site (http://map.nasa.gov/).

Proposers who require computing time at NCCS or NAS must provide an estimate and justification of the number of node-hours required each year of the proposal. This is in addition to indicating on the NSPIRES cover pages that HEC resources are requested. Proposers should also identify their need, if any, for expert assistance resources. These requirements should be covered in clearly identified subsection of the Scientific/Technical/Management portion of the proposal.

2.3. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $3.5M
Number of new awards pending adequate proposals of merit	~ 3-8
Maximum duration of awards	5 years
Planning date for start of investigation	6 months after proposal due date.
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-MAP
NASA point of contact concerning this program	Dr. David B. Considine Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-2277 E-mail: david.b.considine@nasa.gov

A.13 Atmospheric Composition: Atmospheric Composition, Cloud, and Climate Experiment

NOTICE: NASA intends to solicit proposals in 2010 for participation in an airborne campaign to investigate tropical atmospheric processes related to convection, photochemistry, aerosols and clouds. An amendment to ROSES-2010 will be released with details of the solicitation. Proposals will be due no earlier than 90 days after release of the amendment.

1. Scope of Program

Atmospheric composition changes affect air quality, weather, climate, and critical constituents such as ozone. Atmospheric exchange links terrestrial and oceanic pools within the carbon cycle and other biogeochemical cycles. Solar radiation affects atmospheric chemistry and is thus a critical factor in atmospheric composition. Atmospheric composition is central to Earth system dynamics, since the atmosphere integrates surface emissions globally on time scales from weeks to years and couples several environmental issues. NASA's research for furthering our understanding of atmospheric composition is geared to providing an improved prognostic capability for such issues (e.g., the recovery of stratospheric ozone and its impacts on surface ultraviolet radiation, the evolution of greenhouse gases and their impacts on climate, and the evolution of tropospheric ozone and aerosols and their impacts on climate and air quality). Toward this end, research within the Atmospheric Composition Focus Area addresses the following science questions:

- How is atmospheric composition changing?
- What trends in atmospheric composition and solar radiation are driving global climate?
- How does atmospheric composition respond to and affect global environmental change?
- What are the effects of global atmospheric composition and climate changes on regional air quality?
- How will future changes in atmospheric composition affect ozone, climate, and global air quality?

NASA expects to provide the necessary monitoring and evaluation tools to assess the effects of climate change on ozone recovery and future atmospheric composition, improved climate forecasts based on our understanding of the forcings of global environmental change, and air quality forecasts that take into account the feedbacks between regional air quality and global climate change. Achievements in these areas via advances in observations, data assimilation, and modeling enable improved predictive capabilities for describing how future changes in atmospheric composition affect ozone, climate, and air quality. Drawing on global observations from space, augmented by suborbital and ground-based measurements, NASA is uniquely poised to address these issues. This integrated observational strategy is furthered via studies of atmospheric processes using unique suborbital platform-sensor combinations to investigate, for example: (1) the processes responsible for the emission, uptake, transport, and chemical transformation of ozone and precursor molecules associated with its production in the troposphere and its destruction in the stratosphere and (2) the formation, properties, and transport of aerosols in the Earth's troposphere and stratosphere, as well as aerosol interaction with clouds.

NASA's research strategy for atmospheric composition encompasses an end-to-end approach for instrument design, data collection, analysis, interpretation, and prognostic studies.

2. Description of Solicited Research

In 2010, the entire Atmospheric Composition Focus Area, which includes the Upper Atmosphere research program, the Radiation Science research program, the Tropospheric Chemistry program, and the Atmospheric Composition Modeling and Analysis program, will be calling for proposals to participate in an airborne campaign to investigate tropical atmospheric processes related to convection, photochemistry, aerosols, and clouds. The call for proposals will be released later in calendar year 2010 as an amendment to this ROSES-2010 NRA. This ROSES element was originally published in ROSES-2009 (see Appendix A.17 of ROSES-2009). Because of logistical and programmatic uncertainties and constraints, the campaign, which was originally scheduled for 2011, has been postponed until 2012.

3. Programmatic Information

Questions about this airborne Atmospheric Composition solicitation may be directed to the Program Officers:

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Dr. Hal Maring
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Science Mission Directorate
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Dr. Jassim Al-Saadi
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A.14 ATMOSPHERIC COMPOSITION: MODELING AND ANALYSIS

1. Scope of Program

Atmospheric composition changes affect air quality, weather, climate, and critical constituents such as ozone. Atmospheric exchange links terrestrial and oceanic pools within the carbon cycle and other biogeochemical cycles. Solar radiation affects atmospheric chemistry and is thus a critical factor in atmospheric composition. Atmospheric composition is central to Earth system dynamics, since the atmosphere integrates surface emissions globally on time scales from weeks to years and couples several environmental issues. NASA's research for furthering our understanding of atmospheric composition is geared to providing an improved prognostic capability for such issues (e.g., the recovery of stratospheric ozone and its impacts on surface ultraviolet radiation, the evolution of greenhouse gases and their impacts on climate, and the evolution of tropospheric ozone and aerosols and their impacts on climate and air quality). Toward this end, research within the Atmospheric Composition Focus Area addresses the following science questions:

- How is atmospheric composition changing?
- What trends in atmospheric composition and solar radiation are driving global climate?
- How does atmospheric composition respond to and affect global environmental change?
- What are the effects of global atmospheric composition and climate changes on regional air quality?
- How will future changes in atmospheric composition affect ozone, climate, and global air quality?

NASA expects to provide the necessary monitoring and evaluation tools to assess the effects of climate change on ozone recovery and future atmospheric composition, improved climate forecasts based on our understanding of the forcings of global environmental change, and air quality forecasts that take into account the feedbacks between regional air quality and global climate change. Achievements in these areas via advances in observations, data assimilation, and modeling enable improved predictive capabilities for describing how future changes in atmospheric composition affect ozone, climate, and air quality. Drawing on global observations from space, augmented by suborbital and ground-based measurements, NASA is uniquely poised to address these issues. This integrated observational strategy is furthered via studies of atmospheric processes using unique suborbital platform-sensor combinations to investigate, for example: (1) the processes responsible for the emission, uptake, transport, and chemical transformation of ozone and precursor molecules associated with its production in the troposphere and its destruction in the stratosphere and (2) the formation, properties, and transport of aerosols in the Earth's troposphere and stratosphere, as well as aerosol interaction with clouds. NASA's research strategy for atmospheric composition encompasses an end-to-end approach for instrument design, data collection, analysis, interpretation, and prognostic studies.

2. Atmospheric Composition Modeling and Analysis Program Activities

2.1 Research Areas of Interest

The modeling and analysis effort is generally aimed at the questions of tropospheric air quality and oxidation efficiency, pollution sourced aerosol where they impact cloud properties, stratospheric chemistry and ozone depletion, and chemistry/climate interactions. Studies of long-term trends in atmospheric composition are also of interest to the program, particularly if a governing process can be identified. The program is particularly interested in studies which integrate observations from multiple instruments with models to address attribution and predictions. Use of satellite and suborbital data sets (ARCTAS, INTEX, and AVE field campaigns) and ground based measurements (ground-based measurements, such as ozonesondes, NDACC, AERONET, and MPLNET) are encouraged for modeling constraints and verification where applicable. Those proposals that focus primarily on the analysis and utilization of satellite data from the A-Train, Terra, and international composition satellites should consider proposing to the Aura Science Team solicitation (Appendix A.15).

Retrospective studies are also encouraged. Modeling tools can range from primarily conceptual to process-level to regional to fully global, three-dimensional atmospheric composition models. The Atmospheric Composition Modeling and Analysis program (ACMAP) is focused primarily on data analysis, model utilization, and model evaluation, rather than model development. Proposals with a primary focus on model development and only a secondary focus on utilization and data analysis are not encouraged. Therefore proposals are encouraged in the following areas:

Area A. Research topics in the area of tropospheric air quality and oxidizing capacity include the effects of climate change on tropospheric air quality and air quality on climate. Studies of the attribution of changes in air quality and oxidizing capacity over the past 20 years are encouraged.

Additional topics include upper tropospheric composition, the interaction between the regional and global scale atmosphere, boundary layer processes, convection and long-range transport, and exchange between the stratosphere and troposphere. Studies of the changes in chemically and radiatively active trace gases in the upper troposphere on climate will also be considered.

Area B. Studies of aerosol characteristics with respect to their impacts on actinic fluxes and tropospheric chemical processes are encouraged. In addition, studies that deal with pollution effects on aerosol and cloud interactions and the potential feedback to atmospheric chemistry will be considered.

Area C. Stratospheric chemistry and ozone depletion studies of interest to the program include utilizing observations to understand the impact of very short-lived halogen-containing species on the stratospheric halogen and ozone budgets, the chemical, dynamical, and radiative processes controlling interaction between the stratosphere and troposphere. The polar regions are of particular interest with respect to chemical and radiative impacts of stratospheric ozone change on the lower atmosphere.

To understand the stratospheric ozone and its response to changes in ozone-depleting substances (ODSs), it is necessary to recognize and attribute the observational signal of ozone response to ODS change in the context of a changing and variable climate. The program, therefore, seeks studies which will evaluate the potential impacts on future stratospheric ozone concentrations of both climate change and variability and changes in the concentrations of ODSs.

Area D. Proposals are solicited to demonstrate and advance capabilities of modeling and data analysis systems that are capable of ingesting atmospheric composition observations from multiple platforms including satellite, airborne and ground-based. Such modeling systems may ultimately be used for conducting Observing System Simulation Experiments (OSSEs) for atmospheric composition across the range of spatial scales from global to urban. Demonstrated improvement in model analyses and predictions resulting from assimilation of observations of multiple chemical species and/or aerosols is a primary goal, as it would enhance the scientific value of past and current observations. Application of such tools to establishing requirements of future observations, including Decadal Survey missions focused on atmospheric composition, is a secondary goal. To be responsive to this solicitation, proposals must emphasize demonstration of improved synthesis and interpretation of atmospheric observations rather than primarily model development.

2.2 Applied Research and Innovative Applications

Information and capabilities generated by ACMAP may also contribute to a body of applications knowledge and address applied research topics which can lead to near-term applications. The Applied Sciences Program supports applied science research and enables practical applications of Earth science products and knowledge. As such, the ACMAP and Applied Sciences Program have identified that there may be opportunities to support applications-oriented activities in response to the four areas above.

Through this solicitation, the Applied Sciences Program is seeking to support up to two (2) new projects that may address issues of applied research or applications for decision support. Proposers particularly interested in applications-oriented activities should include the following: description of the applied research need or application to decision making, demonstration that the proposed approach is of appropriate quality to be applicable, and support for the approach through applied sciences literature and/or strong letters of support from end user organizations.

Note: Proposers to the main ACMAP element are not required nor necessarily expected to address applied research or applications-oriented activities in their proposal.

3. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $2.3 M/year
Number of new awards pending adequate proposals of merit	~ 10-15
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	Not requested.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-ACMAP

NASA point of contact concerning this program	Dr. Richard S. Eckman Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-2567 E-mail: Richard.S.Eckman@nasa.gov

A.15 ATMOSPHERIC COMPOSITION: AURA SCIENCE TEAM

1. Scope of Program

Atmospheric composition changes affect air quality, weather, climate, and critical constituents such as ozone. Atmospheric exchange links terrestrial and oceanic pools within the carbon cycle and other biogeochemical cycles. Solar radiation affects atmospheric chemistry and is thus a critical factor in atmospheric composition. Atmospheric composition is central to Earth system dynamics, since the atmosphere integrates surface emissions globally on time scales from weeks to years and couples several environmental issues. NASA's research for furthering our understanding of atmospheric composition is geared to providing an improved prognostic capability for such issues (e.g., the recovery of stratospheric ozone and its impacts on surface ultraviolet radiation, the evolution of greenhouse gases and their impacts on climate, and the evolution of tropospheric ozone and aerosols and their impacts on climate and air quality). Toward this end, research within the Atmospheric Composition Focus Area addresses the following science questions:

- How is atmospheric composition changing?
- What trends in atmospheric composition and solar radiation are driving global climate?
- How does atmospheric composition respond to and affect global environmental change?
- What are the effects of global atmospheric composition and climate changes on regional air quality?
- How will future changes in atmospheric composition affect ozone, climate, and global air quality?

NASA expects to provide the necessary monitoring and evaluation tools to assess the effects of climate change on ozone recovery and future atmospheric composition, improved climate forecasts based on our understanding of the forcings of global environmental change, and air quality forecasts that take into account the feedbacks between regional air quality and global climate change. Achievements in these areas via advances in observations, data assimilation, and modeling enable improved predictive capabilities for describing how future changes in atmospheric composition affect ozone, climate, and air quality. Drawing on global observations from space, augmented by suborbital and ground-based measurements, NASA is uniquely poised to address these issues. This integrated observational strategy is furthered via studies of atmospheric processes using unique suborbital platform-sensor combinations to investigate, for example: (1) the processes responsible for the emission, uptake, transport, and chemical transformation of ozone and precursor molecules associated with its production in the troposphere and its destruction in the stratosphere and (2) the formation, properties, and transport of aerosols in the Earth's troposphere and stratosphere, as well as aerosol interaction with clouds. NASA's research strategy for atmospheric composition encompasses an end-to-end approach for instrument design, data collection, analysis, interpretation, and prognostic studies.

2. Aura Science Team Activities

2.1 Analysis of Satellite Remote Sensing Data

This solicitation seeks proposals for the analysis of satellite remote-sensing data of the Earth's atmosphere, particularly those using data generated by the Earth Observing System (EOS) Aura satellite. We are also encouraging proposals that combine data from Aura with data from other sensors within the "A-Train" or AM constellations (particularly Aqua, Terra, CALIPSO, and CloudSAT) or satellites from other space agencies (particularly SciSat/ACE, Envisat, MetOp, SMILES). These proposals should enable NASA research in the area of stratospheric and tropospheric chemistry, as well as improve the measurements of aerosols and trace gases, and determining the impacts of trace gasses and aerosols on climate and air quality. Proposals should specifically address the use of the satellite data.

Solicitation goals include:

- Developing new or significantly improving existing data products from the EOS Aura instruments using Level 2 data,
- Developing new or significantly improved Level 2 data are not supported by the Aura project core data analysis budget,
- Using Aura data to track changes in stratospheric and tropospheric chemistry, determine the exchange of trace gases between the stratosphere and troposphere, and estimate the transport properties of the stratosphere and upper troposphere.
- Using Aura data along with other satellite trace gas data sets to quantify and map emissions and quantify the impact of long-range transport and export of trace gases important to air quality,
- Using Aura data to determine the effects of air pollutants such as ozone and aerosols on climate, and
- Using Aura data to better merge the activities of the atmospheric composition research community and air quality monitoring activities of other agencies within the United States (see section 2.1 below).

NASA encourages proposals that develop new Level 2 or high level data products include a representative from the Instrument Team which produced the original data.

Proposals that address interdisciplinary research in trace gases, and proposals that primarily address data analysis of suborbital campaigns, ground-based measurements, and models to advance the science described above, should not be submitted here. Instead, they should be submitted to the Atmospheric Composition Modeling and Analysis program (Appendix A.14).

Activities that are not included in this solicitation include:

- A-Train (Aura, CALIPSO, Aqua) instrument algorithm maintenance, incremental algorithm improvement, data product validation, and the production of standard data products; and

- Development of models used to analyze data sets. Models of this type are developed under the Modeling, Analysis, and Prediction (MAP, Appendix A.12) or Atmospheric Composition Modeling and Analysis (ACMAP, Appendix A.14) programs.

2.2 Applied Research and Innovative Applications

Data, products, and knowledge from Aura have demonstrated significant value and utility for a growing number of applications The Applied Sciences Program supports applied science research and enables practical applications of Earth science products and knowledge. As such, the Atmospheric Composition Program and the Applied Sciences Program have identified an interest to support applications-oriented team members. These applications-oriented team members are expected to address applied research topics, communicate information to the appropriate management, policy and applications communities, and represent provide feedback from those same communities to the Aura Science Team.

Through this solicitation, the Applied Sciences Program is seeking to support up to two (2) new Aura Science Team members and investigations. In order to quality for this support, proposers interested in performing applied research activity should include the following in their proposals: applied research credentials, topic(s) of the applied research investigation or decision-support applications, interest and credentials to support and represent the applications communities, and interest and abilities to enable applications and value in decision making activities.

Note: Proposers to the Aura Science Team element for analysis of satellite remote sensing data are not required to address applied research or applications-oriented activities in their proposal.

3. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $4.2M/year
Number of new awards pending adequate proposals of merit	~ 15-25
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	Not requested.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.

Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-AURA
NASA point of contact concerning this program	Dr. Kenneth W. Jucks Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0476 E-mail: kenneth.w.jucks@nasa.gov

A.16 TERRESTRIAL HYDROLOGY

1. Scope of Program

The NASA Terrestrial Hydrology program (THP) has the scientific objective "to use remote sensing to develop a predictive understanding of the role of water in land-atmosphere interactions and to further the scientific basis of water resources management." The NASA THP is a component of the Water and Energy Cycle Focus Area (see Section 2.3 of Appendix A.1 for a description of Earth science focus areas).

THP uses NASA's unique view from space to study hydrologic processes associated with runoff production, hydrologic fluxes at the land-air interface, and terrestrial water stores. THP fosters the development of hydrologic remote sensing theory, new hydrologic satellite missions, hydrologic remote sensing field experiments, and the interface of hydrology with other disciplines, such as ecology or modeling. Particular emphasis is placed on the application of satellite based remotely sensed data for characterizing, understanding, and predicting the terrestrially linked components of the hydrologic cycle and the dynamics of large-scale river basins. THP is currently focused on research relating to multiple missions, either currently operational, such as AQUA and GRACE, or in formulation, such as SMAP and GPM, or in planning stages, such as SWOT, SCLP, and GRACE-2. THP projects are also extensively using data collected at previously funded field campaigns, such as those focused on soil moisture (SMEX'02, '04, and CLASIC) and/or those focused on snow (CLPX'02, '03, etc.). More information on current THP projects and plans, as well as links to related field campaigns, can be found at the THP website (http://thp.gsfc.nasa.gov/) or at mission specific websites (e.g., http://smap.jpl.nasa.gov/ or http://swot.jpl.nasa.gov/).

2. Description of Solicited Research

A current stress on interpretation of hydrological information derived from satellites, or global circulation models (GCMs), is their native spatial resolution. In the case of satellite information, a single value is often a composite of tens of square kilometers (e.g., AMSR-E soil moisture and snow water equivalent have spatial resolutions of approximately 25 km^2). In the case of GCMs, a single value is thought to be representative of a grid box that covers at least that spatial area if not much more. As environmental science has advanced and societal needs for environmental description has grown, a single value meant to represent a large area is insufficient.

The Terrestrial Hydrology program solicits three types of research that deal with or relate to this problem of nascent coarse spatial scales. In particular, THP is interested in developing science that will further the use of future sensors for both scientific and applied science uses. In addition to the recently launched SMOS satellite, THP is specifically interested in research in preparing for SMAP, SWOT, SCLP (and CoreH2O), and GRACE-2 and the characteristics of the data they will provide. As these missions will provide global coverage, any THP sponsored research should be appropriate for global scale deployment and not overly limited to a small domain (either physically or relating to a particular set of environmental constraints).

Research is sought that applies to at least one of the following areas.

2.1 Downscaling of Remote Sensing Data

Higher spatial resolution remote sensing data sets exist that might be used to classify attributes of a coarser pixel. As an example, some global data sets from the MODIS sensors, which may be on the order of 500 m to 1km spatially, are strongly coupled with the hydrological variables linked to the relevant missions listed above. Also, numerous surface topography data exist, albeit not all have global coverage that might improve interpretation of coarse satellite information. Research can use either static or slowly changing variables (such as topography or vegetation) or dynamic variables (such as surface temperature) or both in their downscaling techniques.

2.2 Satellite Validation Approaches

Historically, a commonly employed form of satellite validation is to compare a time series of satellite observations (of a given surface area location) with one or more in situ point observation time series from within that area. While helpful, THP encourages development of new approaches for validation that could be employed for the above mentioned satellites of interest. Researchers are encouraged to move well beyond basic time series comparison and attempt to compare the information content between satellite and ground based-observations that would result in a more comprehensive commentary on the quality of the satellite data.

2.3 Model downscaling

Similar to Downscaling of Remote Sensing Data (Section 2.1), except THP is seeking new forms of downscaling that could be applied to GCMs (a.k.a. climate models) that would employ *extensive* use of remote sensing data. It would be helpful if research in this category could present a small case study to demonstrate the potential of this approach. If the case study is done for a single (or small number) of typical GCM grid boxes, the proposal should clearly articulate a valid rationale to support deployment of this approach on a much larger area (e.g., continental if not global).

3. Programmatic Information

3.1 Award Information

Total funds available for work selected under this solicitation are approximately $2.5 M per year for three years. The program anticipates making approximately fifteen selections.

It is anticipated that project start dates would be January 2011. If a PI would like an alternative start date (but still within 2011), it should be clearly indicated in the proposal.

Based on the quality of proposals received, awards will be distributed across the three research themes identified in Section 2. Proposals outside these research themes may be considered but such proposals must be highly meritorious and demonstrate high urgency and relevance to NASA terrestrial hydrology science scope.

3.2 Applied Research and Innovative Applications

Information and capabilities generated by THP may also contribute to a body of applications knowledge and address applied research topics which can advance water resource management applications. The NASA Applied Sciences Program supports applied research and enables practical applications of Earth science products and knowledge. As such, the THP and Applied Sciences Water Resources Program have identified that there may be opportunities to support applications-oriented activities in response to areas in Section 2.

Through this solicitation, the Applied Sciences Program is seeking to support up to three (3) new proposed projects that may address issues of applied research or applications for decision support. To qualify for support by the Applied Sciences Program, the proposed approaches and/or data developed must be of appropriate quality and/or context to be useful to decision makers. Proposers particularly interested in applications-oriented activities should include the following in their proposals: description of the applied research need or application to decision making, demonstration that the proposed approach is of appropriate quality to be applicable, and support for the approach through applied sciences literature and/or strong letters of support from end user organizations.

Note: Proposers to the main THP element are not required nor necessarily expected to address applied research or applications-oriented activities in their proposal.

3.3 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $2.5M
Number of new awards pending adequate proposals of merit	~ 15
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2011

Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-THP
NASA point of contact concerning this program	Dr. Jared K. Entin Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0275 E-mail: Jared.K.Entin@nasa.gov

A.17 NASA Energy and Water Cycle Study

NOTICE: This DRAFT text provides a general description of the NASA Energy and Water-cycle Study (NEWS) program. An amendment to ROSES will be released at least 90 days prior to the proposal due date in order to clarify the exact topics that are being solicited. Prospective proposers are encouraged to be familiar with the contents of the NEWS website, as this solicitation will seek research activities to build from the current projects.

1. Scope of Program

The U.S. Climate Change Science Program (CCSP) has established the water cycle goals of the Nation's climate change program (see the CCSP strategic plan at http://www.climatescience.gov/Library/stratplan2003/). Accomplishing these goals will require, in part, an accurate accounting of the key reservoirs and fluxes associated with the global water and energy cycle, including their spatial and temporal variability, through integration of all necessary observations and research tools. To this end, in conjunction with NASA's Earth science research strategy (see NASA's Earth science research plan at http://nasascience.nasa.gov/about-us/science-strategy), the overarching long-term NASA Energy and Water Cycle Study (NEWS) grand challenge can be summarized as *documenting and enabling improved, observationally based, predictions of water and energy cycle consequences of Earth system variability and change.* This challenge requires documenting and predicting trends in the rate of the Earth's water and energy cycling that corresponds to climate change and changes in the frequency and intensity of naturally occurring related meteorological and hydrologic events, which may vary as climate may vary in the future. The cycling of water and energy has obvious and significant implications for the health and prosperity of our society. The importance of documenting and predicting water and energy cycle variations and extremes is necessary to accomplish this benefit to society.

As the Earth's water and energy cycle is central to the mechanics and impacts of climate change, NASA's Earth Science Program seeks to advance and integrate water and energy cycle observation, scientific understanding, and ultimately its prediction to enable society to cope with future climate adversities. Discovery-driven water and energy research projects carried out by individuals or small groups of scientists have yielded significant advances in our understanding of key Earth science processes. To meet the NEWS challenge, the compendium of these water and energy cycle discoveries must be unified and integrated into a comprehensive and coordinated science solution. A coordinated team effort is required that will integrate NASA's global water and energy cycle resources to directly address the NEWS challenge. More information on NEWS is available at http://wec.gsfc.nasa.gov/. Interested collaborators with NEWS are specifically recommended to review progress and plans of current NEWS activities that are available at this web-location.

Through national and international relationships, NEWS will ultimately facilitate NASA's providing added value to the Earth observations resulting from NASA research and development, assist in bringing in added satellite calibration/evaluation data sources, and deliver independent observationally-based data sets for evaluating 4-dimensional data assimilation (4DDA) and prediction capabilities on a regional and global basis.

The overarching goal of NEWS investigations will be to integrate Earth Science Research Program components to make decisive progress toward the NEWS challenge. To achieve this objective, the NEWS investigations will integrate and interpret past, current, and future space based and *in situ* observations into assimilation and prediction products and models that are global in scope. These activities will serve efforts to improve understanding, modeling, and information for global prediction systems. To achieve these goals, the NEWS investigations must recognize that accurate prediction of not only trends in the mean, but also extremes and abrupt changes, is a key step toward useful applications. The critical feedbacks within the overall NEWS strategy are the lessons that scientific analysis, modeling, prediction, and consequences can guide and identify the technological and observational requirements of future NASA missions.

The program is always seeking collaboration with other projects and/or programs to make greater progress on broad water and energy cycle questions. Potential collaborators are strongly encouraged to review on-line documentation of existing NEWS projects, available at http://nasa-news.org/. NEWS investigations are expected to interact proactively with the entire NEWS team, other NASA projects, and related national and international projects and programs to optimize progress toward integrating Earth Science resources (e.g. satellite data products, model and computational resources, ongoing research activities, etc.) to make decisive progress toward the NEWS grand challenge.

2. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $2.5M
Number of new awards pending adequate proposals of merit	~ 20
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.

Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-NEWS
NASA point of contact concerning this program	Dr. Jared K. Entin Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0275 E-mail: Jared.K.Entin@nasa.gov

A.18 PRECIPITATION MEASUREMENT MISSIONS SCIENCE

NOTICE: No proposals are being solicited in this area during this fiscal year. The Precipitation Measurement Missions Science program will not be competed in 2010. The Precipitation Measurement Missions Science program is tentatively scheduled to next solicit proposals in ROSES 2011.

The Precipitation Measurement Missions Science program seeks scientific investigations related to satellite observations of precipitation using measurements from, but not limited to, the Tropical Rainfall Measuring Mission (TRMM) launched in November 1997, and investigations related to future precipitation missions, such as the next generation constellation-based Global Precipitation Measurement (GPM) Mission. This program supports scientific investigations in three research categories: (1) development, evaluation, and validation of TRMM and GPM retrieval algorithms, (2) development of methodologies for improved application of satellite measurements, and (3) the use of satellite and ground measurements for physical process studies to gain a better understanding of the global water cycle, climate, and weather; and concomitant improvements in numerical models on cloud resolving to climate scales.

A new PMM science team was selected during FY 2010 based upon a ROSES 2009 solicitation. The next solicitation in this context is expected in FY 2012 based upon a ROSES 2011 solicitation.

For information on this program, contact:

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A.19 EARTH SURFACE AND INTERIOR

1. Scope of Program

1.1 Thematic Areas and Research Questions

The Earth Surface and Interior (ESI) focus area can be divided into three thematic areas,

- Land Surface Change and associated Natural Hazards;
- Space Geodesy; and
- Earth's Planetary Interior- its structure and dynamics,

that address the following four research questions within the Earth Science Division:

1) Prediction: How can knowledge of the Earth's surface change be used to predict and mitigate natural hazards?

The overarching goal of the ESI focus area is to assess, mitigate, and forecast the natural hazards that affect society, including such phenomena as earthquakes, landslides, coastal and land surface erosion, floods, and volcanic eruptions.

Near term predictions of volcanic eruptions are moderately successful for certain, limited, and well studied, volcanic areas. These near term predictions can be improved through better remote sensing utilizing optical and geodetic imaging and enhanced predictive modeling. During the past year, significant success has been achieved in the application of stochastic techniques to identify with significant spatial resolution areas at high risk of significant earthquakes. NASA has also made available significant new high resolution Shuttle Radar and LIDAR Topographic maps and InSAR data from strain maps to study volcanic inflation and inundation dynamics from lahars and floods. NASA is collaborating with its national and international partners to develop an expanded access to remote data sets for research in the mitigation of geohazards within defined natural laboratories such as the EarthScope and Asia-Pacific Natural Laboratories.

2) Variability: How is the Earth's surface being transformed by naturally occurring tectonic and climatic processes?

Space geodetic techniques are revealing a seismic precursory and stress transfer events that appear to be important components of the earthquake cycle. The integration of geodetic and seismic models is leading to better estimates of crustal strength and dynamics within seismic zones. High resolution topography from the Shuttle Radar Mission and satellite and airborne LIDAR coupled with hyperspectral and multispectral optical imaging are providing detailed structural and lithologic models for the resolution of tectonic and climatic influences upon an evolving terrain. Geodetic imaging, utilizing InSAR, LIDAR, and optical mapping techniques, constitutes the highest priority for new investments within the ESI focus area. Other electromagnetic techniques such as ELF/ULF network measurements are also being studied to gain a better understanding of the physics of the earthquake cycle.

3) Forcing: What are the dynamics of the Earth's interior and how do these forces drive change at the Earth's surface?

Space geodetic research is making enormous strides in defining the dynamics of the crust, mantle, and core through measurements of surface deformation, the Earth's angular momentum. Likewise, the wonderful progress of gravity and geomagnetic satellite missions such as GRACE, Oersted, SAC-C, CHAMP, and soon COSMIC, GOCE and SWARM, during the International Decade of Geopotential Field Research, is providing high resolution long term data to model the geodynamo and provide high resolution information on the structure, composition, and dynamics of the Earth's mantle, lithosphere, oceanic, and atmospheric envelope. The combined analysis of satellite gravity, geomagnetic, and space geodetic measurements will likely lead to a better understanding of the state of stress in crust and mantle and ultimately to improved prediction capabilities for geohazards. Also of importance to the ESI program are better macroscopic observations and models for ionospheric and magnetospheric dynamics. These areas are being studied for the improvement in the separation of sources in geomagnetic modeling and for the detection of subtle surface disturbances such as surface seismic waves and tsunami's and the sounding of the deep interior of the Earth.

4) Response: How is global sea level affected by natural variability and human induced change in the Earth System?

The rate of sea-level change is estimated to be 1-2 mm per year measured within the terrestrial reference frame; a critical component of these estimates is the response of the solid Earth, including subsidence and erosion in coastal zones and crustal warping beneath the deepening oceans and thinning ice sheets.

Of critical importance in the broad range of ESI and related climate change studies is the definition of a stable and accurate terrestrial reference frame and the interpretation of associated changes in the Earth's shape, gravity field, and angular momentum. The program is seeking to improve the performance of the global geodetic observing and analysis capability through the design of new observing strategies, technologies, and analysis capability.

1.2 The ESI Program Plan

The strategic plan of the Earth Surface and Interior focus area is entitled *Living on a Restless Planet* and is available at http://solidearth.jpl.nasa.gov/seswg.html. The program plan is a 25-year vision drafted by the Solid Earth Sciences Working Group (SESWG) in close consultation with the solid Earth science community and the Federal agencies. The SESWG report was adopted as the ESI focus area's strategic plan following the review and endorsement by the National Research Council (NRC) in 2004. The NRC review entitled *Review of NASA's Solid-Earth Science Strategy* (http://books.nap.edu/catalog/11084.html).

The SESWG recognized that understanding the solid Earth and moving toward predictive capabilities, where appropriate, requires a broad observational strategy, incorporating numerous methodologies (including space-borne, airborne, and ground measurements), technological advances, and complementarity among observations. The SESWG recommended the following six observational strategies to address the fundamental solid Earth questions:

- Surface Deformation;
- High-resolution Topography;
- Variability of Earth's Magnetic Field;
- Variability of Earth's Gravity Field;
- Imaging Spectroscopy of Earth's Changing Surface; and
- Space Geodetic Networks and the International Terrestrial Reference Frame.

2. Programmatic Information

Proposals that respond to this solicitation must identify one or more of the six scientific challenges identified within *Living on a Restless Planet* and explain in succinct language how the proposal will advance the state of knowledge in these scientific areas through the advancement of space based or airborne observations, the analysis of these observations, and/or new modeling capabilities.

Researchers are encouraged to submit research proposals that advance the priorities set forth in the ESI program plan entitled *Living on a Restless Planet* including one or more of the following:

1. Geophysical models and techniques for the advancement of understanding, prediction, and mitigation of geohazards including earthquakes, landslides, and volcanic eruptions;

2. Geopotential field (e.g. gravity and geomagnetism) research that addresses the measurement of mass transport within the Earth System and the modeling of the geodynamo;

3. The development and application of remote sensing techniques to characterize understand land surface change induced by environmental and tectonic forces; and

4. Techniques that would characterize the ionosphere and neutral atmosphere in order to better understand the dynamics of the Earth’s surface including the use of Synthetic Aperture Radar, VLBI, and GNSS.

Proposers are encouraged to

- Utilize Existing or planned space-based and airborne observational capabilities and remote sensing data sets;
- Utilize observational infrastructures such as the EarthScope Program and Asia-Pacific Natural Laboratory, the Global Geodetic Observing System (GGOS), WInSAR, International GPS Service, International VLBI Service, and the International Laser Ranging Service; or
- Cite the relevance of their work to the advancement of the scientific goals and/or missions recommended with the NRC Decadal Study entitled: *Earth Science and Applications from Space: Imperatives for the Next Decade and Beyond, 2007* (http://www.nap.edu/catalog.php?record_id=11820).

2.1. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $3M
Number of new awards pending adequate proposals of merit	~ 20
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-ESI
NASA point of contact concerning this program	Dr. John LaBrecque Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1373 E-mail: John.LaBrecque@nasa.gov

A.20 ADVANCED CONCEPTS IN SPACE GEODESY

1. Scope of the Solicitation

The National Research Council's Decadal Survey in Earth Science (*Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*; available at http://www.nap.edu/catalog.php?record_id=11820) recognized that we must "confront key scientific questions related to ice sheets and sea-level change, large-scale and persistent shifts in precipitation and water availability, transcontinental air pollution, shifts in ecosystem structure and function in response to climate change, impacts of climate change on human health, and the occurrence of extreme events, such as severe storms, heat waves, earthquakes, and volcanic eruptions." The Decadal Survey recommended a number of efforts and missions to address these challenges that directly relate to space geodetic science. Specifically, the Decadal Survey recommended four space geodetic missions, ICESat, DESDynI, LIST, and GRACE II, as well as the deployment of a constellation of GPS Radio Occultation instruments. The Decadal Survey also expressed concern at the uncertain future of the space geodetic infrastructure and recommended renewed investments in the ground network infrastructure that supports Earth observations.

More recently the Global Geodetic Observing System has defined its goals for the accuracy and stability of the International Terrestrial Reference Frame (ITRF) of 1 mm accuracy and 0.1 mm/yr stability (*Global Geodetic Observing System: Meeting the Requirements of a Global Society on a Changing Planet in 2020*; http://www.springer.com/978-3-642-02686-7). These goals were primarily set in response to the measurement needs of sea level change.

Space geodetic science and the attendant technologies fulfill a unique role in the measurement of mass transport within the Earth System. Mass transport is driven by climatic, tectonic and anthropogenic forces. The measurement of the manifestations of mass transport including glacial ablation, sea level change, ocean circulation, land subsidence, topographic change, geohazards, atmospheric and ionospheric dynamics, communications, positioning, navigation, and timing are highly dependent upon space geodetic science and infrastructure.

This solicitation seeks proposals that advance the objectives of the Decadal Survey recommendations related to space geodetic science including:

- the theoretical and technical foundation of space geodetic science and infrastructure including the theory of geodetic reference frames and their determination from observational data;
- algorithms and observational strategies for geodetic imaging, including Synthetic Aperture Radar (SAR) and LiDAR, and the combined analysis of these data sets for applications to the DESDynI, ICESAT, and LIST mission concepts via airborne and space borne demonstrations, such as strategies for dealing with or utilizing ionospheric and atmospheric dynamics and their effects upon microwave propagation;
- new techniques for precision positioning, navigation, and timing that will advance Earth System Science observational strategies;
- new measurement techniques for Global Navigation Satellite Systems (GNSS) remote sensing such as GNSS occultation and GNSS reflections; and

- the development of advanced techniques in geodetic network architecture and algorithms with a focus upon real time network analysis and improved accuracy and stability of the ITRF as identified by the Global Geodetic Observing System.

2. Programmatic Information

Proposals will be evaluated according to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*.

2.1 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	$3M
Number of new awards pending adequate proposals of merit	20
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.

Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-GEODESY
NASA point of contact concerning this program	Dr. John LaBrecque Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1373 E-mail: John.LaBrecque@nasa.gov

A.21 APPLICATIONS OF GEODETIC IMAGING

1. Scope of Solicitation

This solicitation seeks proposals for the development and application of Geodetic Imaging to a well identified societal benefit such as the utilization of a data base for the prediction and mitigation of geohazards or the preservation of natural resources. In all cases, proposals are required to identify the application and provide evidence that partnerships or opportunities exist for the continuation of this effort beyond the life of the proposed project.

The National Research Council's Decadal Survey in Earth Science (*Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*; available at http://www.nap.edu/catalog.php?record_id=11820) recognized that we must "confront key scientific questions related to ice sheets and sea-level change, large-scale and persistent shifts in precipitation and water availability, transcontinental air pollution, shifts in ecosystem structure and function in response to climate change, impacts of climate change on human health, and the occurrence of extreme events, such as severe storms, heat waves, earthquakes, and volcanic eruptions." The Decadal Survey recommended a number of efforts and missions to address these challenges that directly relate to space geodetic science with an overarching objective of "scientific discovery and the development of applications that will enhance economic competitiveness, protect life and property and assist in the stewardship of this planet for this and future generations." Specifically, the Decadal Survey recommended four space geodetic missions, ICESat-2, DESDynI, LIST, and GRACE II, as well as the deployment of a constellation of GPS Radio Occultation instruments.

The Deformation, Ecosystem Structure and Dynamics of Ice (DESDynI) mission is one of the Tier-1 missions recommended by the Decadal Survey (http://desdyni.jpl.nasa.gov/). DESDynI will include an L-band InSAR and a multi-beam LiDAR, each on a separate spacecraft. DESDynI is currently under pre-Phase A study. In order to better understand the potential applications of DESDynI, a workshop was held in October 2008. The DESDynI Applications Workshop report (available at http://desdyni.jpl.nasa.gov/applications/) provides numerous examples for potential use of L-band InSAR and Lidar to support various applied efforts including: geohazard assessment and response, hydrological and ocean applications, subsurface reservoirs, and forest and ecosystems management.

NASA and its partner agencies have developed numerous resources in support of Geodetic Imaging including the access to international space borne Synthetic Aperture Radar data (e.g., TerraSAR-X, EnviSat ASAR, ALOS-PALSAR, RADARSAT-1, ERS-1, ERS-2) for availability through the holdings of the NASA Distributed Active Archive Center (DAAC) at the Alaska Satellite Facility (ASF) and to members of the WInSAR consortium (supported by NASA, NSF, and the USGS). For further information on ASF DAAC and WInSAR holdings of SAR data go to http://www.asf.alaska.edu/sardatacenter and to http://winsar.stanford.edu/main.php respectively. ALOS has been collecting L-band PALSAR data since launch in January 2006, and its baseline mission plan commonly has provided 2-4 fine beam mode acquisitions per year over both North and South America. Beginning in April 2010, NASA will provide operational downlink of ALOS data acquired over the Americas with TDRSS. In addition to reducing data latency, it is expected that PALSAR coverage of the Americas will be significantly enhanced and will then provide fine beam coverage of many areas of North and South America every 46-day cycle. ALOS PALSAR data down-linked via TDRSS will be made available for NASA research use via the ASF DAAC. NASA is considering the possibility of making low-level interferometric products such as coherence and interferograms available from the DAAC on a routine basis. This could significantly reduce the amount of time required to stage data for subsequent analysis and use. NASA is seeking community input into the need for and design of such potential products.

NASA's new airborne repeat pass L-band InSAR capability UAVSAR is also collecting data that are made available to the scientific community for demonstration of applications in land cover, cryospheric, solid Earth, and hydrological science. During its science demonstration period in 2009, UAVSAR acquired multiple coverages of the San Andreas Fault, volcanoes in the Cascades and Aleutian Islands and the Long Valley and Yellowstone calderas, the Gulf Coast and numerous other sites for study of ecosystem structure and deformation (http://uavsar.jpl.nasa.gov/). Similar campaigns are expected to be flown in 2010 and beyond. UAVSAR data are available on-line from the ASF DAAC.

GNSS remote sensing is also being advanced with the continued availability of SAC-C, CHAMP, GRACE, and COSMIC GPSRO systems.

The Applications of Geodetic Imaging Program specifically solicits proposals that further develop and apply geodetic imaging towards realization of societal benefits related to improved understanding and management of geohazards (e.g., earthquake, volcano, landslide, subsidence, tsunami, flooding) and associated threats to life and property (such as the linkages between earthquake and fire or fire, landslide and flooding). Proposals may consider any or all phases of the disaster management cycle (understanding, forecast, warning, response, recovery, and mitigation). NASA is particularly interested in proposals that will leverage its investment in the acquisition of geodetic imaging data sets such as airborne and spaceborne L-band SAR/InSAR (e.g., UAVSAR and ALOS PALSAR), LiDAR (e.g., LVIS and IceSAT), and GNSS data.

Given the enhanced availability of L-band SAR/InSAR data, a major focus of this solicitation is the devolopment and advancement of applications in preparation for DESDynI. Since these data holding will be particularly rich for the Americas, NASA specifically encourages proposals for multi-hazard studies at a regional scale for the following geographic regions: Pacific Northwest, Southwestern U.S., Gulf Coast / Central US, and Central / South America. Since NASA is considering the possible future generation of continental scale deformation products for North America, a scientific and applications advisory group is being solicited to help define the objectives, processing, and format of such products. Proposals that include a task to participate in this advisory group should budget for one two-day meeting per year, nominally at JPL.

Proposals in response to this solicitation must identify a clearly articulated application for geodetic imaging data either to be acquired or within the existing and available data base. The proposal must identify the end user of the product of this proposed work and include that end user as a member of the proposing team.

The Solid Earth Science Focus Area manages this program element. There are strong ties to the goals of the Applied Science Program, which supports applied research and enables practical applications of Earth science products and knowledge. As such, through this solicitation the Applied Sciences Program is seeking to support up to three (3) additional projects. These projects should seek to exploit the data products generated from the geodetic imaging technologies and resulting data to address issues of applied research or applications for decision support and sustained use in decision making.

In addition, NASA is interested in proposals scientific and applied studies of permafrost using L-band SAR/InSAR. The Cryospheric Science Program is seeking to support up to three (3) such projects.

2. Programmatic Information

Proposals will be evaluated according to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*. In addition to the factors given there, the evaluation of intrinsic merit for a proposal shall also include the quality of any letters and statements of support by partners and end users in the application. Cost sharing is strongly encouraged, though it is not part of the peer review proposal evaluation criteria. However, after review and at the time of project selection, NASA will strongly consider the extent to which the proposed project includes funds or significant in-kind contributions from non-Federal sources and Federal agencies, especially from end-user organizations.

3. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected annual program budget for new awards	~$3M
Number of new awards pending adequate proposals of merit	~20
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.

Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-GEOIM
NASA point of contact concerning this program	Craig Dobson Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0254 E-mail: Craig.Dobson@nasa.gov

A.22 NPP SCIENCE TEAM FOR CLIMATE DATA RECORDS

1. Scope of Program

1.1 Overview

NASA's Earth Science Program aims to utilize global measurements in order to understand the Earth system and interactions among the oceans, land, atmosphere, and biota. To achieve this goal, a combination of shorter-term, process-oriented measurements is complemented by longer-term satellite measurements of a limited number of environmental properties. For the latter, a key requirement is the provision of well-calibrated, multi-year and multi-satellite data and data product series. The NASA Earth Observing System (EOS) satellites were deployed between 1999 and 2004 (the largest platforms were launched as follows: Terra in December 1999; Aqua in May 2002; and Aura in August 2004) to provide the new global observations needed to advance Earth system science and to initiate a number of new or improved long-term global data sets. The United States plans to continue many of these long-term data sets through the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) beginning in 2014. The NPOESS Preparatory Project (NPP), currently scheduled for launch in 2011, will provide a bridge to ensure data continuity between the NASA EOS research satellites and the NPOESS operational environmental satellite system.

Long-term, high-accuracy, stable, environmental observations are essential to document the state of the global Earth system as well as past and future variability and changes within it. These Earth system data records (ESDRs) and climate data records (CDRs) are required for quantitative understanding of the Earth system and for ascertaining the magnitude of any natural or human-induced changes to that system. It is imperative that the different satellite sensors used to create a long time series data set be well-characterized, stable, and inter-calibrated. It is equally imperative that the data products created over time be accurate and consistent, with known precision and well-quantified uncertainties. Creating and maintaining such high-quality data sets is a long-term, systematic process, requiring the highest levels of national (and international) cooperation and coordination. The NPP is the first satellite mission to address this challenge for a wide range of land, ocean, and atmospheric science data sets while simultaneously preparing to address operational requirements for meteorological observations. NPP builds on the tremendous success of NASA's EOS program in providing time series data products that have proven invaluable for delivering a wealth of information on global change trends within the Earth system. NPP also builds upon the efforts of international programs to coordinate Earth observations from space in order to ensure high-quality, inter-calibrated measurements that facilitate interoperability, including the efforts of the Committee on Earth Observation Satellites (CEOS) and its Calibration/Validation Working Group, the World Meteorological Organization's (WMO) Global Space-Based Inter-Calibration System, and the Global Climate Observing System's Climate Monitoring Principles (for more information, see http://www.ceos.org/, http://gsics.wmo.int/ and http://www.wmo.ch/pages/prog/gcos/index.php?name=ClimateMonitoringPrinciples). NPP's critical and mandated observations are needed for U.S. Global Change Research, U.S. Integrated Earth Observation System, and U.S. Ocean Action Plan efforts and contribute to the Global Earth Observation System of Systems (GEOSS).

This solicitation provides for the continuation of the work of the NPP Science Team, previously solicited under the 2006 NASA Research Announcement *Earth System Science Research using Data and Products from Terra, Aqua, and ACRIMSAT Satellites* (Appendix A.15 of ROSES 2006; NNH06ZDA001N-EOS) and the 2003 NASA Research Announcement *NPP Science Team for Climate Data Records* (NRA-03-OES-01). NASA requests investigations to continue the evaluation and improvement of NPP/NPOESS Environmental Data Records (EDRs), to develop new scientific approaches for extending key data records that cannot be continued by NPP/NPOESS, and to demonstrate applications of NPP data. The emphasis for all types of investigations is on securing continuous, well-characterized, long time series measurements of sufficient quality to answer critical Earth system science, global change, and/or applied sciences questions.

1.2 Background

1.2.1 Roles and Responsibilities within NPP and NPOESS

NASA's roles and responsibilities in NPP and NPOESS are significantly different from those for most satellite missions for which NASA sponsors science team activities. Proposers will need to be aware of these differences in order to prepare proposals that respond appropriately to this opportunity in support of NASA's contributions to NPP.

NPOESS is the convergence of the military (Defense Meteorological Satellite Program (DMSP)/Department of Defense) and civilian (Polar Operational Environmental Satellite (POES)/National Oceanic and Atmospheric Administration) meteorological satellite systems. In addition, NPOESS will provide over two dozen essential climate and environmental measurements (http://www.ipo.noaa.gov/index.php?pg=edrnpp&tab=5). Thus, the NPOESS system was planned to provide both "operational" data, for weather forecasting and real-time strategic and management applications, as well as "climate-quality" data for long-term, multi-satellite measurements of key environmental properties. The Department of Defense, Department of Commerce, and NASA jointly sponsor the Integrated Program Office (IPO) that oversees the development of NPOESS (see http://www.ipo.noaa.gov/). Agency roles and responsibilities are as follows:

- The Department of Commerce (DoC): National Oceanic and Atmospheric Administration (NOAA) serves as the host agency for the converged system and leads satellite operations. (DoC provides 50 percent of the funding for NPOESS.)
- The Department of Defense (DoD): DoD is responsible for the acquisition of the NPOESS system. (DoD provides 50 percent of the funding for NPOESS.)
- NASA: NASA is responsible for the development and insertion of new technology to enhance the research and operational capability of NPOESS. (NASA provides no direct funding to NPOESS.)

Northrop Grumman Space Technology (NGST) was awarded the prime system integrator contract for NPOESS in 2002.

NPP is a joint mission involving collaboration between NASA and the IPO, and it is being conducted on a no-exchange-of-funds basis among the participating agencies. It will collect and distribute remotely-sensed land, ocean, and atmospheric data for both the meteorological and global climate change communities during the time when responsibility for many of these measurements transition from EOS Terra, Aqua, and Aura to the NPOESS operational missions (see http://jointmission.gsfc.nasa.gov/ and http://www.ipo.noaa.gov/index.php?pg=instr&tab=2 for more detailed information about NPP measurements). The NPP mission has two major goals:

- To provide a continuation of the EOS record of climate-quality observations after EOS Terra, Aqua, and Aura (i.e., it will extend key Earth system data records and/or climate data records of equal or better quality and uncertainty in comparison to those of the Terra, Aqua, and Aura sensors), and
- To provide risk reduction for NPOESS instruments, algorithms, ground data processing, archive, and distribution prior to the launch of the first NPOESS spacecraft. (But note Section 1.2.2 below regarding the recent decision to consider NPP operational.)

Five sensors will be flown on the NPP mission:

- Visible Infrared Imaging Radiometer Suite (VIIRS),
- Cross-track Infrared Sounder (CrIS),
- Advanced Technology Microwave Sounder (ATMS),
- Ozone Mapping and Profiler Suite (OMPS), and
- Clouds and the Earth's Radiant Energy System (CERES).

Agency roles and responsibilities for NPP are as follows:

- NASA (outside of the IPO) provides the ATMS and CERES instruments, spacecraft, and launch services.
- NPOESS IPO provides the CrIS, VIIRS, and OMPS nadir instruments; Command Control and Communications Segment (C3S); and the Interface Data Processing Segment (IDPS).
- NOAA (outside of the IPO) provides the data Archive and Distribution Segment (ADS).
- NASA and NOAA (outside of the IPO) are jointly providing the OMPS limb instrument.

1.2.2 Recent Changes and Current Status of NPP and NPOESS

In 2006, due to a Nunn-McCurdy breach in the cost requirement, the NPOESS program was restructured and recertified. As a result, NPOESS was reduced to 2 rather than 3 orbits (the early morning and afternoon orbits were retained and the mid-morning orbit was eliminated, with a decision to rely upon EUMETSAT instead), the first NPOESS spacecraft (C1) won't launch before 2014 (later than previously planned), and a number of previously manifested climate sensors were removed from NPOESS and NPP:

- The Earth Radiation Budget Sensor (ERBS), Total Solar and Spectral Irradiance Sensor (TSIS), Altimeter, Space Environmental Sensor Suite (SESS), and Aerosol Polarimeter Sensor (APS) as well as the Survivability sensor were demanifested.

- NPOESS was directed to fly with the Space Environment Monitor (SEM) and CERES instruments instead of ERBS and SESS.
- The limb sensor from OMPS was de-manifested for both NPP and NPOESS.

These actions preserved the continuity of existing (or better) weather monitoring capability, but impacted several key climate and environmental measurements by either eliminating planned continuity, increasing the risk of measurement gaps, or relying on less capable measurement systems and technologies. Loss of these capabilities threatened to interrupt well-established data records of key climate and environmental properties, some of which go back as much as 30 years. Subsequently, several of these key measurements were restored when NASA and NOAA were able to secure the resources to add back the OMPS limb sensor and the CERES instrument to NPP and NPOESS C1 and the TSIS instrument to NPOESS C1.

In March 2009, the Program Executive Committee for NPOESS decided that NPP is a critical operational mission. This means that from the operational environmental satellite system perspective, NPP is no longer only a risk reduction mission.

As of December 2009, the NASA-provided NPP spacecraft, ATMS, and CERES sensors have been delivered, and ATMS and CERES have been integrated onto the NPP spacecraft. The IPO-provided OMPS sensor has been delivered and integrated, and the project is awaiting delivery of the IPO-provided VIIRS and CrIS sensors for final integration and testing. Due to ongoing delays caused by both management and technical issues, the NPP launch will be no earlier than January 2011. The NPOESS C1 launch will be no earlier than March 2014, and the NPOESS C2 launch will be no earlier than May 2016.

1.2.3 Approaches to NPP Data Processing and Data Product Development

NPP data will be processed by the IPO-provided NPOESS data system, providing an early demonstration of the NPOESS data processing capabilities. The Interface Data Processing Segment (IDPS) receives raw instrument data and telemetry from ground stations supporting the NPP mission. The IDPS captures the Raw Data Records (RDRs) from the data stream, then processes the RDRs into Sensor Data Records (SDRs) and ultimately Environmental Data Records (EDRs). During the time of NPP, the IDPS will supply RDRs, SDRs, and EDRs to two meteorological centers for evaluation or use in environmental applications and to the NOAA-provided Archive and Distribution Segment (ADS) for archiving and access/distribution to the broader user community. The IDPS also provides RDRs to NASA's Science Data Segment (SDS). In addition, the IDPS provides routine instrument calibration data and monitors the performance of data processing algorithms employed in the generation of environmental data and products.

As part of its SDS, NASA has developed several disciplinary Earth science Product Evaluation and Analysis Tool Elements (PEATE) to support NPP Science Team members and the NPP Project staff in their evaluation of the EDRs (http://www.igarss08.org/Abstracts/pdfs/3929.pdf). The PEATEs provide functions for the NPP Science Team and the NPP Instrument Calibration Support Element (NICSE) in support of their goals to evaluate SDR and EDR performance and to assess the suitability of operational EDRs for use in climate analyses. The PEATEs also support development of improvements to the operational algorithms which generate SDR and EDR products in the IDPS. In summary, the PEATEs provide support to the NPP Science Team to:

- analyze operational data records (RDR, SDR, or EDR),
- analyze pre- and post-launch instrument calibration,
- analyze operational IDPS algorithm software,
- devise algorithm improvements, and
- test and demonstrate calibration and algorithm improvements.

Data processing for OMPS and CERES follows a different plan. Only the nadir products from OMPS will be handled in the process described above. These will use past heritage algorithms from both the Total Ozone Mapping Spectrometer (TOMS) and Solar Backscatter UltraViolet (SBUV) instruments to obtain total ozone column products. The limb-viewing solar occultation data from OMPS will be used to produce research products through the OMPS PEATE and will be archived separately by NASA.

The CERES instrument is one in a series of CERES sensors flown on a number of satellites to produce a long-term data record of the Earth's radiation budget. The need for a consistent long-term record of the Earth's radiation budget requires a high degree of care and continuity in the generation of energy budget data products. Thus, CERES data will be processed and data products produced at the Distributed Active Archive Center (DAAC) at NASA Langley Research Center where other CERES data products are currently being produced.

1.3 Calibration and Validation

Current NPP Science Team members have been following the calibration and validation plans being developed by the IPO and NGST in order to evaluate their suitability for ensuring high-quality ESDRs and CDRs from NPP. They have also been preparing to provide scientific inputs on or, in the case of some Principal Investigators, to make available certain, specific NASA EOS calibration/validation capabilities in support of critical calibration and validation approaches for science-quality data. It is expected that NPP will be launched during the periods of performance for the awards solicited under this element and that NASA NPP Science Team Members will need to have access to and become involved in the IPO-led calibration and validation activities for NPP insofar as their evaluation of EDRs for CDRs or ESDRs requires. Information about NPP/NPOESS calibration and validation plans can be found at http://npoess.noaa.gov/ams/2009/posters/AMS_09_GRAVITE_Zajic_V8.pdf.

2. Description of Solicited Research

This solicitation requests proposals from members of the scientific community to participate in the NPP Science Team. NASA requests investigations for:

- New and successor investigations to continue the evaluation of NPP/NPOESS Environmental Data Records (EDRs), to demonstrate the suitability of these data sets for use as ESDRs and/or CDRs, and to develop and evaluate improvements to EDR algorithms that could make them more suitable as ESDRs or CDRs;

- New investigations to develop scientific approaches for continuing key ESDRs begun by EOS that cannot be continued by NPP/NPOESS due either to their omission from the initial plans for NPP/NPOESS or to known performance limitations of the instruments currently in development; and
- New investigations to develop and demonstrate innovative and practical applications of NPP data.

The emphasis for all types of investigations is on securing continuous, well-characterized, long time series measurements of sufficient quality to answer critical Earth system science, global change, and/or applied sciences questions.

2.1 Evaluation of Environmental Data Records (EDR)

2.1.1 Proposals Focused on Particular Data Products or Suites of Data Products

New and successor proposals are requested to continue the evaluation of NPP/NPOESS Environmental Data Records (EDRs) begun in prior solicitations and to demonstrate the suitability of these data sets for use as ESDRs and CDRs. These studies must include a plan to evaluate the accuracy with which the operational algorithms provided by the IPO through its contractors can extend the time series of science-quality data records begun with NASA's EOS and earlier satellite systems. The focus should be on the quality of the measurement(s) and data product(s) and their adequacy for documenting changes, trends, and variability in Earth's climate and within the global Earth system. An understanding of accuracy, precision, and stability of the measurement record will be essential. Proposers should plan for the possibility of developing and demonstrating improvements to EDR algorithms in cases where the EDRs may be found to be inadequate for use as ESDRs or CDRs. Proposers should present an end-to-end plan for EDR evaluation, including the investigator's plans to interface with and make use of the appropriate PEATEs. Proposers should include an assessment of known and potential launch delays on the utility of NPP/NPOESS data records in terms of the impacts of reduced overlap with EOS satellites or data gaps on data product calibration/validation and the utility of the data sets for scientific investigations.

The current NPP Science team has over 35 members working on more than 24 EDRs and related data products and calibration/validation tasks. Additional work is being conducted for OMPS limb and CERES as noted above in Section 1.2. Much of the NPP Science Team's pre-launch preparation work has been completed, although day-to-day requests from the NPP and NPOESS Projects for scientific inputs place continuing demands on science team members. NPP is expected to launch during the periods of performance for the awards solicited under this element, and proposers should plan to profile their work and cost plans to reflect somewhat less intense activity prior to the launch of NPP and during the immediate post-launch instrument check-out period and to reflect greater activity once the SDRs and EDRs are available for evaluation. Proposers also are encouraged to consider proposing as small teams collaborating on the evaluation of groups of related data products if greater efficiency and cost savings might be achieved in doing so.

The following broad categories of data products are being produced by NPP and are to be evaluated by the NASA-sponsored NPP Science Team (but note certain exceptions relative to this call under e) and f) below:

a) *Vertical atmospheric profiles of temperature and moisture*: Changes in the vertical distribution of temperature and moisture are primary indicators of climate change. The AIRS instrument on EOS Aqua has added the advantages of hyperspectral infrared sounding to the long-term microwave sounding record from the NOAA polar platforms. The NPP CrIS/ATMS suite of instruments will continue the Aqua AIRS/AMSU/AMSR data records. (EDRs: Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, Pressure Vertical Profile)

b) *Atmospheric particulates—aerosols and clouds:* Changes in cloudiness and aerosol loading together represent the largest sources of uncertainty in our understanding of the Earth's climate system and our quantitative understanding on the climate feedbacks associated with increasing CO_2 emissions. NPP VIIRS will continue the cloudiness record started with AVHRR and continued by EOS MODIS and will continue some of the advanced cloud properties data records from EOS MODIS, not including CO_2 slicing cloud top height and the detection of multi-layer clouds. (EDRs: Cloud Base Height, Cloud Cover/Layers, Cloud Effective Particle Size, Cloud Optical Thickness, Cloud Top Height, Cloud Top Pressure, Cloud Top Temperature). NPP VIIRS will continue the ocean aerosol data record started with AVHRR and, with research retrievals, continue the global (land and ocean) aerosol record started with EOS MODIS. These properties include, but are not limited to, the temporal and spatial distribution of aerosol optical depth (AOD) and aerosol size. (EDRs: Aerosol Optical Thickness, Aerosol Particle Size, Suspended Matter)

c) *Ocean biological and biogeochemical properties and related variables; sea surface temperature; and sea ice*: Long-term measurements of phytoplankton pigments (e.g., phytoplankton chlorophyll *a*), physiology, and carbon species in the ocean allow us to estimate and monitor changes primary productivity and in the magnitude and distribution of the ocean's carbon sources and sinks. Ocean biophysical measurements are used to understand physical drivers and processes affecting the ocean's biology and chemistry, such as fertile upwelling conditions that support important ocean fisheries, ocean acidification, and harmful algal bloom development. The products have implications for carbon and ecosystem management as well as public health and help us understand the ocean's role in Earth's climate. NPP VIIRS was intended to continue the ocean data record started in 1978 with CZCS and improved upon by the SeaWiFS and the EOS MODIS instruments. (EDR: Ocean Color / Chlorophyll) Sea Surface Temperature (SST) is a key geophysical variable coupling the ocean and atmosphere. Precise sea surface temperature measurements are a critical diagnostic for global weather and climate models. Long-term changes in ocean circulation and changes in periodic coupled-ocean-atmosphere processes such as El Nino/La Nina are indicators of climate change. NPP VIIRS will continue the SST record started with AVHRR and continued by EOS MODIS. (EDR: Sea Surface Temperature) The development and analysis of sea ice data records derived from satellite radiometers enables the study of the long-term variability of the polar sea ice cover and its relationship to climate change as well as the study of air-sea-ice interactions at polar latitudes. In particular, these data records are critical to quantifying long-term trends, and understanding these changes in the context of changes in the ocean-atmosphere system. NPP VIIRS will continue the sea ice data record started with AVHRR and EOS MODIS. (EDR: Sea Ice Characterization)

d) *Vegetation biophysical measurements, land cover, and related land surface properties:* Measurement of vegetation reflectance properties allows estimation of vegetation indices, leaf area index (LAI), fraction of absorbed photosynthetically active radiation (FPAR), and albedo -- which, in turn, are used to monitor plant stress, assess vegetation health, estimate terrestrial primary productivity, and assess carbon sources and sinks. NPP VIIRS will continue the Vegetation Index record started with AVHRR and improved by EOS MODIS and new records (e.g., albedo) started with MODIS. (EDRs: Vegetation Index, Albedo) Changes in land cover and land use are making significant changes on the global landscape, with significant implications for carbon cycling, sustainability of ecosystem goods and services, and feedback to the climate system. Moderate resolution observations provide global land cover and burned area data products and important measures of phenological changes. NPP VIIRS will continue the data records initiated with AVHRR and improved upon with EOS MODIS. (EDRs: Surface Type, Vegetation Index) Measurements of land surface temperature and emissivity are key to understanding land surface processes, combining surface-atmosphere interactions and the energy fluxes between the atmosphere and the ground. Measurements of fire occurrence (day/night), fire location, and fire energy are used in monitoring the spatial and temporal distribution of fires in different ecosystems; detecting changes in fire distribution; and identifying new fire frontiers, wild fires, and changes in the frequency of the fires or their relative strength. NPP VIIRS will continue the land surface temperature data record and some of the fire data records initiated with the AVHRR and improved upon with EOS MODIS. (EDR: Land Surface Temperature) The highly reflective nature of snow combined with its large coverage during the Northern hemisphere winter makes snow an important component of the Earth's radiation balance. Snow on the ground influences biological, chemical and geological processes, and many areas of the world require close monitoring of snowpacks throughout the winter and spring for assessing water supply and flooding potential. NPP VIIRS will continue the data records initiated with EOS MODIS. (EDR: Snow Cover/Depth)

e) Ozone total column and vertical profile and other atmospheric constituents: Satellite measurements of total column ozone are the global standard for monitoring the response of the ozone layer to the Montreal Protocol mandated reductions in atmospheric chlorine and bromine emissions. The NPP OMPS instruments will continue the ozone data record, started in 1978, by the Total Ozone Mapping Spectrometer (TOMS) series of instruments and carried on by the Ozone Monitoring Instrument (OMI) instrument on EOS Aura. The limb observing component of OMPS will continue the data records of ozone profile observations that started with the Upper Atmosphere Research Satellite (UARS) and were continued by the Microwave Limb Sounder (MLS) instrument on EOS Aura. The changing climate is affecting the speed and timing of ozone layer recovery, adding to the importance of maintaining continuous data records. (EDRs: Ozone Column, Ozone Profile) Evaluation of the OMPS nadir products is being solicited under this program element. Such work could involve comparisons with EOS Aura's OMI, the European Global Ozone Monitoring Experiment-2 (GOME-2), ground based observations (such as those in the Network for the Detection of Atmosphere Composition Change (NDACC) network), global ozone sondes, etc. OMPS limb EDRs are not being produced by the IDPS because the OMPS limb capability was a late readdition to NPP. Production and evaluation of these products are being covered now by the activities of the NASA SDS Ozone PEATE, NPP Science Team members, and other NASA programs. Successor proposals to continue the NPP Science Team work on OMPS Limb algorithms and data production are welcome under this solicitation.

f) Solar and infrared radiative fluxes at the surface and top of the atmosphere: Measurements of broad-band and/or spectrally resolved short- and long-wave radiative fluxes at the top of the atmosphere and Earth's surface are vital for understanding changes in the Earth's radiation budget. NPP CERES will provide a consistent database of accurately known fields of Earth's reflected solar and Earth's emitted thermal radiation, continuing data records initiated with the Earth Radiation Budget Experiment (ERBE) instruments and improved upon by the CERES instruments on TRMM and EOS. (EDRs: Net Solar Radiation, Top of the Atmosphere; Downward Longwave Radiation at the Surface; Downward Shortwave Radiation at the Surface; Outgoing Longwave Radiation, Top of the Atmosphere) Evaluation of the EDRs for CERES is being done by the CERES Team and is not solicited under this program element.

In addition to the EDRs noted above, certain SDRs and intermediate products are also being evaluated in order assure the quality of the EDRs as well as of the precursor data for science-quality data products that could be developed in the future, but which are not among the current EDRs; an example is Surface Reflectance. Investigations to explore and demonstrate options for making systematic time series data records that will not be provided by NPP/NPOESS, but that could be made using NPP RDRs, SDRs, or intermediate products may be submitted in response to this Section. However, such proposals will be considered of lower priority without a compelling scientific rationale for why that product must be given priority now.

Additional information about NPP data products can be found at http://nppwww.gsfc.nasa.gov/science/DataProducts.html.

2.1.2 Calibration and Validation

Some members of the current NPP Science Team have been preparing to provide scientific inputs on, or to make available certain EOS calibration and validation capabilities in support of, critical calibration and validation approaches for science-quality data. Successor proposals in these areas are welcome.

New research activities to add scientific calibration/validation expertise or to complement planned IPO activities for work essential to the evaluation of EDRs will be considered. Proposers must avoid duplicating calibration/validation work that is the responsibility of NGST and the IPO and should offer studies that complement and add value to those efforts while maintaining a tight focus on activities essential for completing the evaluation of the EDRs and/or offering improvements necessary to create an ESDR or CDR. New field validation campaigns will not be considered.

2.2 Development of New Approaches to Extend Critical Earth System Data Records that Cannot be Produced by NPP

Investigations to explore and demonstrate options for obtaining systematic time series data records that cannot be provided by NPP are sought. Due to performance limitations documented during instrument testing for NPP, a few of the measurements planned are not expected to be of a sufficient quality to usefully extend the current multi-sensor time series. These data products include Ocean Color/Chlorophyll and some aerosol properties (potentially Aerosol Optical Depth) from VIIRS. NASA will continue to evaluate the EDRs for those data products (and such proposals are requested in Section 2.1.1 above) so as to fully document their character and quality and to explore any potential adjustments or algorithmic solutions that might allow for scientific utility. However, NASA is also interested in identifying options to extend these critical time series data products in other ways. In some cases, the performance limitations for an NPP instrument may be mitigated for the instrument version to fly on NPOESS; in these cases there will only be a short potential gap to fill. In other cases, this may not be the case and alternative data sources will be needed for a longer period of time.

When NPP and NPOESS were first being planned and the requirements of the three partner agencies were being integrated, it was not possible to accommodate all of the new science data products being produced by EOS in the plans for NPOESS. Examples of data products that will not be provided by NPP are chlorophyll fluorescence, fire radiative power, stratospheric profiles of water, and atmospheric profiles of N_2O and CH_4. Thus, unless some alternative data source is identified, the time series for these products will end when the EOS satellite sensor making the respective measurement stops operating or data quality degrades beyond research quality. Proposals that address such data gaps, providing tangible ways to extend the data records, will be considered. Such proposals must present a compelling scientific rationale for why that product must be given priority now.

NASA is, therefore, interested in initiating a few studies to explore the suitability of alternative national or international satellite data sources and/or combinations of satellite data and suborbital (e.g., surface-based network) data to continue EOS data records that cannot be continued by NPP. Studies proposed may 1) identify existing and planned U.S. or international satellite measurements and offer to evaluate their potential to continue a particular EOS data record, 2) develop the theoretical basis for a production algorithm, and/or 3) prototype or demonstrate the data product (producing, perhaps a regional or short time period global product) to show the character and quality of the new product and assess its suitability for extending the time series. Investigations to actually produce a new, global, time-series data product are not requested at this time; NASA has other programs that offer opportunities to produce new data products (e.g., the Making Earth Science Data Records for Use in Research Environments (MEaSUREs) program; see Appendix A.33 of ROSES 2010). This opportunity allows for investigators to do the research and preparatory work that would lead to such a future proposal.

Investigations to explore and demonstrate options for making systematic time series data records that will not be provided by NPP/NPOESS, but that could be made using NPP RDRs, SDRs or intermediate products will not be considered responsive under this Section. However, some studies of this nature could be considered under Section 2.1 above. Proposers of these new approaches to extending critical ESDRs and CDRs should consider offering work plans and budgets with more activities and resource requirements in the first year or so, emphasizing the period prior to the launch of NPP when the resource requirements of team members working on NPP EDR evaluation and improvement may be lower.

2.3 Development and Demonstration of Innovative and Practical Applications

Just as data from EOS and previous missions have great value for Earth system research, their value and utility for a growing number of applications have also been demonstrated, and many of these demonstrations have been supported and managed by the NASA Applied Sciences Program. The Applied Science Program supports applied science research and enables practical applications of Earth science products and knowledge. The program serves as a bridge between the Earth science research community and the information and tools required by organizations, agencies, and businesses. As such, the Research Program and the Applied Sciences Program have identified an interest to support applications-oriented members on Earth science mission and measurement teams. The Applied Sciences Program manages its efforts through eight (8) applications areas: Agriculture, Air Quality, Disaster Management, Ecological Forecasting, Public Health, Water Resources, Weather, and Climate. For more information on the NASA Applied Sciences, please see http://nasascience.nasa.gov/earth-science/applied-sciences.

Through this solicitation, the Applied Sciences Program is seeking to support up to three (3) new NPP Science Team member investigations that would incorporate NPP data products into decision support systems of end-user organizations. These applications-oriented science team members will be expected to address applied research topics, communicate information to the appropriate management, policy and applications communities, and represent and provide feedback from those communities to the NPP Science Team. In order to qualify for this support, proposers interested in these positions should include the following: applied research credentials, topic(s) of the applied research investigation or decision-support applications, interest and credentials to support and represent the applications communities, and interest and abilities to enable applications and value in decision making activities.

2.4 Relationships to EOS Terra and Aqua Research Proposals and Projects

In 2006 NASA solicited for proposals to focus on Earth System Data Records and Climate Data Records, merging NPP and EOS Terra and Aqua activities (Appendix A.15 of ROSES 2006; NNH06ZDA001N-EOS). EOS Terra and Aqua algorithm and scientific data analysis research was solicited in ROSES 2009 (see Appendix A.41 of ROSES 2009; NNH09ZDA001N-EOS).

This solicitation is only for NPP Science Team activities. NASA recognizes that there are strong synergies between EOS and NPP algorithm-related activities and that the investigators proposing successor proposals may experience difficulties in preparing stand-alone proposals in response to each opportunity. Such proposers planning to respond to both solicitations are advised to clearly describe each set of activities in the appropriate proposal and then document the cross-cutting synergistic work and costs. Each budget and work plan must be complete and stand alone. However, budget narratives should include statements regarding the tasks, personnel time, and specific costs that would change if the other proposal were also selected for funding.

3. Programmatic Information

3.1 Activities of Science Team Members

NPP Science Team members will be expected to:

- Participate in technical interchange meetings, NPP science team meetings, and relevant measurement team meetings (see ROSES-2009, Appendix A.41, Section 3 for descriptions of measurement teams) and more frequent teleconference calls (proposers should budget for ~2 domestic trips per year for meetings);
- Review sensor and algorithm documents, algorithm code, and system descriptions as appropriate;
- Conduct data simulation studies as appropriate;
- Prepare an algorithm analysis report and recommend algorithm improvement activities;
- Participate in the planning for science operations;
- Participate in NPP calibration and validation planning as appropriate; and
- Provide information to NASA on a variety of technical matters associated with NPP instruments and algorithms.

It is expected that the participation at all NPP Science Team meetings and NASA-supported reviews will be by the team member or a named co-investigator.

Because of the unusual nature of this science team, care should be taken to document all investigators' qualifications for membership. The proposers should identify the specific areas (e.g., which sensor and specific aspects of the sensor or algorithm) in which they intend to contribute and they should document their relevant experience. They should also explain the scientific relevance of the issue to be addressed and their plans to carry out the work. If the proposers are offering a successor proposal for continued NPP Science Team membership, the proposal should include a description of their past productivity and contributions to NPP. The information to be provided should not exceed the page limits specified in the *NASA Guidebook for Proposers.*

3.2 Evaluation Criteria

Proposals will be evaluated according to the criteria specified in section C.2 of the *NASA Guidebook for Proposers*. In addition, the evaluation of intrinsic merit for a proposal shall consider the experience of the offeror (investigators and their institutions) in engaging in data sharing and providing timely access to data and research products on related and relevant projects.

3.3 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $6M
Number of new awards pending adequate proposals of merit	~ 30-40
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-NPP

NASA point of contact concerning this program	Dr. Diane E. Wickland Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0245 E-mail: Diane.E.Wickland@nasa.gov

A.23 RECOMPETITION OF THE GRACE SCIENCE TEAM

1. Scope of Program

The Gravity Recovery and Climate Experiment (GRACE) Earth System Science Pathfinder Program (ESSP) was launched on March 17, 2002. The GRACE mission is an innovative and advanced technology mission to measure the static and time varying components of the Earth's gravity field. The GRACE mission is a multidisciplinary program with expected contributions to solid Earth science, polar science, physical oceanography, hydrology, atmospheric science. The high resolution static and temporal gravity fields measured by GRACE provide first ever opportunities to study global circulation, atmospheric, and hydrologic transport, the internal structure and dynamics of the Earth. These new measurements are also expected to contribute to the mitigation of flooding and drought through a better understanding of the regional distribution of water and its climatic variability.

The GRACE mission is a collaborative mission between NASA/JPL and the German Aerospace Center DLR with co-principal investigators Byron Tapley of the University of Texas at Austin and Christoph Reigber of the GeoForchungZentrum in Potsdam, Germany. During the first three years of its mission GRACE and its science team achieved considerable success and earned its science pathfinder status by demonstrating the importance of precision measurements of planetary gravity fields to a broad spectrum of interdisciplinary science.

The GRACE mission has numerous accomplishments including:

- Factor of 100 improvement in the mean gravity field;
- Measurement of the global mass flux associated with monthly rainfall accumulations;
- Key enabling contribution in the substantiation of the Lens-Thirring effect in fundamental physics;
- First comprehensive measurement of seasonal and inter-annual polar ice mass balance;
- Estimation of hydrological balance for large globally distributed basins including natural and anthropogenic forcings;
- Measurement of global seasonal hydrological exchange between oceans and land;
- The first space-borne measurement of mass transport due to an earthquake;
- The measurement of changes in oceanic circulation due to steric forcings; and
- Measurement of the mass flux variations of large mountain glaciers.

NASA has approved extended mission operations for GRACE through September 30, 2013, subject to continued performance, achievements, and the availability of funds.

Three advanced gravity field missions have been launched this decade. These are CHAMP (launched July 15, 2000), GRACE (launched March 17, 2002) and ESA's Earth Explorer Gravity Field and Steady-State Ocean Circulation (GOCE) (launched March 17, 2009).

The scientific goals of the GRACE mission complement a number of international programs including the World Ocean Circulation Experiment (WOCE), the Climate Variability Program (CLIVAR), and the Global Ocean Observing System (GOOS). The GRACE mission is also responsive to NASA's Solid Earth Science Working Group Report *Living on a Restless Planet* (http://solidearth.jpl.nasa.gov/) that identifies the study of the dynamics of the Earth's gravity field as one of six significant challenges for the next twenty five years.

The primary goal of the GRACE mission is to obtain accurate high-resolution global models for temporal and spatial variability of the Earth's gravity field. The spatial and temporal variability of the Earth's gravity field is a direct manifestation of global mass distribution and its movement. The variability in the gravity field, satellite altimeter data, and other in-situ data are being used in geophysical models to advance our knowledge of concerning changes in ocean heating, sea level, and oceanic currents, regional scale changes in water resources associated with flooding and drought, changes in the Antarctic and Greenland ice sheets, structure and dynamics of the Earth's core and mantle, surface displacements associated with mountain building other tectonic forces.

An additional science goal of the GRACE mission is to enable advances in the atmospheric sciences by the recovery of refractivity (and the derived quantities of temperature and water vapor profiles) and small scale ionospheric structure from the use of GPS radio occultation data. GRACE accelerometers are also capable of measuring upper thermospheric circulation in the form of drag on the satellite.

For further reference see the 1997 NRC report *Satellite Gravity and the Geosphere* (http://www.nap.edu/catalog.php?record_id=5767), the GRACE web page at http://www.csr.utexas.edu/grace/ or http://www.gfz-potsdam.de/pb1/op/grace/index_GRACE.html , and http://podaac.jpl.nasa.gov/grace/bibliography.html for a partial bibliography of published GRACE related studies.

2. Programmatic Information

This solicitation seeks proposals that will advance the development of new methods, algorithms, and models for the exploitation of gravity field observations to be made by GRACE and future space based gravity field missions for the broad spectrum of Earth system science challenges. Proposals are encouraged which are multidisciplinary in scope and which address the Earth System Science questions defined in the NASA Science Plan (http://nasascience.nasa.gov/about-us/science-strategy/).

Due to the extreme sensitivity of the GRACE measurement technique, ground calibration of the mission is problematic. This solicitation, therefore, seeks proposals that provide predictive models for the static and time varying gravity field that can be verified through both ground and GRACE space-borne observations. This solicitation seeks improved models for the static gravity field, and its short term and secular variations and their influence upon the terrestrial reference frame.

This solicitation seeks proposals for the identification and quantification of atmospheric, oceanographic, hydrospheric, cryospheric and solid Earth structure and dynamics manifested in the GRACE observations. The analysis effort can include other data sources that complement the GRACE measurements such as Earth rotation and temporal and static gravity field measurements, and other innovative approaches including the use of data from other satellite missions such as CHAMP and Laser Geodynamics Satellite (LAGEOS) gravity, Jason I and IceSat altimetry, and Shuttle Radar Topography Mission (SRTM). Proposers are advised to limit their proposals involving GPS occultation to the improvement and/or validation of GRACE gravity field models only.

The focus of the proposals should be upon the GRACE data set though multidisciplinary and multi-sensor studies as well as studies that will utilize the GRACE mission data base to develop new measurement strategies to improve measurements of the Earth's gravity field. In particular, NASA is interested in efforts to advance measurement concepts and algorithms that would utilize missions of the Decadal Survey as well as other observing systems to enhance our understanding of the Earth System through improved accuracy and spatial resolution.

The investigators associated with the selected proposals will become members of the GRACE science team for the term of their grants.

Proposals for follow-on investigations to existing GRACE studies will be considered, but proposers are urged to describe accomplishments achieved and carefully articulate the progress to be made in the follow-on effort.

3. <u>Education and Public Outreach Opportunities</u>

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. <u>Summary of Key Information</u>

Expected program budget for first year of new awards	~ $3M
Number of new awards pending adequate proposals of merit	~ 20
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*

Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-GRACE
NASA point of contact concerning this program	Dr. John LaBrecque Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1373 E-mail: John.LaBrecque@nasa.gov

A.24 ENHANCING THE CAPABILITY OF COMPUTATIONAL EARTH SYSTEM MODELS AND NASA DATA FOR OPERATION AND ASSESSMENT

Amendment 4 on May 7, 2010. This version of the text replaces the prior draft version in its entirety.

1. Scope of Program

1.1 Background

NASA's Earth Science Research Program aims to use global measurements to understand the Earth system and its interactions as steps toward ultimately enabling prediction of Earth system behavior. To achieve this goal, a combination of shorter-term process-oriented measurements is complemented by longer-term satellite measurements of a limited number of environmental properties. For these measurements, NASA's Earth Science Research Program sponsors algorithm development, calibration/validation activities, and modeling studies to produce high-quality data products for scientific research and operational use.

This solicitation recognizes the advances already made by investigations which were solicited by prior NASA Research Announcements and/or National Oceanic and Atmospheric Administration (NOAA) Announcements of Opportunity and which focused in the areas of sensor calibration, algorithm development and refinement, product validation, and scientific data analysis. This solicitation offers investigators an opportunity to analyze, assess, and increase the impact of NASA data in research and operational environments, particularly in the areas of weather prediction, climate projection assessment, and global carbon cycle modeling in anticipation of carbon management regulations.

This solicitation also recognizes that there may be more efficient ways to deliver model predictions or datasets using the latest innovations in computing and computational technologies. NASA will support research proposals to experiment with the latest computing technologies with specific models and assimilation systems.

2. Areas of Proposals Solicited

This solicitation seeks three areas of proposals: (a) Acceleration of Operational Use of Research Data, including Joint Center for Satellite Data Assimilation (JCSDA), (b) data for IPCC climate projection assessment, and (c) computational support of Earth system modeling.

2.1 Acceleration of Operational Use of Research Data

2.1.1 Operational Short-term Weather Predictions

NASA encourages more rapid use of NASA's observations in operational weather predictions. Research and development proposals are sought to accelerate the operational use of NASA data. Proposals may be in areas of transitioning existing research data into the operational environments or of developing algorithms in the operational environment to accept future NASA

NPOESS Preparatory Project (NPP) Joint Polar Satellite System (http://eospso.gsfc.nasa.gov/eos_homepage/mission_profiles/show_mission.php?id=71&mission_cat_id=17, or decadal survey measurements.

In order to facilitate a rapid transition of research data into an operational environment, NASA has set up the Short-term Prediction Research and Transition Center (SPoRT; http://www.ghcc.msfc.nasa.gov/sport/) at NASA Marshall Space Flight Center. The SPoRT center is NASA's primary research and operation transition interface with the National Weather Service for short-term weather predictions. NASA is seeking external research proposals to collaborate with the SPoRT center to transition research data into at least one operational environment. Since the main motivation is to broaden the utilization of NASA's research satellite observations, proposals using models, data assimilation systems, or weather information systems, other than those currently employed by an operational entity, will *not* be considered.

Potential proposers are encouraged to contact the SPoRT center. The point of contact at SPoRT is Dr. Gary Jedlovec, gary.jedlovec@nasa.gov, 256-961-7966. Total funding for this area is approximately $500K per year. Two to three projects may be selected.

2.1.2 Joint Center for Satellite Data Assimilation

The Joint Center for Satellite Data Assimilation (JCSDA; http://www.jcsda.noaa.gov/) was established by NASA and NOAA in July 2001 to accelerate and improve the quantitative use of research and operational satellite data in weather and climate, ocean and environmental analysis, and prediction models. The Department of Defense (DoD) has since joined NASA and NOAA in supporting the JCSDA. Seven partner organizations (http://www.jcsda.noaa.gov/partners.php) benefit from the partnership in which the resources and talents of several agencies are combined to solve problems of mutual interest. The JCSDA research and development also benefited from the efforts made by investigators external to the JCSDA partners.

Research and development proposals are sought, from external investigators, in the following four specific areas in global models or data assimilation systems used by the JCSDA partner organizations.

1. Snow/soil moisture assimilation work for the Land Information System (LIS) that is/will be common to NOAA National Center for Environmental Prediction (NCEP), NASA, and Air Force Weather Agency (AFWA), to be coordinated with related efforts within Environmental Modeling Center (EMC) and Global Modeling and Assimilation Office (GMAO);
2. Work toward establishing a JCSDA capability of maintaining a high-quality spectroscopy database over all remote sensing parts of the electromagnetic spectrum from ultraviolet to microwave wavelengths. Community Radiative Transfer Model (CRTM) fast models need to be periodically updated using the new line by line data base;
3. Some experiments seem to indicate that a greater impact on Numerical Weather Prediction (NWP) skill is obtained by the use of Atmospheric Infrared Sounder (AIRS) temperature retrievals than by use of AIRS radiances from both temperature and moisture channels. Efforts are sought that elucidate this issue in the JCSDA operational systems, identifying the elements of retrieval algorithms that enhance the impact of AIRS in

analyses and NWP skill, a careful comparison with the procedures used in radiance assimilation, and modification of the radiance assimilation procedures if warranted; and

4. Development of a common JCSDA Infrared (IR) and Microwave (MW) emissivity database for use by all partners, along with test cases to be used for impact experiments.

Total funding for the above area is approximately $500K per year. Three to four projects may be awarded. Awards will be in the form of a Cooperative Agreement or contract. Baseline models and data assimilation systems will be provided by the JCSDA. Proposals using models or data assimilation systems other than that provided by the JCSDA will not be considered. To avoid the appearance of conflict of interest, NASA will not accept proposals including investigators (PI or Co-I) from the following organizations, which helped to define the research topics for this call: NOAA/National Environmental Satellite Data and Information Service/Center for Satellite Applications and Research, NOAA/NWS/NCEP, Navy/Naval Research Laboratory/Marine Meteorology Division, AFWA, NASA/Goddard Space Flight Center/Science and Exploration Directorate/Earth Science Division, and NOAA/Office of Oceanic and Atmospheric Research/Atlantic Oceanographic Meteorological Laboratory. Proposals with funded investigators from all other organizations are permitted.

Parallel to this solicitation, NOAA is offering the Federal Funding Opportunity (FFO). Research organizations are also encouraged to check out the NOAA FFOs referred to at the JCSDA web site (http://www.jcsda.noaa.gov/).

2.2 Data for IPCC Climate Projection Assessment

NASA encourages more widespread use of NASA satellite observations, particularly, but not limited to, ocean biological and biogeochemical (ocean color) data, in existing global and regional models to be employed by the IPCC or similar climate or global carbon cycle assessments. There is a need to better parameterize the ocean's biology and chemistry within global climate and carbon cycle models and to constrain the energy and carbon fluxes across the air-sea interface. This is in the interest of supporting the Fifth IPCC Assessment Report (AR5) and future IPCC assessments for Working Group 1 Climate Model intercomparisons, to inform any future carbon management strategies, or to support development of tools for climate adaptation and mitigation. For example, a carbon management system will require global carbon cycle models to verify permanent carbon sequestration, which is dependent on quantification of carbon sources, sinks, fluxes, stocks, etc. and processes affecting them in the ocean. Research and development proposals are sought to accelerate the use of NASA ocean color satellite data for these purposes. NASA will select up to two projects that directly support the IPCC AR5 Working Group 1 Climate Model intercomparison projects (in the interest of climate or carbon cycle assessments). Proposals may seek to transition existing research data into the global climate and/or carbon cycle assessment environments or develop algorithms to accept future NASA ocean color satellite observations.

NASA is also interested in the improved access and documentation of satellite observational data sets for the Climate Model Intercomparison Project Phase 5 (CMIP5), which will support the IPCC AR5 report. Research and development proposals are sought to organize satellite observations to support the construction, validation, or verification of cloud or radiation components of models and to support the construction of interface between the ocean and atmosphere in the coupled models. The proposals must demonstrate the use of the data in CMIP5 studies. Since the data will be used for the CMIP5 and IPCC AR5, the resulting data must be accessible through the Earth System Grid (ESG) nodes.

Proposals *must* use models, data assimilation systems, or global climate or carbon cycle information systems that are currently employed by the IPCC or similar climate or global carbon assessment activities and the plan for transition of the research data or results must be clearly identified and committed to the proposed effort.

Total funding for this area is approximately $1M per year. Four to six projects may be selected.

2.3 Computational Climate Modeling

NASA's weather and climate models are used in long-term climate projections, inter- and intra-seasonal climate, and global weather predictions. As the spatial resolution of the models is increased, they require more computational resources. It is highly desirable that the efficiency of the computational models be increased so that maximum efficiency can be gained from advances in computational technology, including hardware, software, networks, and tools. NASA has identified several areas for which improvements in the efficiency of its models as implemented with currently available and planned computing technology are highly desired.

In addition, the long-term integration of the models often generates a large number of output files. NASA is seeking to develop innovative approaches to improve our ability to create time series of specific parameter(s) from model output.

The total funding for this area is approximately $1M per year. Four to six projects are sought in the following areas:

1. Acceleration of NASA Global Modeling and Assimilation Office (GMAO) GEOS-5 atmospheric model or NOAA/NASA Grid point Statistical Interpolation (GSI) using the Graphic Processing Unit (GPU) technology,
2. Acceleration of radiative transfer codes, both CRTM and Rapid Radiative Transfer Model (RRTM)/G, using GPU technology,
3. Utilization of parallelism to improve the input/output (I/O) performance of the GEOS-5 model and its associated adjoint model,
4. OpenAD automatic numerical model adjoint generation software development applicable to GEOS-5 and GSI Fortran-Message Passing Interface (MPI)-based components, including issues involving communication and Earth System Modeling Framework (ESMF) constructs, and
5. Develop innovative approaches to I/O for post-processing large GEOS-5 or Model-E data volumes across many files on high performance computers, especially using virtual file systems.

3. Programmatic Information

3.1 Identify the Research Area

Proposers must identify and respond to only one of the three areas defined in Section 2.

3.2 Prior Research Results

Proposers responding to sections 2.1 and 2.2 must identify prior research results that demonstrate the potential value of the NASA research data on operational or assessment activities. The citation of one or more peer-reviewed papers in which positive results have been reported is considered to be the minimum requirement.

3.3 Schedule

Proposals responding to area 2.1: Acceleration of Operational Use of Research Data should propose a schedule with the aim to fully transition the operational use of NASA research data to an operational entity within two years of the inception of the project.

3.4 Peer Review

Proposals will be evaluate by peer-review panels. Mail reviews will not be used. For the proposals responding to the JCSDA requirements the panel members will be selected by the JCSDA partner agencies. The final selection authority will be NASA.

3.5 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	Up to $3M
Number of new awards pending adequate proposals of merit	~ 12 - 18
Maximum duration of awards	2 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.
Due date for proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.

Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pages; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-COUND
NASA point of contact concerning this program	Dr. Tsengdar Lee Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0860 E-mail: tsengdar.j.lee@nasa.gov Dr. Paula S. Bontempi Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1508 E-mail: paula.s.bontempi@nasa.gov

A.25 HYSPIRI PREPARATORY ACTIVITIES USING EXISTING IMAGERY

1. Scope of Program

In response to the National Research Council's Decadal Survey report *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* (http://www.nap.edu/catalog.php?record_id=11820), NASA continues to develop concepts for a Hyperspectral Infrared Imager (HyspIRI) mission. Plans are for the mission to carry an imaging spectrometer operating in the visible to the shortwave infrared (VSWIR) regions of the electromagnetic spectrum and a multispectral thermal infrared (TIR) imager. This combination of sensors on the same spacecraft will allow unique opportunities for synergistic science in a wide range of disciplines.

To support the development of HyspIRI mission concepts and to engage potential research communities in preparation for data from a HyspIRI mission, NASA plans to assemble HyspIRI-like data sets from existing high-altitude airborne and/or satellite platforms carrying imaging spectrometers and multispectral thermal instruments.

2. Types of Proposals Sought

Proposals should make use of existing airborne and satellite imagery to create data sets that address compelling research questions requiring the use of data from both a VSWIR imaging spectrometer and a multichannel TIR instrument. Proposals that seek to acquire new airborne data sets are not responsive to this solicitation.

This is a research solicitation. Proposals must outline and seek to address with HyspIRI-like data a strong research question providing the basis for hypothesis-driven science.

You can find examples of the types of questions those proposing might address in the Science section of the HyspIRI Mission Study web site at http://hyspiri.jpl.nasa.gov/science/. The combined questions (cq's) and related subquestions at this site are especially relevant to this solicitation.

NASA conducted a similar HyspIRI call for proposals under its Research Opportunities in Space and Earth Sciences (ROSES) 2009 solicitation (see Appendix A.29 of ROSES 2009). You will find a list and short description of the six awards made under that solicitation by going to: http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={DAFC4BF9-606A-4869-D6C0-806F77BC6B3E}&path=past and clicking on the link under "Selections."

Current plans for a HyspIRI mission suggest a ground spatial resolution of 60 meters for both the VSWIR imaging spectrometer and the multispectral TIR imager. Thus, to provide as accurate a representation as possible of the spatial resolution of anticipated HyspIRI imagery, NASA is seeking proposals that would use existing data from both the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) and the MODIS/ASTER airborne simulator (MASTER) instruments when flown aboard the NASA ER-2 high-altitude aircraft or a comparable platform. In addition, proposals using satellite imagery from the Hyperion instrument aboard the Earth Observing-1 satellite and thermal products from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instrument aboard the Terra satellite are welcome.

More information about these airborne and satellite instruments is available on the Web at the following URLs.

AVIRIS:	http://aviris.jpl.nasa.gov/
MASTER:	http://masterweb.jpl.nasa.gov/
Hyperion:	http://eo1.gsfc.nasa.gov/ and http://eo1.usgs.gov/
ASTER:	http://asterweb.jpl.nasa.gov/

In addition to imagery from these sources, the NASA Ames Research Center acquired coincident MASTER and HyMap hyperspectral imagery of Costa Rica during March and April of 2005 for the Government of Costa Rica. Both systems produced data at a resolution of 19 meters, and the coverage encompassed approximately 83% of the country. Those who would like to use this imagery in response to this solicitation are encouraged to contact Jeff Myers at NASA Ames Research Center (jeffrey.s.myers@nasa.gov or 650-604-3598) regarding access to this data set. Data coverage maps may be perused on the MASTER website (see above).

Funded projects under this solicitation should help lay the foundation for future solicited airborne campaigns seeking to acquire new imagery for HyspIRI precursor science.

Those proposing under this solicitation should allocate funds within their budget for one domestic trip to attend the HyspIRI Science Workshop.

3. Summary of Key Information

Expected total program budget for new awards	~ $500,000
Number of new awards pending adequate proposals of merit	~ 3 to 7
Maximum duration of awards	1 year
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	8 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	12 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.

General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-HYSPIRI
NASA point of contact concerning this program	Mr. Woody Turner Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1662 E-mail: Woody.Turner@nasa.gov

A.26 EARTH SCIENCE U.S. PARTICIPATING INVESTIGATOR

1. Scope of Program

1.1 Background

NASA's strategic goal in Earth science is motivated by the fundamental question "How is the Earth changing and what are the consequences for life on Earth?" NASA's mission in Earth science, as mandated by the Space Act, is to "… conduct aeronautical and space activities so as to contribute materially to … the expansion of human knowledge of the Earth and of phenomena in the atmosphere and space." NASA has a long history of contributing to the knowledge of our Earth system using satellite observations, as was documented by the National Research Council (NRC) in its recently-released report *Earth Observations from Space: The First 50 Years of Scientific Achievements* (http://www.nap.edu/catalog.php?record_id=11991). There is great potential for future space-based observations of the Earth, as was documented by the NRC in its first ever decadal survey for Earth science, *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* (http://books.nap.edu/catalog.php?record_id=11820). NASA's Earth science programs are essential to the implementation of three major Presidential initiatives: Climate Change Research (June 2001), Global Earth Observation (July 2003), and the U.S. Ocean Action Plan (December 2004). The current Earth science research plan for NASA may be found as Chapter 4 of the *Science Plan for NASA's Science Mission Directorate 2007-2016* (http://nasascience.nasa.gov/about-us/science-strategy/), hereafter referenced as the *2007 NASA Science Plan*.

Together with the overarching question given above, NASA developed a hierarchy of science questions, with a second tier of questions that represents a paradigm of variability, forcing, response, consequence, and prediction:

- How is the global Earth system changing?
- What are the primary forcings of the Earth system?
- How does the Earth system respond to natural and human-induced changes?
- What are the consequences of change in the Earth system for human civilization? and
- How will the Earth system change in the future, and how can we improve predictions through advances in remote sensing observations, data assimilation, and modeling?

In addressing these questions, NASA makes use of space-based, surface-based, airborne, and balloon-based measurements, as well as a broad suite of observations (both space-based and other) made by our interagency and international partners. Particular interest is given to having close connections with the satellite observations of international partners, especially as coordinated through the Committee on Earth Observation Satellites (http://www.ceos.org/) as well as other large international coordinating organizations, such as the World Meteorological Organization (http://www.wmo.int/pages/prog/sat/).

1.2 Science and Program Objectives

NASA solicits proposals for USPI investigations that address the Earth Science Research Program objectives listed in the *2007 NASA Science Plan*. This solicitation is for Earth science investigations that address the science questions listed in the *2007 NASA Science Plan* and that contribute and facilitate access to foreign space agencies' assets.

2. Programmatic Considerations

2.1 Proposal Opportunity Period and Schedule

The schedule that applies to this Earth Science USPI program element is given in Section 3.

2.2 Proposal Requirements and Constraints

2.2.1 *Type of Investigation*

A proposed investigation as a USPI on a non-NASA space mission may be as a Co-Investigator (Co-I) for an instrument, experiment, or technology demonstration that is being built and flown by a sponsor agency other than NASA. The Co-I role can include, but is not limited to, instrument design, modeling and simulation of the instrument's operation and measurement performance, calibration of the instrument, scientific analysis and/or research of the data returned, and/or development of innovative data analysis techniques. A USPI may also serve as a member of a non-NASA space mission science or engineering team and participate in science team activities such as mission planning, mission operations, data processing, data analysis, and data archiving. No matter what the nature of the USPI role, an investigation proposed under this category must be for a science or technology investigation and must include some meaningful data analysis component, archiving of the set of data products generated by the USPI as part of his/her task, and the publication of science results in the peer reviewed literature. All aspects of the investigation through publication must be within the proposed cost.

Investigations requiring the provision of flight hardware are not solicited through this USPI solicitation.

A proposed investigation as a USPI on a non-NASA space mission may take any form that clearly and demonstrably enhances the scientific output of the mission, benefits the U.S. scientific community, and enables the U.S. Earth science community access to a highly valued scientific data set.

The proposed investigations can vary in duration, to include just the prime science mission phase, or to begin at the post confirmation development phase (e.g., for calibration analysis) through the prime mission operational phase, depending on the science requirements of the investigation. All investigations shall include one year for archiving of data products resulting from this effort following the conclusion of the prime mission phase. The emphasis of the investigations proposed should be on supporting the development and validation of Earth science data products that will be distributed promptly to the Earth science research community.

Investigations focused on analysis and interpretation of the data products produced by this effort should be proposed separately through the annual ROSES call in response to an appropriate element.

This program element solicits new investigations only. Proposals whose intent or purpose is to extend or directly supplement existing investigations already funded for approved space flight missions or other Earth Science Division research programs are not appropriate for this program element. Investigators who are members of the science teams of ongoing missions and who propose to use data from those missions must clearly demonstrate that the proposed research is distinct from their existing efforts.

2.2.2 *Cost Considerations*

For individual investigators, the cost for proposals should be between $125K and $150K per selected investigation per year through the prime science mission phase plus one year for additional data archiving for the baseline scientific investigation. NASA plans to distribute $750K per year for this solicitation.

NASA reserves the right to make no selection if there are no proposals of appropriate merit.

2.2.3 *Duration of Award*

Proposals should be for the entire duration of the proposed investigation. This may be no more than through the prime science mission, plus one year for additional data archiving for the baseline scientific investigation. The budget justification in the body of the proposal should cover this entire period.

Awards will be for a maximum of five years. If the proposed investigation is for more than five years, then a continuation proposal may be submitted for a new award covering a period of up to five additional years. The progress and accomplishments of the initial five years of the investigation will be reviewed as part of the decision making process for the continuation award.

The budget for only the first five years of the investigation should be entered into the NSPIRES budget forms.

2.2.4 *Technical Requirements and Constraints*

In addition to the requirements given in ROSES, all proposed investigations must also demonstrate:

1. their formal relationship with the sponsoring agency’s mission (e.g., selected participant, invited participant, or proposed participant);
2. the status of the mission within the sponsoring agency (i.e., Pre-Phase A, Phase A, Phase B, etc.) including the level of commitment that the sponsoring agency has made to complete development;
3. a description of the type and the characteristics of the data from this investigation, as well as any ancillary science data that will be archived as part of this investigation, and a clear

statement of the data policy for the mission that documents the process and schedule by which the data will be made available to the Earth science community; and

4. a detailed explanation of how the U.S. Earth science community benefits from this participation.

2.3 Proposal Evaluation Factors

Proposers are reminded that the evaluation criteria for this solicitation are given in the *NASA Guidebook for Proposers* (see below for reference). These criteria are intrinsic merit, relevance to NASA's strategic goals and objectives, and cost realism and reasonableness. In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "intrinsic merit" specifically includes the following factors:

- The benefits to the U.S. Earth science community from this investigation; and
- The demonstrated scientific merit that this investigation's archived data adds to the U.S. Earth science community.

2.4 Award Management

Awards will likely be executed directly from NASA Headquarters, although NASA reserves the right to implement them through a NASA Center (or the Jet Propulsion Laboratory) in order to facilitate coordination with related flight projects that the Center may be carrying out.

2.5 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~$750K
Number of new awards pending adequate proposals of merit	5-6
Maximum duration of awards	Through the end of the Prime Mission plus one year for data analysis and archiving (see Section 2.2.3).
Due date for Notice of Intent (NOI) to propose	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.

Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-ESUSPI
NASA point of contact concerning this program	Dr. Garik Gutman Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Tel: 202-358-0276 Email: ggutman@nasa.gov

A.27 COMMERCIAL REUSABLE SUBORBITAL RESEARCH PLATFORMS FOR EARTH SCIENCE

1. Background

NASA's Earth Science Research Program is an end-to-end program that starts with the development of observational techniques and the instrument technology needed to implement them; tests them in the laboratory and from an appropriate set of suborbital platforms; uses the results from suborbital and orbital observations to increase basic process knowledge; and incorporates results into complex computational models that can be used to more fully characterize the present state and future evolution of the Earth system. Commercial Reusable Suborbital Research (CRuSR) platforms are one class of suborbital platforms that can be used for NASA Earth science, others include aircraft and balloons.

SMD recognizes that CRuSR platforms may provide unique opportunities to support Earth science that cannot be accomplished by other suborbital platforms including aircraft (piloted and uninhabited), balloons, and sounding rockets.

The Commercial Reusable Suborbital Research (CRuSR) Program will procure reusable suborbital launch vehicle services for the conduct of NASA scientific research, education, and technology advancement. The use of these commercial services may reduce the cost of suborbital flight research by leveraging private investment. Commercial suborbital vehicles are anticipated to be operational by about 2011, and there may also be flight research opportunities as the vehicles are tested and demonstrated.

2. CRuSR Proposals

Prior to the finalization of ROSES-2010 for release, sufficient technical information on vehicles for writing and evaluating proposals was not available to proposers. Once that technical information is available, ROSES-2010 will be amended to solicit proposals for investigations using CRuSR vehicles through the Commercial Reusable Suborbital Research Platforms for Earth Science program

3. Contact for Further Information

Additional information on CRuSR vehicles, including technical capabilities, operational constraints, and anticipated costs to researchers, is available at http://suborbitalex.arc.nasa.gov/node/61.

Investigators interested in proposing CRuSR payloads when proposing opportunities are offered are strongly urged to discuss prospective investigations with operations personnel at NASA Ames Research Center (for CRuSR). Questions concerning potential CRuSR investigations may be addressed to:

Mr. Mike Skidmore
Commercial Reusable Suborbital Research Program Office
Mail Stop 240-10
Ames Research Center
National Aeronautics and Space Administration
Moffett Field, CA 94035
Telephone: (650) 604-6069
Email: Mike.Skidmore@nasa.gov

A.28 NEW INVESTIGATOR PROGRAM IN EARTH SCIENCE

NOTICE: The New Investigator Program (NIP) for Earth Science will not be competed in 2010. NIP is scheduled to next solicit proposals in ROSES 2011.

1. Scope of Program

1.1 Introduction

The New Investigator Program (NIP) in Earth Science is designed to encourage the integration of Earth system research and education by scientists and engineers at the early stage of their professional careers. The program encourages scientists and engineers at academic and/or research institutions to develop a broader sense of responsibility for effectively contributing to the improvement of science education and public science literacy; it provides an opportunity for the investigators to develop partnerships and/or enhance their skills, knowledge, and ability to communicate the excitement, challenge, methods, and results of their work to teachers, students, and the public. The Earth Science Division places particular emphasis on the investigators' ability to promote and increase the use of space-based remote sensing through the proposed research and education projects.

All NIP proposals must contain both a research element that addresses one of the topical areas identified below, as well as a significant program of education and outreach activities and/or interdisciplinary endeavors from which the community of practitioners in Earth, space, and environmental sciences can benefit. The research Focus Areas appropriate for the NIP are (see Appendix A.1 for a description of Earth Science Focus Areas):

- Carbon Cycle and Ecosystems,
- Climate Variability and Change,
- Water and Energy Cycle,
- Atmospheric Composition,
- Weather, and
- Earth Surface and Interior.

The proposed research project must be led by a single, eligible (see further below for eligibility) Principal Investigator (PI); however, the research project itself may be collaborative. In particular, interdisciplinary or educational collaborations with partners from institutions other than the submitting institution are encouraged. International collaborations are also encouraged, although funds from NASA may not be used to fund research carried out under the auspices of a non-U.S. institution. Access to unique research equipment, facilities, and/or geographical locations and the opportunity to collaborate with outstanding foreign researchers and educators may provide substantial benefits to the research proposed.

The NIP in Earth Science was originally established in 1996. The frequency of solicitation is currently every two years.

1.2 Eligibility

An NIP proposal PI must be a U.S. citizen or have lawful status of permanent residency (i.e., holder of a U.S. Permanent Resident Card, also referred to as the Green Card)[1]. He/she must be a recent Ph.D. recipient, defined as having graduated on or after January 1 of the year that is no more than five years before the issuance date of this ROSES NRA.

Institutions and organizations are encouraged to submit proposals under the NIP on behalf of their outstanding new faculty members or employees who intend to develop academic careers involving research and education in Earth system science and associated applications as long as the individuals are the proposed PIs.

To be eligible for an NIP award, proposed PIs must meet the following requirements:

- Be employed at an institution in the U.S., its territories or possessions, or the Commonwealth of Puerto Rico, which awards a baccalaureate or advanced degree in a field supporting the objectives of NASA Earth system studies, or be employed at any nonprofit research institution or other nonprofit organization that performs significant amount of work in fields of research supporting the objectives of NASA Earth Science Program. Such organizations could include museums, observatories, Government or nonprofit research laboratories, as well as nonprofit entities in the private sector.

- Be in tenure- or nontenure-track positions in either teaching or research or both, as long as the employing institution assumes the responsibility of submitting the proposal with the individual as the proposed PI. Note that individuals who have interrupted their careers for substantive reasons, such as family leave or serious health problems, and are more than five years beyond the receipt of their Ph.D. degrees may also be eligible. In such cases, prior concurrence from NASA is encouraged before proposal submission.

- Not hold or have held tenure (or equivalent) on or before the submission deadline of this program.

- Not be a current or former recipient of the NIP or PECASE (see further below) award.

NIP awardees are not eligible for supplemental Education and Public Outreach awards as described in Section I(c) of the *ROSES Summary of Solicitation*.

[1] The prospective PI may submit a proposal to NIP if he or she is reasonably certain that the Green Card will be in hand soon after the proposal submission. The evaluation of proposals takes approximately 5 months, and awards are made within a couple of weeks after the announcement of selections. NASA will not award a grant if the submitting institution cannot certify the PI's eligibility.

2. Programmatic Information

2.1 Funding

Proposals to the NIP are openly solicited approximately every two years. The awards, to be provided in the form of "education grants," range between $80-$120K per year for a period of up to three years, subject to satisfactory progress and availability of funds.

2.2 Relationship of NIP to PECASE Awards

Each year, NASA selects its nominees for Presidential Early Career Awards for Scientists and Engineers (PECASE) from the exceptionally meritorious awardees sponsored by its research programs. PECASE awards recognize outstanding scientists and engineers who, early in their career, show exceptional potential for leadership at the frontiers of knowledge. Each Presidential award is of five-year duration. NASA does not issue a special announcement for the PECASE award. The awardees of the New Investigator Program constitute a primary, but not the only, source of nominations for the PECASE by the Earth Science Division. If an NIP awardee is selected for the PECASE award, the duration for the combined honor is five years. Conversely, a current or former recipient of a PECASE award is not eligible to apply to the NIP.

2.3 Proposal Preparation

The NIP proposals should be prepared in accordance with the instructions given in the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers* (see further below) with the following exceptions:

- The Science/Technical/Management section of the proposal should contain a detailed statement of both the proposed Research as well as the proposed Education/Outreach activities. In order to accommodate this expanded purview, the length of this section of the proposal is expanded to 20 single-spaced pages including figures and tables. All other characteristics of the proposal as given in the *NASA Guidebook for Proposers* are the same.

- The Education/Outreach Plan should be a section distinct from the Research Plan, describing the specific role played by the PI in the proposed educational activities that address the educational objectives and evaluation criteria laid out in the NASA Education Strategic Coordination Framework, available at http://education.nasa.gov/about/strategy/. The focus of the Education Plan should be a significant degree of participation by the PI in an existing, systemic, and sustainable educational system or framework, whereby scientific and technological research, as a *process* and a *product*, contributes to the forming of inquiry minds and the harnessing of exploration, inspiration, and awe. The Education Plan should address a real educational need and does not have to address all aspects of college, elementary/secondary, and informal education. The proposed PI is encouraged to incorporate her/his own talent, interest, and/or expertise, as well as the need of their institutional environment. She/he is encouraged to partner with educators or educational organizations/entities whose primary mission is in education, science communication, or interpretation; she/he is also encouraged to partner with programs or entities focused on promoting the participation of underrepresented groups in Earth science. Stand-alone educational efforts and/or development of educational resources without a clear plan for evaluation and dissemination are not acceptable for the NIP. The PI is encouraged to exploit resources already developed in Earth science education and outreach (see http://nasascience.nasa.gov/educators/earth-science-education-catalog). Expenditures to enable such participation of the PI in an educational endeavor may command up to 25% of the total proposed budget. Student support to graduate and/or undergraduate students proposed under the Research Plan is considered as such, and will not accrue merit under the education/outreach evaluation.

2.4 Budget Requirements

The NIP awards are typically three years in duration. The award amount for each is judged according to the scope of the proposed work and the overall competition. Salary for up to three months per year of PI time is allowable. Funds may be used for support by students (undergraduate or graduate) and/or postdoctoral fellows who are involved in the proposed research, for support of educational expertise in the educational activities, for research expenses such as costs incurred in field experiments, purchase of equipment and/or supplies, computing, travel, etc. If research collaboration is a component of the proposal, it is presumed that the collaborator(s) have their own means of research support; that is, an NIP award may not include expenses for personnel or activities at collaborating institutions, nor salary costs for senior personnel, consultants, or subcontractors unless in support of the proposed educational activities accompanied by appropriate justification.

NASA strongly encourages, but does not require, that the submitting institution contribute to the cost of the proposed NIP project. Of special interest is cost sharing in which the employing institution would provide release time to enable the applicant to more fully concentrate on the activities related to the proposal. Institutional support of equipment purchase and co-funding of student and/or postdoctoral support would also be recognized as valuable cost sharing. Hardware purchased through start-up funds for a recently hired investigator or salary support provided through other Federally sponsored research may not count as cost sharing for the purpose of a NIP proposal.

2.5 Proposal Review and Evaluation

The general evaluation factors in Appendix C of the *NASA Guidebook for Proposers* apply to the NIP proposals with the following clarifications:

- For the Research Plan, in addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion “relevance to NASA's strategic goals and objectives” specifically includes the following factor: long-term commitment to the applicant's career development by the employing institution.
- For the Education Plan, the specific factors for the evaluation criteria (Intrinsic Merit, Relevance to NASA’s Objectives, and Cost) are described at http://nasascience.nasa.gov/researchers/education-public-outreach/explanatory-guide-to-

smd-e-po-evaluation-factors and are based on the NASA Education Program Operation Principles.

- The evaluation of the two Plans will be combined for the final selection, and the Research Plan will carry approximately double the weight of the Education Plan.

3. NASA Point of Contact concerning this Program

Dr. Ming-Ying Wei
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: (202) 358-0771
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A.29 APPLIED SCIENCES PROGRAM: DECISION SUPPORT

NOTICE: The Applied Sciences Program will not issue a program-wide solicitation in ROSES 2010. With ROSES 2010, the Applied Sciences Program will begin soliciting proposals separately for each of the individual applications programs within the Applied Sciences Program. The Applied Science Program is also funding proposals for applications-related activities within ROSES 2010 program elements managed by other Earth Science Research Programs. Appendix A.1 and Section 3 below articulate the specific program elements that the Applied Sciences Program is supporting in ROSES 2010.

1. Applied Sciences Program Objectives

The overarching purpose of the Applied Sciences Program is to discover and demonstrate innovative and practical applications of NASA Earth science research, technology, and observations. To this end, the program seeks to increase the benefits to society of the nation's investments in the NASA Earth science research program.

The Applied Sciences Program supports applied science research, applications, and decision support activities that supply foundational applied knowledge and enable practical applications of Earth science products and knowledge in partnership with end-user organizations. The Program thus serves as a bridge between the data and knowledge generated by NASA Earth science research programs and the information needs and decision making of government agencies, companies, and other organizations.

2. Program Elements and Joint Solicitations

Applied Sciences Program activities promote innovation in the use of Earth science data, transition of applied knowledge to public and private organizations, and adoption of applications by end-user organizations. The Program works in partnership with organizations that develop, own, and employ decision support tools, systems, assessments, etc. to serve and support their management, business, and policy-making activities. The Program allows and encourages all sectors, including the private sector, to be involved in project teams and submit proposals.

The Applied Sciences Program manages according to eight applications areas:

Agriculture	Air Quality	Natural Disasters
Ecological Forecasting	Public Health	Water Resources
Weather	Climate	

The Applied Sciences Program and the R&A Program have identified that there are certain activities that fall between the topics each program has traditionally funded. These activities address issues of applied research that can contribute to the body of "applications knowledge" and the fundamental understanding on how to achieve applications and support decision making. As such, the Applied Sciences Program is allocating resources specifically to solicit and fund applications-oriented activities in certain R&A program elements.

3. Applied Sciences Program Solicitations in ROSES 2010

The Applied Science Program is directly soliciting proposals through two program elements in ROSES 2010.

Climate and Biological Response: Research and Applications (Appendix A.30) solicits proposals in support of the Ecological Forecasting application area and the Water Resources application area. Applications proposals in response to this program element solicitation should integrate forecasting tools into the landscape or seascape management frameworks of participating agencies, including the impact of a changing climate on the management of the populations, species, communities, and ecosystems.

Earth Science Applications Feasibility Studies: Public Health (Appendix A.31) solicits proposals in support of the Public Health application area. Applications proposals in response to this program element solicitation should provide feasibility studies of applications of Earth science research results that will improve decision-making activities concerning emerging and reemerging diseases and current infectious disease issues.

The Program is also funding proposals for applied research projects and applications-oriented activities in the following ROSES-2010 program elements, which are managed by other Earth Science Research Programs:

- Carbon Cycle Science (Appendix A.5);
- Atmospheric Composition: Modeling and Analysis (Appendix A.14);
- Aura Science Team (Appendix A.15);
- Terrestrial Hydrology (Appendix A.16);
- Applications of Geodetic Imaging (Appendix A.21); and
- NPP Science Team (Appendix A.22).

Proposal teams may want to consult the Applied Sciences Program webpage for additional information about the Program and proposal preparation tips and suggestions for applications-oriented projects.

4. Point of Contact for Further Information

Lawrence Friedl
Applied Sciences Program
Earth Science Division
Science Mission Directorate
NASA Headquarters
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E-mail: LFriedl@nasa.gov
Website: http://nasascience.nasa.gov/earth-science/applied-sciences

A.30 CLIMATE AND BIOLOGICAL RESPONSE: RESEARCH AND APPLICATIONS

1. Scope of Program

As the Intergovernmental Panel on Climate Change (IPCC) noted in its 2007 Working Group II 4th Assessment Report (http://www.ipcc.ch/), a changing climate is a key factor determining the characteristics and distributions of biological systems, including the distribution and abundance patterns of plants and animals. Furthermore, this report also documents the vulnerability of freshwater resources and ecosystems to changing climate. However, our ability to anticipate how changes in climate will drive changes in biological systems remains limited.

The number and variety of climate data records has grown over the past two decades and these data sets increasingly provide robust time series of climate change. Still, there is much uncertainty with regard to what changes in these physical climate records mean for biological systems.

Leaving aside the important issue of biological feedbacks to climate, we need to make progress connecting climate drivers to biological responses in order to improve our basic understanding of climate change impacts and to develop tools for managing species and ecosystems, and their associated landscapes and seascapes, under a changing climate. Doing so requires bringing together time series of climate observations, time series of biological observations, and ecological and climate models. Connecting climate and biological observations allows us to detect correlations and patterns that may (or may not) link to causality. Using climate and ecological models allows us to incorporate our existing knowledge of connections between the physical and biological components of the Earth system and the critical processes resulting in biological responses, thus enabling a better understanding of causality. This improved understanding allows Federal, state, and local managers, along with the general public, to craft practical strategies for managing the impacts of a changing climate.

2. Types of Proposals Sought

This solicitation seeks two types of proposals: (a) basic research proposals and (b) applications proposals to support ecosystem and landscape management. While this solicitation is not exclusively focused on public lands and waters, proposals addressing these managed areas are especially welcome given the participation of land management agencies in this call for proposals.

Each type of proposal should combine several components.

2.1 Type A: Research Proposals

Research proposals should improve fundamental scientific knowledge of the impacts, in terms of patterns and processes, of climate change on the following elements of biological systems:

1. The distribution and/or abundance of species, populations, or functional groups of species; or

2. The sustainability over time and/or connectivity of ecosystems across landscapes or seascapes.

Research proposals should include:

1. Time series of existing climate-relevant observations (for example—but not limited to—temperature, precipitation, sea ice, snow cover, insolation, clouds, water vapor, aerosols, fires, floods, droughts, sea-level rise, etc.) from airborne or space-based platforms;
2. Time series of biological observations on (1) the distribution and/or abundance of species, populations, or functional groups of species or (2) the sustainability over time and/or connectivity of ecosystems across landscapes and seascapes from *in situ* (i.e., ground-based or in-water) devices, airborne platforms, and/or space-based satellites; and
3. Ecological models or their outputs (e.g., niche-based or physiological distribution models, population models, spatially-explicit individual-based models).

Research proposals may also wish to integrate the following:

1. Climate models or their outputs (e.g., through general circulation model downscaling, regional climate models); and
2. Biophysical data (e.g., soils, topography, geology, biogeochemistry) that may account for variations in response to climate variability within and among geographic areas.

As the Smithsonian Institution is a partner in this joint solicitation, proposers are encouraged to consider including biological and other ecosystems data from selected Smithsonian Institution Global Earth Observatories (SIGEO) sites (http://www.sigeo.si.edu/). Biological and ecosystems data from other sites are also welcome.

Given the relatively complex nature of these proposals and their multiple components, this solicitation anticipates proposals from multidisciplinary teams.

2.2 Type B: Applications Proposals to Support Ecosystem and Water Resource Management

Applications proposals should enhance the management of populations, species, communities, and ecosystems across landscapes and seascapes of concern through the development or improvement of forecasting tools for resource managers that project the impact of a changing climate on these populations, species, communities, and ecosystems. Ecosystems here may include forests and water resources important to landscape managers.

Proposers should fully explain how they plan to integrate the forecasting tools they develop or improve into the spatially-explicit geographic landscape or seascape management frameworks of participating user agencies with management responsibility. Within these landscape or seascape frameworks, proposers should clearly state the management endpoint (e.g., population, species, community, ecosystem, and important forest or water resources) they intend to address.

Applications proposals should include:

1. Time series of existing climate-relevant observations (please see Section 2.1 above for examples) from airborne or space-based platforms;
2. Time series of biological observations on (1) the distribution and/or abundance of species, populations, or functional groups of species or (2) the sustainability over time and/or connectivity of ecosystems across landscapes and seascapes from *in situ* (i.e., ground-based or in-water) devices, airborne platforms, and/or space-based satellites; and
3. Ecological models or their outputs (e.g., niche-based or physiological distribution models, population models, spatially-explicit individual-based models) or ground/surface water models (e.g., flow, transport, spatially-explicit process models).

Applications proposals may also wish to integrate the following:

1. Climate models or their outputs (e.g., through general circulation model downscaling, regional climate models); and
2. Biophysical data (e.g., soils, topography, geology, biogeochemistry) that may account for variations in response to climate variability within and among geographic areas.

Additionally, Applications proposals must include:

1. Participation by representatives of the agencies that would ultimately host the forecasting tools; and
2. Plans and a schedule for the transition of the forecasting tools into the host agency.

The National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), and the U.S. Geological Survey (USGS) are partners in this joint solicitation. Therefore, the following topics are of particular interest:

1) Landscape approaches to managing U.S. National Parks (http://www.nature.nps.gov/);
2) Landscape approaches to managing FWS trust resources including:
   a) refuges (http://www.fws.gov/refuges/index.html),
   b) migratory birds under the Migratory Bird Treaty Act (http://www.fws.gov/migratorybirds/), and
   c) threatened and endangered species under the U.S. Endangered Species Act (http://www.fws.gov/Endangered/); and
3) Work supporting other U.S. Department of Interior (DOI) agencies as USGS is the research arm of the DOI.

NPS, FWS, and USGS are currently developing the Landscape Conservation Cooperative concept for managing landscapes. Proposals working to support the development of this concept are welcome.

In addition, proposals addressing the forecasting needs of other U.S. land management agencies (e.g., the U.S. Forest Service, NASA Centers) or those of National Oceanic and Atmospheric Administration (NOAA) ecosystem managers are welcome.

Proposals should come from multidisciplinary teams with the expertise both to develop or improve the forecasting tools and transition the tools to use by the user agencies.

Also of interest are proposals, within the guidelines listed above, that support conservation management by ensembles of managed lands with different types of land owners and mixed uses, e.g., parks, refuges, National Forest lands, Bureau of Land Management landscapes, private lands managed by conservation organizations, etc.

2.3 Requirements Applicable to All Proposals

Proposals in both terrestrial and aquatic (freshwater and marine) environments are welcome.

Proposals must incorporate remotely-sensed data.

Proposers must indicate whether they are Research (Type A) or Applications (Type B) proposals or both. While some proposals may span both Types A and B, this solicitation anticipates that most proposals will be either Type A or Type B.

All successful project teams, whether Research or Applications, should plan on participating in annual NASA-hosted team meetings within the U.S. that will bring together both Research and Applications project personnel and facilitate the general transition of research results into applications activities.

The use of sensor webs (interconnected networks of sensors) and/or the incorporation of citizen science, social networking, and crowdsourcing techniques to enhance observational or modeling components of proposals is most welcome.

Arctic projects are encouraged to connect with the Study of Environmental Arctic Change (SEARCH, http://www.arcus.org/SEARCH/index.php), the interagency effort to understand the nature, extent, and future development of the system-scale change presently seen in the Arctic.

3. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $5M

Number of new awards pending adequate proposals of merit	~ 10 to 17
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	8 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-BIOCLIM

Agency points of contact concerning this program	NASA: Mr. Woody Turner Program Scientist, Biological Diversity Program Manager, Ecological Forecasting Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1662 E-Mail: woody.turner@nasa.gov Smithsonian Institution: Dr. Leonard P. Hirsch Senior Policy Advisor Smithsonian Institution 1100 Jefferson Drive, SW Washington, DC 20013-7012 Telephone: (202) 633-4788 E-Mail: lhirsch@si.edu USGS: Dr. Bruce Jones Chief Scientist for Biology US Geological Survey 12201 Sunrise Valley Drive 300 National Center Reston, VA 20192 Telephone: (703) 648-4762 E-Mail: kbjones@usgs.gov FWS: Dr. Kurt Johnson Climate Change Scientist Office of the Science Advisor U.S. Fish and Wildlife Service 4401 N. Fairfax Drive, Room 700d Arlington, VA 22203 Telephone: (703) 358-1917 E-Mail: kurt_johnson@fws.gov NPS: Dr. Shawn Carter Climate Change Monitoring Coordinator National Park Service 1201 Eye St., NW Washington, DC 20005 Telephone: (202) 513-7186 E-Mail: shawn_carter@nps.gov

A.31 EARTH SCIENCE APPLICATIONS FEASIBILITY STUDIES: PUBLIC HEALTH

1. Scope of Program

1.1 Overview

The Applied Sciences Program, Public Health Applications Element, within the NASA Earth Science Division manages this activity. This solicitation seeks proposals:

- To perform short-term, feasibility studies of applications of Earth science research results that will improve decision-making activities in the focus area of Public Health.

The overall objective of these projects is to generate and test preliminary ideas for applications of Earth science products to determine their potential value and readiness for a more in-depth project.

1.2 Program Objectives

The overarching purpose of the Applied Sciences Program is to discover and demonstrate innovative and practical applications of NASA Earth science research, technology, and observations. To this end, the program seeks to increase the benefits to society of the nation's investments in the NASA Earth science research program.

The Applied Sciences Program supports applied science research, applications, and decision support activities that supply foundational applied knowledge and enable practical applications of Earth science products in partnership with end user organizations[1]. The program thus serves as a bridge between the data and knowledge generated by NASA Earth science and the information needs and decision making of government agencies, companies, and other organizations.

The Applied Sciences Program employs an "end-to-end" approach to extend Earth science research results as inputs to decision-making activities. The Program works together with organizations that develop, own, and employ operational decision support tools, systems, assessments, etc. to serve their mandated responsibilities, such as Federal and not-for-profit organizations. It also works with international, national, and regional associations, such as the World Health Organization and the Red Cross. The Program also allows and encourages private sector companies to submit proposals and/or be involved in project teams.

1.3 Priority Topics

Applicants may propose projects in the priority area of Public Health.

The Public Health application area focuses on Earth science applications to public health and safety, particularly regarding infectious disease, emergency preparedness and response, and

[1] The term "end user" here means the organization(s) that will ultimately operate the improved decision-making activity.

environmental health issues. The application explores issues of toxic and pathogenic exposure, as well as natural and man-made hazards and their effects, for risk characterization/mitigation and improvements to health and safety.

In this solicitation, the program primarily requests feasibility studies of applications of Earth science research results that will improve decision-making activities concerning emerging and reemerging diseases and current infectious disease issues. These studies are particularly encouraged for the regions of North and South America, however, no region is discouraged from proposing. Proposals are encouraged to include different types of models (e.g., ecological forecasting models, Global Climate Models (including regional downscaling)) in their studies to complement the utilization of an array of Earth observations.

The program also will accept proposals that test the feasibility and investigate the integration of previously-funded work into new or different decision-making systems and tools.

The Public Health Program website is available at http://nasascience.nasa.gov/earth-science/applied-sciences/.

2. Category of Projects

Through this solicitation, the Applied Sciences Program supports projects that utilize NASA Earth science research results in decision-making activities for Public Health.

2.1 Project Scope and Purpose

The Applied Sciences Program seeks results-oriented projects focused on the integration of Earth science research results into decision making activities related to Public Health. The objective of a proposed project must be to test the initial feasibility of a concept for potential application of specific NASA Earth science research results to a decision-making activity.

Applicants may propose concepts that would:

- Enhance the performance of *existing* decision-making activities and processes through the integration of NASA Earth science products; or
- Develop new capabilities for decision making, provided that the need and activity can be clearly defined, and that potential end users are identified.

Proposals that pursue innovative uses and integration of an array of Earth science results and develop and demonstrate improvements to decision-making activities are preferred. NASA Earth science research results can include Earth science measurements (particularly NASA spacecraft observations, both in orbit and planned), outputs and predictive capabilities from Earth science models (especially ones that use NASA spacecraft observations or are NASA-sponsored), algorithms, visualizations, new knowledge about the Earth system, and other techniques and geosciences products. Proposals may blend commercial remote sensing and geospatial information with NASA Earth science measurements to integrate into and improve decision making.

The Applied Sciences Program supports projects that address topics that are of national or regional importance. Projects may be international, national, regional or subregional in scope but all have potential importance at regional or national scales.

2.2 Specific Suggestions and Considerations

The Applied Sciences Program encourages teams to consider using an array of appropriate Earth science research results. The program encourages teams to consider using products from recently-launched NASA missions, Earth science models, and simulated products from future satellite observations (e.g., Glory, NPP, GPM, LDCM, NPOESS, and SMAP). The Program strongly encourages teams to engage people who are knowledgeable of NASA science, model, and sensors (e.g., science teams and instrument scientists) to understand capabilities and limitations.

3. Programmatic Information

Expected program budget for new awards	$750K total
Anticipated number of awards pending adequate proposals of merit	5-7 projects
Expected Range of Award per project	$100K - $150K
Period of Performance	12-24 months
Expected Project Start Date	circa October 1, 2010
Contributions from Partner Organizations	Encouraged; however, partner funding does not count toward funding level guidelines.

4. Amendments and Clarifications to the *Summary of Solicitation*

The following information provides clarifications or amendments to the *ROSES Summary of Solicitation*. The information below supersedes direction provided in the respective sections of the *ROSES Summary of Solicitation*.

4.1 Funding Policies: Changes to Section II(a) of the *Summary of Solicitation*

This solicitation is for new awards. NASA will not accept proposals for successor proposals to solicited projects whose periods of performance are ending – unless the work proposed is to investigate the integration of the previously funded work into new systems and tools. NASA will not accept proposals for supplemental funding of existing, solicited projects in response to this solicitation.

4.2 Eligibility of Applicants: Changes to Section III(a) of the *Summary of Solicitation*

All organizational sectors are eligible to apply, including academia, private, government, and nonprofit sectors. Multi-organizational and disciplinary teams are strongly encouraged.

4.3 Cost Sharing or Matching: Changes to Section III(c) of the *Summary of Solicitation*

Contributions and cost sharing from proposing institutions and partner organizations is highly encouraged, but not required. The Program accepts in-kind contributions during the course of the project as cost sharing. Relevant past work, prior results, or previous support and accomplishments can be described, but the Program does not consider these as cost sharing or in-kind contributions for proposals to this solicitation.

4.4 *Proposal Format and Contents: Changes to Section IV(b)(ii) of the Summary of Solicitation*

Proposals should adhere to the following page guidelines and order. Content descriptions, if specified below, modify Section 2.3 of the *NASA Guidebook for Proposers*.

Proposal Cover Page	As found on NSPIRES site or Grants.gov (includes budget summary)
Proposal Summary	300 words (included in cover page)
Table of Contents	1
Decision-making Activity – Description	½ - 1
Earth Science Research Results	1
Technical/Scientific/Management Section (including charts/figures/tables)	6-8
- Integrated System Solution (ISS) chart (optional)	
- Figures and Tables (as appropriate; integrated into text if possible)	
Feasibility Criteria	½
Anticipated Results/Improvements	½
Schedule	½
Statements of Commitment – Co-Is	as needed
Statements from End-user Organizations	up to 4
Budget Justification: Narrative and Details	as needed
Facilities and Equipment (if applicable)	1
Curriculum Vitae: Principal Investigator	2
Each Co-Investigator	1
Current/Pending Support	as needed
References and citations	as needed

Decision-making Activity
This section must identify and describe the decision-making activity to be enhanced in the project. The section should describe the management, business, or policy topic or issue that it serves, the specific analyses and decisions the end-user organization makes, and how the organization uses the decision-making activity to support its actions and decisions. Applicants are strongly encouraged to quantify the pre-project, baseline performance of the decision-making activity.

Earth Science Research Results
This section must identify and describe the Earth science research results (see Section 1.2 of this appendix) that the proposal seeks to integrate into and improve the decision-making activity.

Technical/Management/Scientific Section
As the main body of the proposal, this section should cover the following material:

- Objectives, relevance, and importance of the proposed topic and activity;
- Technical approach and methodology to be employed, including any innovative aspects, integration problems, and rationale for the NASA Earth research results to be integrated;
- Approach to assess the feasibility and quantify improvements;
- Challenges and risks affecting project success

Feasibility Criteria
This section must articulate the criteria and measures (both quantitative and qualitative) the team will use to determine the feasibility of the candidate configuration(s).

Anticipated Results
This section must state the team's hypothesis for the expected, quantitative improvement(s) over the "baseline" performance.

Statements of Commitment
In addition to the brief statements from Co-Is required per Section 2.3.10 of the *NASA Guidebook for Proposers*, this section may include up to 4, one-page letters from the end-user organizations stating their interest and potential benefit from the proposed project.

Budget
The NASA Science Mission Directorate has adopted commercial data purchases as a mainstream way of acquiring research-quality data, as these commercial capabilities become available. Per NASA policy, NASA encourages the use of commercially available data sets by Principal Investigators, as long as it meets the scientific requirements and is cost-effective. In addition to the budget guidance in the *Summary of Solicitation*, the proposal should identify the commercial data sources intended for use and details on the associated cost.

4.5 <u>Evaluation Criteria: Subfactors for Section V(a) of the *Summary of Solicitation* and Section C.2 of the *NASA Guidebook for Proposers*</u>

In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "relevance to NASA's strategic goals and objectives" specifically includes the following factors:

- Overall intent and ability to demonstrate the feasibility of NASA Earth science research to address a topic of importance to the nation;
- Overall intent and ability to employ NASA Earth science research results to make potentially valuable, substantive improvements to decision-making activities; and,
- Importance, breadth and potential impact of the project.

In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "intrinsic merit" specifically includes the following factors:

- Overall quality of the project idea, design, and innovation;

- Overall ability to develop and test the feasibility of the proposed concept;
- Overall plan and ability to use an appropriate array of Earth science results; and
- Overall plan and ability to use Earth science model outputs, model predictive capabilities, spacecraft measurements from more recent NASA Earth science missions, and simulated products from future planned missions;

In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion “cost realism” specifically includes the following factor:

- Overall approach and ability to manage the project and achieve stated objectives in the time and at the costs specified.

Cost sharing is not part of the proposal evaluation criteria. At the time of project selection when deciding between proposals of otherwise equal merit, NASA will consider the extent to which the proposed project includes funds or in-kind contributions from non-Federal sources and Federal agencies, consistent with Section 4.3 of this appendix and Section III(c) of the *Summary of Solicitation.*

4.6 *Award Reporting Requirements: Changes to Section VI(c) of the Summary of Solicitation*

The following reports will be required of awarded proposals. In cases where teams of organizations or subcontracts exist, consolidated project reports, including financial records, must be submitted and is the responsibility of the lead organization. The proposed budget should provide for these reporting requirements.

Semiannual Reports – Performance and Financial
Brief semiannual reports are required that provide information on the following: major activities and accomplishments of preceding six months (including publications and presentations), schedule status, financial activity, and performance measures. The report should be approximately 1-2 written pages, with the actual length depending on the level of activity. The first report must identify changes made during the award negotiations. The Program will work with the project team on an appropriate format.

Final Report/Feasibility Assessment
The final report should describe the system configuration(s) assessed in the project, quantitative and qualitative enhancements to the decision support activity, change in performance, feasibility criteria results, explanations of any variations from anticipated results, discussion of major problems (technical and other) encountered and resolved, lessons learned, recommendations, and remaining issues facing the sustained use of the Earth science products in the decision-making activity. The program may request a presentation of the project report, results, and findings.

During contract negotiation, NASA representatives will discuss methods, including electronic reporting, to transmit the reports and presentation packages. The NASA Shared Services Center (NSSC) will also solicit and archive the annual reports and final report.

5. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

6. Summary of Key Information

Expected program budget for first year of new awards	See Section 3 of this appendix.
Number of new awards pending adequate proposals of merit	See Section 3 of this appendix.
Maximum duration of awards	12 to 24 months
Due date for Notice of Intent to propose (NOI)	Not requested
Due date for Proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	See Section 3 of this appendix.
Page limit for the central Science-Technical-Management section of proposal	See Section 4.4 of this appendix and also Chapter 2 of the *NASA Guidebook for Proposers*.
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program (see Section 1.2 of this appendix) are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*
Detailed instructions for the preparation and submission of proposals	*See the NASA Guidebook for Proposers at http://www.hq.nasa.gov/office/procurement/nraguidebook/*. See also Section 4.4 of this appendix for content guidance and changes.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES:	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov:	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-PHFEAS
Point of contact concerning this appendix and general questions	Mr. John Haynes Applied Sciences Program Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-4665 E-mail: jhaynes@nasa.gov

A.32 EARTH SYSTEM DATA RECORDS UNCERTAINTY ANALYSIS

1. Scope of Program

1.1 Introduction

The Earth Science Division (ESD) uses NASA's unique capabilities in space to study the fundamental Earth processes that power climate, weather, and natural hazards, and the impact of those processes on the quality of life. In pursuit of its objectives in Earth system science research, NASA is generating Earth system data of unprecedented quality and quantity and developing data processing and modeling capabilities to transform these data into products, information, and, ultimately, new knowledge of our planet. NASA Earth science data, data products and data processing algorithms are stored in archives at centers across the United States and linked by the Internet for data access and distribution.

A major need stated in the NASA Earth science research strategy is to develop long-term, consistent, and calibrated data and products that are valid across multiple missions and satellite sensors.

NASA has invested in the creation of consistent time series satellite data sets over decades, through both mission science team-based and measurement-based data product reprocessing and through solicitations for merged data products (most recently ROSES 2006 Making Earth Science data records for Use in Research for Earth Science, or MEaSUREs, Program). The Earth Science Division has focused on data sets creation for particular Earth science research measurement needs, and has defined a term for data sets to be used these needs: Earth System Data Records (ESDRs), including Climate Data Records (CDRs). An ESDR is defined as a unified and coherent set of observations of a given parameter of the Earth system, which is optimized to meet specific requirements in addressing science questions. These data records are critical to understanding Earth System processes, are critical to assessing variability, long-term trends and change in the Earth System, and provide input and validation means to modeling efforts.

The Earth System Data Records Uncertainty Analysis program seeks to extend and enhance the use of Earth System Data Records, including Climate Data Records, through rigorous estimation of error in Earth System Data Records used by NASA communities. Earth System Data Records Uncertainty Analysis projects increase the science value of Earth System science measurements by identifying and validating systematic errors, and improving error estimations. The Earth System Data Records Uncertainty Analysis program contributes to supporting agency research and applied science goals and objectives.

1.2. Types of Proposals

The Earth System Data Records Uncertainty Analysis program provides support for indepth analysis of the properties of long-term data sets, with a focus on detecting systematic error, better quantifying error, and properly attributing uncertainty sources. A second focus is to resolve known issues of such data sets. In so doing, projects may orchestrate correct (and appropriate) methodologies, and may utilize advanced algorithms, techniques, and technologies that advance the understanding of uncertainties in Earth system science measurements. Resultant tool development is a third focus of the program.

The scope of problems that Earth System Data Records Uncertainty Analysis projects address include:

- Estimating, validating, and conveying measurement differences between sensors or between sensors, validation measurements and/or models;
- Estimating, validating, and conveying measurement errors in merged data products;
- Estimating, validating, and conveying systematic errors in long-term Earth system science data records; and
- Other contributions to the determination, validation, and conveyance of Earth science measurement quality and quantification of uncertainties.

The data methodologies or techniques employed by Earth System Data Records Uncertainty Analysis projects and their applicability to the problems being solved must be scientifically rigorous, peer-recognized, and substantiated.

To minimize project risk, any technologies employed by Earth System Data Records Uncertainty Analysis projects for disseminating new capabilities must have high technology readiness levels (TRL), 6 or higher, and it must be made clear how the technologies will improve community understanding of the data records, broaden data use or increase data usability, and support research science or applied science goals.

Any resultant software tool development shall fall under the scientific software of Earth Science Alternate Data Rights, which will be incorporated into the Cooperative Agreement, which shall be the award instrument for NASA- and selected Projects. (See the *Other Documents* section on the NSPIRES index page for this program element appendix.)

2. Programmatic Information

2.1 Proposal Requirements

In addition to the proposal requirements given in the *NASA Guidebook for Proposers*, proposals to the Earth System Data Records Uncertainty Analysis program must address these additional requirements:

- Identify the particular data set to be analyzed and the Earth Science research or applied science need or use for this data set. Proposers should cite documentation of current validation status of the particular data set, and known uncertainty and quality attributes.

- Identify all challenges in the uncertainty analysis and describe the effort required.

- The period of award for these projects is nominally three years. Shorter and longer timescales may be proposed as appropriate. Proposal plans and deliverables described must state the length of effort and provide milestones and deliverables within the timeline.

2.3 Award Type and Funding

The vehicle for projects selected through this solicitation will be a Cooperative Agreement (CA). Proposers should be aware of the differences between a CA and other vehicles such as grants. See the *NASA Guidebook for Proposers* for guidance.

2.4 Relationship to Other NASA Program Elements

This Earth System Data Records Uncertainty Analysis solicitation is not a duplicative call for activities described in other ROSES solicitations, including algorithm development and maintenance and data analysis under the Science of Terra and Aqua program (ROSES-09 Appendix A.41), science data product generation under the MEaSURES integrated system solutions (Appendix A.33), solution network development through the Applied Sciences Program: Decision Support (ROSES-09 Appendix A.29), technology deployments solicited through Advancing Collaborative Connections for Earth System Science (Appendix A.34), or information systems development solicited through the Advanced Information Systems Technology program (Appendix A.37). Proposers should carefully consider their planned work in relation to the Earth System Data Records Uncertainty Analysis program guidelines before submitting.

2.5 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $6M
Number of new awards pending adequate proposals of merit	~ 12 - 20
Maximum duration of awards	4 years (nominally, awards are for 3 years)
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.

Page length for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-ESDRERR
Point of contact concerning this program	Ms. Martha Maiden Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1078 E-mail: martha.e.maiden@nasa.gov

A.33 MAKING EARTH SYSTEM DATA RECORDS FOR USE IN RESEARCH ENVIRONMENTS

The Making Earth System data records for Use in Research Environments (MEaSUREs) program will not be competed in 2010. NASA expects to continue to solicit Earth science data products and system capabilities through future MEaSUREs solicitations. However, currently all funds available for these activities are committed to the support of awards selected through prior year solicitations.

The overall objective of the Making Earth System data records for Use in Research Environments (MEaSUREs) program is to select projects providing Earth science data products or services evaluated on their contributions in research, and on their contribution to advancing NASA's Earth system "missions to measurements" concept. MEaSUREs may also solicit infusion or deployment of applicable science tools that contribute to data product quality improvement, consistency, merging or fusion, or understanding.

MEaSUREs does not solicit proposals for systems and information technology. Proposers wishing to support the deployment of data and information systems and services; and tools that enhance NASA's data and information systems infrastructure, increase the interconnection of services for research, and enable freer movement of data and information within the distributed system of users and providers, are invited to apply to the Advancing Collaborative Connections for Earth System Science (ACCESS) Program (Appendix A.34).

MEaSUREs does not solicit proposals for science data product algorithm development or refinement, or for calibration/validation activities. These research activities are solicited through other Earth Science Research Program opportunities (see Appendix A.1).

For information on this program, contact:

Ms. Martha E. Maiden
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
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E-mail: Martha.e.maiden@nasa.gov

A.34 ADVANCING COLLABORATIVE CONNECTIONS FOR EARTH SYSTEM SCIENCE

NOTICE: The Advancing Collaborative Connections for Earth System Science (ACCESS) program will not be competed in 2010. NASA expects to continue to solicit improvements to NASA's Earth science data systems through future ACCESS solicitations. However, currently all funds available for these activities are committed to the support of awards selected through prior year solicitations.

1. Scope of Program

The primary objective of the Advancing Collaborative Connections for Earth System Science (ACCESS) program is to enhance, extend, and improve existing components of NASA's distributed and heterogeneous data and information systems infrastructure. NASA's Earth science data systems, comprised of both core and community elements, directly support agency science and applied science goals and objectives. ACCESS projects increase the interconnectedness and reuse of key information technology software, techniques, and services underpinning the advancement of Earth science research.

The ACCESS program supports the deployment of data and information capabilities that enable the freer movement of data and information within our distributed environment of providers and users. This often requires the utilization of tools and services to aid in measurable improvements of Earth science data access and data usability. Awarded projects are expected to augment NASA's heterogeneous data system components by leveraging these proven information technologies in order to rapidly deploy data system services that bridge specific gaps within the agency's Earth science information systems.

The ACCESS program seeks to deploy and reuse existing technological solutions in the support of Earth science data and information needs. The use of mature technologies and practices helps to lower the overall project risk of system deployment, while making these new capabilities readily available to research and applied science communities. The ACCESS program encourages targeted solutions to current data access and data usability issues by supplying new tools or services to our Earth science research community.

2. Point of Contact for Further Information

Mr. Stephen Berrick
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Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
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A.35 INSTRUMENT INCUBATOR

1. Scope of Program

1.1 Introduction

NASA's Earth Science Technology Office (ESTO) manages the development of a range of advanced technologies to meet future Earth science measurements and operational requirements. ESTO technology investments attempt to address the full science measurement process: from instruments needed to make observations, to data systems and information products that make those observations useful.

The Instrument Incubator Program (IIP) seeks proposals for technology development activities leading to new system and subsystem level airborne and space-based measurement techniques to be developed in support of the Science Mission Directorate's (SMD) Earth Science Division. The objectives of the IIP are to research, develop and, demonstrate new measurement technologies that:

- Reduce the risk, cost, size, volume, mass, and development time of Earth observing instruments, and
- Enable new Earth observation measurements.

The IIP is designed to reduce the risk of new, innovative instrument systems so that they can be successfully used in future science missions to reduce overall development time. Figure 1 shows the idealized relationship between the IIP and development of future missions.

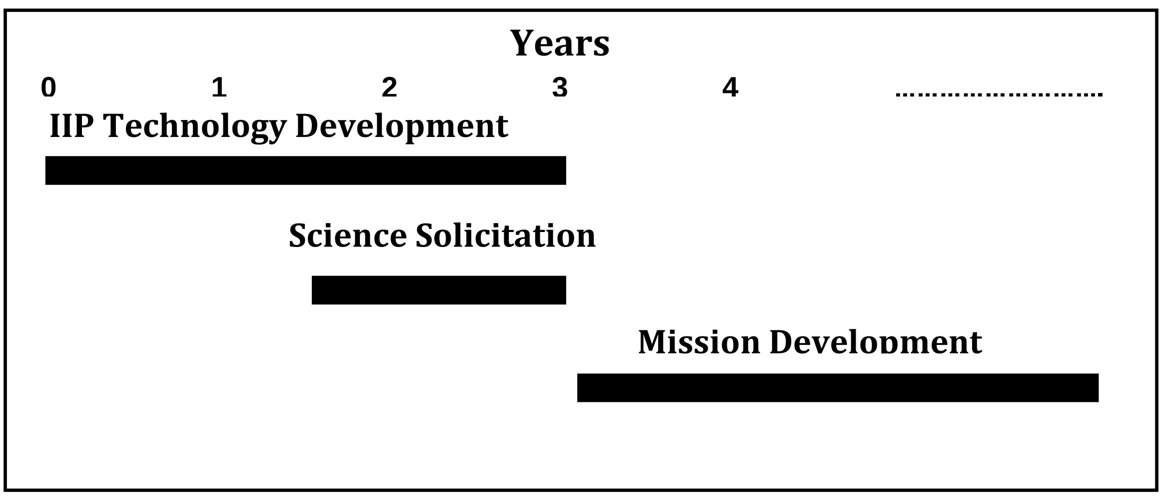

Figure 1. Idealized Relationship between IIP and Future Flight Missions

Critical to this design is the relationship between the various technology development programs that the SMD has available to enable missions. For technology infusion into NASA science missions to take place in a timely and efficient manner, appropriate funding must be applied at each stage or readiness level associated with the development of key and enabling technologies. Technology development activities are planned and initiated so that major technological risk is retired prior to a science solicitation via an Announcement of Opportunity (AO) or Request for Proposal (RFP). A focused, science-driven approach with direct traceablility to planned measurements can effectively harness advanced instrument technology capabilities and leverage developments in technology programs funded by NASA, other Government agencies, private organizations, and academic institutions. Within this development environment, the IIP can rely upon the NASA Advanced Component Technology (ACT) Program for advanced instrument components and subsystems and other NASA programs for space flight validation.

NASA's Technology Readiness Level (TRL) is an ordinal classification system that allows comparison of the degree of maturity of technologies under development. TRLs range from 1 to 9 (see Section 2.1.2.2, Table 1 for TRL definitions), and these indicate completion of increasingly demanding proof-of-performance criteria at various stages of a technology development. Figure 2 shows the progression of TRL goals for two ESTO programs, for flight validation, and for future science missions.

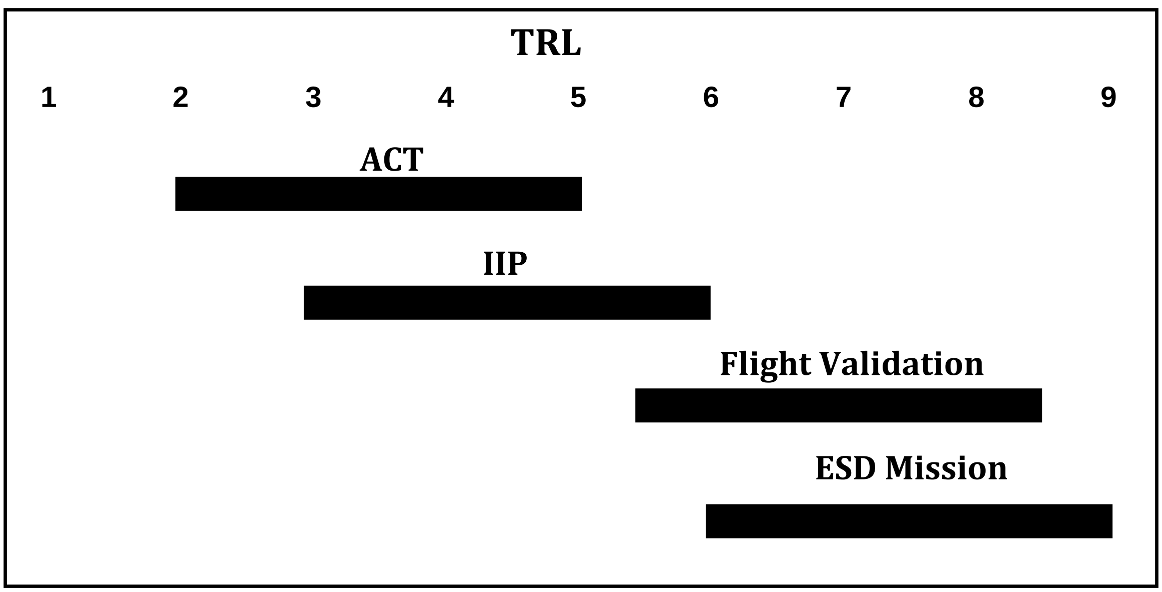

Figure 2. TRL Ranges for Technology Development Programs and Science Missions

1.2 Background and Solicitation Justification

A series of future Earth Science mission concepts have been recommended by the National Research Council (NRC) in response to a request from NASA's Office of Earth Science, the National Oceanic and Atmospheric Administration (NOAA) National Environment Satellite Data and Information Services, and the U.S. Geological Survey (USGS) Geography Division. The full NRC report entitled, "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond" may be accessed on the web at http://www.nap.edu/catalog/11820.html. This report is referred to as the "Decadal Survey."

New technology will play a key role in enabling many of the NRC recommended measurements and helping to reduce the cost of other measurements. This IIP solicitation will facilitate the implementation of the recommended measurements by carefully choosing where to invest in future instrumentation to get the greatest benefit from NASA's technology development funds.

1.3 Proposal Research Topics

1.3.1 *Goals of the Instrument Incubator Program*

This solicitation covers instrument design, breadboard, prototype, and engineering model construction, laboratory demonstrations, and field demonstrations for innovative measurement techniques that have the highest potential to meet the objectives of the IIP and the measurement capability requirements for the NASA Earth Science community.

The IIP is envisioned to be flexible enough to accept instrument and measurement concepts at various stages of maturity (see Figure 3), and through appropriate risk reduction activities advance the system's technology readiness level to that necessary to compete successfully in future science solicitations or space flight demonstrations. The proposer must define the starting point for the instrument or measurement technique and the exit or success criteria for the proposed activity.

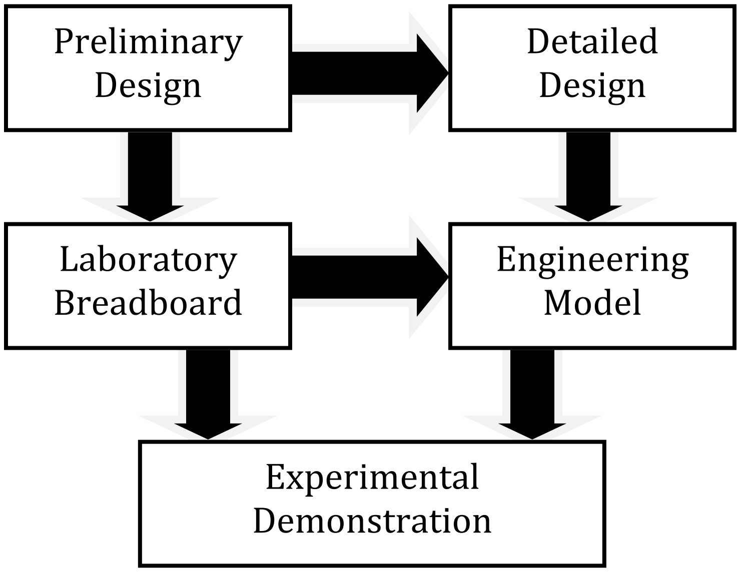

Figure 3. Entry and exit points defined by proposer

1.3.2 *Proposal Research Topics*

The NRC Decadal Survey recommends an integrated strategy for Earth science and applications from space. This IIP solicitation focuses on the instrumentation to make the science measurements that are described by the Decadal Survey. The measurements called out in the Decadal Survey mission concepts include such things as radiation balance; soil moisture; ice sheet height; surface deformation; vegetation structure; land surface composition; carbon dioxide column integrals; ocean, lake, and river water levels; atmospheric gas columns; ocean color; aerosol and cloud profiles; land surface topography, temperature and humidity sounding; gravity fields; snow accumulation; ozone and trace gas profiles; and tropospheric winds. This list is illustrative only – proposers should refer to the Decadal Survey itself for clarification of the exact measurements desired.

The measurements called for in the Decadal Survey have been assembled into a series of mission concepts divided into three timeframes or tiers. Proposers should carefully consider these timeframes in deciding what types of technology to propose for a given measurement. It may be more appropriate to propose more mature technologies for the earlier mission concepts and more challenging, lower TRL technologies for the later mission concepts. However, note that technology development must be included in the proposal, even for earlier missions, since the IIP is a technology development program.

Priority for selection will be given to those proposals that most clearly address the following focus areas:

1. (DS Tier I) Proposals for the development of instruments for SMAP and ICESat II missions are discouraged. Proposals related to CLARREO and DESDynI may be considered if the technology development approach is consistent with current planned implementation timeline of these two missions.
2. (DS Tier II) Emphasis for selection will be placed on the development and maturation of instruments that can <u>significantly</u> reduce the cost by minimizing risk, cost, size, volume, mass, and development time to enable the Earth science measurements recommended in the mid-term Decadal Survey missions.
3. (DS Tier III) Proposals for the development of instruments that enable Earth science measurements of far-term Decadal Survey missions are also encouraged.
4. (Science Plan and Other) Support may also be provided for innovative instrument approaches that support compelling Earth Science measurements identified in the Decadal Survey or other key Earth Science documents.

Note that proposals for the development of airborne calibration and validation systems supporting the Decadal Survey missions' priorities are allowed.

2. <u>Programmatic Information</u>

This solicitation provides additional details governing the proposed activities that supersede the general guidelines announced in the *NASA Guidebook for Proposers* and incorporated by reference into this ROSES solicitation. The most recent edition of this Guidebook may be accessed on the web at http://www.hq.nasa.gov/office/procurement/nraguidebook/.

2.1 Proposal Content and Submission

2.1.1 *Notice of Intent to Propose*

A Notice of Intent (NOI) to propose is encouraged, but not required, for the submission of proposals to this solicitation. The information contained in the NOI is used to help expedite the proposal review activities and, therefore, is of considerable value to both NASA and the proposer. NOIs shall be submitted electronically via NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) by the due date given in Section 3. Since NOIs submitted after the deadline may still be useful to NASA, late NOIs, as well as indications of intent NOT to propose on an earlier NOI submission, may be submitted by email to the point of contact for this solicitation (see Section 3).

2.1.2 *Proposal Content*

2.1.2.1 Proposal Summary

Each proposal shall include a proposal summary that describes the proposed work in no more than 300 words. The proposal summary shall include: (a) objectives and benefits; (b) an outline of the proposed work and methodology; (c) the period of performance; and (d) entry and planned exit TRL.

2.1.2.2 Scientific/Technical/Management Section

This section completely replaces Section 2.3.5 of the *NASA Guidebook for Proposers*.

This section must include the following content information in subsections that use the same titles. Failure to provide any of this material may be cause for the proposal being judged as noncompliant and returned without further review. The Project Description shall be limited to 15 nonreduced, single-spaced typewritten pages. Standard proposal style formats shall be in accordance with Section 2.2 of the *NASA Guidebook for Proposers.* Proposals that exceed the 15-page limit will be truncated at 15 pages.

1. Applicability to Earth Science Measurements – Describe the benefits to future Earth Science missions that utilize the proposed technology. Proposers shall include a one-page relevancy scenario showing how the proposed technology contributes to one or more Earth Science measurements. Proposals that fail to include a relevancy scenario will be considered noncompliant and will be returned without review.

2. Description of Proposed Technology – Provide a description of the proposed new technology for an instrument system or subsystem. Describe the technical approach and include an operational concept for the proposed technology that shows how it

addresses Earth science needs. Discuss any possible benefits to other NASA Earth or Space Science activities or commercial benefits.

3. Comparative Technology Assessment – Describe the anticipated advantages of this technology compared to those currently in use - e.g., reduction of size, mass, power, volume or cost, improved performance, or enabling of a new capability not previously possible. Reference the current state of the art and relate it to the proposed work.

4. TRL Assessment – Proposers must define the starting point for the instrument technology or measurement technique and the exit or success criteria for the proposed activity. The TRL shall advance by at least one level during the period of performance of the activity. If proposed activity duration is for multiple years, advancement of one TRL per year is desirable.

   For this solicitation, the entry TRL shall be between 3 and 5. Table 1 provides high-level definitions for instrument system technology TRLs. More detailed TRL definitions can be found at http://esto.nasa.gov/files/TRL.doc. The proposer shall identify the entry TRL, the planned exit TRL, and success criteria in their proposal. The proposer shall substantiate the entry TRL in the proposal. Proposals that fail to include and substantiate the entry TRL will be considered noncompliant and will be returned without review.

Table 1. TRL Definitions Summary

TRL	Definition
1	Basic principles observed and reported
2	Technology concept and/or application formulated
3	Analytical and experimental critical function and/or characteristic proof-of-concept
4	Component and/or breadboard validation in laboratory environment
5	Component and/or breadboard validation in relevant environment
6	System/subsystem model or prototyping demonstration in a operational environment
7	System prototyping demonstration in a operational environment
8	Actual system completed and "flight qualified" through test and demonstration
9	Actual system flight proven through successful mission operations

5. Research Management Plan – Proposer must provide a statement of work that concisely describes each task and milestone to be accomplished in the course of the

research and development. Define the success criteria associated with each task or milestone. Also include a schedule chart that identifies critical milestones. At least two milestones per twelve-month period must be defined.

Subcontracting portions of the research project is acceptable, but overall management and reporting are the responsibility of the proposing organization.

6. Personnel – Provide a list of key personnel and identify experience related to the proposed activity. Proposers should be sure to include science, technology development, and instrument development skills on the team. The key personnel list is included in the overall page count and must include, as a minimum, the Principal Investigator (PI). Optionally, one-page resumes for Key Personnel may be supplied; these resumes are not included in the overall page count.

7. Facilities and Equipment – Describe significant facilities and equipment required to complete the work. Before requesting funding to purchase a major item of capital equipment, the proposer should determine if sharing or loan of equipment already available within the proposing organization is a feasible alternative.

8. Special Matters – Proposers should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal.

9. Quad Chart – Provide a summary chart (quad chart) that shall contain the following information:

   - Upper Left Quadrant: "Description and Objectives"
   - Lower Left Quadrant: "Approach" and "Co-Is/Partners"
   - Upper Right Quadrant: A visual, graphic, or other pertinent information
   - Lower Right Quadrant: "Milestone Schedule" and "Entry TRL."

A template and example of the quad chart can be downloaded from http://esto.nasa.gov/files/EntryQuad_instructions_template.ppt. This quad chart is not included in the overall page count.

2.1.3 *Proposal Submission*

Proposals shall be submitted electronically via NSPIRES, as described in the *NASA Guidebook for Proposers* (see Chapter 3 for details). Proposals submitted after the due date will not be evaluated or selected.

2.2 Award Information

2.2.1 *Funding*

The Government's obligation to make award(s) is contingent upon both the availability of appropriated funds from which payment can be made and the receipt of proposals that NASA determines are acceptable for award under this solicitation. No additional funds beyond the negotiated award value will be available. NASA does not allow for payment of profit or fee to commercial firms under grant awards (see Section 2.2.3).

The funding available for this solicitation will limit the number and magnitude of the proposals awarded. The ESTO expects that a total of 15 to 20 proposals will be selected and awards issued with values not to exceed $1.5M per year per award.

Proposers are encouraged to offer cost sharing. If a cost sharing arrangement is proposed, appropriate data rights that recognize the proposer's contributions, as well as the Government's rights to access, will be negotiated prior to award.

2.2.2 *Period of Performance*

The minimum period of performance is 12 months. The total proposed period of performance must not exceed 36 months. Grants may be awarded for up to a three-year performance period. Annual reviews will be held according to the criteria specified in the *NASA Grants and Cooperative Agreement Handbook* (14 CFR 1260). Proposals must define clear, measurable milestones to be achieved for each year of performance in order to warrant continuation in the second and third years.

2.2.3 *Type of Award*

All selected proposals will result in the award of grants, cooperative agreements, or intra- or inter-Government transfers, as appropriate. <u>Contracts are specifically excluded as an award vehicle for this solicitation.</u> Grants and cooperative agreements will be subject to the provisions of the *NASA Grants and Cooperative Agreement Handbook*. If a commercial organization wants to receive a grant or cooperative agreement, cost sharing is required unless the commercial organization can demonstrate that it does not expect to receive substantial compensating benefits for performance of the work. If this demonstration is made, cost sharing is not required but may be offered voluntarily (see also Section D, Provision 1274.204, of the *Grants Handbook*).

2.3 <u>Evaluation Criteria</u>

Evaluation criteria are given in Section C.2 of the *NASA Guidebook for Proposers*.

The first criterion, intrinsic merit, includes the technical merit of the proposed investigation. In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "intrinsic merit" specifically includes the following factors:

1. Feasibility and merit of the proposed technical approach to achieve the technology development objectives;
2. Degree of innovation of the proposed technology development concepts and approach;
3. Substantiated justification and appropriateness of the entry and exit technology readiness level (TRL); and

4. Feasibility of obtaining the potential reduction in risk, cost, size, and development time, or making the newly enabled measurement, with the proposed sensor or instrument; and feasibility of making a demonstrable TRL increase. The TRL must advance by at least one (1) level during the performance period of the project.

The second criterion, relevance to NASA's objectives, includes the applicability of the proposed investigation for technology needs in support of Earth Science measurements. In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "relevance to NASA's strategic goals and objectives" specifically includes the following factors:

1. The proposal's relevance and potential contribution to NASA's scientific and technical areas of emphasis, including the potential to contribute to future Earth science instruments to make measurements which are part of the Decadal Survey measurements concepts or support other compelling Earth science measurements.
2. The potential for the sensor or instrument technology development to reduce the risk, cost, size, and development time of Earth science instruments or to enable new Earth science measurements. Potential cost reductions should be clearly stated and substantiated to the extent possible, with supporting analysis that indicates scalability;
3. The potential of the sensor or instrument technology to be integrated, once matured, into future Earth Science NASA missions and
4. The potential for the sensor or instrument technology development to have commercial benefits.

The third criterion is cost realism and reasonableness. In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "cost realism" specifically includes the following factors:

1. Adequacy and realism of proposed milestones and associated success criteria;
2. Realism and reasonableness of the proposed cost and comparison of costs to available funds;
3. Adherence to sound and consistent management practices appropriate to the TRL level of the proposed task;
4. Past performance and related experience in the proposed area of technology development;
5. Qualifications of key personnel and adequacy of facilities, staff, and equipment to support the proposed activity. This factor includes evaluation to ensure that the team has strong technology development and instrument development skills, as well as any leveraging/teaming such as recent SBIR awardees; and
6. Commitment of the organization's management to the proposed technology development (evidenced by cost and resource sharing, prior teaming arrangements, etc.). Proposers should identify any previous investment by the organization/program and provide supporting documentation.

2.4 Technical Reporting Requirements

Once awarded, all status information, presentation material, and report deliverables applicable to this IIP solicitation shall be submitted to the web-based ESTO IIP-10 Award Administration e-Book located at http://esto.reisys.com/esto/. A user account on the ESTO e-Book will be provided to the PI upon award. Due to NASA IT security requirements, all PIs must register with NASA's Identity Management and Account Exchange (IdMAX) system before a user account on e-Book will be established. In order to create an IdMAX account, some personal information will be required. All submissions to e-Book shall be made in PDF (preferred), Microsoft Word, Microsoft Excel, or Microsoft PowerPoint.

The following deliverables shall be required of awarded proposals. In cases where subcontract arrangements exist, consolidated project reports are the responsibility of the PI. The proposed budget should provide for these reporting requirements. In this context, "Annual" refers to a twelve-month task effort that commences at award.

2.4.1 *Initial Plans and Reports*

Within 15 days of award, the PI shall update a Project Plan, initial Quad Chart, and initial TRL assessment. The project plan, initial (entry) Quad Chart, and initial TRL assessment (and supporting data) shall be uploaded to the appropriate locations in the ESTO e-Book for this solicitation.

The project plan shall identify plans for all technical, schedule, and resource activities for the proposed life of the project.

The Quad Chart shall contain the following information:

- Upper Left Quadrant: "Description and Objectives"
- Lower Left Quadrant: "Approach" and "Co-Is/Partners"
- Upper Right Quadrant: A visual, graphic, or other pertinent information
- Lower Right Quadrant: "Milestone Schedule" and "Entry TRL."

The Quad Chart shall be updated at least annually and more often if appropriate. A template is available in the ESTO e-Book under "Information" and "File Templates."

An initial TRL assessment, and the basis for that assessment, shall be provided within 15 days of award for the critical technology developments of the activity. The TRL assessment shall be updated at least annually, more often if appropriate.

2.4.2 *Bimonthly Technical Reports*

The bimonthly technical report shall focus on the preceding three month's efforts. Each report shall address:

1. Technical status: The PI shall summarize accomplishments for the preceding two months, including technical accomplishments (trade study results, requirements analysis, design, etc.), technology development results, and results of tests and/or demonstrations.
2. Schedule status: The PI shall address the status of major tasks and the variance from planned versus actual schedule, including tasks completed, tasks in process, tasks expected to complete later than planned, and tasks that are delayed in starting, with rationale for each and recovery plans as appropriate.

Bimonthly Technical Reports shall be uploaded to the appropriate location in the ESTO e-Book at two-month intervals, starting on the second-month anniversary date of the signing of the award vehicle.

In months for which the PI is providing interim or annual review, the requirement for a bimonthly report is superseded by the interim or annual review requirements discussed in the next two sections.

Reports shall be submitted in PDF, Microsoft Word, or Microsoft PowerPoint compatible file formats by the required due date, or by close of business of the first workday following the due date if the due date falls on a weekend or a holiday. A teleconference or brief meeting may be conducted between the ESTO and the PI to review and discuss each report.

2.4.3 *Interim Reviews*

The PI shall provide an Interim Review at the end of the first six-month calendar period commencing from the date of award and at twelve-month intervals thereafter. The PI must provide a presentation summarizing the work accomplished and results leading up to this Interim Review and must:

1. Describe the primary findings, technology development results, and technical status, e.g., status of design, construction of breadboards or prototype implementations, results of tests and/or proof-of-concept demonstrations, etc;
2. Describe the work planned for the remainder of the project and critical issues that need to be resolved to successfully complete the remaining planned work;
3. Summarize the cost and schedule status of the project, including any schedule slippage/acceleration. A schedule milestone chart of all major task activities shall be created and maintained and shown at all reviews. A cost data sheet shall be created and maintained, showing total project costs committed, obligated, and costed, along with a graphical representation of the project cost profile to completion;
4. Provide a summary of anticipated results at the end of the task; and
5. At the second review and subsequent reviews, address the comments and recommendations prepared by the reviewers participating in the most recent review.

The ESTO will conduct the Interim Review via teleconference. The presentation shall be uploaded to the appropriate location in the ESTO e-Book at least two (2) working days prior to the review. Following the review, the presentation, updated in accordance with comments and discussion resulting from the review, will constitute the Interim Report and shall be uploaded to the appropriate location in the ESTO e-Book within ten days after the review.

2.4.4 *Annual or Final Review*

The PI shall provide an Annual Review at the end of each twelve-month calendar period commencing from the date of award. The Annual Reviews are similar to the Interim Reviews and include all of the products required at an Interim Review with the following exceptions:

1. The review is held at the PI's facility or a mutually agreed to location.
2. The review is attended by an independent technical reviewer from an organization separately funded by ESTO.
3. Hardcopy handouts shall be provided by the PI at the review.
4. The PI may provide a laboratory demonstration, if appropriate, to show technical results and status.
5. Report any educational and outreach components of the project, e.g., graduate degrees, educational activities; technology infusion or patents applied for or granted; journal or conference publications; presentations at professional conferences, seminars and symposia; demonstrations; media exposure; and, other activities that contributed to the overall success of the research project.
6. The Annual Review should be comprehensive, and should include a discussion of the planned content of the written report.

The review package shall be uploaded to the appropriate location in the ESTO e-Book at least two (2) working days prior to the review. The presentation, updated in accordance with comments and discussion resulting from the review, together with the separate Annual Report, shall constitute the Annual Report deliverable, and shall be uploaded to the appropriate location in the ESTO e-Book within ten days after the review.

2.4.5 *Final Review*

The PI shall provide a Final Review at the completion of the activity. The Final Review is similar to the Annual Reviews and includes all of the products required at an Annual Review with the following exceptions:

1. The Final Review must provide conclusions of the work performed and make recommendations for follow-on activities that should be pursued, with estimates of the cost and schedule to achieve TRL 7.
2. As this is the Final Review, there is no need to present future work plans or a cost profile.

The written Final Report shall include the following:

1. Background of the project, including the science rationale for conducting this technology development;

2. Results of all analyses, element, subsystem, or system designs, breadboards and/or prototyping implementations and designs;
3. Performance analysis results of tests and/or demonstrations; estimation of reduction(s) in size, mass, power, volume and/or cost; improved performance; description of newly enabled capability; and documentation of technology dependencies;
4. Tables, graphs, diagrams, curves, sketches, photographs, and drawings in sufficient detail to comprehensively explain the results achieved;
5. An updated TRL assessment, including a rough order of magnitude cost and a description and estimate of the duration of the follow-on activities necessary to achieve TRL 7;
6. Updated Quad Chart; and
7. At the end of the period of performance, the PI shall provide a final Accomplishments Chart which contains the following information (a template is available in the e-Book):
    - Upper Left: "Description and Objectives."
    - Middle: "Accomplishments."
    - Upper Right: A visual, graphic, or other pertinent information.
    - Bottom: "Co-Is" (name and affiliation), "Entry TRL" and "Exit TRL."

The Final Report, updated Quad Chart or Accomplishments Chart, and updated TRL assessment shall be uploaded with the updated Final Review presentation to the appropriate locations in the ESTO e-Book within ten days of the final review.

2.4.6 *Earth Science Technology Conference and Workshops*

The awardee is encouraged to participate in the annual Earth Science Technology Conference (ESTC). The ESTC is an opportunity for NASA planners, managers, technologists and scientists to review the research funded by the ESTO. It is also an opportunity for researchers from NASA, academia and industry to meet with their peers and to better understand NASA Earth science requirements.

Travel expenses will be provided for non-Government awardees selected to participate in the ESTC. A travel charge number will be provided to NASA awardees selected to participate; an invitational travel order will be issued to other (non-NASA) Government awardees selected to participate. Therefore, no travel costs for participation in ESTC should be included in the proposal. If selected for participation in the ESTC, the awardee should be prepared to make a presentation, provide a paper, or create a poster providing a description of the project, the objectives, approach, technical status, and schedule information.

2.5 <u>Education and Public Outreach Opportunities</u>

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal.

For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	Up to $1.5M per year per award
Number of new awards pending adequate proposals of merit	~ 15-20
Maximum duration of awards	Minimum 1-year / Maximum 3-year awards
Due Date for Notice of Intent to Propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for delivery of proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Page length for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*. See Section 2.1.2.2 of this appendix.
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA. See Section 2.1.2.2 of this appendix.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guideline for Proposers.*
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-IIP

NASA point of contact concerning this program	Mr. Parminder Ghuman Earth Science Technology Office Code 407 NASA Goddard Space Flight Center Greenbelt, MD 20771 Telephone: (301) 286-8001 E-mail: Parminder.S.Ghuman@nasa.gov

A.36 ADVANCED COMPONENT TECHNOLOGY

NOTICE: The Advanced Component Technology program will not be competed in 2010.

1. Objectives

The Advanced Component Technology (ACT) program seeks proposals for technology development activities leading to new component- and subsystem-level airborne and space-based measurement techniques to be developed in support of the Science Mission Directorate's Earth Science Division. The objectives of the ACT program are to research, develop, and demonstrate component- and subsystem-level technology development that:

- Reduce the risk, cost, size, volume, mass, and development time of Earth observing instruments and platforms; and
- Enable new Earth observation measurements.

2. Program Description

The ACT program brings instrument components to a maturity level that allows their integration into other NASA technology programs, such as the Instrument Incubator Program. Some of these components are directly infused into mission designs by NASA flight projects and others "graduate" to other technology development programs for further development.

3. Point of Contact for Further Information

Mr. Parminder Ghuman
Earth Science Technology Office
Code 407
NASA Goddard Space Flight Center
Greenbelt, MD 20771
Telephone: (301) 286-8001
Email: Parminder.S.Ghuman@nasa.gov

A.37 ADVANCED INFORMATION SYSTEMS TECHNOLOGY

The Advanced Information Systems Technology program will not be competed in 2010. The Advanced Information Systems Technology program is expected to be competed again in 2011.

1. Objectives

The objectives of the Advanced Information Systems Technology (AIST) program are to identify, develop, and (where appropriate) demonstrate advanced information system technologies which:

- Reduce the risk, cost, size, and development time of Earth Science Division (ESD) space-based and ground-based information systems;
- Increase the accessibility and utility of science data; and
- Enable new observation measurements and information products.

2. Program Description

Advanced information systems are used to process, archive, access, visualize, and communicate science data. Advanced computing and communications concepts that permit the transmission and management of terabytes of data are essential to our vision of a unified observational network. Information provided to a nationwide community of users will result in significant leaps of knowledge of Earth science dynamics that benefit the global community.

ESTO's AIST program employs an end-to-end approach to evolve technologies – from the space segment, where the information pipeline begins, to the end user, where knowledge is advanced.

3. Programmatic Information

Mr. Steven A. Smith
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A.38 SCIENCE DEFINITION TEAM FOR THE CLARREO MISSION

1. Scope of Program

Proposals are solicited for participation in the prelaunch Science Definition Team for the Climate Absolute Radiance and Refractivity Observatory (CLARREO) Mission.

CLARREO is identified as a top priority mission in the National Research Council report *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* (http://www.nap.edu/catalog.php?record_id=11820); this report is hereafter referred to as the Decadal Survey.

The CLARREO mission addresses the need to rigorously observe climate change on decade time scales and to use decadal change observations as the most critical method to determine the accuracy of climate change projections, such as those in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (http://www.ipcc.ch/). Climate predictions verified against decadal change observations with rigorously known accuracy are key to enabling sound policy decisions.

The CLARREO mission accomplishes this critical objective through highly accurate and SI traceable decadal change observations sensitive to many of the key uncertainties in climate radiative forcings, responses, and feedbacks that in turn drive uncertainty in current climate model projections. Accuracy levels are determined both by the projected decadal changes from anthropogenic forcing along with the background natural variability above which such changes must be detected. To achieve CLARREO accuracy requirements, mission design rigorously accounts for uncertainties of calibration, sampling, and analysis methods. Unlike most other missions, all of the CLARREO requirements are determined *not* by instantaneous accuracy, but instead by accuracy sufficient to detect large time/space scale decadal changes: global, zonal, annual, seasonal. *CLARREO is not a climate process mission nor a weather mission: it is a mission focused entirely on rigorous decadal climate change observations.*

The NRC Decadal Survey concluded that the single most critical issue for current decadal change observations was their lack of accuracy and low confidence in observing the small but critical climate change signals. CLARREO is the recommended path forward to address this challenge. The NRC panel's recommended approach was to execute fundamental climate change benchmark measurements containing high information content about the climate system. The planned set of CLARREO benchmark measurements is:

- The CLARREO infrared SI traceable benchmark measurement is the Absolute Spectrally Resolved Radiance Emitted from Earth to Space determined with an accuracy of 0.1K (3 σ). The measurement is traced to the SI standards for the Kelvin and the Watt.
- The CLARREO Global Navigation Satellite Systems Radio Occultation system (GNSS-RO) SI traceable benchmark measurement is the phase delay rate of the

transmitted signal occulted by the atmosphere from low-earth orbit. The measurement is traced to the SI standard for the second.

- The CLARREO solar reflected SI traceable benchmark measurement is the Absolute Spectrally Resolved Nadir Reflectance of Solar Radiation from Earth to Space determined with an accuracy of 0.3% (2 σ). The percentage is relative to the mean reflected solar energy from the Earth. While spectral reflectance is a measurement relative to solar spectral irradiance, use of the TSIS spectral solar irradiance observations enables traceability to the SI standard for the Watt.

The CLARREO suite of measurements is designed to provide an integrated view of the entire climate system. In particular, these measurements are designed to provide information on key uncertain climate forcings, responses and feedbacks associated with atmospheric temperature profile; water vapor profile; broadband reflected and emitted radiative fluxes; cloud properties; and surface albedo, temperature, and emissivity.

The CLARREO measurements will enable rigorous decadal change observations through two independent benchmarking approaches. The first approach is optimal detection using spectral fingerprints of decadal change based directly on the CLARREO data. The second approach is Reference Intercalibration using the CLARREO spectra as orbiting reference radiometers to improve the calibration of other operational satellite instruments relevant to climate such as CrIS, CERES, and VIIRS.

Additional information on the CLARREO mission can be found at the CLARREO website: http://clarreo.larc.nasa.gov/

2. Science Definition Team for the CLARREO Mission

The objective of this solicitation is to select a Science Definition Team (SDT) to engage in the science definition and planning for the CLARREO mission. The SDT will function during Phase A and B of the project. This planning period will be followed by the execution phase, for which a successor Science Team will be selected to carry out additional prelaunch and postlaunch science activities.

The SDT role will primarily be to provide expert guidance to the CLARREO project in the areas of science objectives; science requirements; measurement requirements; algorithm development; data products; mission success criteria; potential descope options; and calibration, validation, and liaison with the broader science and applications communities.

Members of the SDT will attend approximately three meetings per year in person and will provide expert guidance on issues related to CLARREO science. Between SDT meetings, members will be available for teleconferences as needed. Members are expected to provide guidance on achieving the required science objectives stated in the Decadal Survey. Specifically, the Science Definition Team members will:

- Refine and prioritize the scientific goals for the mission, recognizing the limits on

resources likely to be available;
- Identify the required measurements necessary to meet the science goals;
- Refine and prioritize the measurement requirements and accuracies derived from the science objectives;
- Provide guidance for the development of calibration and validation plans for the mission;
- Define the geophysical products and data sets to be provided by the mission and the algorithm development work required to create these products and data sets;
- Identify and perform necessary prelaunch studies to meet the science objectives and evaluate such studies when completed;
- Provide guidance on the development of the science data processing system necessary to support the mission scientific goals; and
- Provide guidance on the use of CLARREO data for testing and improving climate projections.

The SDT leadership will be provided by Bruce Wielicki (LaRC) as overall Science Definition Team Leader, together with the Project Scientist David Young (LaRC) and Deputy Project Scientist Kurt Thome (GSFC). The SDT Leader will organize, plan, and chair the team meetings; integrate the input of the various team members; and work to achieve consensus on the overall science objective and requirements. The three mission science leaders (listed above) and the Science Definition Team will act in close association with the NASA Earth Systematic Mission Office and Program Scientist to achieve these goals.

The Phase A and B science activities, including studies selected under this solicitation, will be organized into Working Groups associated with the key aspects of the mission. SDT members may be considered to serve as a Working Group Leader for specific aspects of the CLARREO mission. Proposals are solicited for Working Group Leaders responsible for science studies related to:

1. Infrared benchmarking,
2. Reflected solar benchmarking,
3. Infrared reference intercalibration,
4. GNSS RO science, and
5. Climate modeling.

The leads for the remaining Working Groups (infrared science, reflected solar science, reflected solar reference intercalibration, and data management) will be designated by the project. The SDT Leader will assign each member of the SDT to one or more Working Groups.

3. Proposal Requirements

Proposals for SDT membership should include a 10-page description of the proposer's interest and the expertise the proposer would contribute to the SDT. Proposals will be evaluated on the basis of the principal investigator's proven capabilities, as well as the approaches and activities proposed to address topics that will define CLARREO scientific measurement requirements.

Direct experience with previous and current satellite instruments is desirable but not required. Proposers should consider how previous and current satellite data and global climate modeling activities could contribute to their studies. Examples of the types of contributions from members of the SDT might include, but are not limited to:

- Climate trend detection and attribution using CLARREO data;
- Methods of using CLARREO data as reference calibration for operational sensors;
- Testing and validation of global climate models using CLARREO data;
- Simulations of CLARREO data using climate models, as well as simulations using existing global satellite data sets combined with radiative transfer models;
- SI-traceable uncertainty analysis;
- Optimal temporal and spatial sampling; and
- Postlaunch validation approaches.

Results from previous CLARREO science studies and workshops can be found at: http://clarreo.larc.nasa.gov/workshops.html.

Proposers wishing to serve as Working Group Leader should state so in their proposal. They should identify the specific Working Group(s) that they are interested in leading and for each of these positions include up to two (2) additional pages to describe their qualifications for leading that Working Group. An SDT member will be selected to lead at most a single Working Group.

All proposals must include a budget covering activities to be undertaken as a member of the SDT (but not as a Working Group Leader). Those proposers wishing to serve as Working Group Leader must also include separate budget(s), one for each Working Group leadership proposed, covering only Working Group Leadership activities. If selected as a Working Group Leader, the total funding provided will be based on the sum of the SDT-only budget and the Working Group Leader budget.

Proposals may have more than one investigator for consideration within the science team. These proposals should clearly describe the unique contribution being proposed for each investigator, their qualifications, and the level of effort and budget for each proposer. NASA may only select a subset of the investigators from each of these proposals if only a part of the proposal is deemed selectable.

Non-U.S. organizations are welcome to submit proposals on a no-exchange-of-funds basis and within the constraints described in the *NASA Guidebook for Proposers* (http://www.hq.nasa.gov/office/procurement/nraguidebook/). For such proposals, it is critical that the proposal contains a certification that a sponsoring foreign government agency or foreign institution commits to bear the cost of the research proposed to be performed by the non-U.S. organization, should the proposal be selected by NASA.

4. Summary of Key Information

Expected annual program budget for new awards	~ $1.6M/year
Number of new awards pending adequate proposals of merit	~ 10-12
Maximum duration of awards	3 years.
Due date for Notice of Intent to propose (NOI)	Not requested.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-CLARREO
NASA point of contact concerning this program	Dr. Kenneth W. Jucks Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0476 E-mail: kenneth.w.jucks@nasa.gov

APPENDIX B. HELIOPHYSICS RESEARCH PROGRAM

B.1 OVERVIEW

1. Overview

NASA's Heliophysics Research Program supports research activities that address understanding of the Sun and planetary space environments, including the origin, evolution, and interactions of space plasmas and electromagnetic fields throughout the heliosphere and in connection with the galaxy. Understanding the origin and nature of solar activity and its interaction with the space environment of the Earth is a particular focus. The program seeks to characterize these phenomena on a broad range of spatial and temporal scales, to understand the fundamental processes that drive them, to understand how these processes combine to create space weather events, and to enable a capability for predicting future space weather events.

The program supports investigations of the Sun as a typical dwarf star including processes taking place throughout the solar interior and atmosphere; the evolution and cyclic activity of the Sun; and the origin and behavior of the solar wind, energetic particles, and magnetic fields in the heliosphere and their interaction with the interstellar medium. The program also supports investigations of the physics of magnetospheres, including their formation and fundamental interactions with plasmas, fields, and particles; and the physics of the mesosphere, thermosphere, ionosphere, and aurorae of the Earth, including the coupling of these phenomena to the lower atmosphere and magnetosphere.

The Heliophysics Research Program of 2010 represents a strategic commitment to system science — emphasizing the understanding of fundamental processes and interconnections across the traditional science disciplines. In concert with the other NASA science divisions (Planetary Science, Astrophysics, and Earth Science), the Program shares responsibility for learning about the Earth, our solar system, the universe, and their interrelationships. This kind of comprehensive knowledge is necessary if mankind is to reach beyond the confines of our planet and navigate safely across the vast ocean of space.

The Heliophysics Research Program is formulated to contribute directly and substantially to national priorities:

Leadership in Fundamental Research: The Heliophysics Research Program is the world's leading scientific effort in and across the field of Heliophysics science. Investigations selected for the program address problems of the highest intrinsic science and technical merit that are relevant to NASA's Heliophysics strategic objectives.

Educating the Next Generation and Creating a World-class Workforce: NASA is committed to communicating the new knowledge gained from its programs and to inspiring a new generation of scientists and engineers. Future Heliophysics experimentalists are prepared via intensive internships in the suborbital programs, support for postdoctoral positions, and the SMD-wide NASA Earth and Space Science Fellowship (NESSF) program for graduate students. Science workshops and annual graduate-level summer schools sustain a pipeline of participation.

Driving Technological Innovation: Innovation is the engine that drives scientific progress in Heliophysics research and its prompt transition from basic understanding to advanced applications. Being at the forefront of scientific endeavors necessarily entails the need for new measurement, data analysis, and modeling techniques. Heliophysics technology development projects focus on the rapid development and infusion of new, mission-enabling technologies.

Enhancing Environmental Stewardship: The Earth is embedded in the extended atmosphere of the Sun, and the Sun's magnetic variability drives the Earth and Earth's environment. The physical mechanisms that link the variations seen on the Sun with the variability occurring at the Earth are poorly understood. In addition, it is known that important elements of our society's technological infrastructure are vulnerable to the effects of disturbances in Earth's space environment that are caused by activity at the Sun. However, there has been rapid progress over the past ten years. NASA's Heliophysics research programs are dedicated to understanding these effects, to understand their root cause, and provide the information needed to protect assets critical to our society and economy.

The scientific documentation underlying the Heliophysics Research Program provides the needed background for proposals addressing its objectives. The science carried out must directly address NASA's Strategic Subgoal to study the Sun and its interactions with the Earth and the Solar System (see Section I(a) and Table 1 in the *ROSES Summary of Solicitation*)**.** In particular, proposals must address the more specific Science Outcomes (see Section I(a) and Table 1 in the *ROSES Summary of Solicitation*), which are to achieve:

- Progress in understanding the fundamental physical processes of the space environment—from the Sun to Earth, to other planets, and beyond to the interstellar medium;
- Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres; and
- Progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space.

NASA's Heliophysics research program is an end-to-end one that starts with the formulation of theories as explanations of the phenomena under study, and the design of experimental studies to test these theories; the development of observational techniques and the instrument technology needed to implement them; experiments in the laboratory and from an appropriate set of balloon- sounding rocket- and/or space-based platforms; uses the results to increase basic knowledge; incorporates results into computational models that can be used to more fully characterize the present state and future evolution of the Heliophysics system; and develops conduits to other national and international agencies that can use the generated knowledge in space weather forecasting and in policy and resource management.

A brief description of each program element offered in the Heliophysics Research Program is given below. The intent of these summary statements is to give the prospective proposer insight into the element's purpose and context within the overall program structure. Detailed descriptions of each element are to be found in Appendices B.2 through B.8.

2. Program Elements

Heliophysics Theory:
Theory investigations are the foundation of the Heliophysics Research Program. They lead the way to new understanding of previous investigations and drive science concepts for future strategic missions. The Heliophysics Theory program element supports large PI-proposed team efforts that require a critical mass of expertise to make significant progress in understanding complex physical processes with broad importance. Competed once every three years, theory investigations will be solicited in 2010 as part of the Heliophysics Theory program element described in Appendix B.2.

Supporting Research and Technology (SR&T):
SR&T investigations are the advanced planning arm of the Heliophysics research program. Results of investigations in the program guide the direction and content of future science missions. This element supports individual research tasks that employ a variety of fundamental research techniques (e.g., theory, numerical simulation, and modeling), analysis and interpretation of space data, development of new measurement concepts, and laboratory measurements of relevant atomic and plasma parameters, all to the extent that they have a clear application to Heliophysics program goals. Geospace SR&T tasks are solicited as part of the Geospace Science element described in Appendix B.3, while solar and heliospheric SR&T tasks are solicited as part of the Solar and Heliospheric Science program element described in Appendix B.4.

Low Cost Access to Space (LCAS):
LCAS investigations have as their objective science investigations that may be completed through suborbital rocket, Commercial Reusable Suborbital Research (CRuSR), or balloon flight of experimental instrumentation, as well as proof-testing new concepts in experimental techniques that may ultimately find application in free-flying Heliophysics space missions. Geospace LCAS investigations are solicited as part of the Geospace Science program element described in Appendix B.3, while solar and heliospheric LCAS investigations are solicited as part of the Solar and Heliospheric Science element described in Appendix B.4.

Instrument Development:
Instrument development investigations have as their objective the development of instrument technologies that show promise for use in scientific investigations on future Heliophysics science missions, including the development of laboratory instrument prototypes, but not of flight hardware. The goal is to define and develop scientific instruments and/or components of such instruments to the point where complete instruments may be proposed in response to future Announcements of Opportunity without significant additional technology development. Geospace instrument development investigations are solicited as part of the Geospace Science program element described in Appendix B.3, while solar and heliospheric instrument development investigations are solicited as part of the Solar and Heliospheric Science element described in Appendix B.4.

Heliophysics Guest Investigators (GI):
Heliophysics GI investigations are focused on maximizing the scientific return from the missions of the Heliophysics System Observatory (HSO). The GI program enables a broad community of heliophysics researchers in universities and other institutions to use the HSO data in innovative scientific investigations to (a) broaden the scientific output of existing missions, or (b) apply the data from existing missions to new scientific goals. The focus of the selected research continuously evolves to ensure that the most important questions identified by the operating mission senior reviews are addressed. The Heliophysics Guest Investigator program element, Appendix B.5, is not competed in ROSES-2010.

LWS Targeted Research and Technology (TR&T):
The goal of NASA's Living With a Star (LWS) Program is to develop the scientific understanding needed for the United States to effectively address those aspects of Heliophysics science that may affect life and society. To ensure this the TR&T program solicits large-scale problems that cross discipline and technique boundaries leading to a physics-based understanding of the integral system linking the Sun to the Solar System both directly and via the heliosphere, planetary magnetospheres, and ionospheres. The proposals must identify how this new understanding will have a direct impact on life and society. In addition, TR&T supports the Sun-Climate objective whose goal is to deliver the understanding of how and to what degree variations in the solar radiative and particulate output contribute to changes in global and regional climate over a wide range of time scales. Development of Tools and Methods that are needed to achieve the LWS goals are also supported. The LWS TR&T program element is described in Appendix B.6.

LWS Targeted Research and Technology (TR&T) Strategic Capability:
A primary goal of NASA's LWS Program is the development of first-principles-based models for the coupled Sun-Earth and Sun-Solar System, similar in spirit to the first-principles models for the lower terrestrial atmosphere. Such models can act as tools for science investigations, as prototypes and test beds for prediction and specification capabilities, as frameworks for linking disparate data sets at vantage points throughout the Sun-Solar System, and as strategic planning aids for enabling exploration of outer space and testing new mission concepts. Strategic Capabilities are the development and integration of such models for all the various components of this system. The LWS Strategic Capability program element is described in Appendix B.7.

Heliophysics Data Environment Enhancements:
Progress in space science is sparked by space observations. It is essential that observations be properly recorded, analyzed, released, documented, and rapidly turned into scientific results. Heliophysics Data Environment Enhancement investigations support and extend data services necessary for the conduct of heliophysics research. Holders of heliophysics data propose for small grants to continue resident archives of data from previously operating missions and to participate in one of the several virtual observatories either in existence or proposed. Aspects to be taken into account are the special needs driven by the increasing complexity of missions, the associated increasing complexity and volume of data, and the need for innovative and enabling technologies. The data environment enhancement program element is described in Appendix B.8.

Education and Public Outreach (EPO):
NASA’s founding legislation, the Space Act of 1958, directs the Agency to expand human knowledge of Earth and space phenomena and to preserve the role of the United States as a leader in aeronautics, space science, and technology. High achievement in science, technology, engineering, and mathematics (STEM) education and public scientific literacy is essential to the accomplishment of NASA’s mission. Heliophysics EPO investigations typically pertain to and emphasize the system-science approach of Heliophysics research with the aim of encouraging upcoming generations to pursue education and careers in this area. A “multimission” approach is preferred, given the very broad nature of the science regimes studied. Heliophysics education and public outreach investigations are solicited through the Opportunities in Education and Public Outreach for Earth and Space Science program element described in Appendix E.4.

3. General Guidance for Proposals to Heliophysics Programs

Proposals to any of the Heliophysics scientific research program elements are expected to present within their Scientific/Technical/Management section a clear description of a specific scientific problem, of how the attack on this problem will be carried out, and of the relevance of the proposed research to NASA's Heliophysics strategic objectives.

Proposals to any of the Heliophysics scientific research program elements are expected to present clear descriptions of (1) a specific scientific problem, (2) the importance of the problem, (3) the relevance of the problem to NASA's heliophysics strategic objectives, and (4) a complete method of attack on this problem. Principal Investigators (PIs) have the privilege of choosing the science question(s) they wish to address. However, having done so, they are expected to detail a methodology/science plan that clearly and specifically addresses the chosen question(s). Historically, proposals that are focused on a specific science question have been more successful at constructing methodologies than those that propose to address a broad science topic or a large number of science questions.

The development and testing of new instrument concepts, new observing techniques, new models, new data analysis techniques, and/or new supporting infrastructures that are pertinent to discipline goals is also supported. However, proposals for such efforts must provide an explanation of the relationship between such proposed efforts and clearly defined Heliophysics science problems.

Proposals with the intent of duplicating or directly supplementing investigations selected for current approved space flight missions are not appropriate for this ROSES NRA. Investigators who are funded members of the science teams of ongoing missions (including mission PIs and Co-Is) and who propose to use data from these missions in SR&T, Guest Investigator, or other Heliophysics program element’s efforts proposed through this ROSES NRA must clearly delineate between their mission responsibilities and the proposed efforts.

It is the overall guiding objective of each of these program elements to contribute as effectively and directly as possible to the achievement of NASA Heliophysics strategic goals. Priority for selection is given to those proposals that most clearly demonstrate the potential for such contributions.

B.2 HELIOPHYSICS THEORY

1. Scope of Program

The Heliophysics Research Program of the Science Mission Directorate (see Appendix B.1) supports investigations of the Sun and planetary space environments, including the origin, evolution, and interactions of space plasmas and electromagnetic fields in the heliosphere and in connection with the galaxy. Understanding the origin and nature of solar activity and its effect on the space environment of the Earth is a particular focus.

The Heliophysics Theory Program (HTP) is specifically designed to support theory and modeling investigations of problems that fall within the general realm of Heliophysics, but are of sufficient breadth that their successful completion requires the efforts of a synergistically interacting group of investigators led by a single Principal Investigator.

Theory investigations are the foundation of the HTP. They lead the way to new understanding of previous investigations and drive science concepts for future strategic missions. The ultimate goal of such investigations is to provide a complete chain of reasoning extending from the basic laws of nature to comparison with observation to the identification of future quantitative tests of the behavior of the environment.

HTP investigations are carried out in support of the NASA strategic goal to “Understand the Sun and its interactions with the Earth and the Solar System” and the NASA specific research objective to “Understand the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium” (see Section I(a) and Table 1 of the *ROSES Summary of Solicitation*). Competed once every three years, theory investigations will be solicited in 2010 for 3-year awards.

Proposals to the HTP are expected to present clear descriptions of (1) a specific scientific problem, (2) the importance of the problem, (3) the relevance of the problem to NASA's heliophysics strategic objectives, and (4) a complete method of attack on this problem. These descriptions should be presented concisely in the Proposal Summary and they should be discussed more deeply within the proposal scientific/technical/management section.

Proposals that serve only as an umbrella for a variety of separate research tasks, even though they each may be related by a common theme and may each be of high scientific merit, are not appropriate for the HTP. Proposals for focused smaller-scope theoretical efforts should be submitted to the Heliophysics Research Geospace Science program (Appendix B.3 of this ROSES NRA) or Heliophysics Research Solar and Heliospheric Science program (Appendix B.4 of this ROSES NRA). Efforts focused on those aspects of the Sun-Solar System that directly affect life and society are not appropriate for the HTP, but may be appropriate for the Living With a Star Targeted Research and Technology Strategic Capability program (Appendix B.7 of this ROSES NRA).

2. Programmatic Information

Selections for the HTP are for three-year periods of performance with annual funding contingent upon the submission of satisfactory progress reports and available funding. The total annual budget for this program element is about $4.3 M, and the average annual FY 2007 funding per group was $400K.

2.1 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $4M
Number of new awards pending adequate proposals of merit	~ 10
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the heliophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.

Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-HTP
NASA point of contact concerning this program	Dr. Barbara L. Giles Heliophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1762 E-mail: HQ-HTP@mail.nasa.gov

B.3 HELIOPHYSICS RESEARCH: GEOSPACE SCIENCE

1. Scope of Program

1.1 Overview

The Geospace Science (G/Science) program is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to see the overview of the Heliophysics Research Program in Appendix B.1 of this ROSES NRA. There is also significant Geospace content in the Heliophysics Theory program (Appendix B.2), the Heliophysics Guest Investigators program (Appendix B.5), and in the Living with a Star Targeted Research and Technology program (Appendix B.6). Proposers are encouraged to review these other Heliophysics Research Programs to determine the most appropriate solicitation for an intended proposal.

The goal of the G/Science program is to understand the space that surrounds and is influenced by the various solar system bodies. These studies range over regions that begin with the Earth's upper atmosphere, including the mesosphere and thermosphere, and extend outwards through the ionosphere, into and beyond the magnetosphere. The G/Science program also supports studies of the space *plasma* environments of other solar system bodies. These studies are carried out in support of NASA Strategic Subgoal 3B: "Understand the Sun and its effects on Earth and the solar system" from *The 2006 NASA Strategic Plan* (available at http://www.nasa.gov/about/budget) (see Section I(a) and Table 1 in the *ROSES Summary of Solicitation*). The recommended priorities of the heliophysics community are discussed in the National Research Council decadal survey for space physics, *The Sun to the Earth -- and Beyond: A Decadal Research Strategy in Solar and Space Physics* (http://www.nap.edu/catalog/10477.html), the *Science Plan for NASA's Science Mission Directorate (2007-2016)* (http://nasascience.nasa.gov/about-us/science-strategy), and the Heliophysics Roadmap for Science and Technology 2005-2035, *The New Science of the Sun-Solar System Connection*, (http://sec.gsfc.nasa.gov/Roadmap_FINALpri.pdf).

The Heliophysics Division roadmap is organized around three Research Focus Areas. The G/Science program contributes primarily to the first of these, "Open the Frontier to Space Environment Prediction," which has the goal of understanding "the fundamental physical processes of the space environment - from the Sun to the Earth, to other planets, and beyond to the interstellar medium."

The G/Science program has three components: the Geospace Supporting Research and Technology (G/SR&T) program, the Geospace Instrument Development (G/IDP) program, and the Geospace Low Cost Access to Space (G/LCAS) program. Brief descriptions of the elements of the G/Science program follow below, while specific information can be found in the individual program element descriptions.

- The G/SR&T program supports individual research tasks that employ a variety of research techniques, e.g., theory, numerical simulation, and modeling; analysis and interpretation of space data; development of new instrument concepts; and laboratory measurements of relevant atomic and plasma parameters (Section 1.2 below).

- The G/IDP supports the development of scientific instruments and/or components of such instruments to the point where they may be proposed in response to announcements of future Geospace Science flight opportunities, without additional extensive technology development. G/IDP investigations may include the development of laboratory instrument prototypes, but not of flight hardware (Section 1.3 below).
- The G/LCAS program supports science investigations or development that must be completed through suborbital flights (Section 1.4 below).

Priority for selection in the G/Science program is given to those proposals that most clearly demonstrate the potential for making significant contributions to Research Objectives 3B.1, 3B.2, and/or 3B.3 in the *Science Plan for NASA's Science Mission Directorate (2006)* (see Section I(a) and Table 1 of the *ROSES Summary of Solicitation*), <u>especially</u> those demonstrating direct benefit to NASA <u>future mission planning</u>.

Proposals to all of the Geospace elements are expected to present clear descriptions of (1) a specific scientific problem*, (2) the importance of the problem, (3) the relevance of the problem to NASA's heliophysics research focus areas, and (4) a method of attack on this problem. Principal Investigators (PIs) have the privilege of choosing the science question(s) they wish to address. However, having done so, they are then expected to detail a methodology/science plan that clearly and specifically addresses the chosen question(s). Historically, proposals that are focused on a specific science question have been more successful at constructing methodologies that clearly address a single target question than those that propose to address a large number of science questions or that are directed at a broad science topic, rather than a specific question.

* Proposals for making laboratory measurements, or developing new measurement techniques, models, or instrumentation are not necessarily expected to apply the results of their efforts to science questions within the time period of the proposed effort. They must, however, demonstrate that there are specific scientific problem(s) for which the development is a necessary precursor.

Objectives that are outside the scope of the G/Science program and should not be proposed include:

- Efforts focused on those aspects of Heliophysics that directly affect life and society are not appropriate for this G/Sciences program but may be appropriate for the Living With a Star (LWS) Program (see Appendices B.6 and B.7); proposals for the development of space weather prediction capabilities, for example, should be submitted to the LWS Program.
- Proposals for efforts intended to maximize the return from ongoing Heliophysics missions that heavily utilize mission specific data from operating spacecraft are more appropriate for the Heliophysics Guest Investigators program (see Appendix B.5).
- Proposals with the intent of extending or directly supplementing investigations selected for current, approved space flight missions are not appropriate for this NRA. Investigators who are members of the science teams of ongoing missions and who

propose to use data from these missions in SR&T efforts proposed through this NRA must clearly delineate between their mission responsibilities and the proposed efforts.

- The G/Science program does not support the routine, long-term gathering of observational data.
- The Geospace program is intended to deal primarily with plasma physics. Hence, its scope includes planetary magnetospheres, but not planetary atmospheres. The G/Science program does not, for instance, study sputtering processes, because the basic physics involved has to do with surface reactions. It does not support studies of the sources of neutral constituents of planetary magnetospheres. On the other hand, studies of the effects of neutral components on processes that are primarily plasma processes are within scope for the program.
- Proposals dealing with the chemistry and/or dynamics of the middle and/or lower terrestrial atmosphere (i.e., below the mesosphere) are not appropriate for this G/Sciences program.

1.2 Geospace Supporting Research and Technology Program

The G/SR&T program supports individual research tasks that employ a variety of research techniques in pursuit of Geospace program goals. Specifically, the G/SR&T program supports theoretical research, the development and exercise of models and simulations, and the analysis and interpretation of data for the purposes of identifying and understanding the physical processes important to geospace structure and dynamics. The exploration of new instrument concepts, new observing techniques, new models, and/or new data analysis techniques are also supported, but must be clearly motivated by science questions important to the program. All proposals must provide an explanation of the relationship of the proposed effort to G/Science goals.

One of the requirements that proposals to the G/SR&T program must meet in order to achieve a rating of high scientific merit is to demonstrate appropriate and feasible methodology. This includes demonstration that any data to be used are of sufficient quality to provide clear results. It should be noted that this demonstration can seldom be convincingly argued for data that do not yet exist.

It is expected that there will be approximately $2.4M available in Fiscal Year (FY) 2011 to support new G/SR&T investigations selected through this solicitation. Annual funding in past G/SR&T programs has averaged $110K per investigation.

1.3 Geospace Instrument Development Program

The G/IDP supports the development of instrument technologies that show promise for use in scientific investigations on future Geospace Science missions, including the development of laboratory instrument prototypes, but not of flight hardware. The goal of the program is to define and develop scientific instruments and/or components of such instruments to the point where complete instruments may be proposed in response to future Announcements of Opportunity without significant additional technology development.

It is anticipated that the scientific payloads on most future Geospace Science missions will be limited to small, low mass, low power consumption, and low cost instruments. Therefore, proposals for instrument definition and development satisfying these general specifications are especially solicited.

Proposals to the G/IDP are not necessarily expected to apply the results of their efforts to science questions within the time period of the proposed effort. <u>They must, however, demonstrate that there are specific scientific problem(s), for which the development is a necessary precursor.</u>

It is expected that there will be approximately $300K available in FY 2011 to support new G/IDP investigations selected through this solicitation. Annual funding in past G/ID programs has averaged $150K per investigation.

1.4 <u>Geospace Low Cost Access to Space Program</u>

The G/LCAS program supports research in magnetospheric, ionospheric, thermospheric, and mesospheric physics that requires the space flight of instrumentation. The program offers a variety of methods for providing low cost access to space, including standard and long-duration balloons, sounding rockets, and sounding rocket-class payloads flown as secondary payloads or on other flights of opportunity. See Section 2.2 below for special instructions for proposals in this element of the G/Science program.

It is expected that there will be approximately $1.2M available in FY 2011 to support new G/LCAS investigations selected through this solicitation. Recent G/LCAS awards have averaged $320K, $450K, and $350K for, respectively, the first, second, and third years of the investigation.

2. <u>Programmatic Information</u>

2.1 <u>Geospace Supporting Research and Technology and Instrument Development Programs</u>

Proposals should be for whatever time period is required in order to complete the investigation, up to but not exceeding three years in duration. The G/SR&T and G/IDP programs do not make separate grants to the Principal and Co-Investigators of the same investigation at different institutions, except in those cases where a Co-Investigator is affiliated with a U.S. Government Laboratory (see the *NASA Guidebook for Proposers*, Section 2.3.10(c)), in which case NASA separately funds that Co-Investigator through a direct transfer of funds. In all other cases, the PI institution is expected to fund participating Co-I(s).

2.2 <u>Geospace/Low Cost Access to Space (LCAS)</u>

Proposals to the G/LCAS program are expected to describe a complete suborbital science investigation, including payload construction, launch phase, data analysis, and publication of results. Proposals should be for whatever time period is required in order to complete the investigation, up to but not exceeding three years' duration. As a rule, new investigations are awarded definition-level funding in their first year, full funding for development in their second year, leading to flight early in their third year, which concludes with data analysis.

The total expense associated with a suborbital investigation includes costs for launch services, as well as payload development. Operational support includes the elements that support getting the carrier (i.e., the rocket/payload) into the space environment. Examples include provision of the vehicle, payload support systems, tracking radars, telemetry stations, uplink command systems, launchers, and logistics. The funding for science support elements, such as science radars, lidars, ionosondes, optical sites, and the associated logistics, must be included in science proposal budgets.

The information needed in order to generate an estimate of the costs associated with the operational requirements for proposed investigation includes the envisioned vehicle type, payload mass, trajectory requirements, launch site, telemetry requirements, attitude control or pointing requirements, and any plans for payload recovery and reuse. This information will be requested on G/LCAS proposal cover pages, and cost estimates based on this data will be used in proposal selection.

Launch vehicle services

NASA provides two different avenues for procurement of suborbital launch vehicle services: the use of NASA-provided services (managed by the NASA Sounding Rocket Program Office (SRPO) and the NASA Balloon Program Office(BPO)) and the purchase of commercial services via the Commercial Reusable Suborbital Research (CRuSR) Program Office (see below). Regardless of which launch vehicle service they anticipate selecting, all prospective PIs, are strongly urged to discuss prospective investigations with program personnel (see below) to ensure that probable operational costs are properly anticipated.

NASA-provided Sounding Rocket Services

Sounding Rocket Vehicles. Information on the capabilities of current available vehicles is available at http://www.nsroc.com/front/html/mmframe.html. Proposers are encouraged to consider these capabilities in designing their investigations, but SRPO has the final authority in the choice of which vehicles to be used.

Sounding Rocket Launch Sites. The nominal U.S. launch sites for sounding rockets are White Sands Missile Range (WSMR) in New Mexico, Wallops Island in Virginia, Poker Flat Rocket Range (PFRR) in Alaska and Reagan Test Site (RTS) in the Kwajalein Atoll. The G/LCAS program also accepts proposals for launches with modest operational requirements from the established non-U.S. launch sites at Andoya, Norway, and Kiruna, Sweden.

Questions concerning sounding rockets may be addressed to:

Mr. Philip Eberspeaker
Sounding Rocket Program Office
Code 810
Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-2202
Email: Philip.J.Eberspeaker@nasa.gov

NASA-provided Balloon Services

Questions concerning balloon services may be addressed to:

Mr. Craig Purdy
Balloon Office
Code 800
Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-1453
Email: Craig.L.Purdy@nasa.gov

Commercial Suborbital Rocket Services

Prior to the finalization of ROSES-2010 for release, sufficient technical information on commercial reusable suborbital research (CRuSR) vehicles for writing and evaluating proposals was not available to proposers. Once that technical information is available, ROSES-2010 will be amended to solicit proposals for investigations using CRuSR vehicles through the Geospace Science program.

Additional information on CRuSR vehicles, including technical capabilities, operational constraints, and anticipated costs to researchers, is available at http://suborbitalex.arc.nasa.gov/.

Questions concerning CRuSR vehicles may be addressed to:

Mr. Mike Skidmore
Commercial Reusable Suborbital Research Program Office
Mail Stop 240-10
Ames Research Center
National Aeronautics and Space Administration
Moffett Field, CA 94035
Telephone: (650) 604-6069
Email: Mike.Skidmore@nasa.gov

Export Control Laws.

Export licenses are required for all foreign nationals accessing sounding rocket hardware. G/LCAS program PIs should contact the Sounding Rocket Program Office regarding PI responsibilities in this arena. Getting the required State Department licenses can take some time and PIs are urged to begin the process well before team members need access to the actual rocket hardware. Questions concerning sounding rockets and U.S. Export Control Laws and Regulations may be addressed to the Sounding Rocket Program Office.

Proposals from Multiple Institutions.

Proposals for suborbital investigations often involve the development of payloads that require major hardware collaborations amongst several organizations. In such cases, lead Principal Investigators (PIs) may propose a direct subcontracting arrangement between his/her organization and the Co-Investigator (Co-I) institution(s), in which case all the nominal instructions in the *NASA Guidebook for Proposers* (see further below) apply.

Alternatively, NASA recognizes that some cost savings may be achieved by providing separate awards to each collaborating institution, where the lead investigator from each Co-Investigator institution serves as the "Institutional PI" for the award to his/her institution (see Section 1.4.2 in the *NASA Guidebook for Proposers*). In order to provide for such multiple-award flexibility, the following instructions should be followed for proposals that involve major hardware contributions from multiple institutions:

- Only the "lead proposal" for the overall investigation, submitted by a single PI, will be reviewed. This lead proposal must include:
  - A clear statement in the first sentence of the *Proposal Summary* that identifies the proposal as the lead proposal.
  - The *Cover Page/Proposal Summary/Budget Summary* of the lead proposal, showing only the summary of the budget requested by the lead organization.
  - The PI's work statement and budget justification (narrative and details), plus appended *Task Statements* and the budget justifications (narrative and details) from all other collaborating Co-I institutions (see further below) as part of its budget justification.
  - A table in the budget details that shows the costs for the lead organization, plus those for each Co-I institution, which together must add to the total yearly requests for the entire, integrated investigation for its complete period of performance.

- Each collaborating Co-I institution proposal must:
  - Have a *Proposal Title* that is identical to the title of the lead proposal, except that "[Institution Name] Co-I" is added to the end.
  - Have a *Proposal Summary* that clearly cross-references the PI of the lead proposal in the first sentence.
  - Complete the *Cover Page/Proposal Summary/Budget Summary* and include all materials indicated in the *NASA Guidebook for Proposers*.

- Contain, in lieu of the scientific/technical/management section, a *Task Statement*, not to exceed five pages, that describes the contribution of the Co-I institution and the role of the Co-I(s) to the overall investigation. In the case of multiple Co-Is from the same institution, a single Co-I serving as the "Institutional PI" must be identified.
- Include a full institutional budget covering the Co-I institution's proposed activities.
- Be submitted electronically through the institution's Authorized Organizational Representative (AOR), with the Co-I (Institutional PI) from that institution listed as the PI.

Owing to the larger scope and personnel involvement in G/LCAS proposals, the page limit for the science/technical/management section given in the *NASA Guidebook for Proposers* is revised from the default standard of 15 pages to 20 pages.

2.3 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	G/SR&T: \$2.4M G/IDP: \$300K G/LCAS: \$1.2K
Number of new awards pending adequate proposals of merit	G/SR&T: 22 G/IDP: 2 G/LCAS: 4
Maximum duration of awards	G/SR&T: 3 years G/IDP: 3 years G/LCAS: 3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp except for G/LCAS proposals where the page limit is 20 pp.; see also Chapter 2 of the *NASA Guidebook for Proposers*

Relevance	This program is relevant to the heliophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA..
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-GEO
NASA point of contact concerning this program	Dr. Mona Kessel Heliophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0064 E-mail: mona.kessel@nasa.gov

B.4 HELIOPHYSICS RESEARCH: SOLAR AND HELIOSPHERIC SCIENCE

1. Scope of Program

- There is a change in the maximum duration allowed for Low Cost Access to Space proposals. Although most LCAS awards are for three years' duration, a four-year proposal may be accepted to develop a completely new, highly meritorious investigation through its first flight.
- There is a change in the structural elements for this Solar and Heliospheric Program call. The Instrument and Technology Development (ITD) portion of the program has been separated from the Supporting Research (SR) and now encompasses its own element.

1.1 Introduction

Proposers to this program element are encouraged to read Appendix B.1 for an overview of the Heliophysics Research Program in the NASA Science Mission Directorate.

The Solar and Heliospheric Physics (SHP) program has as its objective the comprehensive study of all five solar and heliospheric research areas, namely:

- Solar interior;
- Solar photosphere;
- Solar chromospheres, transition region, and corona;
- Inner heliosphere; and
- Outer heliosphere and the interstellar boundary

This program has three main research thrusts, non-flight Supporting Research (SR, Section 1.2 below), Instrument and Technology Development (ITD) that may be carried out in the laboratory and/or observatory (see Section 1.3 below), and payloads on balloons, sounding rockets, or as secondary, rocket-class payloads on flights of opportunity that is generically referred to as Low Cost Access to Space (LCAS; see Section 1.4 below). These studies support NASA's strategic goal to understand the Sun and its effects on Earth and the Solar System (see Section I(a) and Table 1 of the *ROSES Summary of Solicitation*) as discussed in the *Science Plan for NASA's Science Mission Directorate (2007-2016)* (available at http://nasascience.nasa.gov/about-us/science-strategy). Proposals in interdisciplinary research areas (e.g., solar-stellar connections) are appropriate for this program if the proposed research has clear application to Heliophysics program goals.

Objectives that are outside the scope of the SHP program and should not be proposed include:

- Supporting Research efforts focused on those aspects of Heliophysics that directly affect life and society are not appropriate for this SHP program but may be appropriate for the Living With a Star Program (see Appendices B.6 and B.7 of this ROSES NRA); Hardware development either through the Instrument and Technology Development or LCAS is not subject to this restriction.

- Proposals for efforts intended to maximize the return from ongoing Heliophysics missions that heavily utilize mission specific data from operating spacecraft are more appropriate for the Heliophysics Guest Investigators program (see Appendix B.5).
- Proposals with the intent of extending or directly supplementing investigations selected for current, approved space flight missions are not appropriate for this solicitation. Investigators who are members of the science teams of ongoing missions and who propose to use data from these missions in SR efforts proposed through this solicitation must clearly delineate between their mission responsibilities and the proposed efforts.

As part of a mission-oriented agency, the Heliophysics Research Program seeks to fund those efforts that directly impact NASA missions or interpretation of their data. Therefore, investigations that are judged to be more appropriate for submission to other Federal agencies, even if of considerable merit, will not be given high priority for funding through this solicitation.

1.2 Solar and Heliospheric Physics Supporting Research (SR)

For purposes of program balance, the NASA SHP SR program element is organized into a matrix of four techniques, viz,

- Ground- and space-based observations;
- Theory and/or modeling;
- Data analysis; and
- Ancillary laboratory research (e.g., derivation of atomic constants, photometric calibrations, or simulation of solar and heliospheric phenomena),

for each of the five solar and heliospheric research areas noted in Section 1.1 above. Supporting research investigations in all matrix categories are invited (e.g., Solar Photosphere/Data Analysis, Outer Heliosphere/Theory-Modeling, etc.).

This SHP SR program supports investigations involving analyses of existing data or the development of data reduction software that will be demonstrably available in the public domain. Acceptable SR investigations include the development of theoretical models and numerical simulation techniques pertinent to solar and heliospheric physics, and, in special cases, the development or coordination of solar and heliospheric ground-based observing capabilities that support NASA SHP flight programs.

The SHP SR program also supports investigations involving analyses of existing NASA space mission data, but only if such data reside or will be placed in research-quality databases in the public domain. For non-NASA missions, such as, for example, the National Oceanic and Atmospheric Administration's (NOAA's) Solar X-Ray Imager (SXI), etc., preference will be given to those proposals intending to utilize open databases. For investigations using restricted data, the proposer must submit a letter from the experiment Principal Investigator confirming that the data will be made available for the proposed SR work in a timely manner, which NASA reserves the right to confirm.

Similarly, if the proposed effort involves software that is not in the public domain or available to the public for purchase, the proposal should include a letter from the software copyright holder confirming that the software will be made available for the proposed SR work.

1.3 Solar and Heliospheric Physics Instrument and Technology Development (ITD)

The SHP ITD Program supports the development of instrument concepts that show promise for use in scientific investigations on, or give rise to future Heliophysics/Solar and Heliospheric Physics missions, including the development of laboratory instrument prototypes, detectors, instrument components, etc., but not of major space flight hardware. Proposals for ITD must demonstrate relevance to the Heliophysics program, including clearly defined scientific goals appropriate for SHP. ITD proposals are not necessarily expected to apply the results of their efforts to science questions within the time period of the proposed effort. They must, however, demonstrate that there are specific scientific problem(s), for which the development is a necessary precursor.

Especially welcomed are proposals that seek to explore and demonstrate concepts for new instruments for future suborbital or orbital flight opportunities, such as those identified in the National Research Council decadal survey for space physics, *The Sun to the Earth — and Beyond: A Decadal Research Strategy in Solar and Space Physics* (available at http://www.nap.edu/catalog/10477.html).

1.4 Low Cost Access to Space Program in Solar and Heliospheric Physics

The SHP Low Cost Access to Space (LCAS) program is expected to continue to lead the way in the development of a large fraction of instrument concepts for future solar and heliospheric missions using a variety of methods for providing low cost access to space. These methods include standard and long-duration balloons, sounding rockets, commercial reusable suborbital research rockets, and sounding rocket-class payloads flown as secondary payloads or on other flights of opportunity. Proposals for the SHP LCAS program must be for a complete science investigation, including clearly defined scientific goals appropriate for SHP, payload construction, launch phase, data analysis, and publication of results.

Suborbital investigations provide unique opportunities not only for executing intrinsically meritorious science investigations, but also for advancing the technology readiness levels of future space flight detectors and supporting technologies, and for preparing future leaders of NASA space flight missions, such as junior researchers and graduate students. For suborbital proposals, specific factors that will be considered when evaluating a proposal's intrinsic merit are the scientific merit, the degree to which it advances the technology readiness level of a detector or supporting technology, and the degree to which it advances the readiness of junior researchers or graduate students to assume leadership roles on future NASA space flight missions.

Proposals which do not sufficiently tie LCAS and instrument development efforts to SHP science goals will receive lower priority.

Launch vehicle services

NASA provides two different avenues for procurement of suborbital launch vehicle services: the use of NASA-provided services (managed by the NASA Sounding Rocket Program Office (SRPO) and the NASA Balloon Program Office (BPO)) and the purchase of services via the Commercial Reusable Suborbital Research (CRuSR) Program (see below). Regardless of which launch vehicle service they anticipate selecting, all prospective PIs are strongly urged to discuss prospective investigations with program personnel (see below) to ensure that probable operational costs are properly anticipated.

NASA-provided Services

Sounding Rocket Program: Information on the NASA Sounding Rocket Program, including currently available vehicles, is available at http://sites.wff.nasa.gov/code810/. Proposers are encouraged to consider these capabilities in designing their investigations, but SRPO has the final authority in the choice of which vehicle is to be used.

Balloon Program: Information on the NASA Balloon Program, including currently available options and launch sites, is available at http://sites.wff.nasa.gov/code820/. Proposers are encouraged to consider these capabilities in designing their investigations, but BPO has the final authority in the choice of which vehicles to be used.

Commercial Services

Prior to the finalization of ROSES-2010 for release, sufficient technical information on commercial reusable suborbital research (CRuSR) vehicles for writing and evaluating proposals was not available to proposers. Once that technical information is available, ROSES-2010 will be amended to solicit proposals for investigations using CRuSR vehicles through the Solar and Heliospheric Physics program.

Additional information on CRuSR vehicles, including technical capabilities, operational constraints, and anticipated costs to researchers, is available at http://suborbitalex.arc.nasa.gov/.

LCAS Page Limit

Owing to the larger scope of SHP LCAS proposals, the page limit for the science/technical/management section given in the *NASA Guidebook for Proposers* is revised from the default standard of 15 pages to 20 pages.

Questions concerning sounding rocket vehicles and operations may be addressed to:

Mr. Philip Eberspeaker
Sounding Rocket Program Office
Code 810
Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-2202
Email: Philip.J.Eberspeaker@nasa.gov

Questions concerning balloon operations may be addressed to:

Mr. Craig Purdy
Balloon Program Office
Code 820
Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-1453
Email: Craig.L.Purdy@nasa.gov

Questions concerning CRuSR operations may be addressed to:

Mr. Mike Skidmore
Commercial Reusable Suborbital Research Program Office
Mail Stop 240-10
Ames Research Center'
National Aeronautics and Space Administration
Moffett Field, CA 94035
Telephone: (650) 604-6069
Email: Mike.Skidmore@nasa.gov

2. Programmatic Information

2.1 Available Funds

A total of about $5M SHP program funds in Fiscal Year (FY) 2012 will allow the selection of about 35 new awards from proposals for SR, ITD, and LCAS.

It is anticipated that approximately $0.5M will be made available to support new selections for ITD. Proposals of exceptional scientific merit requesting annual funding for up to that maximum amount will be considered for funding.

As part of total SHP funding, the LCAS Program has approximately $2M available for a selection made through this solicitation of perhaps three LCAS investigations of up to four years duration beginning in early FY 2012.

2.2 Maximum Duration of Awards

Typical duration of awards for SHP program is 3 years. Duration of proposed work up to four years can be requested for SR and ITD proposals. However, a strong justification must be provided to support the extension of funding into the fourth year. Although most LCAS awards are for three years' duration, a four-year proposal may be accepted to develop a completely new, highly meritorious investigation through its first flight.

2.3 Additional Instructions for the Cover Page

To aid in the identification of peer reviewers, it is essential that the electronically submitted proposal *Cover Page* (in NSPIRES) for SHP proposals include a single choice of descriptor (e.g., Theory or Modeling/Solar Chromosphere, Transition Region, and Corona; Ground-based Observations/Solar Interior; Data Analysis/Inner heliosphere; etc.) as the "Technique/Research Area" designation that will appear on the Web site format.

2.4 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $5M
Number of new awards pending adequate proposals of merit	~ 32 for SR and ITD combined and ~ 3 for LCAS.
Maximum duration of awards	SR and ITD - 4 years; LCAS – 4 years; shorter-term proposals are welcome.
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	October 1, 2011

Page limit for the central Science-Technical-Management section of proposal	15 pp; except for LCAS where the page limit is 20 pp.; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the heliophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-SHP
NASA point of contact concerning this program	Dr. Jeffrey Newmark Heliophysics Division Science Mission Directorate NASA Headquarters Washington DC 20546-0001 Telephone: (202) 358-0684. E-mail: Jeffrey.Newmark@nasa.gov or hq-shp-ps@nasa.gov Dr. Arik Posner Heliophysics Division Science Mission Directorate NASA Headquarters Washington DC 20546-0001 Telephone: (202) 358-0727 E-mail: Arik.Posner@nasa.gov

B.5 HELIOPHYSICS GUEST INVESTIGATORS

NOTICE: The Heliophysics Guest Investigator program will not be competed in 2010. The program is fully subscribed in this Fiscal Year, and will not be competed again until ROSES 2011.

1. Scope of Program

A multiple-year Heliophysics Guest Investigators program (GIP) is offered for investigations that draw extensively upon the data sets from the missions of the Heliophysics System Observatory. This program is intended to maximize the return from these missions by providing support for research of breadth and complexity beyond those typically being carried out by the presently funded investigations. Since 1997, four Heliophysics Senior Review panels have reviewed the GIP in the context of the activities of the operating missions. The panels have uniformly endorsed a strong GIP to complement the mission-sponsored investigations. (See http://nasascience.nasa.gov/heliophysics/mission_list for the reports of the Senior Review panels.) In particular, the 2008 Senior Review panel stated that, *"The present senior review panel, like those in years past, believes that the Guest Investigator Program is an extremely effective means of enhancing the scientific return from operating NASA missions. As has been pointed out before, the impact of the Guest Investigator Program is particularly great for younger researchers, and is an obvious way to enable talented workers to remain in our research fields."*

Proposals are expected to present clear descriptions of 1) a specific scientific problem, 2) a method of attack on this problem, 3) the importance of the problem, and 4) the relevance of the problem to NASA's strategic objectives. These descriptions should be presented concisely in the proposal summary and they should be discussed more deeply within the proposal scientific/technical/management section.

The GIP emphasizes the use of data from NASA's Heliophysics missions, including those missions with which NASA is an international partner. Investigations using data from multiple spacecraft and those investigations addressing global system problems are of special interest. Investigations may also use some theory and modeling to carry out the associated interpretative data analysis.

The use of collaborative data from space sensors or ground observations sponsored by other sources, such as non-Heliophysics NASA missions or sources from other U.S. Government organizations, may be necessary for the proposed research. The use of such collaborative data is appropriate if it is clearly demonstrated that the proposed research will rely primarily upon data from one or more of NASA's Heliophysics missions.

2. Programmatic Information

For general questions about this Guest Investigator Program, please contact the Program Officer:

Dr Jeffrey J.E. Hayes
Heliophysics Division
Science Mission Directorate
NASA Headquarters
Washington DC 20546-0001
Telephone: (202) 358-0353
E-mail: HQ-HGIP@mail.nasa.gov

B.6 LIVING WITH A STAR TARGETED RESEARCH AND TECHNOLOGY

NOTICE: This draft version of Appendix B.6: Living With a Star Targeted Research and Technology is released with the ROSES-2010 NASA Research Announcement. An amendment to ROSES-2010 will be released with the 2010 Focused Science Topics in a final version of this program element appendix after the Living With a Star Targeted Research and Technology Steering Committee has submitted its final report. Proposals will be due no earlier than 90 days after release of the amendment. The text given below will be superseded.

1. Scope of Program

NOTE: See Section 2.2 for additional compliance requirements. Proposals that do not meet these compliance criteria will be judged noncompliant and will not be reviewed.

1.1 Overview

The goal of NASA's Living With a Star (LWS) Program is to develop the scientific understanding needed for the United States to effectively address those aspects of Heliophysics science that may affect life and society. The LWS Targeted Research and Technology (TR&T) program element solicits proposals leading to a physics-based understanding of the integral system linking the Sun to the Solar System both directly and via the heliosphere, planetary magnetospheres, and ionospheres. The TR&T program's objectives can be achieved by data analysis, theory, and modeling, and the development of tools and methods (e.g., software for data handling). LWS is a crosscutting initiative whose strategic goals relate to all aspects of NASA's Mission, namely (in no priority order):

1. Solar energetic particles and galactic cosmic rays pose major radiation hazards for space hardware and astronauts. Penetrating particle radiation adversely affects aircraft avionics and potentially the health of airline crews and passengers on polar flights. Communication and navigation systems are directly affected by impulsive changes in the solar particle and electromagnetic output leading to rerouted polar flights and GPS outages. In support of NASA's Vision for Space Exploration and the national communication, navigation, and transportation infrastructure, the TR&T program needs to deliver the understanding and modeling required for useful prediction of the variable solar particulate and radiative environment at the Earth, Moon, Mars, and throughout the Solar System.

2. One of the major challenges facing humanity is global climate change. In order to gauge the response of the terrestrial climate system to natural and anthropogenic forcings, NASA through the TR&T program and Earth Science Division in conjunction with other national agencies such as NOAA and NSF needs to deliver the understanding of how and to what degree variations in the solar radiative and particulate output contribute to changes in global and regional climate over a wide range of time scales.

3. National infrastructures are increasingly dependent on satellites orbiting Earth. With increasing miniaturization these systems are ever more sensitive to variations in the near-Earth space environment. To protect these assets, the TR&T program needs to deliver the understanding and modeling required for effective forecasting/specification of magnetospheric radiation and plasma environments.

4. The upper atmosphere and ionosphere is central to a host of space weather effects, including anomalous satellite drag, GPS position error, radio blackouts, radar clutter, and geomagnetically induced currents. In order to mitigate space weather's impact on life and society, NASA through the TR&T program in conjunction with other national agencies such as NSF and DoD needs to deliver understanding and predictive models of upper atmospheric and ionospheric responses to changes in solar electromagnetic radiation and to coupling above and below.

These strategic goals will guide the selection of focused science topics for this solicitation. The primary goal of the LWS Program is to make progress in understanding this complex system, focusing on the most critical interconnections.

The *Final Report of the LWS TR&T Science Definition Team (SDT)* (December 2003), located on the LWS TR&T homepage at http://lws-trt.gsfc.nasa.gov/trt_resources.htm, identified TR&T as a systematic, goal-oriented research program. The TR&T component of the LWS Program provides the theory, modeling, and data analysis necessary to enable an integrated system-wide picture of Heliophysics science with emphasis on societal relevance.

Significant progress toward quantitative understanding and predictive capability with respect to these problems will require large-scale, integrated modeling activities. Recognizing the need for activities that would be broader and more sustained than those that can be supported by a traditional NASA grants program, the *Final Report of the LWS TR&T Science Definition Team* recommended that "…large modeling activities that address coupling across traditional science domains in the Sun-Earth chain specifically be included as strategic capabilities." The TR&T SDT also recommended the formation of a TR&T Steering Committee in order to update periodically the designated strategic capabilities for future solicitations. The most recent report of this Steering Committee is available on the LWS TR&T homepage at http://lws-trt.gsfc.nasa.gov/trt_resources.htm.

As a result of these studies and recommendations, the LWS TR&T program has defined a strategy with three program elements, namely, Strategic Capabilities, Targeted Investigations, and Cross-Disciplinary Infrastructure Building programs.

Further background material concerning relevant research objectives can be found in the following documents:

- The National Academy of Sciences Web tutorial, entitled "*Space Weather: A Research Perspective*" (http://books.nap.edu/openbook.php?isbn=0309058821);
- The Sun Earth Connection LWS web site (http://lws.gsfc.nasa.gov/);

- The LWS Science Architecture Team report to SECAS (http://lws.gsfc.nasa.gov/documents/sat/sat_report2.pdf);
- The NRC Decadal Survey Report *The Sun to the Earth and Beyond* (http://www.nap.edu/books/0309089727/html/);
- *The Heliophysics Roadmap* (http://sec.gsfc.nasa.gov/2009_Roadmap.pdf);
- *The TR&T Science Definition Team Report* (http://lws-trt.gsfc.nasa.gov/TRT_SDT_Report.pdf); and
- *The latest TR&T Steering Committee Team Report* (http://lws-trt.gsfc.nasa.gov/trt_resources.htm).

1.2 Targeted Investigations

The stated goal of LWS, that of achieving an understanding of those aspects of the Sun-Solar System that have direct impact on life and society, poses two great challenges for the TR&T program. First, the TR&T program must tackle large-scale problems that cross discipline and technique boundaries (e.g., data analysis, theory, modeling, etc.); and second, the TR&T program must identify how this new understanding will have a direct impact on life and society.

This Targeted Investigations program element is subdivided into the three components described below: (1) Focused Science Topics, (2) Sun-Climate Theme, (3) Tools & Methods. The maximum duration of these awards are 4 years, 3 years, and 2 years, respectively. Read the following sections carefully; there are significant changes, especially as related to compliance.

Proposals will be judged noncompliant and will not be reviewed if the Evaluation Criteria found in section 2.2 and detailed in sections 1.2.1 and 1.2.3 are not met.

1.2.1. Focused Science Topics

A set of Focused Science Topics has been chosen for emphasis in this solicitation and these are listed below. The maximum duration of these awards is 4 years. NASA desires a balance of research investigation techniques for each Topic, including theory, modeling, data analysis, observations, and simulations. Any individual proposal does not need to include all techniques. Given the submission of proposals of adequate number and merit, up to eight selections will be made for each Focused Science Topic. Once selected, these investigators will form a team in order to coordinate their research programs. One of the PIs will serve as the Team Leader for the Focused Science Topic for which he/she proposed, and will receive supplemental funding as necessary to support costs associated with these duties. Proposers are encouraged to propose to act as a Team Leader and if they do so, should include a brief section in their proposal describing how they would lead the team effort. Up to one extra page in the proposal is allowed for this proposed effort. All proposers for Focused Science Topics should include sufficient travel funds in their proposed budgets to cover two team meetings per year to be held on the U.S. coast furthest from their home institutions. See Instructions for TR&T Focus Team Members and Leaders at (http://lws-trt.gsfc.nasa.gov/trt_focusteams.htm) for full details of responsibilities.

While the primary evaluation criteria remain unchanged (see *ROSES Summary of Solicitation*, Section V(a), and the *NASA Guidebook for Proposers*, Appendix C.2), the criterion for relevance includes relevance to one of the Focused Science Topics as an essential requirement for selection within this component. In addition, NASA is instituting a compliance check as follows:

In order to be compliant to this ROSES element, each proposal submitted must contain a section, entitled "Proposed Contributions to the Focus Team Effort" and identified in the proposal's table of contents. Failure to include this section will result in the proposal being judged noncompliant, and the proposal will be returned.

This section must include the following three items:

- The relevance of the proposal to the scientific objectives of the Focused Topic;
- The potential contributions (e.g., data sets, simulation results, novel understanding of physical mechanisms, etc.) from the proposed effort to the Focused Science Team's effort; and
- Metrics and milestones for determining the successful progress and outcome of the proposed research.

Since each Focused Science Team has to produce a joint statement of work specifying its deliverables, success criteria, and milestones, the mandatory section described here can serve as a starting point for this SOW.

The *NASA Guidebook for Proposers* states that "NASA strongly encourages PIs to specify only the most critically important personnel to aid in the execution of their proposals." LWS further emphasizes that Focus Teams will be formed from individual proposals selected in a Focus Topic. Therefore, individual proposals do not need to tackle the whole problem, but can instead seek to solve a piece of the problem.

1.2.2 The Sun-Climate Theme

The LWS Sun-Climate strategic objective is to *"deliver the understanding of how and to what degree variations in the solar radiative and particulate output contribute to changes in global and regional climate over a wide range of time scales."* The new Sun-Climate Theme is established to address this objective. The maximum duration of these awards is 3 years. This theme represents a new opportunity to foster cross-disciplinary investigations of connections between solar forcing and climate. Particular emphasis is placed on coupling of the upper and lower atmosphere and the processes responsible for transmitting solar variations to the Earth's surface where they can affect regional climate. Only investigations of sun-climate issues will be considered compliant with this theme; climate investigations that are not directly relevant to solar forcing are not being solicited. Atmospheric responses on time scales of seasons to millennia are of primary interest.

It is anticipated that this new TR&T program element will be solicited on an annual basis over the next several years. Rather than aiming science contributions at a focused science team, proposers will submit individual investigations that must explicitly describe how the proposed work will lead to progress in achieving the prioritized goal quoted above. Contributions from a solar and upper atmosphere perspective will likely be on equal footing with those from a lower atmosphere climate dynamics and chemistry perspective. Exchange among diverse research foci within the Sun-Climate Theme is expected to grow through regular meetings (initially once a year), and individual collaborations are strongly encouraged.

Thematic Description: Proposals submitted to the new Sun-Climate Theme will target processes by which solar radiative and particulate forcing can impact the Earth's climate. Solar activity variations clearly influence the upper atmosphere, but signals diminish toward the surface. Nevertheless, in some locations climate-related parameters such as the historical surface temperature or moisture records exhibit variations that appear to be related to the solar cycle. Two key issues must be addressed to make progress in quantifying the solar contribution to climate variability and change: (1) Observed decadal to centennial-scale climate signals throughout the atmosphere and at the surface must be categorized as either systematically related to solar activity changes or as spurious because of internal climate system variations on similar time scales. (2) The emphasis of solar impact studies in climate research must be broadened beyond mean radiative forcing to include both direct and indirect atmospheric impacts of spectral irradiance and particle precipitation variations over the full range of spatial and temporal scales.

The intent of this Sun-Climate Theme is to initiate cross-disciplinary research that will develop a more solid mechanistic understanding of pathways by which solar variability affects the various levels of the atmosphere, and how these effects are communicated toward the troposphere and surface where they modulate global and regional climate. It also targets the pathways by which ongoing climate change influences the atmospheric response to solar forcing, both directly and via upward coupling. Investigations that identify these processes and analyze variations over a wide range of time scales are necessary to reconcile observations and understanding of the natural modulation of climate by the Sun, and to delineate the Sun's role in regional climate variability and current climate change. This information is crucial for testing climate models that are used for regional climate change prediction. Thus, this program component solicits investigations that seek to define and quantify the solar-induced changes in a "whole atmosphere" approach, emphasizing downward and upward coupling between the upper and lower atmosphere.

Objectives and Metrics: The overall objective is to predict the climate response to solar variability on regional as well as global scales. Metrics will be gauged for a number of tasks: (1) Identifying and quantifying the relevant pathways by which solar forcing causes variability in climate parameters such as atmospheric temperature, circulation, and wave activity over a broad range of time scales; (2) Isolating the regional and global climate response to variations in these pathways; (3) Assessing the sensitivity of these pathways to long-term change in the troposphere and atmospheric composition; (4) Incorporating solar forcing effects into coupled chemistry climate models (CCMs) to produce verified simulations of these effects on atmospheric processes; (5) Testing and improving the predictive capabilities of the CCMs and Earth System Models with regard to solar-induced forcing. Also of interest is identifying the minimum specifications of vertical extent, resolution and process complexity that a lower atmosphere model would need in order to adequately simulate solar effects on surface climate and variability.

It is expected that numerical modeling, theory, data analysis and assimilation investigations will contribute to the Sun-Climate Theme, with studies addressing seasonal to millennial time scales.

The following topics are examples of relevant areas of investigation; these are meant only to be illustrative, and are not all-inclusive:

- Quantify wintertime constituent transport from the thermosphere to the stratosphere, and any subsequent effects on the troposphere, to investigate the influence on these processes of solar particle variability.
- Quantify stratospheric ozone variations caused by solar irradiance variability, and the impacts of these variations on atmospheric circulation patterns.
- Explore the sensitivity of planetary-wave propagation and of large-scale circulation processes, such as the Brewer Dobson circulation, to solar variability.
- Develop and apply statistical procedures to climate data in order to quantify solar-variability signals on various time scales, tying these signals to radiative, chemical or dynamical processes.
- Determine what regional climate variability is systematically influenced by solar variability.
- Develop an assimilation of meteorological data from the troposphere up to the lower thermosphere to identify the impact of solar variations.
- Investigate the sensitivity of inter-hemispheric coupling to wave activity variations induced by solar variability.
- Evaluate the spectral detail necessary for proper treatment of the radiative and photochemical response to solar spectral variability.
- Identify the dominant processes by which galactic cosmic rays can influence climate, including impacts on cloud condensation nuclei and thus cloud cover and cloud radiative forcing as well as impacts on the global atmospheric electric circuit.
- Assess the influence of climate change on any of the above.

Note that this theme is *not* soliciting proposals for the development of solar irradiance proxies, unless they are specifically focused on improving the treatment of atmospheric coupling. Furthermore, this theme does not address day-to-day weather variability, unless it is connected to longer-term changes in tropospheric and stratospheric climate.

1.2.3 Tools and Methods

The Tools and Methods component supports studies that deliver tools and/or methods that enable critically needed science advances. The maximum duration of these awards is 2 years. Examples include (1) the development of new empirical methods or analysis techniques, such as local helioseismology, that can be used to forecast solar, interplanetary, and geospace activity, (2) the development of new feature recognition or artificial intelligence (AI) algorithms that can advance predictive capabilities for the LWS system, and (3) the development of software tools that can identify, retrieve, assimilate, and/or portray data in order to model results from different sources for LWS research and forecasting objectives. Tools that address the four LWS TR&T strategic goals will be especially welcome.

A deliverable product(s) and delivery site must be specified along with a delivery date. The deliverable product can be, for example, a stand-alone product or a web application, and must be delivered to a LWS approved repository/server such as the Community Coordinated Modeling

Center (CCMC; http://ccmc.gsfc.nasa.gov/), an existing Heliophysics virtual observatory (VxO), solar soft repository, or a mission site. The delivery date must be during the final year of work with enough time left to support appropriate documentation and handover to the CCMC/VxOs/solar soft/mission to insure longevity and to enable its independent use by the scientific community. All tools will be listed with links from the LWS TR&T web site (http://lws-trt.gsfc.nasa.gov).

Furthermore, the Proposal Summary that is submitted at the NSPIRES website must include explicit language stating the following:

- *Deliverable:* What will be the tool or method?
- *Delivery Site:* Where will it be delivered (e.g., CCMC, data center, mission site, etc.)?
- *Schedule:* When will it be delivered?

Proposals that do not include the Deliverable, Delivery Site and Schedule explicitly in the Proposal Summary will be deemed noncompliant and will not be reviewed.

1.3 Cross-Discipline Infrastructure Building Programs

One of the major challenges facing the LWS Program is the development of a research community that can cross traditional discipline boundaries and attack the system-wide problems that are central to understanding and modeling the Sun-Solar System connection. In order to address this challenge, proposals to this LWS TR&T program may include one or more of these infrastructure-building elements: cross-disciplinary workshops, and/or summer schools. Most of these activities will be supported through formal proposals to the TR&T program as part of the regular proposal cycle. In all cases, an extra two pages will be allowed to the page limit for the science/technical/management section of the proposal (see Section 3 below) for each of these activities.

(a) Support of LWS Workshops/Campaigns: Given the goals of the Infrastructure Building Program, there are several guidelines that successful requests for workshop/campaign support must satisfy:

- The workshop must address a science or technology topic that is both timely and important to the goals of LWS.
- Workshops must focus on comparing and validating tools that have already been developed. Examples of possible workshops include 1) predicting all clear forecasting, 2) comparison of helioseismic techniques, and 3) velocity estimation methods.
- Other workshop topics must be cross disciplinary in nature and bring together researchers from different disciplines in LWS science.
- Although there are no restrictions as to where the workshop will be held, it will clearly be advantageous to hold it at a location that is convenient and cost-effective for LWS researchers and students.
- Workshops that encourage the training of new researchers in LWS system science are strongly encouraged.
- Workshops that leverage funding from other institutions and agencies are strongly encouraged.

(b) Support of LWS Summer Schools for Graduate Students: The details of the summer school (e.g., format, location, duration, etc.) are left to the proposer to define. However, proposals should provide convincing evidence concerning the breadth of the topics to be considered, the means to be taken to assure participation by recognized research/education authorities, and any institutional support that may be forthcoming (note: shared support of this activity is strongly encouraged). One or two such proposals may be selected for summer school activities not to exceed more than two years during the nominal four-year period of performance for the parent research proposal.

2. Programmatic Information

2.1 Types and duration of investigations

This program element contains three components described in Section 1.2: (1) Focused Science Topics, (2) Sun-Climate Theme, (3) Tools and Methods. The maximum duration of these awards are 4 years, 3 years, and 2 years, respectively. In addition there are Cross-Discipline Infrastructure Building Programs described in Section 1.3. The maximum duration of these awards are 2 years.

Read the preceding sections carefully; there are significant changes, especially as related to compliance. Proposals may be judged non-compliant and not be reviewed if certain criteria are not met. Highlights are listed below.

2.2 Compliance Criteria

Proposers are reminded that the evaluation criteria for this solicitation are given in the *NASA Guidebook for Proposers* (see below for reference). These criteria are intrinsic merit, relevance, and cost realism and reasonableness.

For Focus Science Topics (only) described in Section 1.2.1, the compliance check will include the following:

- Each proposal submitted must contain a section, entitled "Proposed Contributions to the Focus Team Effort" and it must be identified in the proposal's table of contents. Failure to include this section will result in the proposal being judged non-compliant, and the proposal will not be reviewed. See Section 1.2.1 for more details.

For Tools and Methods, described in Section 1.2.3, the compliance check will include the following:

- The Proposal Summary that is submitted to the NSPIRES website must include explicit language stating the Deliverable, Delivery Site, and Schedule. Proposals that do not include this information explicitly in the Proposal Summary will be deemed non-compliant and will not be reviewed. See Section 1.2.3 for more details.

For the new Sun-Climate Theme component, described in Section 1.2.2, and the Cross-Discipline Infrastructure Building Program described in Section 1.3, there are no additional the compliance criteria.

2.3 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $4 M/Yr
Number of new awards pending adequate proposals of merit	~ 30
Maximum duration of awards	Tools and methods: 2 years Sun-Climate Theme: 3 years Focused Science Topics: 4 years Cross-Discipline Infrastructure: 2 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	~6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the heliophysics strategic goals and subgoals in NASA's Strategic Plan; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.

Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-LWSTRT
NASA point of contact concerning this program	Dr. Madhulika Guhathakurta Heliophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1992 E-mail: lws.trt@nasa.gov

B.7 LIVING WITH A STAR TARGETED RESEARCH AND TECHNOLOGY: STRATEGIC CAPABILITY

1. Scope of Program

This draft version of Appendix B.7: Living With a Star Targeted Research and Technology (TR&T): Strategic Capability is released with the ROSES-2010 NASA Research Announcement. An amendment to ROSES-2010 will be released with the 2010 Strategic Capability Topic(s) in a final version of this program element appendix after the Living With a Star Targeted Research and Technology Steering Committee has submitted its final report. Proposals will be due no earlier than 90 days after release of the amendment. The text given below will be superseded.

1.1 Overview

A primary goal of NASA's Living With a Star (LWS) Program is the development of first-principles-based models for the coupled Sun-Earth and Sun-Solar System, similar in spirit to the first-principles models for the lower terrestrial atmosphere. Such models can act as tools for science investigations, as prototypes and test beds for prediction and specification capabilities, as frameworks for linking disparate data sets at vantage points throughout the Sun-Solar System, and as strategic planning aids for enabling exploration of outer space and testing new mission concepts. To begin the process of developing and integrating models for all the components of the Sun-Earth and Sun-Solar System chain, the LWS Targeted Research and Technology (TR&T) Science Definition Team (SDT) identified these models and their integration as strategic capabilities that are critical for the TR&T program and recommended that they be funded as a distinct program element within the TR&T program.

1.2 Strategic Goals

Strategic goals of immediate concern to NASA's LWS program will be identified in the LWS TR&T Steering Committee 2010 Report.

2. Programmatic Information

2.1 LWS TR&T Strategic Capability

Given the unique nature of the LWS TR&T's strategic capability, proposal reviewers will include both scientific peers and knowledgeable representatives from the LWS/Space Weather user community. Proposals will be evaluated on the basis of their relevance, feasibility, intrinsic scientific merit, and compliance with requirements to provide public access to the models, tools, and value-added products developed.

The total funding available in Fiscal Year (FY) 2011 for new proposals submitted in response to this solicitation is expected to be about \$0.5 M. This funding is expected to support approximately 1-2 awards. Proposals for efforts up to five years' duration are allowed.

The recommendation for funding will be based on the peer evaluation and the scientific and technical merit of each proposal.

The NASA program officers will recommend for selection the proposals that best address the objectives of this solicitation within the resource constraints. NASA reserves the option of funding co-investigator institutions either as a subaward of the principal investigator institution's award or as a separate award directly to the co-investigator institution.

2.2 Proposal Requirements

Proposals to this solicitation are expected to satisfy the following requirements:

- The total award size for any proposal will not exceed $500K per year for a period of performance of up to five years.
- For each institutional partner that proposes a budget of $100K or more within a multi-institutional collaboration, the proposal should identify a lead co-investigator, provide a statement of work, and provide a separate budget for that institutional partner.
- Proposals should provide a detailed (~1 page) description of how the proposed work will benefit the goals and objectives described in Sections 1.1 and 1.2 and the timetable over which these benefits will accrue.
- The proposal must provide a set of clearly defined milestones and a description how and when these milestones will be accomplished.
- All models and software modules produced must be submitted to an appropriate modeling center, such as the Community Coordinated Modeling Center (http://ccmc.gsfc.nasa.gov/).
- The Federal Government must be granted a license for full and unrestricted use of the software, including the possible transition to space weather operations centers, consistent with 14 CFR 1260.30 (see Section A of the *NASA Grant and Cooperative Agreement Handbook* at http://prod.nais.nasa.gov/pub/pub_library/grcover.htm). In addition,
    a) the source code must be fully functioning,
    b) the code must be clearly documented according to standard software best practices,
    c) the code must be capable of running on actual, real-time, data as input and produce useful output, and
    d) to be part of end-to-end modeling efforts, the code's interoperability should be demonstrated.
- The proposal must include a description of how the resulting model(s) or software module(s) will be validated, documented, and delivered to potential users.
- Those investigators whose research requires high performance computing should refer to the *ROSES Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to the LWS TR&T Program to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at the Ames Research Center's Advanced Supercomputing Division. Please note that the description of the computing resources needed should include an estimate of the aggregated computing time per year (number of runs times,

number of processors per run times, number of hours per run), as well as the associated storage capacity needed to support the investigation. Peer-review panels will be asked to consider the realism and reasonableness of the computing request as a requirement for the science investigation and as an appropriate utilization of a highly constrained resource. Successful investigations selected for funding will be considered for an allocation of the requested computing resources, but the fully requested level cannot be guaranteed.

The program will provide links to the abstracts of all selected proposals and their annual progress reports, including developed and tested software and/or refined data products, at http://lws-trt.gsfc.nasa.gov/.

In addition to the regularly scheduled annual reports expected for any proposal selected in response to this opportunity, the Program Officers in the NASA LWS TR&T program will conduct a comprehensive review of the milestones accomplished three years after award initiation. At that time, and as directed by NASA HQ, each principal investigator will submit a detailed report to the LWS TR&T Program Officer describing (1) progress to date, (2) problems encountered, and (3) plans for the remaining two years of funding. Each principle investigator will present these results either on site or during a visit to NASA Headquarters. Consistent with their policy of routinely seeking counsel of the scientific community, NASA will invite appropriate members of the research and user community to review and comment upon this three-year report. With the findings from these reviews, NASA will then provide opportunity to the PI teams to revise their plans when requesting continued funding for the fourth year.

2.3 Demonstration of Relevance to NASA's LWS Objectives

Proposers are reminded that the evaluation criteria for this solicitation are given in the *NASA Guidebook for Proposers* (see below for reference). These criteria are intrinsic merit, relevance to NASA's strategic goals and objectives, and cost realism and reasonableness. In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "intrinsic merit" specifically includes the following factors:

- The degree to which the proposed investigation is relevant to the Strategic Goals listed in Section 1.1 and described in Section 1.2; and
- The proposed investigation's feasibility, intrinsic scientific merit, and compliance with requirements to provide public access to any tools and value-added products developed.

2.4 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $0.5M
Number of new awards pending adequate proposals of merit	~ 1-2
Maximum duration of awards	5 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers.*
Relevance	This program is relevant to the heliophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *2008 NASA Guidebook for Proposers*
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-LWSSC
NASA point of contact concerning this program	Dr. Madhulika Guhathakurta Heliophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1992 E-mail: lws.trt@nasa.gov

B.8 HELIOPHYSICS DATA ENVIRONMENT ENHANCEMENTS

1. Scope of Program

1.1 Introduction

The new challenges in solar and space physics, including linking solar phenomena to human consequences as studied in NASA's Living With a Star (LWS) Program, will require unprecedented integration of data and models across many missions, data centers, agencies, and countries. Accomplishing this requires a coordinated effort to link data and service providers to scientific users through software that uses descriptions of resources in a largely universal language to give a uniform face to an underlying heterogeneous and distributed set of sources.

In June 2007, NASA's Heliophysics (HP) Division published its data policy[1] that maintains the current distributed data environment, adopts Virtual Observatories (VOs) as the means for integrating data searches and retrievals across the environment, and introduces Resident Archives as a means of retaining science expertise with data sets after the termination of flight mission activities that created the data. The data policy advocates the peer review process as a means of creating and maintaining the elements of the HP data environment. The data policy was revised in April 2009 to introduce the Heliophysics Data and Model Consortium as the umbrella organization for the Virtual Observatories and Resident Archives and to more clearly define HP "Final Archives."

The Heliophysics Data Environment Enhancements program targets the integration of the many data services for solar and space physics data necessary for conducting research in the Heliophysics field. There are three components to this call for proposals: (1) Value-added Services that incorporate significant enhancements to the services provided by one or more of the VOs; (2) Data Services Upgrades that provide improved access to data sets linked to the VOs; and (3) Data Services Continuation (for creation of Resident Archives) that provide ongoing, postmission, VO-coordinated access to scientifically significant data products with continuing access to expertise on the use of the data. Note that this call does not include a request for new VOs, as the current set is complete in its coverage of the HP subfields.

For the purposes of this solicitation, we define a VO as follows:

> *"A Virtual Observatory (VO) is a suite of software applications on a set of computers that allows users to uniformly find, access, and use resources (data, software, document, and image products and services using these) from a collection of distributed product repositories and service providers. A VO is a service that unites services and/or multiple repositories."* [2]

Information on the Heliophysics data environment can be found at http://hpde.gsfc.nasa.gov/. Attention should be given to the data policy and *A Framework for Space and Solar Physics*

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[1] See http://hpde.gsfc.nasa.gov/ for a copy of *NASA Heliophysics Science Data Management Policy*.

[2] From A. Roberts, "VO Framework," the Virtual Observatories in Space and Solar Physics Workshop, Greenbelt, Maryland; October 27, 2004. See http://hpde.gsfc.nasa.gov/vo_workshop_papers.html.

Virtual Observatories that is the report from the *Space and Solar Physics Virtual Observatories Workshop* held on October 27-29, 2004. Other information at this site includes further background, documents, presentations, and VO workshop reports; complete lists of abstracts from previously selected investigations (under "News"); links to many HP data environment data access portals including the HP VxOs[3]; and links to many related virtual observatory efforts.

1.2 Value-Added Services for Virtual Observatories

The VxOs are intended to provide coordinated discovery and access to data and service resources for a substantial fraction of a specific scientific discipline, with the primary but not exclusive focus on NASA's HP science missions. VxOs are based on an understanding of the data needs of its discipline area. They provide data resource documentation and metadata, along with an Application Programmers Interface or other means for the VxO to appear to others as a single provider, and they collect statistical information and community comments to assess success.

Since the current set of VxOs covers all areas of HP, this call requests only proposals primarily offering clearly new value-added services, well coordinated with VxO efforts, not VxOs themselves. Such proposals must be clearly aimed at expanding the capabilities of the VxOs, and not simply providing a loosely related service. Proposers should know what services are currently offered or in development, and should look to augment or supplement these. Successful value-added services will be expected to become closely linked to one or more VxOs, and to have a long-term plan that includes support for the service from a VxO, NASA data center, or another clearly identified source.

1.3 Data Services Upgrades and Continuation

Also solicited by this program are proposals designed to upgrade existing Heliophysics data repositories to improve the quality, utility, and accessibility of datasets relevant to Heliophysics research. Possible upgrades could include (but are not limited to) placing datasets online, translating datasets into more readily accessible hardware and/or software formats, improving the data quality, providing data access and interpretation tools, improving metadata, and otherwise improving the interface of the data service to an existing or proposed VxO. Note that the term "dataset" can apply not only to data products derived directly from NASA-funded instruments or other instrumentation but also to higher-level datasets derived from the results of data analyses, data assimilation, and modeling.

Also solicited are continuation proposals by current awardees to continue existing data services featuring data from Heliophysics missions that have terminated or will soon terminate; such Data Service Continuation proposals will result in "Resident Archives" (RAs). These are intended to continue access to data with expert help for as long as the community (or the proposing team) regards such access as useful. When RA access is no longer deemed necessary, the final legacy data files will be served from a Final Archive such as the Space Physics Data Facility, or the Solar Data Analysis Center, or other archive by arrangement with NASA Headquarters.

[3] The 'x' in VxO denotes a virtual observatory for the 'x' scientific community in the Heliophysics research field. Examples would include VSO for the Virtual Solar Observatory, VMO for a Virtual Magnetospheric Observatory, etc.

1.4 General Scope

This program seeks improvements to the Heliophysics data environment through specific activities described in Sections 1.2 and 1.3 above. Note that there are other programs advertised in this ROSES NRA that have provided opportunities to improve the Heliophysics data environment, for example, the Living With a Star Targeted Research and Technology program (see Appendix B.6 of this ROSES NRA), and the Applied Information Systems Research program (see Appendix E.2 of this ROSES NRA).

2. Programmatic Considerations

Proposals must discuss the relationship of the proposed effort to the present, as well as anticipated, state of knowledge in the field, to the anticipated readiness of needed technologies, to the relevant datasets that should be available from any related planned missions, and to any related NASA community research efforts.

All proposals to this call should address two general areas:

1. Science Rationale. The science rationale includes
   a. Key objectives and their scientific importance;
   b. Relationship to NASA strategic plans and the HP data policy; and
   c. Uniqueness or scientific advantages of the proposed approach compared to alternatives.

2. Architecture and Implementation Approach. The architecture and implementation approach includes
   a. Technical approach and its requirements and feasibility;
   b. Data products or other resources supported or enhanced;
   c. Metadata and documentation of products and required ancillary data or services;
   d. Infrastructure and constraints assumed in place at the time of implementation; and
   e. Compatibility with VxOs and the Space Physics Archive Search and Extract (SPASE) Data Model[4].

All proposals are expected to result in significant and useful tools, services, and/or products within the grant period. The total funding available for awards will be approximately $700K in FY 2010, with no *a priori* division amongst the type of awards. It is expected that Data Upgrades will be for up to $50K for one year and Resident Archives up to $50K per year for four years. Value Added Services will typically be $100K to $150K per year for up to four years. Higher funding will be considered in each case, with sufficient justification for truly unusual cases. For equally rated proposals, data oriented proposals (RAs and Upgrades) will take precedence over ones that are service oriented. It should be noted that although the allotment for RAs is up to $50K, it will not be practical to support each instrument on all the NASA HP missions as they retire at this level; efforts should be made to use economies of scale (e.g., combining with

[4] See http://hpde.gsfc.nasa.gov/ and references contained therein for more information on the SPASE Data Model; the direct link is http://www.spase-group.org.

existing or other proposed RAs), the resources of Final Archives, and other means to contain costs.

2.1 Virtual Observatory Value-Added Service Proposals

Proposals in this area will be for periods of performance from one to four years. The number of value-added service proposals awarded will be consistent with available funding and the levels requested in the selected investigations.

A proposal for a value-added service to the VxO infrastructure should include:

- An argument for why the service is scientifically important to a broad range of at least one Heliophysics VxO community.
- Evidence that the service is new and will likely be used, with use cases and supporting evidence.
- A clear link to the HP Data Environment and in particular the details of how the service will inherently use the capabilities of one or more VxOs. The relationship of the service to the SPASE data model should also be stated.
- Evidence that the service is required and would not, for example, be better done as a one-time effort by a data provider, and that it is not already being implemented by a VxO or data center.
- An argument for why the service is located at provider sites, VxO sites, some other site(s), or would be a downloadable tool; any or all of the above are possible.
- A demonstration that the service is not dependent on a particular site being available and maintained by a particular group, unless that group is clearly associated with a VxO or other reliably persistent entity (e.g., a NASA data center).
- A plan for implementation of the service that will lead to useful results within the proposed time and that states why the requested resources are necessary and sufficient for success. There should be a clear path for continuation of the service beyond the proposal period through adoption by a VxO or NASA data center, or some other specific means.
- A plan for community input and feedback on the utility and functionality of the service and for the incorporation of the feedback into the development process.

The titles of proposals submitted to this portion of the solicitation must contain the words “Value Added Services for VxOs.” The Scientific/Technical Management Section (including figures) of proposals submitted to this portion of the solicitation should be no more than 15 pages.

2.2 Data Services Upgrades Proposals

Funding in this area is intended to support small, short-term (1 year) awards to improve the quality, utility, and accessibility of datasets relevant to heliophysics research. Note that priority will be given to those proposals from data providers of NASA-sponsored datasets, but other data relevant to HP research will be considered.

A proposal for a Data Services Upgrade should include explicit discussion of each of the following points:

- A clear description of the products to be produced, including the time span covered, the physical quantities to be included, and the format(s), coordinate system(s), and processing level(s) (e.g., calibrated in physical units or not, the former being far preferable).
- An argument for why the datasets involved were scientifically useful in the past, and for how the proposed upgrade will make them more useful in the future. Specific research projects should be mentioned, along with an assessment of whether these will bring qualitatively new insights. This should be supported by, e.g., refereed publications or other citations and uses by people outside the original PI team.
- A demonstration that the proposed upgrade represents a significant improvement in the quality and/or utility of the data, its format, and/or its accessibility.
- The current status of the data and a demonstration that the data can still be retrieved from their current storage medium.
- A statement of the current data volume, the expected data volume after processing, and the fraction of the data expected to be recovered.
- A plan for providing required metadata and ancillary data and descriptions needed for independent scientific usability. A statement of the relationship of the metadata provided to the SPASE data model.
- A discussion of how the resource will be used by VxOs.
- A discussion that demonstrates that the requested resources are necessary and sufficient for success in achieving the proposed upgrade.

The titles of proposals submitted to this portion of the solicitation must contain the words "Data Services Upgrade." The Scientific/Technical/Management section (including figures) of proposals submitted to this portion of the solicitation should be no more than 5 pages.

2.3 Data Services Continuation Proposals

Funding will support modest awards for up to 4 years to continue existing data services, in "resident archives." A Resident Archive (RA[5]) will be created to continue to serve mission data or a subset of a mission's data (e.g. data products for a single instrument) after the mission has ended. This arrangement is intended to keep those most familiar with the data and its caveats involved such that a user will have access to expert assistance in using the data for research. There is no restriction (other than those for this solicitation) on who can apply for an RA for a particular set of products or on possible arrangements with other RAs or data centers.

A Data Services Continuation proposal should include:

- A statement of the scope of the RA, including the data products and services to be included.
- Arguments for why the data should still be served by the PI team or a closely associated team knowledgeable about the data, rather than deposited in a Final Archive. These should demonstrate the science value of the data to qualitatively significant ongoing or

[5] More information on the topic of Heliophysics Resident Archives may be found in the *Heliophysics Science Data Management Policy*, especially Appendix F.

future investigations as indicated, e.g., by refereed publications, specific research project suggestions, and the use of the data by researchers outside the original team.

- A description of how the RA will ensure that the mission data are served to the general community in an efficient and scientifically useful manner consistent with the community data environment guidelines. While level zero data plus on-the-fly processing may be used for serving, it is expected that a set of “legacy products” in physical units and accessible formats will also be available and served.
- A plan to maintain the integrity of the data by safeguarding against data loss; this could be achieved by a number of approaches, including the use of mirror sites, backup storage at the National Space Science Data Center (NSSDC) or elsewhere, as well as with such tools as checksums.
- A statement of the relationship of the RA to one or more of the VxOs and of the relationship of the proposed or existing metadata to the SPASE data model.
- A statement of the type and amount of expert assistance with data issues to be provided.
- An inventory of documentation to be provided for data, calibration, and validation methods; and for the mission, observatory, and instrument(s), along with a demonstration that these are adequate to assure the data will be independently usable.
- Considerations of potential cost-savings and increased utility through collaboration with others, including other investigator teams, existing or proposed RAs, NASA data centers, or other data centers.
- A plan to obtain community input to ensure success and make improvements.
- A plan to make sure the data will be archived and available after the RA is no longer deemed useful or cost effective (i.e., a plan for transfer to another RA or a Final Archive, as defined in the data policy).
- A demonstration that the resources requested will be necessary and sufficient to perform the RA functions. Proposals are expected to make use of economies of scale, when appropriate, by combining related serving functions across related data products (related by, e.g., mission, data type, institution, personnel, etc.).

Activities that are not to be proposed for a Resident Archive would be the generation of significant upgrades to the datasets, reprocessing data, upgrading data processing algorithms, or providing new data products derived from the resident data. These types of postmission data activities need to be funded from other sources (in some cases, this could be through a separate Data Services Upgrade). On the other hand, a function of a resident archive could include “loading” newly derived data products into the archive with appropriate changes to metadata, documentation, web interfaces, etc.

The proposal should maintain reserves such that, if the Data Services Continuation award is not renewed or is subsumed under another RA structure, the RA would transfer the data to the other RA or a Final Archive. The RA proposal should include a plan for such transfer to a Final Archive in a manner that will still allow basic data access to at least the basic legacy data files.

The titles of proposals submitted to this portion of the solicitation must contain the words “Data Services Continuation.” The scientific/technical/management section (including figures) of proposals submitted to this portion of the solicitation should be no more than 10 pages.

2.4 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	$700K
Number of new awards pending adequate proposals of merit	Depends on the nature of the submitted proposals: as many as 10.
Maximum duration of awards	See Section 2.
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	See Sections 2.1, 2.2, and 2.3. See also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the heliophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-HDEE
NASA point of contact concerning this program	Dr. Jeffrey J.E. Hayes Heliophysics Division Science Mission Directorate NASA Headquarters Washington DC 20546-0001 Telephone: (202) 358-0353 E-mail: HQ-HDEE@mail.nasa.gov

APPENDIX C. PLANETARY SCIENCE RESEARCH PROGRAM

C.1 OVERVIEW

The Planetary Science Research Program supports investigations of all classes of objects in the Solar System, except those focused on the Earth and Sun, consistent with the strategy for Solar System Exploration embodied in the *Solar System Roadmap 2006* (available at http://solarsystem.nasa.gov/multimedia/downloads.cfm). A proposal submitted to any of the following programs in this section must present, within its scientific/technical/management section, a clear description of a specific scientific problem, a description of how the attack on this problem will be carried out, and a discussion of the relevance of the proposed research to NASA's current and/or future programs. Proposals whose intent or purpose is to extend or directly supplement investigations already selected for approved space flight missions are not appropriate for this NRA, and investigators who are members of science teams of ongoing missions must delineate clearly between their mission responsibilities and any research efforts proposed through this NRA. Furthermore, proposals that include analysis of data from planetary division space flight missions must use publicly available data released through the Planetary Data System (PDS) at http://pds.jpl.nasa.gov/. Proposals that utilize any data from planetary division space flight missions, in any amount, that is not yet publicly available on the PDS will not be considered.

Changes in the Planetary Science Research Program for the ROSES-2010 solicitation are summarized below:

1. The In-Space Propulsion program will be solicited in 2010.
2. The Mars Instrument Development Project (Appendix C.14) and the Mars Technology Project (Appendix C.15) are on hold pending programmatic decisions to be made in the first quarter of 2010.
3. The Astrobiology Science and Technology Instrument Development (ASTID) program (Appendix C.19) and the Astrobiology Science and Technology for Exploring Planets (ASTEP) program will be solicited in 2010.
4. The Dawn at Vesta Participating Scientist (DAVPS) program will not be solicited in 2010.

A brief description of each program element offered in the Planetary Science Research Program is given below. The intent of these summary statements is to give the prospective proposer a brief overview. A detailed description of the types of research supported by each program element can be found in the Scope of Program section of the respective program element description.

The Cosmochemistry program supports investigations of a variety of extraterrestrial materials (meteorites, cosmic dust, and lunar samples) that are aimed at understanding the geochemistry of the Solar System bodies (planets, satellites, including the Earth's Moon, and small Solar System bodies). (Appendix C.2)

The goal of the Laboratory Analysis of Returned Samples (LARS) program is to maximize the scientific return from extraterrestrial samples from NASA missions and to develop laboratory instrumentation and advanced analytical techniques. (Appendix C.3)

The Planetary Geology and Geophysics (PGG) program supports scientific investigations of the planetary surfaces and interiors, satellites (including the Moon), satellite and ring systems, and smaller Solar System bodies such as asteroids and comets. (Appendix C.4)

The NASA Planetary Astronomy (PAST) program will continue to support both ground-based astronomical observations and suborbital investigations involving sounding rockets, balloons or reusable sub-orbital vehicles. Proposals are solicited for observations over the entire range of wavelengths from the ultraviolet to radio that contribute to the understanding of the general properties and evolution of the Solar System, its planets, their satellites, and of asteroids and comets. (Appendix C.5)

The Planetary Atmospheres (PATM) program supports scientific investigations that contribute to the understanding of the origins and evolution of the atmospheres of planets and their satellites and of comets. Its broad objectives include the determination of compositions, dynamics, energetics, and chemical behaviors of planetary atmospheres. (Appendix C.6)

The Outer Planets Research (OPR) program supports diverse scientific investigations that contribute to the understanding of the giant planets in the outer Solar System, as well as the smaller solid bodies including comets, asteroids, and the Kuiper Belt. This now also includes what was in the Jupiter Data Analysis program: Jupiter science data obtained by the New Horizons spacecraft, as well as the Voyager, Galileo, and Cassini spacecraft. (Appendix C.7)

The goal of the Lunar Advanced Science and Exploration Research (LASER) program is to support and enhance lunar basic science and lunar exploration science as part of the Vision for Space Exploration’s return to the Moon initiative. (Appendix C.8)

The Near Earth Object Observation (NEOO) program supports investigations whose primary objectives are to inventory and characterize the population of NEOs which may represent a hazard for impacting the Earth with the potential to significantly affect its climate and biosphere. (Appendix C.9)

The objective of the Cassini Data Analysis program (CDAP) is to enhance the scientific return of the Cassini mission by broadening the scientific participation in the analysis and interpretation of the data returned by the mission. (Appendix C.10)

The objective of the Planetary Mission Data Analysis program (PMDAP) is to enhance the scientific return of completed Planetary Science Division missions by broadening the scientific participation in the analysis of data and samples collected by those missions. The PMDAP is intended to complement and not to overlap other active data analysis programs, e.g., Mars Data Analysis program (MDAP), CDAP, and OPR. (Appendix C.11)

The objective of the Mars Data Analysis program (MDAP) is to enhance the scientific return from the Mars Pathfinder, Mars Global Surveyor, Mars Odyssey, and Mars Exploration Rover missions by broadening scientific participation in the analysis of their respective data sets and to fund high-priority areas of research that support planning for future Mars missions. (Appendix C.12)

The Mars Fundamental Research program (MFRP) seeks to sponsor the best and most innovative scientific research concerning atmospheric, climatological, and geologic processes on Mars and offers opportunities for Mars research beyond that available from analysis of spacecraft data alone. (Appendix C.13)

The Mars Instrument Development Project (MIDP) is on hold pending programmatic decisions to be made in the first quarter of calendar year 2010. It is not expected that proposals for MIDP will be solicited this fiscal year.. (Appendix C.14)

The Mars Technology Project (MTP) is on hold pending programmatic decisions to be made in the first quarter of calendar year 2010. It is not expected that proposals for MTP will be solicited this fiscal year.. (Appendix C.15)

The Planetary Instrument Definition and Development program (PIDDP) supports the advancement of spacecraft-based instrument technology that shows promise for use in scientific investigations on future planetary missions. (Appendix C.16)

The goal of NASA's Astrobiology: Exobiology and Evolutionary Biology program is to understand the origin, evolution, distribution, and future of life in the Universe. Research is centered on the origin and early evolution of life, the potential of life to adapt to different environments, and the implications for life elsewhere. (Appendix C.17)

Planetary Protection Research (PPR) is aimed at the numerous areas of research in exobiology that have implications for the prevention of contamination of extraterrestrial environments by terrestrial organisms carried by spacecraft launched from Earth and, conversely, for understanding the potential hazards associated with possible extraterrestrial organisms that could be brought to Earth by sample-return missions. Research is required to allow NASA to understand the potential for both forward and backward contamination, as well as to set standards in these areas for spacecraft preparation and operating procedures and for returned-sample analysis. (Appendix C.18)

The Astrobiology Science and Technology Instrument Development (ASTID) program element requests proposals to develop instrumentation capabilities that will help meet Astrobiology science requirements on future space flight missions, as well as unique Astrobiology science objectives on Earth. (Appendix C.19)

The Astrobiology Science and Technology for Exploring Planets (ASTEP) program solicits proposals for investigations to explore the Earth's extreme environments in order to develop a sound technical and scientific basis to search for life on other planets. (Appendix C.20)

The In-Space Propulsion (ISP) program solicits promising propulsion-system approaches (solid, liquid, etc) that can achieve TRL-6 within 3 years with a premium placed on 1) minimizing the overall mass of the Mars Ascent Vehicle and associated support systems on the MSR lander, and 2) minimizing both development and flight risks. While the proposed solutions must, at a minimum, be applicable to the conceptualized Mars Sample Return mission, technologies that are applicable to sample return missions from additional non-terrestrial bodies are highly desirable. (Appendix C.21).

The Moon and Mars Analog Missions Activities (MMAMA) program addresses the need for integrated interdisciplinary field experiments as an integral part of preparation for planned human and robotic missions to the Moon and Mars. The focus will be on providing high-fidelity scientific investigations, scientific input, and science operations constraints in the context of planetary field campaigns. Funding provided in this program element is intended to enable researchers to conduct scientific investigations and integrate their instruments, projects, and/or protocols into field activities designed to help NASA plan for future exploration of the Moon, Mars, and other planetary bodies with both robots and humans (Appendix C.24)

The Origins of Solar Systems program solicits basic research proposals to conduct scientific investigations related to understanding the formation and early evolution of planetary systems and to provide the fundamental research and analysis necessary to detect and characterize other planetary systems. These investigations may involve analytical and numerical modeling, laboratory research, and observational studies in the following areas: star formation and the relationship to planetary system formation, solar nebula processes, accumulation and dynamical evolution, analysis of primitive materials, and the detection and characterization of other planetary systems. (Appendix E.3).

The Fellowships for Early Career Researchers have been established to facilitate the integration of new Planetary Science Division researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (*i.e.*, tenure-track, civil servant, or equivalent) position. (Appendix C.22) Participation is limited to proposers to the following Planetary Science Division science research programs offered in this solicitation:

- Cosmochemistry (Appendix C.2);
- Planetary Geology and Geophysics (Appendix C.4);
- Planetary Astronomy (Appendix C.5);
- Planetary Atmospheres (Appendix C.6);
- Outer Planets Research (Appendix C.7);
- Lunar Advanced Science and Exploration Research (Appendix C.8);

- Near Earth Object Observations (Appendix C.9);
- Planetary Mission Data Analysis (Appendix C.11);
- Mars Data Analysis (Appendix C.12);
- Mars Fundamental Research (Appendix C.13);
- Astrobiology: Exobiology and Evolutionary Biology (Appendix C.17);
- Astrobiology Science and Technology for Instrument Development (Appendix C.19); and
- Astrobiology Science and Technology for Exploring Planets (Appendix C.20).

The Planetary Major Equipment (PME) program allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by investigations sponsored by the following Planetary Science Division's science research programs offered in this solicitation:

- Cosmochemistry (Appendix C.2);
- Laboratory Analysis of Returned Samples (Appendix C.3);
- Planetary Geology and Geophysics (Appendix C.4);
- Planetary Astronomy (Appendix C.5);
- Planetary Atmospheres (Appendix C.6);
- Outer Planets Research (Appendix C.7);
- Lunar Advanced Science and Exploration Research (Appendix C.8);
- Near Earth Object Observations (Appendix C.9);
- Mars Fundamental Research (Appendix C.13);
- Astrobiology: Exobiology and Evolutionary Biology (Appendix C.17); and
- Origins of Solar Systems (Appendix E.3).

New instrumentation may also be proposed. Planetary Major Equipment proposals may be submitted <u>only</u> in conjunction with new science research proposals to this solicitation <u>or</u> as an augmentation to planetary science multiple year awards. (Appendix C.23)

C.2 COSMOCHEMISTRY

1. Scope of Program

The Cosmochemistry Program supports investigations of extraterrestrial materials that are aimed at understanding the geochemistry of the Solar System bodies (planets, satellites, including the Earth's Moon, and small Solar System bodies). The goal of this program is to support research projects that increase the understanding of the chemical origin of the Solar System and the processes by which its planets and small bodies have evolved to their present states. NASA is particularly interested in proposals for sample-focused research projects that closely support its missions for exploring the Solar System or that contribute to the development of future missions. Individual investigations may contribute new data, analyze and synthesize existing data, or combine both kinds of activities.

Examples of the kinds of research supported by this program include:

- Measurements of mineral compositions, major and trace element chemistry, isotopic compositions, radiometric ages, magnetism, or radiation exposure effects;
- Petrologic studies of extraterrestrial materials;
- Laboratory studies of phase stability, chemical partitioning, and other processes necessary to interpret planetary data; and
- Synthesis of previously obtained geochemical data.

Although no priorities are imposed on the general kinds of investigations, an ideal program is envisaged as a balance among them, consistent with the quality of submitted proposals and their relevance to the current Cosmochemistry Program.

This program might also support certain types of research on terrestrial analog samples, when such efforts contribute to overall program goals in cosmochemistry. Terrestrial research should address key geochemical processes in early planetary evolution, terrestrial history in terms of general Solar System processes, or the reasons for differences in evolution among the various planetary bodies, including Earth, the Moon, and parent bodies of meteorites. Proposals to analyze terrestrial samples should clearly explain the nature of the planetary connection, since this will be a key factor in ascertaining the relevance of such proposals for selection for this program.

Proposals for topical conferences, workshops, or symposia related to the Cosmochemistry program may also be proposed through this solicitation. Proposers are encouraged to review the guidelines found on page 3 of the SMD memo on Priorities for Conference Spending of April 27, 2009, which can be found at http://nasascience.nasa.gov/researchers/sara/library-and-useful-links/SMD2009memo.pdf

An important goal of the Planetary Science Research Program is to facilitate access to data and extraterrestrial sample material for scientific and educational purposes, in addition to NASA-supported research projects. NASA's Johnson Space Center, Houston, Texas, is responsible for the security of and access to all returned extraterrestrial samples, as well as the interplanetary dust particles collected by high-altitude aircraft and the meteorites collected in the Antarctic by field parties supported by the National Science Foundation (NSF). For information on how to obtain any of the specimens in these collections, see http://curator.jsc.nasa.gov/ or contact:

Office of the Curator
Code KT
Johnson Space Center
National Aeronautics and Space Administration
Houston, TX 77058-3696

2. Programmatic Considerations

2.1 Instrumentation: Construction or Upgrade

The Planetary Major Equipment program described in Appendix C.23 of this NRA allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by investigations for certain programs sponsored by the Planetary Science Research Program, including this one. New analytical instrumentation requests, as well as requests for upgrades to existing instruments, costing more than $25,000, should be identified and requested in a special section of the proposal that is to be titled "Major Equipment Request." However, note that a Planetary Major Equipment proposal must be affiliated with a “parent” NASA Planetary Science Division research proposal in order to be considered for selection; see Appendix C.23 for details.

2.2 Early Career Researchers

Early career researchers are encouraged to apply for the Early Career Fellowships (see Appendix C.22 in this NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (i.e., tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Early Career Fellowships.

2.3 NASA Provided High-End Computational (HEC) Facilities

Those investigators whose research requires high-performance computing should refer to the *ROSES Summary of Solicitation*, Section I(d), “NASA-provided High-End Computing Resources.” This section describes the opportunity for successful proposers to the Cosmochemistry Program to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center’s Computational and Information Sciences and Technology Office or at the Ames Research Center’s Advanced Supercomputing Division.

2.4 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $5M
Number of new awards pending adequate proposals of merit	~ 30-50
Maximum duration of awards	4 years (or 5 years for programs of exceptional merit and breadth where 4 years is demonstrated to be insufficient)
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2011
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-COS
NASA point of contact concerning this program	Dr. Jeffrey Grossman **[Changed March 30, 2010]** Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1218 E-mail (Preferred): HQ-Cosmo@mail.nasa.gov

C.3 LABORATORY ANALYSIS OF RETURNED SAMPLES

Clarified on April 5, 2010: Section 3 of this Appendix has been clarified in an attempt to remove the apparent overlap with Appendix C.23, the Planetary Major Equipment program, for which LARS awardees are now eligible.

1. Scope of Program

The goal of the Laboratory Analysis of Returned Samples (LARS) Program is to maximize the scientific return from the samples provided by missions such as Genesis and Stardust (see further below) through development of laboratory instrumentation and advanced analytical techniques required for the complete analyses of the samples they return. In addition, this program supports analytical work on samples returned by recent Planetary Science Division missions, including Genesis and Stardust.

Proposals solicited under this program include those that seek to develop new analytical instrumentation or combinations of analytical instruments, or new components of analytical instruments, leading to significant improvements in the precision, resolution, or sensitivity of measurements compared to the existing state of the art. Also of interest are proposals for the development of new analytical techniques for existing instrumentation that will push the limits of current technology, for example, by the elimination of analytical interferences or contamination problems. In all cases, both the development efforts and the clear relevance to recent, current, or in-development NASA sample-return missions must be clearly documented in the proposals.

Some proposals may seek to develop instrumentation and techniques that will be used by only a small number of investigators at a single institution. However, in other instances, the high cost of the instrument and its associated support structure may allow the development of only a limited number of such facilities that must be shared by the entire research community. For these larger and more expensive facilities, proposers should include detailed plans for facility management based on the size of the anticipated user base, including facility oversight, the fraction of time that will be made available to outside users, and the mechanism for allotting such time on a regular basis. In all cases, cost-sharing arrangements in the development of new instrumentation or techniques and evidence of a long-term institutional commitment to the analysis of returned samples will be viewed favorably in the selection process. Collaborations between instrument builders and scientists who understand the samples to be analyzed are encouraged. Ongoing laboratory support (e.g., service contracts) will generally not be supported.

This program supports analysis of extraterrestrial samples from sample return missions, with the exception of lunar samples, whose analysis is supported by LASER (Appendix C.8) and Cosmochemistry (Appendix C.2). Also excluded from LARS, but included in the Cosmochemistry program, are analyses of meteorites or cosmic dust, unless these analyses are directly in support of the interpretation of mission data.

Returned samples from NASA planetary science missions are allocated by the Astromaterials Curator at Johnson Space Center after approval by CAPTEM and NASA Headquarters. If your proposal requires the use of any returned material, such as that from Genesis or Stardust, please review the information at http://curator.jsc.nasa.gov/ and make a request to the Astromaterials Curator, as described.

2. Background

Genesis is a mission designed to return samples of the solar wind to provide constraints on the chemical and isotopic composition of the primitive solar nebula; it was launched in mid-2001 and returned samples to Earth on September 8, 2004. Further information may be found from the mission homepage at http://genesismission.jpl.nasa.gov/. Failure of the parachute system led to a hard landing in the Utah desert, and many of the fragile collectors were shattered on impact and contaminated. Intensive effort is underway by the Genesis science and curation teams to document the chips of collector materials and to measure and remove contamination from the chips. For information on availability of samples, check the curator's website at http://curator.jsc.nasa.gov/.

Stardust, a mission to return samples of a comet's coma, was successfully launched in 1999 and encountered comet Wild 2 in January 2004; it successfully returned its samples to Earth in January 2006. The dust grains that impacted the silica aerogel collectors during a 6.1 km/sec flyby were all small (<100 µm) and fine-grained. In most cases the particles fragmented on impact and interacted strongly with the aerogel. For example, many particles are coated and sometimes penetrated with compressed or melted aerogel. Many particles impacted on the sample collector frame, and work on particle residues in impact craters in the aluminum foils that separated the aerogel cells is also solicited. The aft-facing side of the collector was designed to collect interstellar dust particles, which are expected to be ~0.1 µm in size and to have impacted at more than 20 km/sec. Examination of this interstellar collector is extremely challenging (see http://stardustathome.ssl.berkeley.edu/). In addition to investigations involving direct analysis of Stardust materials, proposals to investigate the details of the capture process are solicited. Further information may be found from the mission homepage at http://stardust.jpl.nasa.gov/ and the curator's website at http://curator.jsc.nasa.gov/.

3. Supplemental Funding for Additional Instrumentation

The Planetary Major Equipment program described in Appendix C.23 of this NRA allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by ground-based investigations for certain programs sponsored by the Planetary Science Research Program, including this one. Analytical instrumentation requests **not already covered by the LARS program**, as well as requests for upgrades to existing instruments, costing more than $25,000, ~~should~~ **may also** be identified and requested in a special section of each proposal, to be titled "Major Equipment Request." However, note that a Planetary Major Equipment proposal must be affiliated with a "parent" SMD research proposal in order to be considered; see Appendix C.23 for details. **[Clarified April 2, 2010]**

4. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental

Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

5. Summary of Key Information

Expected program budget for first year of new awards	~$5M
Number of new awards pending adequate proposals of merit	~ 20-30
Maximum duration of awards	4 years; shorter term proposals are encouraged for instrument development tasks.
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2011
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-LARS

NASA point of contact concerning this program	Dr. Jeffrey Grossman **[Changed March 30, 2010]** Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1218 Email (Preferred): HQ-LARS@mail.nasa.gov

C.4 PLANETARY GEOLOGY AND GEOPHYSICS

1. Scope of Program

The Planetary Geology and Geophysics (PGG) program supports scientific investigations of planetary surfaces and interiors, satellites (including the Moon), satellite and ring systems, and smaller Solar System bodies such as asteroids and comets. The goals of the PGG program are to foster the synthesis, analysis, and comparative study of data that will improve the understanding of the extent and influence of planetary geological and geophysical processes on the bodies of the Solar System.

Planetary spacecraft mission data to be used in proposed investigations must be available in the Planetary Data System (PDS) or similar publicly accessible archive at least 30 days prior to the PGG proposal submission date.

Supported research projects involve analysis and synthesis of existing data to investigate geological and geophysical processes and phenomena observed on natural objects within the Solar System. Types of research solicited by this program include:

- Use of reduced, calibrated, publicly available data from planetary missions or ground-based observational databases to address geological or geophysical questions on specific Solar System objects;
- Photogeologic analysis and geologic interpretation of planetary surfaces;
- Mineralogical, lithological, and geologic mapping of planetary surfaces;
- Theoretical and dynamical modeling applied to geologic and geophysical processes on specific Solar System objects;
- Development and production of cartographic products from planetary datasets;
- Generation of new data in a laboratory or field environment;
- Experimental studies of materials under conditions relevant to specific objects in the Solar System;
- Dynamical evolution of specific planets, satellites, small Solar System bodies, or ring systems;
- Geologic field studies of terrestrial analogs to planetary features or phenomena in the context of providing a better understanding of those planetary features or phenomena; and/or
- Combinations of the activities listed above.

Examples of the type of research supported by this program and abstracts for currently funded investigations are available online at http://nspires.nasaprs.com/. Proposals to study or develop flight instruments, to study future planetary missions, to perform ground-based observations, to perform astrometric measurements and models, or to study extra-solar objects are not solicited by this program.

Investigators funded by current spacecraft missions who wish to apply to the PGG Program must clearly demonstrate that their proposed investigation will use only released and publicly available data. Such investigators must scrupulously comply with the 30-days-prior-to-submission rule (above). Additionally, mission-funded investigators must demonstrate clearly how the proposed PGG research does not overlap and is non-redundant with data analysis duties or responsibilities already funded within their respective mission(s). Lunar investigations are appropriate for PGG if it is demonstrated that they have general application to comparative planetology or study of processes common to terrestrial bodies. For purely lunar science, consider submitting to the Lunar Advanced Science and Exploration Research (LASER) program (Appendix C.8).

Proposed investigations of any planetary or satellite surface that are intended, as a by-product of the scientific research, to produce a geologic map suitable for publication by the U.S. Geological Survey (USGS) should check the relevant box on the proposal *Cover Page* and clearly indicate this intention in the *Proposal Summary,* as well as in the text of the proposal. Information on geologic maps that have been produced or are currently in production may be obtained from Dr. Kenneth Tanaka of the USGS at ktanaka@usgs.gov, or at http://astrogeology.usgs.gov/DataAndInformation/ImagesAndMaps/. Investigators who choose to produce a geologic map as a USGS product will be required to follow newly implemented guidelines for the production and submission of digital products, including the generation of maps that are compatible with Geographic Information System (GIS) software packages, and by providing graphical files compatible with Adobe Illustrator for review and edit (effective January 2011). To support this requirement, beginning in 2009, the USGS will provide mapping base materials in GIS project form which will contain the projected, geographically rectified, and scaled mapping base or mosaic, other useful spatially registered datasets; and released image footprints with web links if available. Investigators selected to publish USGS geologic maps will be expected to review geologic maps generated by other planetary mappers. Investigators proposing to produce a map may request support to perform two planetary geologic map reviews and for GIS training courses.

Investigations that produce new data may be of wide scientific interest. Therefore, it is expected that these data sets would, after a reasonable amount of time, be archived within the NASA Planetary Data System (PDS). Contact R. E. Arvidson (PDS Geoscience Node) for further information regarding the types of data sets that might be of interest for archiving purposes (email: arvidson@wunder.wustl.edu, or telephone: (314) 935-5609).

2. Experimental Facilities Available for the PGG Program

The following facilities are available to investigators supported by the PGG program. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled *Facilities and Equipment*). Also note that, to meet the requirements in Section 2.3 of the *NASA Guidebook for Proposers*, a letter of support will be required from any facility necessary for the proposed effort.

- Planetary Aeolian Facility. The Planetary Aeolian Facility at the NASA Ames Research Center consists of wind tunnels to simulate atmosphere-surface interactions on Earth, Mars, and Venus.

For more information contact:

Dr. Ronald Greeley
Department of Geology
Box 871404
Arizona State University
Tempe, AZ 85287-1404
Telephone: (480) 965-7045
Email: greeley@asu.edu

- Reflectance Experiment Laboratory (RELAB). The RELAB facility at Brown University provides a mechanism for researchers to obtain laboratory spectra of geologic materials for use in compositional and/or geologic applications. NASA supports the RELAB as a multiuser spectroscopy facility. Laboratory time can be made available at no charge to investigators funded by NASA programs. If the proposed research requires new spectra in the VIS/NIR or mid IR, the scope and justification must be provided in the proposal. Information on this facility, a *RELAB User's Manual* and sample submittal forms, and access to RELAB spectroscopy data can be found at: http://www.planetary.brown.edu/relab/

  For assistance contact:

Dr. Carlé M. Pieters
RELAB Science Manager
Department of Geological Sciences
Box 1846
Brown University
Providence, RI 02912-1846
Telephone: (401) 863-2417
Email: Carle_Pieters@brown.edu

- NASA Ames Vertical Gun Range (AVGR). The NASA AVGR is a national facility funded by the NASA Science Mission Directorate (SMD) to enable investigations of impact phenomena and processes. Exploratory or proof-of-concept programs requiring a limited number of experiments can be accommodated at no cost. More extensive programs are subject to review in order to assess feasibility and cost effectiveness.

  For more information, potential users of the AVGR should contact:

Dr. Peter Schultz
Department of Geological Sciences
Box 1846
Brown University
Providence, RI 02912-1846
Telephone: (401) 863-2417
Email: peter_schultz@brown.edu

- NASA Provided High-End Computational (HEC) Facilities

  Those investigators whose research requires high performance computing should refer to the *ROSES Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to the Planetary Geology and Geophysics program to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at the Ames Research Center's Advanced Supercomputing Division.

3. Data Sources Available for the PGG Program

Prospective proposers should be aware of sources for data that might be used in their research and whether the required data are available. Useful contacts for making these determinations are given below:

- General Lunar and Planetary Information. The Lunar and Planetary Institute (LPI) is the most concentrated and readily accessible source of information in lunar and planetary science. Information about its services can be found on the LPI home page at http://www.lpi.usra.edu/ and/or contact:

  Dr. Stephen Mackwell
  Director, The Lunar and Planetary Institute
  3600 Bay Area Boulevard
  Houston, TX 77058-1113
  Telephone: (281) 486-2128
  Email: mackwell@lpi.usra.edu

- Data from Completed NASA Flight Programs. The National Space Science Data Center (NSSDC) archives digital and other data from completed flight experiments. Such data include lunar and planetary photographs, digital planetary images, data from numerous flight experiments, and lunar cartographic products. Investigators are responsible for acquiring the data needed for their proposal. Modest requests for imaging and nonimaging data are free of charge, while charges will be made for large requests. Requests from U.S. investigators for data products and information may be made to:

  National Space Science Data Center
  Code 633.4
  Goddard Space Flight Center
  National Aeronautics and Space Administration
  Greenbelt, MD 20771-0001
  Telephone: (301) 286-6695.

Requests from non-U.S. investigators for NSSDC data products and product availability information may be made to:

World Data Center for Rockets and Satellites
Code 633
Goddard Space Flight Center
National Aeronautics and Space Administration
Greenbelt, MD 20771-0001
Telephone: (301) 286-6695

- Planetary Cartographic Products. A variety of planetary cartographic products such as topographic, orthophoto, geological, and other special maps and geodetic information are available. Requests from NASA-funded investigators for production of special maps or other cartographic materials will be accommodated when possible. Request available data or specific maps from:

  USGS Information Services
  Box 25286
  Denver, CO 80225
  Telephone: (888) 275-8747
  http://ask.usgs.gov/to_order.html

  Request information related to the availability of base maps and materials or U.S. Geological Survey criteria for map publication through http://astrogeology.usgs.gov/DataAndInformation/ImagesAndMaps/ and/or

  Data Manager
  Regional Planetary Information Facility
  Astrogeology Research Program
  U.S. Geological Survey
  2255 North Gemini Drive
  Flagstaff, AZ 86001
  Telephone: (928) 556-7264
  Email: RPIF-flag@usgs.gov

- Regional Planetary Image Facilities. Regional Planetary Image Facilities (RPIFs) contain nearly half a million images of the planets and their satellites taken both from Earth and manned and unmanned spacecraft, as well as topographic and geologic maps produced from these images. The RPIFs, located at institutions worldwide, are intended for use by individuals and groups who use photographic and cartographic materials of the planets and satellites in their research programs. These programs include geologic, photometric, colorimetric, photogrammetric, and atmospheric dynamical studies.

  In addition to the local scientists and their associates who use these data on a daily basis, investigators throughout the world are encouraged to use the RPIFs. Send inquiries to the nearest facility in care of the Director, Regional Planetary Image Facility. Note that, while these centers may be used for on-site study and selection of planetary and satellite images, they are not facilities for the production of photographs for users. Instead, such materials may be obtained from the NSSDC at the NASA Goddard Space Flight Center at the address given above. Additional information, including a listing of RPIF locations worldwide, can be found on the RPIF home page at http://www.lpi.usra.edu/library/RPIF.

- Digital Planetary Image Data. Digital planetary image data are available through the PDS. The Planetary Data System/Imaging Node can be found at http://pds-imaging.jpl.nasa.gov/. Submit requests for imaging data and support documentation to:

  Planetary Data System/Imaging Node
  U.S. Geological Survey
  2255 North Gemini Drive
  Flagstaff, AZ 86001
  Telephone: (928) 556-7053

  The Planetary Data System/Geosciences Node can be found at http://pds.nasa.gov. Requests for other planetary geoscience data may be submitted to:

  Planetary Data System/Geosciences Node
  Washington University
  Campus Box 1169
  One Brookings Drive
  St. Louis, MO 63130
  Telephone: (314) 935-5493

4. Programmatic Information

4.1 Supplemental Funding for Additional Instrumentation

The Planetary Major Equipment program described in Appendix C.23 of this NRA allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by investigations for certain programs sponsored by the Planetary Science Research Program, including this one. New analytical instrumentation requests, as well as requests for upgrades to existing instruments, costing more than $25,000, should be identified and requested in a special section of each proposal, to be titled "Major Equipment Request." However, note that a Planetary Major Equipment proposal must be affiliated with a “parent” Planetary Science research proposal in order to be considered; see Appendix C.23 for details.

4.2 Early Career Researchers

Early career researchers are encouraged to apply for the Early Career Fellowships (see Appendix C.22 in this NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science Division discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (e.g., tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Early Career Fellowships.

4.3 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

5. Summary of Key Information

Expected program budget for first year of new awards	~ $3.0M
Number of new awards pending adequate proposals of merit	~ 35
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	~6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)

Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-PGG
NASA point of contact concerning this program	Dr. Michael S. Kelley Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0607 E-mail: HQ-PGG@mail.nasa.gov

C.5 PLANETARY ASTRONOMY

1. Scope of Program

The NASA Planetary Astronomy program for ROSES-2010 includes support for both ground-based astronomical observations and suborbital investigations involving sounding rockets and balloons. Proposals are solicited for observations over the entire range of wavelengths from the ultraviolet to radio that contribute to the understanding of the general properties and evolution of the Solar System, its planets, their satellites, and of asteroids and comets.

1.1 Ground-based Observations

The investigations proposed to this portion of the program must contain an element of new observation and must support those NASA Solar System program objectives that cannot be met by current spacecraft missions or that directly support specific current flight missions. Ground-based observations that supplement NASA missions returning significant amounts of data within the next three years are especially encouraged. Such observations may be made at any currently operating ground-based facility, public or private, including those supported by NASA.

Proposals to this part of the program will usually be for a duration of 3 years, but may be up to 5 years in duration. However, the justification for a duration longer than 3 years will be used in determining the duration of any award, should the proposal be selected.

Proposals that utilize newly obtained data from large surveys, or other sources where the data is obtained in a routine manner for general use, should include a member of the data collection team as a Co-Investigator or as a Collaborator in order to meet the requirement for an element of new observation.

1.2 Suborbital Flight Investigations

This Planetary Astronomy category supports science investigations and technology development utilizing payloads flown on sounding rockets, balloons or reusable suborbital vehicles. Suborbital payloads may be recovered, refurbished, and reflown, in order to complete an investigation. A discussion of the plans for management and for reduction and analysis of the data should be given. Proposals may request durations of up to five years.

Suborbital investigations provide unique opportunities not only for executing intrinsically meritorious science investigations, but also for advancing the technology readiness levels of future space flight detectors and supporting technologies, and for preparing future leaders of NASA space flight missions, such as junior researchers and graduate students. For suborbital proposals, specific factors that will be considered when evaluating a proposal’s intrinsic merit are the scientific merit, the degree to which it advances the technology readiness level of a detector or supporting technology, and the degree to which it advances the readiness of junior researchers or graduate students to assume leadership roles on future NASA space flight missions.

Budgets are expected to cover complete investigations, including payload development and construction, instrument calibration, launch, and data analysis. The number of investigations that can be supported is limited and heavily dependent on the funds available to this program. Note that NASA does not carry reserves to accommodate any cost overrun incurred by a particular investigation, including the loss of the payload owing to a rocket or balloon system failure. Therefore, failure to achieve the proposed goals within the proposed time and budget could require either descoping the initially proposed investigation, delaying it, canceling a particular launch date opportunity, or canceling the investigation altogether. Note: Proposers may wish to refer to the established suborbital program under the Astrophysics Research and Analysis (APRA) program (Appendix D.3, Section 1.2.2 of this NRA) for more insight on conducting this type of investigation.

2. Programmatic Information

2.1 Supplemental Funding for Additional Instrumentation

The Planetary Major Equipment program described in Appendix C.23 of this NRA allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by ground-based investigations for certain programs sponsored by the Planetary Science Research Program, including this one. New, analytical instrumentation requests, as well as requests for upgrades to existing instruments, costing more than $25,000, should be identified and requested in a special section of each proposal, to be titled "Major Equipment Request." However, note that a Planetary Major Equipment proposal must be affiliated with a “parent” SMD research proposal in order to be considered; see Appendix C.23 for details.

2.2 Proposals Utilizing Goldstone Planetary Radar

Proposals intending to use the planetary radar capabilities of the Deep Space Network Goldstone complex must contact the JPL Goldstone Solar System Radar (GSSR) Task Manager listed below for information on costs associated with using the Goldstone radar which must be included in the proposal.

GSSR Task Manager:

Martin Slade
M/S 238-420
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109
Phone: (818) 354-2765
Email: Martin.A.Slade@jpl.nasa.gov

2.3 Proposals for Suborbital Flight Investigations

Owing to the anticipated greater degree of complexity, the scientific/technical/ management section of proposals for a suborbital flight investigation may be 20 pages long instead of the default 15 pages specified in the *NASA Guidebook for Proposers.*

NASA Provided Services

Investigators proposing payloads to be flown on sounding rockets should answer the program-specific questions on the Planetary Astronomy proposal cover pages. This information is needed by the Sounding Rocket Program Office to generate a rough order of magnitude cost estimate for the operational requirements associated with a proposed investigation and is used for planning purposes. The required information includes the envisioned vehicle type, payload mass, trajectory requirements, launch site, telemetry requirements, attitude control or pointing requirements, and any plans for payload recovery and reuse.

Investigators proposing suborbital payloads on rockets or balloons are strongly urged to discuss prospective investigations with operations personnel at the NASA Wallops Flight Facility to ensure that probable operational costs are properly anticipated. Questions concerning potential sounding rocket investigations may be addressed to:

Mr. Philip Eberspeaker
Sounding Rocket Program Office
Code 810
Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-2202
Email: Philip.J.Eberspeaker@nasa.gov

Questions concerning potential balloon-borne investigations may be addressed to:

Mr. David L. Pierce
Balloon Program Office
Code 820
Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-1453
Email: David.L.Pierce@nasa.gov

Commercial Services

Prior to the finalization of ROSES-2010 for release, sufficient technical information on commercial reusable suborbital research (CRuSR) vehicles for writing and evaluating proposals was not available to proposers. Once that technical information is available, ROSES-2010 will be amended to solicit proposals for investigations using CRuSR vehicles through the Planetary Astronomy program.

Additional information on CRuSR vehicles, including technical capabilities, operational constraints, and anticipated costs to researchers, is available at http://suborbitalex.arc.nasa.gov/.

Questions concerning potential use of reusable suborbital vehicles may be addressed to:

Mr. Mike Skidmore
Commercial Reusable Suborbital Research Program Office
Mail Stop 240-10
Ames Research Center
National Aeronautics and Space Administration
Moffett Field, CA 94035
Telephone: (650) 604-6069
Email: Mike.Skidmore@nasa.gov

2.4 Early Career Researchers

Early career researchers are encouraged to apply for the Fellowships for Early Career Researchers (see Appendix C.22 in this ROSES NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science Division discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (*i.e.,* tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Fellowships for Early Career Researchers.

2.5 NASA Provided High-End Computational (HEC) Facilities

Those investigators whose research requires high-performance computing should refer to the *Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to the Planetary Astronomy program to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at the Ames Research Center's Advanced Supercomputing Division.

2.6 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $1.5M
Number of new awards pending adequate proposals of merit	~ 10-14
Maximum duration of awards	Up to 5 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; 20 pp for suborbital proposals (see Section 1.2.2); see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-PAST
NASA point of contact concerning this program	Dr. Philippe Crane Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0716 E-mail: HQ-PAST@mail.nasa.gov

C.6 PLANETARY ATMOSPHERES

1. Scope of Program

The Planetary Atmospheres program supports scientific investigations that contribute to the understanding of the origins and evolution of the atmospheres of planets and their satellites and of comets. Its broad objectives include the determination of compositions, dynamics, energetics, and chemical behaviors of planetary atmospheres. For example, investigations that may be submitted to this program are those that seek to study the sources and mechanisms for deposition of energy; the characterization and understanding of dynamical processes and circulation, both global and local; relationships between currently observed properties and/or states of matter including clouds, particles, and ices; interaction of atmospheres with the solar wind and the effects of magnetic fields both permanent and induced on these processes; interactions of planetary atmospheres with planetary surfaces; and the chemical abundance, physical conditions, and processes that may have prevailed at the time the planets were formed, as they pertain to atmospheres.

Investigations of the atmospheres of extrasolar planets also are included within the scope of this program, provided that they address the same features, properties, and behaviors listed above; however, the astronomical search for extrasolar planets or research primarily directed toward discovering extrasolar planets are not appropriate for the Planetary Atmospheres program, but instead may be proposed to the Origins of Solar Systems program (Appendix E.3 in this ROSES NRA).

The scope of the Planetary Atmospheres activity also includes laboratory investigations that supply basic physical measurements that are currently needed to interpret planetary data, including measurements and calculations of spectroscopic, optical, and thermodynamic properties of materials found in planetary atmospheres. In addition, while comparative studies of various planetary atmospheres (including the Earth) are appropriate, investigations that focus primarily on the Earth's atmosphere are not; research opportunities supporting the Atmospheric Composition Focus Area of the Earth Science Research Program may be found in Appendix A of this solicitation. Comet investigations are relevant only if they address comet coma properties and behaviors.

Proposals for the analysis of atmospheric data from NASA space science missions that are calibrated and archived and in the public domain on the Planetary Data System are encouraged. However, if there is a specific data-analysis program devoted to the area of the proposal, such as Outer Planets Research (Appendix C.7), Cassini Data Analysis (Appendix C.10), or Mars Data Analysis (Appendix C.12), then the proposal should be submitted to that ROSES program element.

Proposals that serve as an umbrella for a variety of research tasks are appropriate only if the proposed tasks have a clear focus and directly address the objectives of this program.

2. Programmatic Information

Investigations which involve the participation of postdoctoral fellows and graduate students are encouraged.

It is expected that most proposals will request a duration of 3 years, but proposals may be submitted for projects of duration from 1 to 5 years. The detailed justification for the duration of the proposed work will be an important evaluation criterion. Proposals that are otherwise excellent, but do not provide sufficient justification for the duration of the proposal, are less likely to be funded than proposals that do provide appropriate and adequate justification.

Proposals that might otherwise fit the programmatic criteria of the Planetary Atmospheres program, but foresee the use of NASA's suborbital facilities, should be submitted to the Planetary Astronomy program.

2.1 Demonstration of Relevance

Proposals must clearly and explicitly identify the rationale for submitting the proposed investigation to this particular program element of the ROSES NRA and not some other closely related program element. In 2010, proposals will be carefully reviewed against this requirement and the findings will be an important element in the selection process.

2.2 Supplemental Funding for Additional Instrumentation

The Planetary Major Equipment program described in Appendix C.23 of this NRA allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by investigations for certain programs sponsored by the Planetary Science Research Program, including this one. New, analytical instrumentation requests, as well as requests for upgrades to existing instruments, costing more than $25,000, should be identified and requested in a special section of each proposal, to be titled "Major Equipment Request." However, note that <u>a Planetary Major Equipment proposal must be affiliated with a "parent" research proposal in order to be considered</u>; see Appendix C.23 for details.

2.3 Early Career Researchers

Early career researchers are encouraged to apply for the Fellowships for Early Career Researchers (see Appendix C.22 in this ROSES NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science Division discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (*i.e.,* tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Fellowships for Early Career Researchers.

2.4 NASA Provided High-End Computational (HEC) Facilities

Those investigators whose research requires high-performance computing should refer to the *Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to the Planetary Atmospheres program to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at the Ames Research Center's Advanced Supercomputing Division.

2.5 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $ 2.9M
Number of new awards pending adequate proposals of merit	~ 10-30
Maximum duration of awards	5 years: shorter term proposals are encouraged.
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.

Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-PATM
NASA point of contact concerning this program	Dr. Philippe Crane Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0716 E-mail: HQ-PATM@mail.nasa.gov

C.7 OUTER PLANETS RESEARCH

1. Scope of Program

The Outer Planets Research (OPR) program supports diverse scientific investigations that contribute to the understanding of the outer Solar System, including the giant planets, their satellites, and smaller solid bodies including comets, asteroids, and Kuiper Belt objects. The program includes both data analysis from NASA missions and fundamental research. The objectives of the OPR program include:

- Enhancing the scientific return from the New Horizons, Cassini, Galileo, Voyager, Pioneer, and Ulysses missions by continuing the analysis of their respective data sets through broadened scientific participation;
- Improving our understanding of the evolution of the outer Solar System, including the giant planets, their satellites, and other small bodies; and
- Defining the dynamical processes operating in the outer Solar System.

Investigators may propose tasks that involve one or more of the following activities that support the program goals above:

- Development of basic theory, laboratory studies, and/or modeling relevant to the interpretation of mission data listed above or the evolution and dynamics of giant planets, their satellites, and other small bodies in the outer Solar System;
- Additional analysis of ground-based observations of asteroids, comets, and outer planets and their satellites funded by the Planetary Astronomy program;
- Correlative analyses that combine data from outer planets missions (New Horizons, Cassini, Galileo, Voyager, Pioneer, and Ulysses), the Planetary Astronomy program, and other sources; and/or
- Research that seeks to place the results of these outer planets missions in a larger context of processes and evolution of bodies in the outer Solar System.

Each proposal must describe a complete scientific investigation organized in terms of unresolved scientific questions to be addressed; objectives of the research; lines of inquiry, methodology, and analysis; and conclusions. Tasks involving the refinement of mission datasets or the creation of new data products are appropriate as long as such tasks support the scientific investigation driving the proposal. Investigations are expected to result in one or more peer-reviewed publications. Investigations that generate data products useful to the broader scientific community are encouraged to include plans in their proposals to make those products easily available (via the Planetary Data System (PDS) or by other appropriate means) by the end of the funding period.

The use of flight mission data in proposed investigations is limited to the New Horizons, Cassini, Galileo, Voyager, Pioneer, and Ulysses missions. However, investigators proposing cometary research may also use data from the Solar and Heliospheric Observatory (SOHO) mission, which has successfully observed dozens of Sun-grazing comets. Investigators may also propose to use data from the Far Ultraviolet Spectroscopic Explorer (FUSE) mission to support research of objects in the outer Solar System (listed under OPR objectives above). Investigators who wish to use data from Discovery missions should submit their proposals to the Planetary Mission Data Analysis (formerly Discovery Data Analysis) program (see Appendix C.11).

Investigators who wish to conduct research to understand the formation and early evolution of extrasolar planetary systems and to provide the fundamental research and analysis necessary to detect and characterize other planetary systems should submit their proposals to the Origins of Solar Systems program (see Appendix E.3).

The OPR program is not intended to support the acquisition of new ground- or space-based observations nor support ground-based observing facilities. Such proposals should be directed to the Planetary Astronomy program (see Appendix C.5). However, investigators who wish to pursue further analysis of existing ground observations of asteroids, comets, giant planets, outer planet satellites, rings, and Kuiper Belt objects are encouraged to apply to the OPR program. Such extended analyses are restricted to observations funded by the Planetary Astronomy program, and OPR proposals must reference and describe the antecedent Planetary Astronomy grant that funded the observations. These proposals are not required to use flight-mission data, though such correlative analyses are encouraged.

Investigators proposing correlative analyses using data from the New Horizons, Cassini, Galileo, Voyager, Pioneer, Ulysses, and SOHO (comets only) missions and other sources should clearly describe the rationale driving the use of the data and the source of the data. Investigations focused solely on analysis of space- or ground-based data that do not utilize data from the missions stated above or from existing ground observations previously funded by the Planetary Astronomy program will not be considered responsive to this program.

Proposals for topical conferences, workshops, or symposia related to the OPR program may also be proposed through this solicitation. Proposers are encouraged to review the guidelines found on page 3 of the SMD memo on Priorities for Conference Spending of April 27, 2009, which can be found at http://nasascience.nasa.gov/researchers/sara/library-and-useful-links/SMD2009memo.pdf

2. Sources of Information and Data

It is the responsibility of the investigators selected for this program to acquire any needed data. Therefore, before submitting a proposal, the investigator must determine that all data required for the proposed investigation are publicly available. Proposals requiring the use of data that are not publicly available at the time of proposal submission may be rejected without review. Mission data are available from the PDS and can be accessed via the Internet at http://pds.jpl.nasa.gov/.

Proposals dealing with mission data should provide convincing evidence that the data has sufficient quality and is available in sufficient quantity to achieve the goals set forth in the proposal. The proposer should demonstrate a familiarity with the data and an understanding of the work required to refine the data for the purposes of the analysis.

3. Programmatic Information

3.1 Evaluation Criteria

Evaluation criteria for the OPR program are given in Appendix C of the *NASA Guidebook for Proposers*. These criteria are intrinsic merit, relevance, and cost realism/reasonableness. In addition to the factors for the relevance criterion given in the *NASA Guidebook for Proposers*, this program specifically includes the following factors of approximately equal importance:

- Relevance of the proposed investigation to the OPR program as demonstrated by linkages between the proposal objectives and the OPR objectives described above; and
- Impact and importance of the proposed research to the field, including a description of how and to what extent the proposed research will advance our current state of knowledge.

Proposals must contain brief narrative text addressing these two factors. Investigators are also strongly encouraged to carefully consider which program element(s) are relevant to the proposed research, submit the proposal accordingly, and describe the rationale for the submission.

3.2 Maximum Duration of Award

It is expected that most proposals will request a duration of 3 years, but proposals may be submitted for projects of duration from 1 to 5 years. The detailed justification for the duration of the proposed work will be an important evaluation criterion. Proposals that are otherwise excellent, but do not provide sufficient justification for the duration of the proposal, are less likely to be funded than proposals that do provide appropriate and adequate justification.

Proposers are reminded that continued funding in any year is contingent upon satisfactory progress, as documented in annual progress reports. Investigations not demonstrating satisfactory progress will be terminated.

3.3 Supplemental Funding for Additional Instrumentation

The Planetary Major Equipment program described in Appendix C.23 of this ROSES NRA allows proposals for upgrading the analytical, computational, and other instrumentation required by investigations for certain programs sponsored by the Planetary Science Research Program, including this one. New, analytical instrumentation requests, as well as requests for upgrades to existing instruments, costing more than $25,000, should be identified and requested in a short additional proposal titled "Major Equipment Request." However, note that a Planetary Major Equipment proposal must be affiliated with a “parent” research proposal in order to be considered; see Appendix C.23 for details.

3.4 Early Career Researchers

Early career researchers are encouraged to apply for the Fellowships for Early Career Researchers (see Appendix C.22 in this ROSES NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (*i.e.,* tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Fellowships for Early Career Researchers.

3.5 <u>NASA Provided High-End Computational (HEC) Facilities</u>

Those investigators whose research requires high-performance computing should refer to the *ROSES Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to the Outer Planets Research program to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at the Ames Research Center's Advanced Supercomputing Division.

3.6 <u>Education and Public Outreach Opportunities</u>

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. <u>Summary of Key Information</u>

Expected program budget for first year of new awards	~ $2M
Number of new awards pending adequate proposals of merit	~ 15
Maximum duration of awards	5 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*

Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-OPR
NASA point of contact concerning this program	Dr. Curt Niebur Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0390 E-mail: HQ-OPRP@mail.nasa.gov

C.8 LUNAR ADVANCED SCIENCE AND EXPLORATION RESEARCH

1. Scope of Program

1.1 Program Overview

The Lunar Advanced Science and Exploration Research (LASER) program funds basic and applied lunar science. The goal of the program is to support and enhance lunar basic science and lunar exploration science as part of the U.S. Space Exploration Policy's return to the Moon (http://www.nasa.gov/mission_pages/exploration/main).

It is the objective of the LASER program to conduct a suite of lunar science investigations spanning the continuum from basic science to applied exploration science. Proposals having significant components of both basic and applied lunar science that further our understanding of the Moon and how to conduct science there are sought and highly encouraged.

The LASER program also welcomes the submission of "data restoration" proposals. The program seeks to identify science data archives that are considered of significant value to lunar science that are in need of restoration and digital archiving. A LASER proposal may request funding support to restore, archive, and prepare these holdings for public access through the Planetary Data System (PDS) (http://pds.nasa.gov/).

1.2 Fundamental (Basic) Lunar Science

The LASER program supports the broad spectrum of fundamental lunar science encompassing investigations of the lunar surface, interior, exosphere, and the Moon's near-space environment. Investigations of Earth-Moon system processes and selenogenesis are equally welcome. Supported investigations include, but are not limited to, theoretical investigations, numerical modeling of physical or chemical processes, experimental/laboratory investigations, and field analog studies. Proposed investigations may involve a combination of these activities. The spectrum of lunar science funded by LASER includes the following fields: geology, geochemistry, geophysics, exospheric science, solar wind environment history/physics, and radiation environment physics. Topical study areas that will be supported by LASER include, but are not limited to, the following:

- Genesis and dynamical evolution of the Earth-Moon system;
- Lunar evolution (crust, interior, radiation environment, etc.);
- Physics and chemistry of the lunar interior (e.g., composition, structure, heat flow etc.);
- Geomorphological analysis of the lunar surface;
- Lunar cratering processes;
- Petrogenesis of lunar materials;
- Lunar volcanological history and processes;
- Evolution of the lunar radiation environment;
- Growth and development of the lunar regolith; and
- Development, composition, and physics of the Moon's exosphere.

A description of science research priorities for lunar exploration can be found in the document: *The Scientific Context for Exploration of the Moon (2007)* by the Space Studies Board of the National Research Council. It can be obtained at http://books.nap.edu/catalog.php?record_id=11954.

1.3 Lunar Exploration Applied Science

The LASER program supports applied science that furthers the goals of the U.S. Space Policy, is synergistic with basic lunar science as discussed in Section 1.2 above, or considerably advances NASA's preparedness for conducting science on and from the Moon. Supported investigations include, but are not limited to, theoretical investigations, numerical modeling of physical and chemical processes, experimental/laboratory investigations, and field analog studies. While LASER is not designed to support large technology or instrument development projects, it is well suited for field activities that integrate technology, operational tests, and basic science to optimize scientific return from robotic and human missions to the Moon. Examples of investigations identified by the Science Mission Directorate as addressing high-priority lunar exploration science objectives include:

- Lunar Data Processing and Modeling to Support Human Lunar Missions and Surface Science Activities. This topic area includes identification, processing, analysis, and delivery to the Planetary Data System of lunar data sets that would be of value to surface science. It also includes modeling that can improve our understanding of the local or general lunar environment (e.g. lighting, thermal, radiation, etc.). This topic also includes any work on the topic of volatile deposition, transport, segregation, and distribution at or near the lunar poles. Developing strategies and identifying considerations for site selection, including the role of planetary processes, resource availability, topography, and geochemistry/mineralogy are included in this topic. Recognizing that measurements to be made on upcoming international robotic missions will add greatly to our quantitative understanding of the Moon, proposals should clearly indicate how any near term theoretical/modeling efforts will add significant value in the current phase of lunar exploration.

- Field Exploration Techniques and Outpost Science Operations. This topic area addresses key field exploration techniques and outpost science and operations, including sample collection, documentation, curation, human-robotic interactions, and planetary protection. This includes development, analysis, and possible ground demonstration of techniques to support science. This topic will support the study of exploratory strategies for maximizing scientific return from surface activities. Studies using field sites, facilities, or hardware on Earth as analogs for lunar science are included, but they must demonstrate how the proposed research will directly benefit lunar science or conducting science on the Moon.

- Lunar Regolith and Simulant Investigations. This topic area includes exploration science research that expands knowledge of the physical and chemical properties of lunar regolith (charging, chemistry, mineralogy, etc.). It includes research that leads to the creation of improved lunar regolith simulants.

- Resource Prospecting. This topic area includes research on or leading to the identification and/or quantification of potential lunar resources (e.g., oxygen, nitrogen, and other volatiles, fuels, metals, etc.).

1.4 Data Analysis

An objective of the LASER program is to enhance the scientific return from NASA - and other - missions to the Moon. These include, but are not limited to, the Ranger, Surveyor, Lunar Orbiter, Apollo program, Clementine, Lunar Prospector, Lunar Crater Observation and Sensing Satellite (LCROSS) and Lunar Reconnaissance Orbiter (LRO) missions. LASER broadens scientific participation in the analysis of mission data sets and funds high-priority areas of research that support planning for future lunar missions. LASER supports scientific investigations of the Moon using publicly available (released) data.

An investigator may propose a study (e.g., scientific, landing site science, cartographic, topographic, geodetic research, etc.) based on analysis of lunar data collected by spacecraft at the Moon (including flybys). Proposals may incorporate the analysis of data from more than one mission. Additional information about NASA and other lunar missions can be found at NASA's National Space Science Data Center (NSSDC) at http://nssdc.gsfc.nasa.gov/planetary/planets/moonpage.html.

Investigations are welcome in the following high priority areas of lunar research:

- Identification of potential landing sites of high lunar science return;
- Characterization of potential landing sites (e.g., geomorphology, regolith, radiation and compositional properties);
- Modeling of the lunar gravitational field, global topography and global lunar figure; and
- Enhancement of the lunar geodetic network to enable precision lunar landing.

Selected investigations may result in by-products such as mineral, topographic, cartographic, and geologic maps, and/or calibration data that are of broad use to the science community; therefore, a plan for archiving and making such by-products readily available must be included in the proposal. NASA reserves the option to require the archiving of data products resulting from LASER selected proposals in the Planetary Data System (http://pds.nasa.gov). Proposers should refer to the following documents for information on PDS compliance:

Document	Version	Hyperlink
Proposer's Archive Guide	1.3	http://pds.nasa.gov/documents/pag/index.html
Standards Reference	3.8	http://pds.nasa.gov/documents/sr/index.html

Additional information on the PDS may be obtained from the following individuals:

Contact	Title	E-mail
William Knopf	Program Executive	william.knopf@nasa.gov
Edwin Grayzeck	Program Manager	edwin.j.grayzeck@nasa.gov

1.5 Witness-plate Science

LASER is also open to proposals that use the Moon as a witness-plate for the study of current and past solar system processes. For example, proposals to investigate lunar craters for the expressed purpose of understanding cratering processes in general are within the scope of the program; however, all else being equal, higher priority will be given to those proposals that are tied more directly to expanding the lunar sciences and lunar knowledge base.

1.6 Data Restoration

The LASER program supports the restoration and digital archiving of unarchived datasets relevant to the lunar sciences. Priority will be assigned to datasets that are identified, and demonstrated by the proposal, to be of high value to lunar science and NASA. Proposals should provide as much information as possible on the nature and current extent of the data proposed for restoration. For evaluation purposes, data restoration proposals should contain a thorough discussion and description of:

- Data Source (e.g., Ranger 8);
- Data Type (e.g., images of a, b, c, etc.);
- Data Format (e.g., tape, hard copy images, punch cards, JPEG);
- Condition of data (e.g., poor, fair, good, excellent); and
- Completeness of data (e.g., fragmentary, etc.).

Proposals should provide the general details of the data restoration procedure, as well as: a) a detailed plan for how the data will be restored; b) a plan and timetable for archiving the data and metadata in PDS, in a PDS-compliant form, and resolving all liens arising from the PDS peer-review; and c) a description of documentation, calibration data, and related software necessary to interpret the data. Proposers should refer to the documents listed in section 1.4 of this element for information on PDS compliance. Additional information on the PDS may be obtained from the individuals listed in the Table contained in section 1.4.

Types of archival data products include low-level (raw) data; high-level (processed) data; and derived data products such as maps, ancillary data, calibration data (ground and inflight), documentation, and related software or other tools. All data products must be documented, validated, and calibrated in physical units usable by the scientific community at large. It is the proposer's responsibility to conform to the standards of the relevant data archive.

2. Programmatic Information

2.1 Sources of Information and Data

The LASER program supports research investigations relevant to the scientific interpretation of data from past lunar missions that are now in the public domain and to the science and exploration objectives of future missions. LASER supports investigations that use only publicly available and released data. Data to be used in proposed investigations must be available in the Planetary Data System (PDS) (http://pds.nasa.gov) or another publicly accessible archive at least 30 days prior to the submission due date for LASER proposals. Spacecraft data that have not been placed in the public domain may not be proposed for use in LASER investigations. Once a proposal has been awarded, investigators are free to augment the proposed dataset under analysis with data deposited in the PDS (or other publically available archive) subsequent to 30 days prior to the LASER submission date.

Members of current lunar flight teams who wish to apply to the LASER program must clearly demonstrate that their proposed investigation will use only released and publicly available data. Flight team members must scrupulously comply with the 30 days prior to submission rule (above). Additionally, current flight team members must rigorously demonstrate how the proposed LASER research does not overlap – and is not redundant with – data analysis duties/responsibilities already funded within their respective mission.

In all cases, it is the responsibility of the LASER investigator to acquire any necessary data. Therefore, before submitting a proposal, each proposer must determine that the necessary data are available. Proposers who wish to use photographic and cartographic materials may access such data through the nearest Regional Planetary Image Facility (RPIF). RPIF locations are listed on the RPIF home page at http://www.lpi.usra.edu/library/RPIF.

2.2 Early Career Researchers

Early career researchers are encouraged to apply for the Early Career Fellowships (see Appendix C.22 in this NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (i.e., tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Early Career Fellowships.

2.3 Supplemental Funding for Additional Instrumentation

The Planetary Major Equipment program described in Appendix C.23 of this NRA allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by investigations for certain programs sponsored by the Planetary Science Research Program, including this one. New, analytical instrumentation requests, as well as requests for upgrades to existing instruments, costing more than $25K, should be identified and requested in a special section of each proposal, to be titled "Major Equipment Request." However, note that a Planetary Major Equipment proposal must be affiliated with a “parent” SMD research proposal in order to be considered; see Appendix C.23 for details.

2.4 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $3M
Number of new awards pending adequate proposals of merit	~ 30
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA’s *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)

Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-LASER
NASA point of contact concerning this program	Dr. Robert A. Fogel Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2289 E-mail: HQ-LASER@mail.nasa.gov

C.9 NEAR EARTH OBJECT OBSERVATIONS

Clarified Wednesday May 5, 2010: Although the NASA budget submittal for FY2011 proposed additional funding for the NEOO Program, it is only a proposed budget until Congress completes its appropriations legislation. Therefore, the current solicitation for this program remains as originally written, with an estimated $1.5M available for the first year of new awards. Should additional FY2011 funding be appropriated by Congress, it is likely that a supplemental solicitation will be released with additional scope for the NEOO Program.

1. Scope of Program

1.1 NEO Survey and Characterization Proposals

Near Earth Objects (NEOs) are defined as asteroids or comet nuclei whose perihelia are less than 1.3 AU. NASA is committed to discovering all NEOs with diameters greater than or equal to ~1 km and to characterizing that population through determination of their orbital elements, with the goal of detecting more than 90 percent of this population as soon as possible. In support of NASA's commitment and goal, this program supports NEO investigations whose primary objective is to complete the inventory of the population of NEOs with diameters greater than or equal to 1 km. In addition to this goal, the U.S. Congress has expressed an interest for NASA to extend the survey down to objects as small as 140 meters which might pose a hazard to impacting the Earth. Therefore, investigations that provide capability to detect the subset of NEOs in this category, Potentially Hazardous Objects (PHOs) down to 140 meters in size, will receive additional consideration.

In order to help achieve this inventory of NEOs, NASA seeks investigations that promise a sustained, productive search for NEOs and/or obtain follow-up observations of sufficient astrometric precision to allow the accurate prediction of the trajectories of discovered objects. NASA will also consider within this program proposals that characterize a representative sample of these objects by measuring their sizes, shapes, and compositions.

In keeping with NASA data rights policies, all funded NEO search or follow-up programs will be expected to make their data permanently available in a timely manner to the scientific community. Specifically, this requirement shall apply to all astrometric measurements of putative asteroids and comets that are made by NEO search and follow-up projects funded under this program. In particular, the internationally recognized archive for this data is the International Astronomical Union (IAU) Minor Planet Center, currently located at the Harvard Smithsonian Astrophysical Observatory (see http://www.cfa.harvard.edu/iau/mpc.html).

1.2 Proposals for Impactor Characterization and Mitigation Studies.

A limited amount of funding under this program ($100-200K) will be made available for research directed at determination of the parameters necessary to understand the characteristics of PHOs important for implementation of mitigation actions against a detected impact threat – that is, for operations designed to disrupt or deflect the trajectory of an asteroid on an impending Earth impact trajectory.

2. Programmatic Information

2.1 Supplemental Funding for Additional Instrumentation

The Planetary Major Equipment program described in Appendix C.23 of this ROSES NRA allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by investigations for certain programs sponsored by the Planetary Science Research Program, including this one. New, analytical instrumentation requests, as well as requests for upgrades to existing instruments, costing more than $25K should be identified and requested in a special section of each proposal, to be titled "Major Equipment Request." However, note that a Planetary Major Equipment proposal must be affiliated with a "parent" SMD research proposal in order to be considered; see Appendix C.23 for details.

2.2 Proposals Utilizing Goldstone Planetary Radar

Proposals intending to use the planetary radar capabilities of the Deep Space Network Goldstone complex must contact the JPL GSSR Task Manager listed below for information on costs associated with using the Goldstone radar, which must be included in the proposal.

Martin Slade
GSSR Task Manager:
M/S 238-420
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109
Phone: (818) 354-2765
Email: Martin.A.Slade@jpl.nasa.gov

2.3 Early Career Researchers

Early career researchers are encouraged to apply to the Fellowships for Early Career Researchers (see Appendix C.22 in this ROSES NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (*i.e.*, tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Fellowships for Early Career Researchers.

2.4 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $1.5M
Number of new awards pending adequate proposals of merit	~ 4-8
Maximum duration of awards	Up to 5 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)

Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-NEOO
NASA point of contact concerning this program	Mr. Lindley N. Johnson Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-2314 E-mail: HQ-NEOO@mail.nasa.gov

C.10 CASSINI DATA ANALYSIS

Clarified on March 1, 2010. Section 1 has been corrected to indicate that data for the first year of work must in the public domain 90 days prior to the due date, and proposals for Jupiter data analysis are directed to Appendix C.7 the Outer Planets Research program.

1. Scope of Program

The objective of the Cassini Data Analysis Program (CDAP) is to enhance the scientific return of the Cassini mission by broadening the scientific participation in the analysis and interpretation of the data returned by the mission. This program solicits research proposals to conduct scientific investigations utilizing data obtained by the Cassini and Huygens spacecraft. PIs are encouraged to read the abstracts of investigations that were selected from previous competitions, which are available online at http://nspires.nasaprs.com/ (select "Selected Proposals," select "Cassini Data Analysis"). All proposals to CDAP should identify and address a clear objective with science research that will be a significant, not incremental, advance in our understanding of the Saturn system.

In order to be considered, proposing PIs must use data that are in the public domain 90 days **[Clarified March 1, 2010]** before the CDAP proposals due date, and they must make clear to the peer reviewers that the data are publicly available. This applies to the first year of proposed work only. It is understood that the second or third year of work will address data that have come into the archive during the first year of the investigation. Proposals that do not comply with this rule will be declared noncompliant and will be declined without evaluation.

NASA's organ for archiving and distributing Cassini data is the Planetary Data System (PDS). In accordance with the approved mission data-archiving plan, Cassini data is archived in the PDS in three-month increments, nine to twelve months after it is received on Earth. PDS archived Cassini data can be found at http://pds-atmospheres.nmsu.edu/data_and_services/atmospheres_data/Cassini/Cassini.html. Data that are otherwise in the public domain via open literature publications and other freely available sources are also eligible, but proposers are cautioned that it may not be calibrated and validated. To the extent that lack of calibration and validation may affect the scientific quality and value of the end product of the investigation, the peer reviewers may note this as a weakness.

Proposals must be focused on the Saturn system and make significant use of data returned by Cassini instruments. Proposals to work with Cassini data and also use ground-based or other data are acceptable, provided that the success of the proposal, as written, is dependent upon the Cassini data. If this is not the case, the proposal should be submitted to another ROSES element, as appropriate; see Appendix C of this ROSES NRA.

In the first two years of the CDAP program data from the Cassini Jupiter flyby in 2000 were eligible. This is no longer true. Proposals that address Jupiter data should be directed to the Outer

Planets Research program described in Appendix C.7 of this ROSES NRA. **[Clarified March 1, 2010]**

Investigations that propose to produce a higher order data product that enhances the science return from the mission, and investigations that incorporate theory, modeling, laboratory studies, correlative analyses, and/or other research that is relevant to the interpretation of data from the mission, are also eligible for CDAP. Proposers are encouraged to seek collaborations with Cassini scientists and to utilize data from more than one instrument, if appropriate, in order to produce the most useful contributions to understanding the Saturn system.

Proposed data products for delivery to the PDS should be clearly described, and the proposer should consult with the manager of the appropriate PDS data node to insure that they will be PDS compliant and constructed as efficiently as possible. For additional information, refer to the PDS Proposer's Archiving guide at http://pds.nasa.gov/documents/pag/index.html. Data products, including maps, improved calibrations, etc., should be submitted to the PDS by the end of the funded research period, unless the investigator explicitly makes a case in the proposal for a later date. Each research proposal must constitute a stand-alone scientific investigation, with stated lines of inquiry, and result in one or more peer-reviewed publications.

2. Sources of Information and Data

It is the responsibility of the proposers to CDAP to specifically identify any needed data and to ascertain that these data are available. Proposals dealing with mission data should provide convincing evidence that the data has sufficient quality and is available in sufficient quantity to achieve the goals set forth in the proposal. The proposer should demonstrate a familiarity with the data and an understanding of the work required to refine the data for the purposes of the analysis.

- Cassini mission pages can be accessed at http://saturn.jpl.nasa.gov/.
- The PDS Cassini data table of contents page is located at http://pds-atmospheres.nmsu.edu/data_and_services/atmospheres_data/Cassini/Cassini.html.
- Links to Cassini support pages of all the PDS Discipline Nodes can be obtained at http://pds-rings.seti.org/cassini/.
- A tutorial on obtaining Cassini data from the PDS can be obtained at http://pds-rings.seti.org/cassini/Tutorial_GSA2005.pdf. See also http://pds-rings.seti.org/roses/cdap.html

3. Programmatic Information

3.1 Annual Progress Report

An Annual Progress Report will be due no later than 60 days in advance of the anniversary date of the award. Awards to NASA Centers (RTOPS) always have an anniversary date of the start of the fiscal year, October 1. Newly archived data will have appeared in the PDS since the original proposal was submitted; therefore, somewhat longer than usual progress reports will be expected. The PI should specifically identify any needed data for the second- or third-year work and ascertain that they are available, devoting the same amount of care to this issue as in the original proposal. It is generally assumed that the analysis and interpretation of the new data will closely parallel that of the data analyzed in year one. If this is not true, then sufficient detail must be provided so that qualified peers can review and evaluate the work plan. In those cases where the original proposal promised to deliver a higher order data product, the progress report must show satisfactory progress toward that goal. A revised budget for the second or third year is neither necessary nor expected; the multiple-year budget approved at the time of the original award is considered binding barring the development of unforeseen issues (see Section D.4 of Appendix D of the *NASA Guidebook for Proposers* for further details).

3.2 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $1.7M/Year
Number of new awards pending adequate proposals of merit	~ 20
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.

Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-CDAP
NASA point of contact concerning this program	Dr. Max Bernstein Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0879 E-mail (Preferred): HQ-CDAP@mail.nasa.gov

C.11 Planetary Mission Data Analysis

1. Scope of Program

1.1 Programmatic Overview

The objective of the Planetary Mission Data Analysis Program (PMDAP) is to enhance the scientific return of Planetary Science Division missions by broadening the scientific participation in the analysis of archived data collected by those missions. In addition, this program supports the analysis of archived planetary data from other NASA SMD missions.

The following planetary missions are a representative, but not complete, alphabetical list of missions for which archived data is available in the PDS:

- Dawn
- Deep Impact
- Deep Space 1
- EPOXI
- Galileo (asteroid flyby data)
- Giotto
- Hayabusa
- Magellan
- MESSENGER
- Near Earth Asteroid Rendezvous (NEAR)
- Pioneer Venus
- Stardust-NExT

Other missions with archived planetary data not covered by other data analysis programs may include, but are not limited to:

- Cosmic Background Explorer (COBE)
- Far Ultraviolet Astronomy Explorer (FUSE)
- Infrared Astronomical Satellite (IRAS)
- Infrared Space Observatory (ISO)
- International Ultraviolet Explorer (IUE)
- Midcourse Space Experiment (MSX)
- Rosetta
- SOHO

The PMDAP also welcomes the submission of “data archiving” proposals. The program seeks to identify science data collections that are considered of significant value to solar system science. The PMDAP will provide funding to restore, prepare, and archive these collections in the PDS so that they may be publicly available and a resource to support solar system exploration.

1.2 Data Analysis Investigations

Scientific investigations proposed to the PMDAP must enhance the science return from a Planetary Science Division mission or planetary data from other NASA/NASA- and non-NASA-supported missions. Such mission data analysis must be the principal focus of the investigation. In support of any mission data analysis proposal to PMDAP, but as a secondary emphasis and only as needed to interpret and analyze NASA's archival data, the proposed research may include the use and application of theoretical research or numerical modeling, may use existing data from ground-based observations, or may use suborbital observations and/or laboratory measurements. In addition, NASA will consider requests for support for new ground-based observations and laboratory measurements provided that the requests are clearly described, that the observations or measurements are important to the success of the proposed PMDAP effort, and that their expense (including salary, travel, etc.) constitutes no more than 10 percent (10%) of the proposal's total budget.

PMDAP supports scientific investigations that use only data available in the Planetary Data System (PDS) (http://pds.nasa.gov/) or other publicly accessible archive(s), such as planetary data in the NASA astrophysics data archives (http://nssdc.gsfc.nasa.gov/astro/). The data must be archived and publicly available 30 days prior to the submission deadline for PMDAP proposals. Spacecraft data that have not been placed in such archives may not be proposed for use in PMDAP investigations. In all cases, it is the responsibility of the PMDAP investigator to acquire any necessary data. Investigators are encouraged to contact the PDS for assistance in identifying specifics of available datasets. It is recommended that datasets to be analyzed be specifically identified in the proposal.

Data accessible in PDS or other archives that are still in "liens resolution" are not considered archived and their analysis will not be supported by this program.

Additional information on the PDS may be obtained from the following individuals:

Contact	Title	E-mail
William Knopf	Program Executive	William.Knopf-1@nasa.gov
Edwin Grayzeck	Program Manager	Edwin.J.Grayzeck@nasa.gov

1.3 Data Archiving into PDS

Selected investigations may result in data products that are of broad use to the science community, including maps, data with improved calibrations, etc. These data should be archived in the Planetary Data System, unless the investigator explicitly makes a case against this in the proposal. When proposing the archiving of such products into the PDS, an archive plan must be included, identifying schedule and budget to go through the PDS ingestion process. NASA reserves the option to require the archiving of data products resulting from PMDAP selected proposals in the Planetary Data System (http://pds.nasa.gov/).

The PMDAP supports the restoration and digital archiving of unarchived, nonlunar datasets relevant to the planetary sciences. (Restoration and archiving of lunar datasets is supported through the LASER program element of ROSES, as described in Appendix C.8.) Priority will be assigned to datasets that are identified and demonstrated by the proposal to be of high value to solar system science and NASA. Proposals should provide as much information as possible on the nature and current extent of the data proposed for archiving. For evaluation purposes, data archiving proposals should contain a thorough discussion and description of:

- Data Source (e.g., Voyager I);
- Data Type (e.g., images of a, b, c, etc.);
- Data Format (e.g., tape, hard copy images, punch cards, JPEG);
- Condition of data (e.g., poor, fair, good, excellent); and
- Completeness of data (e.g., fragmentary, etc.).

Proposals should provide: a) a detailed plan for how the data will be restored; b) a plan and timetable for submitting the data and metadata to PDS in a PDS-compliant form and resolving all liens arising from the PDS peer-review, and c) a description of documentation, calibration data, and related software necessary to interpret the data.

Types of archival data products include, but are not limited to, low-level (raw) data, high-level (processed) data, and derived data products such as maps, ancillary data, calibration data (ground and in flight), documentation, and related software or other tools. All data products must be documented, validated, and calibrated in physical units usable by the scientific community at large. It is the proposer's responsibility to conform to PDS standards.

Proposers should refer to the following documents for information on PDS compliance:

Document	Version	Hyperlink
Proposer's Archive Guide	1.3	http://pds.nasa.gov/documents/pag/index.html
Standards Reference	3.8	http://pds.nasa.gov/documents/sr/index.html

Proposers planning to archive data in the PDS are strongly encouraged to communicate with the PDS Discipline Node responsible for curating similar data (links to the PDS Discipline Nodes are at http://pds.nasa.gov/) to discuss procedures and requirements.

1.4 Program Exclusions

The PMDAP is not intended to overlap other active data analysis programs. Thus the PMDAP does not support the analysis of:

- Lunar data (see the Lunar Advanced Science and Exploration Research (LASER) program in Appendix C.8);
- Mars data obtained by missions to Mars (see the Mars Data Analysis Program (MDAP) in Appendix C.12);
- Jupiter, Saturn, Uranus and Neptune system phenomena (see the Outer Planets Research (OPR) program in Appendix C.7);
- Data from Cassini (see the Cassini Data Analysis Program (CDAP) in Appendix C.10); and

- Data from the New Horizons, Galileo, Voyager, Pioneer, and Ulysses missions (see the Outer Planets Research (OPR) program in Appendix C.7).

This list is not exhaustive. Please refer to the solicitations of the Cassini Data Analysis program (Appendix C.10), the Jupiter Data Analysis program (now incorporated into the Outer Planets Research program (Appendix C.7)), the Mars Data Analysis program (Appendix C.12), and the Lunar Advanced Science and Exploration Research (LASER) program (Appendix C.8). In addition, the restoration and archiving of lunar datasets is supported through the LASER program, and should be the targeted solicitation for investigations of this nature.

Proposers to this NRA should note that the PMDAP is not intended to support:

- Investigations whose primary emphasis is fundamental theoretical research, the development of numerical models, laboratory measurements, or detector development (other NASA programs support these research activities);
- Investigations whose primary focus is on Astrophysics (non-Solar System) objects, Heliophysics, or on the solar-terrestrial interaction (other NASA programs support this kind of research, see Appendices B and D);
- Proposals primarily for the general education and/or training of students (note: this does not exclude graduate students from doing research under the proposal);
- Proposals for organizing and/or hosting scientific meetings; and
- Proposals for the acquisition of substantial computing facilities or resources beyond nominal workstation or network requests.

Spacecraft data that have not been obtained, or those that have not been placed in approved archives may not be proposed for use in PMDAP investigations.

Members of current spacecraft flight teams who wish to apply to the PMDAP must clearly demonstrate that their proposed investigation will use only released and publicly available data. Flight team members must scrupulously comply with the 30-days-prior-to-submission rule (above). Additionally, current flight team members must demonstrate clearly how the proposed PMDAP research does not overlap and is non-redundant with data analysis duties or responsibilities already funded within their respective mission.

2. Programmatic Information

2.1 Early Career Researchers

Early career researchers are encouraged to apply to the Fellowships for Early Career Researchers (see Appendix C.22 in this ROSES NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (*i.e.,* tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Fellowships for Early Career Researchers.

2.2 NASA Provided High-End Computational (HEC) Facilities

Those investigators whose research requires high-performance computing should refer to the *ROSES Summary of Solicitation*, Section I(d), “NASA-provided High-End Computing Resources.” This section describes the opportunity for successful proposers to the PMDAP to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center’s Computational and Information Sciences and Technology Office or at the Ames Research Center’s Advanced Supercomputing Division.

2.3 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $2.8M
Number of new awards pending adequate proposals of merit	~ 15-20
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	~6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA’s *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.

Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-PMDAP
NASA point of contact concerning this program	Dr. Michael S.Kelley Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0607 E-mail: HQ-PMDAP@mail.nasa.gov

C.12 MARS DATA ANALYSIS

1. Scope of Program

The objective of the Mars Data Analysis Program (MDAP) is to enhance the scientific return from missions to Mars conducted by NASA and other space agencies. These include, but are not limited to, the following missions: Mars Pathfinder (MPF), Mars Global Surveyor (MGS), Mars Odyssey (MO), Mars Exploration Rovers (MERs), Mars Express (MEX), Mars Reconnaissance Orbiter (MRO), and Phoenix (PHX). MDAP broadens scientific participation in the analysis of mission data sets and funds high-priority areas of research that support planning for future Mars missions. MDAP supports scientific investigations of Mars using publicly available (released) data. Where justified to support planning for future Mars missions, investigations that use data derived from other sources (e.g., ground-based radar, Hubble) will also be considered.

An investigator may propose a study (scientific, landing site science, cartographic, topographic, geodetic research) based on analysis of Mars data collected by spacecraft at Mars, including MPF, MGS, MO, MERs, MEX, MRO and PHX. Any proposal may incorporate the investigation of data from more than one mission. Additional information about these missions, as well as references containing preliminary science results, can be found on the Mars Exploration Program (MEP) homepage at: http://mars.jpl.nasa.gov/.

MDAP also supports correlative studies that use Mars data from another source, in addition to flight mission data, to further the understanding of some aspect of Mars science. Funds awarded for correlative studies may be used to cover data analysis and expenses involved in collaboration with other Mars investigators but may not be used for taking new observations (whether astronomical, field, or laboratory studies) or for support of observing or laboratory facilities.

Selected investigations may result in by-products such as mineral, topographic, cartographic, and geologic maps, and/or calibration data that are of broad use to the science community. Therefore, a plan for archiving and making such by-products readily available must be included in the proposal. NASA reserves the option to require the archiving in the Planetary Data System (PDS; http://pds.nasa.gov/) of data products resulting from MDAP selected proposals.

An investigator may also propose in the following high-priority areas of Mars research that support planning for future Mars missions:

- Improved atmospheric models that further the understanding and forecasting of Mars atmospheric conditions that affect aerobraking and aerocapture.
- Characterization of potential landing sites for future Mars exploration missions (e.g., geomorphology, distribution and size of rocks, pits, sand dunes, regional and local slopes, surface composition, and texture variability).
- Improved models for the Mars gravity field, global topography, and global planetary figure.
- Improvement of the geodetic network of Mars for precision landing demonstration.
- Analysis and comparison of Mars orbital and surface data to increase the predictive accuracy of surface characteristics of Mars from orbit.

For more information about the type of research supported by the MDAP, please refer to the abstracts of currently funded investigations that are available online at: http://nspires.nasaprs.com/.

Investigators interested in proposing mostly theoretical, modeling, laboratory, or field studies that do not directly use spacecraft data, or proposals whose data analysis components are only a small portion of the total work effort proposed, are advised that such studies are not appropriate for MDAP but may be suitable for submission to the closely related Mars Fundamental Research Program described in Appendix C.13 of this NRA.

2. Sources of Information and Data

MDAP supports investigations that use only publicly available and released data. Data to be used in proposed investigations must be available in the Planetary Data System (PDS) (http://pds.nasa.gov/) or another publicly accessible archive(s) at least 30 days prior to the submission due date for MDAP proposals. Spacecraft data that have not been placed in the public domain may not be proposed for use in MDAP investigations. Once a proposal has been awarded, investigators are free to augment the proposed dataset under analysis with data deposited in the PDS (or other publically available archive) subsequent to 30 days prior to the MDAP submission date.

Members of current Mars flight teams who wish to apply to the MDAP must clearly demonstrate that their proposed investigation will use only released and publicly available data. Flight team members must scrupulously comply with the 30-days-prior-to-submission rule (above). Additionally, current flight team members must demonstrate clearly how the proposed MDAP research does not overlap and is non-redundant with data analysis duties/responsibilities already funded within their respective mission.

In all cases, it is the responsibility of the MDAP investigator to acquire any necessary data. Therefore, before submitting a proposal, each proposer must determine that the necessary data are available. Proposers who wish to use photographic and cartographic materials may access such data through the nearest Regional Planetary Image Facility (RPIF). RPIF locations are listed on the RPIF home page at http://www.lpi.usra.edu/library/RPIF.

Documents that describe the research priorities for Mars exploration include:

- *Assessment of NASA's Mars Architecture 2007-2016* [2006], by the Space Studies Board (SSB) of the National Research Council (NRC) (http://books.nap.edu/catalog.php?record_id=11717);

- Mars Exploration Program Analysis Group (MEPAG) reports (http://mepag.jpl.nasa.gov/) including:
    - *Mars Scientific Goals, Objectives, Investigations, and Priorities* (2008);
    - *Robotic Mars Exploration Strategy 2007-2016 (MAPG);*
    - *Update to the Robotic Mars Exploration Strategy 2007-2016 (MAPG)*

Additional information is available on the MEP web site at: http://mars.jpl.nasa.gov/.

3. Programmatic Information

3.1 Early Career Researchers

Early career researchers are encouraged to apply for the Early Career Fellowships (see Appendix C.22 in this NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (i.e., tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Early Career Fellowships.

3.2 NASA Provided High-End Computational (HEC) Facilities

Those investigators whose research requires high-performance computing should refer to the *ROSES Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to the Mars Data Analysis program to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at the Ames Research Center's Advanced Supercomputing Division.

3.3 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $3M
Number of new awards pending adequate proposals of merit	~ 30
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.

Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-MDAP
NASA point of contact concerning this program	Dr. Robert A. Fogel Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2289 E-mail: HQ-MDAP@mail.nasa.gov

C.13 MARS FUNDAMENTAL RESEARCH

1. Scope of Program

1.1 Programmatic Overview

The Mars Fundamental Research program (MFRP) seeks to sponsor the best and most innovative scientific research concerning atmospheric, climatological, geologic, geophysical, and geochemical processes on Mars. The program offers opportunities for Mars research beyond those available from analyses of spacecraft data alone.

The MFRP includes investigations that use: (i) theoretical and experimental studies, including laboratory studies of analog materials, to investigate the coupled atmospheric and geological systems on Mars; (ii) quantitative terrestrial field experiments that improve understanding of the *in situ* measurements that have been or that will be made on Mars; and (iii) any other innovative research activities that demonstrate relevance to NASA's overarching goals for the scientific exploration of Mars. This program solicitation is intentionally broad, with only a few ground rules and boundary conditions, as follow:

1) Investigations submitted to this program must demonstrate how the research to be undertaken will directly improve our understanding of Mars relative to current knowledge;
2) Research activities must not duplicate those that involve analysis of flight mission data -- such investigations may be submitted to the companion Mars Data Analysis Program (MDAP) (Appendix C.12 in this ROSES NRA);
3) All proposed research must demonstrate relevance to the overarching scientific research directions of the Mars Exploration Program (MEP; see Web site http://mars.jpl.nasa.gov/), as summarized in the *Mars Scientific Goals, Objectives, Investigations and Priorities* by the Mars Exploration Program Analysis Group (MEPAG, 2008) at http://mepag.jpl.nasa.gov/reports, and the *MEP Robotic Mars Exploration Strategy 2007-2016* (2006) JPL 400-1276. Further guidance is provided in the Space Studies Board report, and the *Assessment of NASA's Mars Architecture 2007-2016* (2006) at http://books.nap.edu/catalog.php?record_id=11717; and NASA's response *Update to Robotic Mars Exploration Strategy 2007-2016* (2006) at http://mepag.jpl.nasa.gov/reports;
4) Research involving field experiments must demonstrate how the proposed activities directly relate to current questions about the environment of Mars;
5) Laboratory experiments submitted to MFRP must relate directly to questions about the Martian environment and Mars-relevant materials and must clearly demonstrate the uniqueness of the approach;
6) Proposals to develop basic geochemical and geophysical datasets for Mars-relevant materials are permitted, provided there is sufficient justification for such measurements in the context of the MEP during the coming decade. Basic research pertaining to future Mars sample return may also be considered;
7) Investigations in this program must not be posed as extensions of flight experiments that are part of ongoing or soon-to-be active science missions; rather investigators must state

how any proposed activities that pertain to current or future flight missions are independent of those to be pursued by the typical mission-related science team activities;

8) Investigations using innovative information technology (IT) approaches for understanding Mars as a system, including field experiments that clearly demonstrate the potential of IT solutions to substantially increase the scientific yield (and scope) of planned investigations, are permitted (e.g., IT developments that could radically improve the time required for field deployable rovers to approach rocks and other interesting targets, etc.), provided that scientific products are proposed as an end product (that is, technology demonstrations alone are not relevant to this NRA); and
9) Topical science conferences, workshops, and symposia may be considered by this program element in 2010. Proposers are encouraged to review the guidelines found on page 3 of the SMD memo on Priorities for Conference Spending of April 27, 2009, which can be found at http://nasascience.nasa.gov/researchers/sara/library-and-useful-links/SMD2009memo.pdf

As part of this research solicitation, NASA encourages innovative research approaches involving the full spectrum of possibilities listed in items (1) – (8) above, as well as others that can be scientifically justified.

1.2 Background

NASA's Mars Exploration Program (MEP) (http://mars.jpl.nasa.gov) is a science-driven program that focuses on understanding the planet Mars as a "system." The MEP is characterized by a suite of core program flight missions, as well as fully competed Scout missions, whose aim is to provide new observational and measurement data concerning Mars.

Through MDAP (Appendix C.12), NASA solicits research that is based upon flight mission data from the suite of flight experiments that have flown or are currently collecting data concerning Mars. However, there are a broad variety of fundamental research investigations that are key to understanding Mars as a dynamic system in space and time, some of which may not be directly linked to the flight experiment data that have either recently been collected or will be in the near future. These investigations may be submitted to this MFRP solicitation. It is expected that most MFRP investigations will provide a basis for better or more complete analysis of existing or future Mars spacecraft data.

1.3 Sources of Information and Data

It is the responsibility of the investigator to acquire any required data needed to complete his/her investigation. Therefore, before submitting a proposal, each proposer must determine that the required data are or will be available. Data from Mars Pathfinder, Mars Global Surveyor, Mars Odyssey, Mars Exploration Rover, and Mars Reconnaissance Orbiter missions, as well as data from previous Mars missions, are available from the Planetary Data System, whose home page can be accessed at http://pds.jpl.nasa.gov/. Proposers who wish to use photographic and cartographic materials may find such data at the nearest Regional Planetary Image Facility (RPIF) whose locations are listed on the RPIF home page at http://www.lpi.usra.edu/library/RPIF/. Curation and analysis data on Martian meteorites are available from the Mars Meteorite Compendium at http://curator.jsc.nasa.gov/antmet/mmc/index.cfm.

Documents that describe the science priorities and proposed missions for Mars exploration are referenced above and include:

- MEPAG – *Mars Scientific Goals, Objectives, Investigations and Priorities* (2008), and MEP - *Robotic Mars Exploration Strategy 2007-2016* (2006), both available at http://mepag.jpl.nasa.gov/reports/;
- SSB-NRC - *Assessment of NASA's Mars Architecture 2007-2016* (2006), available at http://books.nap.edu/catalog.php?record_id=11717
- MEP – *Update to Robotic Mars Exploration Strategy 2007-2016* (2006), available at http://mepag.jpl.nasa.gov/reports/.

2. Programmatic Information

2.1 Augmentation for Instrumentation Upgrades

The Planetary Major Equipment program described in Appendix C.23 of this ROSES NRA allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by investigations for certain programs sponsored by the Planetary Science Division, including this one. New, analytical instrumentation requests, as well as requests for upgrades to existing instruments, costing more than $25,000, should be identified and requested in a special section of each proposal, to be titled "Major Equipment Request." However, note that a Planetary Major Equipment proposal must be affiliated with a "parent" research proposal in order to be considered; see Appendix C.23 for details.

2.2 Early Career Researchers

Early career researchers are encouraged to apply to the Fellowships for Early Career Researchers (see Appendix C.22 in this ROSES NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (*e.g.,* tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Fellowships for Early Career Researchers.

2.3 NASA Provided High-End Computational (HEC) Facilities

Those investigators whose research requires high-performance computing should refer to the *Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to the Mars Fundamental Research program to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at the Ames Research Center's Advanced Supercomputing Division.

2.4 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	$2.5-3M
Number of new awards pending adequate proposals of merit	25-30
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-MFRP
NASA point of contact concerning this program	Dr. Marilyn Lindstrom Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1254 E-mail: HQ-MFRP@mail.nasa.gov

C.14 MARS INSTRUMENT DEVELOPMENT PROJECT

NASA's Mars Exploration Program (MEP) calls for a series of highly ambitious missions over the next decade. The overall goals of the MEP must be achieved with relatively low mission risk and within tightly constrained cost resources. The current overarching scientific goals of NASA's Mars Exploration Program are: life, climate, geology, and preparation for human exploration. These have a common, measurable link: water. For Mars (like Earth), water is central to the planet's history; it is also the primary reason for interest in it as a potentially habitable world.

> **NOTICE: The Mars Instrument Development Project (MIDP) is on hold pending programmatic decisions to be made in the first quarter of calendar year 2010. It is not expected that proposals for MIDP will be solicited this fiscal year.**

Questions or comments may be directed to the MIDP Program Executive, at the address given below.

Mr. Dave Lavery
Solar System Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC, 20546-0001
Phone: 202-358-4684
E-mail: dave.lavery@nasa.gov

C.15 Mars Technology Project

NASA's Mars Exploration Program calls for a series of highly ambitious missions over the next decade and beyond. The overall goals of the Mars Exploration Program must be achieved with relatively low mission risk and within tightly constrained cost resources. Information on NASA's Mars programs may be obtained at http://mars.jpl.nasa.gov.

The Mars Technology Project (MTP) seeks to ensure that appropriate spacecraft technologies are available in a sufficiently mature state to be support the challenges of the Mars Exploration Program, and they are ready for incorporation into future mission systems.

> **NOTICE: The Mars Technology Project (MTP) is on hold pending programmatic decisions to be made in the first quarter of calendar year 2010. It is not expected that proposals for MTP will be solicited this fiscal year.**

Questions or comments may be directed to the MTP Program Executive, at the address given below.

Mr. Dave Lavery
Solar System Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC, 20546-0001
Phone: 202-358-4684
E-mail: dave.lavery@nasa.gov

C.16 PLANETARY INSTRUMENT DEFINITION AND DEVELOPMENT

1. Scope of Program

The Planetary Instrument Definition and Development Program (PIDDP) supports the advancement of spacecraft-based instrument technology that shows promise for use in scientific investigations on future planetary missions. The goal of the program is not to develop flight-qualified hardware, but rather to define and develop scientific instruments or components of such instruments to the point where the instruments may be proposed in response to future announcements of flight opportunity without additional extensive technology development. Results of PIDDP have contributed to the development of flight hardware flown on, or selected for, many of NASA's planetary missions. The proposed instrument technology must address specific scientific objectives of likely future science missions.

Instrument definition and development studies can take place at several stages, including feasibility studies, conceptual design, laboratory breadboarding, brassboarding, and testing of critical components and complete instruments. The technology readiness level (TRL) that PIDDP supports is TRL 1-6. For immature or particularly complex new instruments, proposers initially may choose to only define or develop the most risky components. If the proposal is for a component only, one or more likely scenarios for possible follow-on instrument development should be described. Scientific objectives of the instruments, proposed follow-on instruments, and future candidate missions must be discussed in the proposal. In particular, it is the responsibility of the proposer to demonstrate how their proposed instruments address significant scientific questions relevant to stated NASA goals and not for NASA to attempt to infer this. The emphasis in this program is on the development of miniaturized, low-power, low-cost instruments for missions in the Discovery, New Frontiers, Mars Exploration, and other planetary programs. New measurement concepts, methods to significantly improve the performance of existing instruments, and development of technologies that enable integrated instrument packaging (architectures) may also be proposed.

In years when the Astrobiology Science and Technology for Instrument Development program (Appendix C.19) is not solicited, NASA will consider funding a number of astrobiology proposals under PIDDP deemed strategically important. Additionally, in years when the Mars Instrument Development Project (Appendix C.14) is not solicited, PIDDP will consider funding one to two proposals that strategically advance instrument technology beyond the TRL 4 level but not beyond TRL 6.

Proposals not appropriate for PIDDP are those that seek to develop laboratory instruments, ground-based or orbiting telescopes, auxiliary instrumentation such as spectrometers for telescopes, onboard data processing or data compression studies, or any spacecraft technology that does not directly address science instrumentation.

While this program element will be advertised annually, the nature of specific efforts selected for funding will vary, with emphasis in any given year placed on preparation for the nearest term missions for which instruments have not yet been selected. However, support may also be provided for long lead-time definition studies, for innovative approaches that may provide entirely new classes of instruments, for the development of new enabling technology for missions farther in the future, and/or for detector development studies that may advance the technology for a wide range of planetary instrumentation applications. Therefore, proposers are encouraged to relate their proposed efforts as closely as possible to specific future planetary missions and demonstrate how their technology addresses the scientific goals of these missions and the strategic interests of NASA.

2. <u>PIDDP - Focused Future Missions</u>

Proposals for instrument definition and breadboard development for the following future types of missions will be considered for funding through PIDDP. It should be noted that the contemplated sequence of missions described in this solicitation is a best current estimate and is subject to change. NASA reserves the right to make a determination of relevance based on the contemplated sequence of missions as it is understood at the time of proposal evaluation and selection.

- *Discovery Program Missions*

The Discovery Program is envisaged as a series of focused, quick turnaround missions. Development time will be approximately 36 months, and solicitations will occur approximately every 18–24 months, as the budget allows. The Discovery missions may include flybys, orbiters, landers, deployment of airplanes or balloons in planetary atmospheres, Earth-orbiting telescopes, and sample return missions to various Solar System bodies. Scientific studies range widely within the basic fields of planetary astronomy, geology, geochemistry, geophysics, astrobiology, and atmospheric science. Instrumentation and techniques addressing critical scientific questions in this broad range are appropriate development efforts under PIDDP. Technology applicable to multiple missions and investigations will have higher priority for funding. Conversely, proposals for the development of instruments for missions already selected for flight or selected for Discovery Phase A study and/or development will not be accepted under this NRA.

- *Mars Exploration Program (MEP) Missions*

PIDDP seeks new concepts for Mars scientific instrumentation and experiments, including, but not limited to: instruments for radiometric age-dating (for absolute age determination), soil/rock mineralogy and chemistry (including key isotopic ratios, elemental analyses, and organic molecules), water/ice detection and characterization, drilling/coring, sample caching (collect/store samples of rock, soil, atmosphere, etc), and aeronomy and atmospheric physics (including trace gas species detection, including for example CH_4, O_3, SO_2, etc.). Some, but not all, of these are truly new and complex instrument concepts for planetary exploration. As such, proposers may choose to initially pursue only development of the most challenging components, as long as discussion of their connection to possible future instruments and scientific objectives is clearly discussed. Future MEP missions, including mobile analytical laboratories, reconnaissance orbiters, airborne experiments, bore-hole measurement systems, and Mars Sample Return (MSR), will have payloads of small, lightweight, low power-consumption instruments and will launch approximately every 26 months. Instrument development proposals for both U.S. and international follow-on missions to Mars (*i.e.*, beyond the 2011 Mars Science

Laboratory and 2013 MAVEN) are appropriate under this NRA. Instrument technologies for the *in situ* exploration of Mars are of particular interest for future missions. However, next-generation orbital experiments that considerably advance the state of the art (as demonstrated on the 2005 Mars Reconnaissance Orbiter) are also encouraged, with particular attention to orbital detection of evidence of organics, liquid water, climate records, and geophysics.

- *New Frontiers Missions*

PIDDP solicits instrument concepts relevant to possible future New Frontiers missions that will be solicited for specified targets in the Solar System. The NRC Decadal Survey for exploration of the Solar System, entitled *New Frontiers in the Solar System* (2003) (see http://www.nap.edu/openbook.php?isbn=0309084954), lists five candidate missions, three of which were unrealized: Venus *In Situ* Explorer, Lunar South Pole-Aitken Basin Sample Return, and Comet Surface Sample Return.

In addition, in 2007 the New Opportunities in Solar System Exploration (NOSSE) committee recommended five additional investigations for the 2009 New Frontiers AO: Network Science, Trojan/Centaur Reconnaissance, Asteroid Rover/Sample Return, Io Observer, and Ganymede Observer. See http://www.nap.edu/catalog.php?record_id=12175 for this report.

Prospective proposers are encouraged to review this Decadal Survey report and the NOSSE report to learn more about these missions. Emphasis on PIDDP instrument selection will be placed on preparation for the nearest term missions that have not been selected for development.

3. Programmatic Considerations

3.1 Special Requirements for Proposals

Proposals are solicited under this program element for instrument definition and development only for the missions or classes of missions described in Section 2 above. Therefore, all proposals submitted to this program element must specify:

- The mission or class of missions for which the proposed instrument is applicable. Instruments that might fly on more than one mission will be given priority over those applicable to only a single mission.
- The science objectives of the proposed instrument. The relationship between the science objectives and the instrumental capabilities must be clearly demonstrated. For those instruments applicable to more than one mission or capable of meeting multiple science objectives, examples of science objectives for the proposed mission or missions must be given.
- Technological advances to be pursued as an inherent element of achieving the science objectives. Proposers must identify potential mechanisms that could facilitate transfer of these technologies to other users, including the private sector, for possible application beyond the immediate one of meeting mission science objectives.

It is anticipated that the scientific payloads on most future solar system exploration missions will be limited to small, low-mass, low power-consumption, and low-cost instruments. For this reason, only proposals for instrument definition and development satisfying these general specifications will be considered for support.

3.2 Additional Evaluation Factors

All proposals will be evaluated with respect to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*. In addition to the factors specified in the *NASA Guidebook for Proposers*, the intrinsic merit of a proposal shall include the following additional factors:

- The extent to which the proposed instrument is applicable to multiple missions in the Planetary Science objectives;
- The extent to which the instrument addresses a priority science goal of the mission or missions for which it would be a candidate for flight;
- Either the near-term nature of the mission or missions in question, or the necessity of embarking on a long lead-time development of a very important instrument contemplated for flight on a mission that is of high priority, even though it is not in the near-term queue; and
- Whether the instrument is deemed to fall within the scope of PIDDP, including whether it is too developmentally mature for PIDDP.

The Planetary Science Division strongly encourages proposers to investigate current and recent Small Business Innovative Research awards (http://sbir.gsfc.nasa.gov/SBIR/awards.htm) for possible teaming and leveraging of emerging technologies. Collaborations leveraging SBIR funded technologies will be given preference.

3.3 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3.4 Venus Chamber

The Venus Pressure Test Chamber is a NASA facility that enables testing of components and small instruments under temperatures and pressures that simulate Venus surface conditions. Lower temperatures and pressures may also be accommodated. Exploratory or proof-of-concept programs requiring a limited number of experiments/tests can be accommodated at no cost. More extensive programs are subject to review in order to assess feasibility and cost effectiveness.

Any need for extensive use of the chamber should be explicitly described in the proposal. The proposal budget should include an estimate of usage costs.
A letter of support from the Venus Chamber facility is required.

For more information, potential users of the Venus Chamber should contact:

Dr. Natasha Johnson
Astrochemistry Laboratory
Code 691
NASA/Goddard Space Flight Center
Greenbelt, MD 20771
Telephone: (301) 286-3919
Email: natasha.m.johnson@nasa.gov

4. Summary of Key Information

Expected program budget for first year of new awards	~ \$3.0M
Number of new awards pending adequate proposals of merit	~ 10-15
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)

Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-PIDDP
NASA point of contact concerning this program	Janice L. Buckner Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, D.C. 20546-0001 Telephone: 202-358-0183 E-mail: HQ-PIDDP@mail.nasa.gov

C.17 ASTROBIOLOGY: EXOBIOLOGY AND EVOLUTIONARY BIOLOGY

1. Scope of Program

The goal of NASA's Exobiology and Evolutionary Biology program is to understand the origin, evolution, distribution, and future of life in the Universe. Research is centered on the origin and early evolution of life, the potential of life to adapt to different environments, and the implications for life elsewhere. This research is conducted in the context of NASA's ongoing exploration of our stellar neighborhood and the identification of biosignatures for *in situ* and remote sensing applications. For further information on the science scope of Astrobiology, please refer to the Astrobiology roadmap, which can be found on the Astrobiology web page http://astrobiology.arc.nasa.gov/. The areas of research emphasis in this solicitation are as follows:

- *Planetary Conditions for Life*

Research in this area seeks to delineate the galactic and planetary conditions conducive to the origin of life. Topics of interest include the formation and stability of habitable planets, the formation of complex organic molecules in space and their delivery to planetary surfaces, models of early environments in which organic chemical synthesis could occur, the forms in which prebiotic organic matter has been preserved in planetary materials, and the range of planetary environments amenable to life. Emphasis is placed on studies that constrain or extend concepts of possible chemical evolution relevant to the origin, evolution, and distribution of life. Studies of sites thought to be analogues to the early Earth will be considered as part of NASA's broader interest in the search for life in the Universe.

- *Prebiotic Evolution*

Research in the area of prebiotic evolution seeks to understand the pathways and processes leading from the origin of planetary bodies to the origin of life. The strategy is to investigate the planetary and molecular processes that set the physical and chemical conditions within which living systems may have arisen. A major objective is determining what chemical systems could have served as precursors of metabolic and replicating systems on Earth and elsewhere, including alternatives to the current DNA-RNA-protein basis for life. Laboratory and theoretical, as well as related data-analysis, studies will be considered.

- *Early Evolution of Life and the Biosphere*

The goal of research into the early evolution of life is to determine the nature of the most primitive organisms and the environment in which they evolved. The opportunity is taken to investigate two natural repositories of evolutionary history available on Earth: the molecular record in living organisms and the geological record. These paired records are used to: (i) determine when and in what setting life first appeared and the characteristics of the first successful living organisms; (ii) understand the phylogeny and physiology of microorganisms, including extremophiles, whose characteristics may reflect the nature of primitive environments; (iii) determine the original nature of biological energy transduction, membrane function, and information processing, including the construction of artificial chemical systems to test hypotheses regarding the original nature of key biological processes; iv) investigate the development of key biological processes and their environmental impact; v) examine the response of Earth's biosphere to extraterrestrial events; vi) investigate the evolution of genes, pathways, and microbial species subject to long-term environmental change relevant to the origin of life on Earth and the search for life elsewhere; and vii) study the coevolution of microbial communities, and the interactions within such communities, that drive major geochemical cycles, including the processes through which new species are added to extant communities.

- *Evolution of Advanced Life*

Research associated with the study of the evolution of advanced life seeks to determine the biological and environmental factors leading to the development of multicellularity on Earth and the potential distribution of complex life in the Universe. This research includes studies of the origin and early evolution of those biological factors that are essential to multicellular life, such as developmental programs, intercellular signaling, programmed cell death, the cytoskeleton, cellular adhesion control and differentiation, in the context of the origin of advanced life. This research area also includes an evaluation of environmental factors such as the influence of extraterrestrial (*e.g.,* bolide impacts, orbital and solar variations, gamma-ray bursts, etc.) and planetary processes ("Snowball Earth" events, rapid climate change, *etc.*) on the appearance and evolution of multicellular life. Of particular interest are mass extinction events. Proposals aimed at identification and characterization of signals and/or properties of extrasolar planets that may harbor intelligent life are also solicited.

- *Exobiology for Solar System Exploration*

Research in this area focuses on relating what is known about life on Earth to conditions prevailing on other planetary bodies. This research includes assessments of the survivability of various types of Earth microorganisms and the formation and retention of biosignatures under non-Earth conditions (*e.g.,* Mars, Europa). Also included under this research area are efforts to assess the potential habitability of planetary environments other than those found on the Earth. Studies of sites thought to be analogues of other planetary environments that might potentially harbor life will be considered as part of NASA's broader interest in the search for life in the Universe.

2. Programmatic Information

2.1 General Information

Proposals are sought for new projects within the scope of the Astrobiology: Exobiology and Evolutionary Biology program. Proposals submitted in response to this NRA should be for new work that is not currently supported by the program or for investigations that would extend to their next logical phase those tasks that have been funded in the Astrobiology program, but whose periods of performance expired in 2009 or are expiring in the first half of 2010. Periods of performance from one to four years may be proposed, as appropriate, to the nature of the contemplated research. The appropriateness of the proposed funding period will be reviewed and adjustments may be requested. Programmatic balance may limit the opportunities for funding in some areas.

2.2 Supplemental Funding for Additional Instrumentation

The Planetary Major Equipment program described in Appendix C.23 of this ROSES NRA allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by investigations for certain programs sponsored by the Planetary Science Research Program, including this one. New, analytical instrumentation requests, as well as requests for upgrades to existing instruments, costing more than $25,000, should be identified and requested in a special section of each proposal, to be titled "Major Equipment Request." However, note that a Planetary Major Equipment proposal must be affiliated with a “parent” Planetary Science research proposal in order to be considered; see Appendix C.23 for details.

2.3 Development of Astrobiology Instruments

This solicitation *does not request* proposals for the development of advanced instrument concepts and technologies as precursors to astrobiology flight instruments. Such proposals should be submitted to the Astrobiology Science and Technology Instrument Development (ASTID) program (Appendix C.19 in this ROSES NRA and potential amendments thereto). Proposals for science-driven field campaigns that are expected to produce new science results, as well as new operational or technological capabilities, should be submitted to the Astrobiology Science and Technology for Exploring Planets (ASTEP) program (see Appendix C.20 and potential amendments thereto).

2.4 Early Career Researchers

Early career researchers are encouraged to apply for the Fellowships for Early Career Researchers (see Appendix C.22 in this ROSES NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (*i.e.,* tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Fellowships for Early Career Researchers.

2.5 NASA Postdoctoral Program Fellows

Grantees in the program are eligible to serve as mentors to NASA Postdoctoral Program (NPP) Fellows. The tenure of a Fellow must begin before the end of the Exobiology award but may extend beyond it. Proposals from potential Fellows must be submitted through the standard NPP process. The Astrobiology Program expects to select no more than four Fellows associated with Exobiology research in 2010. More information about the NASA Postdoctoral Program may be found at http://nasa.orau.org/postdoc/ and a list of current opportunities may be found at http://www2.orau.gov/NASA_Catalog/.

2.6 Access to the Antarctic

The National Science Foundation (NSF) manages the U.S. Antarctic Program. NASA, therefore, collaborates with the NSF in evaluating the logistics needs of research programs that request access to Antarctic field sites. To that end:

1. Proposals requesting access to Antarctic field sites must justify their request on the grounds that Antarctica is the best or only location for their research.
2. Proposals must include, as an appendix, a completed Antarctic Operations Requirements Worksheet (ORW) and evidence that the ORW has been submitted to the NSF Office of Polar Programs. The ORW and instructions on submitting it to NSF are available at http://www.usap.gov/scienceSupport/polarice/.

Due to the scheduling of NASA and NSF review cycles, proposals requesting access to Antarctica should expect that their first field season will start in late-2012/early-2013. Proposals requiring Antarctic access in their first performance year may suggest a start date commensurate with this schedule.

2.7 Facilities Available for the Exobiology Program

The following facilities are available to investigators supported by the Astrobiology: Exobiology and Evolutionary Biology program. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled *Facilities and Equipment*). Also note that, per the directions in Section 2.3 of the *NASA Guidebook for Proposers*, a letter of support may be required from any facility required for the proposed effort.

- *NASA Ames Vertical Gun Range (AVGR):*

The NASA AVGR is a national facility funded by the NASA Science Mission Directorate to enable investigations of impact phenomena and processes. Exploratory or proof-of-concept programs requiring a limited number of experiments can be accommodated at no cost. More extensive programs are subject to review in order to assess feasibility and cost effectiveness.

Any need for extensive use of the AVGR should be explicitly described in the proposal. The proposal budget should include an estimate of usage costs. A letter of support from the AVGR is required.

For more information, potential users of the AVGR should contact:

Dr. Peter Schultz
Department of Geological Sciences
Box 1846
Brown University
Providence, RI 02912-1846
Telephone: (401) 863-2417
Email: peter_schultz@brown.edu

- *NASA-provided High-End Computational (HEC) Facilities*

Those investigators whose research requires high-performance computing should refer to the *Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to the Astrobiology: Exobiology and Evolutionary Biology program to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at the Ames Research Center's Advanced Supercomputing Division.

- *NASA Venus Pressure Test Chamber*

The Venus Pressure Test Chamber is a NASA facility that enables testing of components and small instruments under temperatures and pressures that simulate Venus surface conditions. Lower temperatures and pressures may also be accommodated. Exploratory or proof-of-concept programs requiring a limited number of experiments/tests can be accommodated at no cost. More extensive programs are subject to review in order to assess feasibility and cost effectiveness.

Any need for extensive use of the chamber should be explicitly described in the proposal. The proposal budget should include an estimate of usage costs. A letter of support from the Venus Chamber facility is required.

For more information, potential users of the Venus Chamber should contact:

Dr. Natasha Johnson
Astrochemistry Laboratory
Code 691
NASA/Goddard Space Flight Center
Greenbelt, MD 20771
Telephone: (301) 286-3919
Email: natasha.m.johnson@nasa.gov

2.8 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 15 months remaining at the time of submission of the supplement proposal.

For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $3.5M
Number of new awards pending adequate proposals of merit	~ 25
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in *NASA's Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-EXO

NASA point of contact concerning this program	Dr. Michael H. New Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1766 E-mail: HQ-EXO@mail.nasa.gov

C.18 PLANETARY PROTECTION RESEARCH

1. Scope of Program

Planetary protection involves preventing biological contamination on both outbound and sample return missions to other planetary bodies. Numerous areas of research in astrobiology/exobiology are improving our understanding of the potential for survival of Earth microbes in extraterrestrial environments, relevant to preventing contamination of other bodies by organisms carried on spacecraft. Research is required to improve NASA's understanding of the potential for both forward and backward contamination, how to minimize it, and to set standards in these areas for spacecraft preparation and operating procedures. Improvements in technologies and methods for evaluating the potential for life in returned samples are also of interest. Many of these research areas derive directly from recent National Research Council (NRC) recommendations on planetary protection for solar system exploration missions (see http://planetaryprotection.nasa.gov/pp/documents/index.htm for online reports and a list of publications).

As a complement to the research program entitled: Astrobiology: Exobiology and Evolutionary Biology (see Appendix C.17), the Planetary Protection Research program solicits research in the following areas:

- Characterizing the limits of life in laboratory simulations of planetary environments or in appropriate Earth analogs, particularly studies of the potential and dynamics of organism survival and reproduction in conditions present on the surface or subsurface of Mars (e.g., gullies and ice-rich environments) or within a subsurface ocean as may be present on Europa and other icy satellites – potentially in the presence of a heat source brought from Earth;
- Modeling of planetary environmental conditions and transport processes that could permit mobilization of spacecraft-associated contaminants to locations in which Earth organisms might thrive, for example Mars Special Regions or the subsurface of icy bodies such as Europa and other outer planet satellites;
- The development or adaptation of modern molecular analytical methods to rapidly detect, classify, and/or enumerate the widest possible spectrum of Earth microbes carried by spacecraft (on surfaces and/or in bulk materials, especially at low densities) before, during, and after assembly and launch processing. Of particular interest are methods capable of identifying microbes with high potential for surviving spacecraft flight or planetary environmental conditions (e.g., anaerobes, psychrophiles, radiation-resistant organisms); and
- New or improved methods, technologies, and procedures for spacecraft sterilization that are compatible with spacecraft materials and assemblies.

It should be noted that the evolving planetary protection requirements of NASA's planetary exploration programs may affect the priorities for funding among these areas.

2. Programmatic Information

2.1 Proposal Constraints

Proposals are sought for new projects in planetary protection that are not within the scope of the Astrobiology: Exobiology and Evolutionary Biology program (see Appendix C.17). Proposals submitted in response to this program element should be for new work that is not currently supported by NASA or for successor proposals that seek to extend to their next logical phase those tasks performing research in Planetary Protection that are currently funded but whose periods of performance will expire in 2010. Periods of performance from one to four years may be proposed, as appropriate, to the nature of the contemplated research. Approximately $300-500K per year of total funding is expected to be available to support two to four research tasks selected from proposals responding to this solicitation.

2.2 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $300-500K
Number of new awards pending adequate proposals of merit	~ 2-4
Maximum duration of awards	4 years; shorter term proposals are encouraged.
Due date for Notice of Intent to Propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.

Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	URL: http://nspires.nasaprs.com (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-PPR
NASA point of contact concerning this program	Dr. Catharine A. Conley Planetary Protection Officer Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-3912 E-mail: HQ-PPR@mail.nasa.gov

C.19 ASTROBIOLOGY SCIENCE AND TECHNOLOGY FOR INSTRUMENT DEVELOPMENT

Clarified on May 6, 2010: Although the identification and characterization of habitable worlds orbiting stars other than our own is an important objective of astrobiology, the Planetary Science Division no longer supports missions pursuing this objective. Proposals to develop instruments or techniques for the identification and characterization of extra-solar planets are not solicited by this Program. Rather they should be submitted to either Appendix D.3 APRA or Appendix D.11 SAT.

1. Scope of Program

1.1 Background

The Astrobiology Science and Technology for Instrument Development (ASTID) program element requests proposals to develop instrumentation capabilities to help meet Astrobiology science requirements on future space flight missions, as well as unique Astrobiology science objectives on Earth. Selected activities are expected to advance the development of scientific instruments or instrument components to the point where the instruments could credibly be proposed in response to future flight opportunity announcements, including instruments that could be accommodated on or in small satellites (under 50kg total spacecraft mass), or as small payloads in support of future science activities associated with missions of human exploration. Note that proposals to build and fly hardware on a specific mission opportunity are not a part of this program element. In addition, the development of instruments for use in future field campaigns is solicited under the Astrobiology Science and Technology for Exploring Planets (ASTEP) program (see Appendix C.20).

Note: In a change from the last ASTID solicitation, this solicitation does not solicit mission-concept proposals for Astrobiology missions.

The scientific goals and objectives of NASA's Astrobiology program are described in the Astrobiology Roadmap that is available on the Astrobiology web site at http://astrobiology.arc.nasa.gov/roadmap. Instrumentation and astrobiology mission concepts developed from research supported through this ASTID program element are meant to address two fundamental questions in Astrobiology, namely, "How does life begin and evolve?" and "Does life exist elsewhere in the Universe?" Objectives that could be addressed by new spacecraft instrumentation and astrobiology small payload missions include, for example:

- To determine whether the atmosphere of the early Earth, hydrothermal systems, or exogenous matter were significant sources of organic matter;
- To search for evidence of ancient climates, extinct life, and potential habitats for extant life on Mars;
- To determine the presence of chemical precursors and potential habitats for life in the outer Solar System; and
- To determine if compounds of biological significance are present beyond our Solar System.

1.2 ASTID Goals for Flight Instruments and Technologies

To take advantage of the wide range of mission opportunities, including aircraft and other suborbital platforms, Astrobiology requires the development of innovative technologies. Because of limited spacecraft accommodations, scientific instruments often must be very small and robust and have low power and telemetry bandwidth requirements. In most cases, instruments on spacecraft need to operate autonomously or allow teleoperation while conducting complex *in situ* sample analyses. Successful instruments must operate in environments often characterized by extremes of temperatures, pressures, gravity, vibrations, and/or radiation and may have to survive long dormant periods while in transit to other worlds and/or subsequent to high-g landing impacts. Sensors already exist that range from fingernail to matchbook sizes, and a wide array of miniaturized chemical laboratories exist that can fit on a compact disk; however, relatively few are ready to be proposed successfully for space flight.

Major targets of Astrobiology interest include (but are not limited to) Mars, Europa, Titan, comets, asteroids, the Earth, extra-solar planetary systems, and dense interstellar molecular clouds. In addition, future opportunities are expected to include astrobiological studies from and on the Moon, and significant opportunities may exist in missions that orbit the Earth at low, medium, and high orbital distances. ASTID program emphasis will be placed on proposals that are relevant to missions possessing the greatest potential of meeting Astrobiology goals for which instruments have not yet been selected or on which instruments may be changed. Furthermore, support can be provided for long lead-time definition studies, for innovative approaches that may provide entirely new classes of instruments, for the development of new enabling technologies for missions further in the future, and/or for development studies that may advance the technology for a wide range of instrumentation applications. It is anticipated that, to develop potential space flight instruments, some approaches will require novel instrument concepts while other approaches will focus on reductions in mass, volume, power requirements, and/or costs of existing technologies. NASA also recognizes that some approaches may require field tests to improve instrument utility and robustness.

While proposals in all areas relevant to Astrobiology goals and objectives may be considered for the ASTID instrument development opportunity, specific needs in the following areas are recognized and will be given high priority for selection:

- The acquisition (*e.g.*, coring, drilling), handling (*e.g.*, moving, storing, documenting) and preparation (*e.g.*, sectioning, crushing, chemically treating) of samples collected for astrobiological objectives,
- *In situ* detection of possible chemical/organic biomarkers and precision measurements of isotopic abundances of the elements C, H, N, O, P, S, and other life-related elements such as Fe, Mn, Mo, etc.
- “Lab-in-a-teacup” systems performing complete analyses (e.g., GC/MS, PCR/Sequencing). While subsystem development for these systems are also of interest, the development of integrated systems of this type are of higher priority.

- For small satellites/small payloads, instruments that can be accommodated within the scope of the small payload opportunities discussed in the June 2007 Workshop report (see http://nai.arc.nasa.gov/asp).

Under this ASTID instrument-development announcement, proposals are sought at three general levels: (i) feasibility study and instrument definition (i.e., proof of concept), (ii) instrument development and definition (*i.e.*, the breadboard stage), and (iii) development of instruments to a sufficiently mature "brassboard" level that they may be proposed in response to future announcements of flight opportunities (flight opportunities include suborbital, orbital, planetary, and deep space platforms).

Proposals to define or develop one or more instrument components, rather than whole instruments, are allowed, particularly for immature or very complex new instruments. However, at least one or more likely scenarios for possible follow-on instrument development activities must be described in the case of component-only proposals, that is, such proposals to study a component must be placed in the context of a complete instrument that can serve to achieve some objective in Astrobiology, even for a hypothetical mission. Scientific objectives of proposed instruments or components must be discussed in the proposal, and proposers are encouraged to relate their proposals as closely as possible to future missions of interest to the Astrobiology program and demonstrate how the technology addresses Astrobiology goals and objectives.

1.3 Examples of Future Missions

Proposals for long-lead time definition studies, novel instrument concepts, and innovative approaches leading to new instrument classes that could be relevant to one or several missions will be considered. Missions suitable for instrument-development under this Astrobiology instrument-development call may include Discovery, New Frontiers, or small payload/small satellite opportunities as defined by recent National Research Council reports or by the Astrobiology Small Payloads workshop report, as well as possible future Flagship mission opportunities. These include missions to small bodies such as comets or asteroids, the icy satellites of Jupiter and Saturn, Mars missions, and future missions of lunar exploration, as well as Earth orbital missions and other free-flying experimental or observational platforms, such as astronomy missions under development or study by NASA and its international partners.

1.4 Nonflight ASTID Goals

Although the focus of the ASTID program is development of scientific instruments for future flight opportunities, consideration will also be given to proposals for development of ground-based laboratory or field instrumentation important to the goals and objectives of the Astrobiology program. Of particular interest will be instrumentation that would potentially enable new research capabilities for Astrobiology, such as the ability to measure novel biomarkers. The proposals for the development of new field-deployable instruments in support of the Astrobiology Science and Technology for Exploring Planets (ASTEP) program are also welcome.

2. Programmatic Information

2.1 General Information

Proposals are sought for new projects within the scope of the Astrobiology Science and Technology for Instrument Development program. Proposals submitted in response to this NRA should be for new work that is not currently supported by the program or for investigations that would extend to their next logical phase those tasks that have been funded in the Astrobiology program, but whose periods of performance expired in 2009 or are expiring in the first half of 2010. Periods of performance from one to four years may be proposed, as appropriate, to the nature of the contemplated research. The appropriateness of the proposed funding period will be reviewed and adjustments may be requested. Programmatic balance may limit the opportunities for funding in some areas.

2.2 Early Career Researchers

Early career researchers are encouraged to apply for the Fellowships for Early Career Researchers (see Appendix C.22 in this ROSES NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (*i.e.*, tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Fellowships for Early Career Researchers.

2.3 NASA Postdoctoral Program Fellows

Grantees in the program are eligible to serve as mentors to NASA Postdoctoral Program (NPP) Fellows. The tenure of a Fellow must begin before the end of the ASTID award but may extend beyond it. Proposals from potential Fellows must be submitted through the standard NPP process. The Astrobiology Program expects to select no more than two Fellows associated with Astrobiology Instrument Development in 2010. More information about the NASA Postdoctoral Program may be found at http://nasa.orau.org/postdoc/ and a list of current opportunities may be found at http://www2.orau.gov/NASA_Catalog/.

2.4 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $2.5M
Number of new awards pending adequate proposals of merit	~ 8
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-ASTID
NASA point of contact concerning this program	Dr. Michael H. New Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1766 E-mail: HQ-ASTID@mail.nasa.gov

C.20 ASTROBIOLOGY SCIENCE AND TECHNOLOGY FOR EXPLORING PLANETS

Amended on April 9, 2010. The proposal due date for this program element has been changed to July 16, 2010.

1. Scope of Program

Future astrobiological research associated with solar system exploration and the Vision for Space Exploration requires the development of astrobiologically relevant, miniaturized instrumentation capable of extensive operations on lunar and planetary surfaces throughout the Solar System. To this end, and in collaboration with other Directorates at NASA and other agencies, this Astrobiology Science and Technology for Exploring Planets (ASTEP) program solicits proposals for investigations focused on exploring the Earth's extreme environments in order to develop a sound technical and scientific basis to conduct astrobiological research on other solar system bodies. The ASTEP program is a science-driven exploration program that is expected to result in new science and operational/technological capabilities to enable the next generation of planetary exploration. A unique feature that is central to the ASTEP program is the use of terrestrial field campaigns to further science and technology and NASA's exploration capabilities. Therefore, proposals that integrate the following three concerted objectives will be given priority:

1) Science: ASTEP seeks science investigations designed to further astrobiological research in the terrestrial extreme environments that may be analogous to those found on other planets, past or present. Such investigations should increase our understanding of the limits and constraints (or lack thereof) of life in extreme environments and lead to a better understanding of how to seek, identify, and characterize life and life-related chemistry that may exist or have existed on other solar system bodies.
2) Technology: ASTEP seeks the development and application of technologies that support science investigations by enabling remote searches for, and identification of, life and life-related chemistry in extreme environments (including lunar and planetary surfaces). These technologies include, but are not limited to, sample acquisition and handling techniques, sample manipulation, and the use of mobile science platforms (including planetary rovers and astronauts) including techniques for autonomous operations and self-contained deployment systems. (N.B. Science instrument technology proposals should be submitted to the Astrobiology Science and Technology Instrument Development Program; see C.19, above.)
3) Field Campaigns: ASTEP seeks systems-level terrestrial field campaigns designed to address astrobiology science goals and demonstrate and validate related technologies in remote and/or extreme environments on Earth. It is expected that such field campaigns will be conducted with complete systems and in a manner that approximates operations during an actual planetary mission, providing an opportunity to understand the performance, capabilities, and efficiencies associated with the tested systems while enabling human participants to gain operational experience with those systems in the field.

In addition, ASTEP solicits proposals to develop technologies (see examples above) that are focused on enabling future field campaigns. Any field testing included in such proposals would be expected to be a minor part of the overall proposed effort.

In summary, ASTEP is expected to lower the risks of planetary exploration through instrument/technology development aimed at or coupled with systems-level field tests in Earth's extreme environments that will obtain scientific data and develop operational capability.

The high-visibility field campaigns to the Earth's extreme environments that are expected to be supported through this program element should also provide significant opportunities for student involvement in exploration, thereby inspiring a technologically competent next generation of scientists, engineers, explorers, and citizens. Therefore, proposals to ASTEP that provide for student involvement (both graduate, as well as undergraduate) are encouraged. In addition, proposals are also sought that incorporate Education/Public Outreach (E/PO) activities through telepresence capabilities and involvement of professional educators and students nationwide in the fun and challenges of science and technology. Further guidance on the E/PO program sponsored by the Science Mission Directorate may be found in Section I(c) of the *ROSES Summary of Solicitation* of this NRA. Conversely, proposers who prefer not to propose a significant E/PO effort should state in their proposals whether they are willing to host an outside E/PO activity arranged by NASA.

2. Programmatic Information

2.1 General Information

Proposals are sought for new science-driven field campaigns that are expected to produce new science results, as well as new operational or technological capabilities. Proposals submitted in response to this NRA should be for new work that is not currently supported by the program or for investigations that would extend to their next logical phase those tasks that have been funded in the Astrobiology program, but whose periods of performance expired in 2009 or are expiring in the first half of 2010. Periods of performance from one to four years may be proposed, as appropriate, to the nature of the contemplated research. The appropriateness of the proposed funding period will be reviewed and adjustments may be requested. Programmatic balance may limit the opportunities for funding in some areas.

2.2 Development of Astrobiology Instruments

This solicitation *does not request* proposals for the development of advanced instrument concepts and technologies as precursors to astrobiology flight instruments. Such proposals should be submitted to the Astrobiology Science and Technology Instrument Development (ASTID) program (Appendix C.19 in this ROSES NRA and potential amendments thereto).

2.3 Access to the Antarctic

The National Science Foundation (NSF) manages the U.S. Antarctic Program. NASA, therefore, collaborates with the NSF in evaluating the logistics needs of research programs that request access to Antarctic field sites. To that end:

1. Proposals requesting access to Antarctic field sites must justify their request on the grounds that Antarctica is the best or only location for their research.
2. Proposals must include, as an appendix, a completed Antarctic Operations Requirements Worksheet (ORW) and evidence that the ORW has been submitted to the NSF Office of Polar Programs. The ORW and instructions on submitting it to NSF are available at http://www.usap.gov/scienceSupport/polarice/.

Due to the scheduling of NASA and NSF review cycles, proposals requesting access to Antarctica should expect that their first field season will start in late-2011/early-2012. Proposals requiring Antarctic access in their first performance year may suggest a start date commensurate with this schedule.

2.4 Early Career Researchers

Early career researchers are encouraged to apply for the Fellowships for Early Career Fellowships (see Appendix C.22 in this ROSES NRA) by simply checking an additional box on the cover page of their proposal. To be eligible, proposers must be within seven years of the date of receipt of their Ph.D. and not currently employed in a tenure-track, or equivalent, position. This program was established to facilitate the integration of new Planetary Science discipline researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (i.e., tenure-track, civil servant, or equivalent) position. For more information, please see Appendix C.22, Fellowships for Early Career Fellowships.

2.5 NASA Post-doctoral Program Fellows

Grantees in the program are eligible to serve as mentors to NASA Post-doctoral Program (NPP) Fellows. The tenure of a Fellow must begin before the end of the ASTEP award but may extend beyond it. Proposals from potential Fellows must be submitted through the standard NPP process. The Astrobiology Program expects to select no more than 2 Fellows associated with ASTEP research in 2010. More information about the NASA Post-doctoral Program may be found at http://nasa.orau.org/postdoc/.

2.6 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected program budget for first year of new awards	~ $4 M
Number of new awards pending adequate proposals of merit	~ 5
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-ASTEP
NASA point of contact concerning this program	Dr. Mary Voytek Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1577 E-mail: HQ-ASTEP@mail.nasa.gov

C.21 IN-SPACE PROPULSION: MARS ASCENT VEHICLE

1. Scope of Program

Over the last decade, NASA has been planning for a Mars Sample Return (MSR) mission. As a result of industry studies in 2001, a Mars Ascent Vehicle (MAV) concept has been incorporated into the current MSR architecture consisting of a 2-stage solid rocket motor (SRM) approach (Stephenson 2002[1]). With an MSR lander mission currently envisioned in the early 2020s, NASA seeks via this solicitation updated MAV propulsion-system approaches (solid, liquid, etc) that can achieve TRL-6 within 3 years.

Promising approaches would be selected with a premium placed on 1) minimizing the overall mass of the MAV and associated support systems on the MSR lander, and 2) minimizing both development and flight risks. While the proposed solutions must, at a minimum, be applicable to the conceptualized Mars Sample Return mission, technologies that are applicable to sample return missions from additional non-terrestrial bodies are highly desirable.

The current MSR lander approach provides thermal control for the bulk of the MAV mass to above -40C, with insulating and heating equipment, and structural support and erection equipment all having a rough mass estimate of 50-60kg. Concepts that could reduce this support equipment could potentially lower the overall MAV-related lander mass.

The fundamental requirements on the MAV are:

1. Deliver a 5kg, 16-cm diameter spherical sample container to orbit.
2. Achieve >400km altitude circular orbit, including dispersions, and an inclination of 30 degrees north within +/- 0.2 degrees from a latitude of 30 degrees north.
3. Be single-point failure tolerant.
4. Transmit both real-time and recorded engineering data to an orbiter with enough fidelity to allow determination of root causes in the case of decreased performance or failure.
5. Not require sub-centimeter center-of-gravity accuracy of the sample container.
6. Fit within a 3m x 0.6m diameter volume in a horizontally stowed position during launch and landing, oriented in any azimuth in relation to the MAV descent trajectory.

2. Description of Tasks and Products

NASA solicits proposals for advanced technology development of MAV propulsion systems to TRL-6. Included are three phases:

- Phase I - System Definition and Development Study
- Phase II - Component Technology Maturation, and

[1] Stephenson, D., "Mars Ascent Vehicle – Concept Development", NASA-Marshall Space Flight Center, Huntsville, AL, 38th Joint Propulsion Conference and Exhibit, July 7 – 10, 2002, Paper #4318. http://pdf.aiaa.org/preview/CDReadyMJPC2002_595/PV2002_4318.pdf

- Phase III - System-level Maturation, including integrated qualification-level testing.

Phase II and III are each optional and may be contingent on down-select of MAV concepts that best meet the needs of the MSR Program as anticipated at the time of selection. Concepts shall be subject to red-team review by JPL Team-X and propulsion experts to ensure uniformity in assumptions (e.g. margins, level of redundancy, mission and platform interfaces) and level of credibility.

2.1 Phase I - System Definition and Development Study

During the study phase, the proposer shall define a MAV system that meets the fundamental requirements listed above, as well as more detailed MAV requirements provided at the beginning of the study. In addition, technology gaps to a TRL-6 propulsion system and a plan to mature shall be defined.

MAV definition would include:

- Preliminary MAV design and performance,
- Identification of TRL and heritage of all baseline hardware,
- Detailed design attributes including configuration, a Master Equipment List (MEL) and mass, power, thermal and data requirements,
- Platform accommodation and support requirements,
- Identification of areas of high risk to mission performance and key risk reduction efforts, and
- Trades and analyses leading to the MAV design, performance estimates and potential benefits to the supporting interfaces and subsystems.

For the propulsion system:

- Identification of technology gaps and technology development risk assessment process, including risk mitigation plan,
- Performance enhancement options, if applicable, and
- A detailed plan, including costs and schedule, for a technology development effort to bring the propulsion system to TRL 6, broken out into Phase II and Phase III, including a list of long-lead items. Milestones occurring at least quarterly shall be identified.

Performance of Phase I shall be within a period of performance of 6 months and include

- Monthly progress reports,
- Participation in a red-team review of the MAV concept by JPL Team-X at month 4 or 5 and incorporation of results into design, and
- A final report and oral presentation that document key results and conclusions of the study with baseline propulsion system design, to be completed and submitted within one month after the technical effort concludes.

2.2 Phase II - Component Technology Maturation

During optional Phase II, the proposer shall develop component technologies identified as gaps during Phase I to TRL-6. Development would include component or subsystem testing to validate performance goals and address environmental compatibility.

Performance of Phase II shall include:

- Monthly progress reports,
- Quarterly oral reports,
- Any modification to Phase III plan due to results, and
- A final report that documents key results and conclusions of the work performed, to be completed and submitted within one month after the technical effort concludes.

2.3 Phase III - System-level Maturation

During optional Phase III, the proposer shall perform propulsion system integration and qualification testing to achieve TRL-6. In addition, the proposer shall provide updates to the propulsion system design details as needed and provide flight system unit cost estimates.

Performance of Phase III shall include:

- Monthly progress reports,
- Quarterly oral reports, and
- A final report that documents key results, conclusions, and validation of TRL-6 achievement, submitted within one month after the technical effort concludes.

2.4 Phase II and III Period of Performance

The total combined periods of performance of Phase II and III shall not exceed thirty-six (36) months. It is expected that these periods would vary for different concepts. Progression to Phase III is contingent on Phase II results.

3. Programmatic Information

3.1 Number of Awards

Up to three (3) Phase I contracts may be awarded for a maximum of $250k each to begin in late FY 2010 or early FY 2011. Down select to 1 or more for Phases II and III is likely. Potential funding levels and schedule of Phases II and III will be based on proposers' estimates of funds needed to achieve TRL-6.

3.2 Teaming Arrangements

Teaming arrangements of all kinds by all types of proposing organizations, including nonprofit and for-profit, academic, private, and governmental, are encouraged. Partnerships between propulsion subsystem providers and potential integrated MAV flight system providers are strongly encouraged. If a non-NASA organization wishes to team with a NASA center for technology development efforts, such negotiations must be accomplished prior to submission of the proposal, and all costs associated with the intended activities at that NASA Center must be included in the cost section of the proposal. Note that no preference will be given to proposals that seek to team with a NASA Center, nor for proposals that come from a NASA Center.

Points of contacts for technology development teaming inquiries are:

Institution	Point of Contact
Glenn Research Center	Mike Meyer Michael.L.Meyer@nasa.gov (216) 977-7492
Jet Propulsion Laboratory	David Vaughan Dave.Vaughan@jpl.nasa.gov (818) 393-6338
Marshall Space Flight Center	Chuck Pierce Charles.Pierce@nasa.gov (256) 544-6366

3.3 FAQ

All questions and responses will be posted online at: http://spaceflightsystems.grc.nasa.gov/Advanced/ScienceProject/ISPT/MAV.

4. Summary of Key Information

Expected program budget for first year of new awards	Phase I: Up to $750K
Number of new awards pending adequate proposals of merit	Phase I: Up to 3
Maximum duration of awards	Phase I: 6 months Phase II and III: 36 months
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	October 1, 2010
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.

Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-ISP
NASA point of contact concerning this program / ISP Program Executive	Dave Lavery Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4684 E-mail: HQ-ISP@mail.nasa.gov

C.22 FELLOWSHIPS FOR EARLY CAREER RESEARCHERS

1. Scope of Program

The Early Career Fellowship program was established to facilitate the integration of new planetary science researchers into the established research funding programs and to provide tools and experience useful when searching for a more advanced (i.e., tenure-track, civil servant, or equivalent) position.

Two proposal opportunities are offered under the Early Career Fellowship program in ROSES-2010. The first is an opportunity for researchers to be selected as Early Career Fellows (Section 4.2). Early career researchers are encouraged to apply for the Fellowship through any participating Planetary Science Research Program element of this ROSES NRA (see Section 2, below). The second is an opportunity for current Fellows (selected in a prior solicitation) to apply for start-up funds (Section 4.3). Selected Fellows have the opportunity to apply directly to the Early Career Fellowship program for up to $100K in start-up funds when they obtain a tenure-track or equivalent position.

2. Eligibility

This program is intended to bring new researchers into the planetary science community and to help them become established in tenured or equivalent positions. In keeping with this goal, proposers who wish to become Early Career Fellows must have received their Ph.D. no earlier than 2003 and must be currently employed as a postdoctoral researcher, research assistant, or an equivalent nontenured position. Tenure-track faculty are not eligible to apply for the Fellowship. Researchers who received their Ph.D. earlier than 2003 and have been inactive from the field for a period of time (for example, for child-rearing) and wish to reenter planetary science research are also welcome to apply, although no applicant may have held tenure (or its equivalent) on or before the submission of his/her proposal.

Participation in this program is funded by individual participating planetary science research programs. Accordingly, participation is limited to proposers submitting research proposals to the following planetary science research programs:

- Cosmochemistry (Appendix C.2);
- Planetary Geology and Geophysics (Appendix C.4);
- Planetary Astronomy (Appendix C.5);
- Planetary Atmospheres (Appendix C.6);
- Outer Planets Research (Appendix C.7);
- Lunar Advanced Science and Exploration Research (Appendix C.8);
- Near Earth Object Observations (Appendix C.9)
- Planetary Mission Data Analysis (Appendix C.11);
- Mars Data Analysis (Appendix C.12);
- Mars Fundamental Research (Appendix C.13); and
- Astrobiology: Exobiology and Evolutionary Biology (Appendix C.17)
- Astrobiology Science and Technology for Instrument Development (Appendix C.19); and

- Astrobiology Science and Technology for Exploring Planets (Appendix C.20).

3. Benefits

Executing a successful research program is dependent on a number of field-specific factors and qualifications. There are, however, a few key elements that are critical to success across the field of planetary science:

- Successful proposal writing;
- Adequate (paid) research time;
- Management of a laboratory;
- Collaboration and networking;
- Frequent and high-quality publications; and
- Adequate start-up equipment funds.

These elements may be particularly critical for early career researchers searching for a tenure-track or equivalent position at the institution of their choice. To facilitate this process, the Early Career Fellowship program strongly encourages qualified proposers to any of the planetary science research programs listed above to carefully consider their own professional development needs and include requests for additional funding (with justifications) for the following elements in their research proposals:

- Salary;
- Undergraduate and/or graduate research assistants;
- Supplies and instrument upgrades (up to $25K);
- Travel to conferences, meetings, and advisory groups;
- Time and travel for learning new skills;
- Participation in NASA's Early Career Workshop, currently held in conjunction with the annual Lunar and Planetary Science Conference;
- Publication page charges;
- Books and journal subscriptions;
- Computer time and/or specialized software; and
- Other research-specific needs.

Successful proposers who are selected as Fellows may then be offered the opportunity to submit proposals for funding to be used at the institution of their choice when they obtain a tenure-track or equivalent position. These proposals can be for up to an additional $100K in a subsequent year of their nominal research award to be used as laboratory start-up funds. This last option, for start-up funds, is available as part of the ROSES-2010 NRA for Fellows selected under prior year ROSES solicitations. Information on applying for start-up funds is given in Section 4.3 (below).

All budget items must conform to any stated limits in the *NASA Guidebook for Proposers.*

4. Programmatic Information

4.1 Introduction

This Fellowship program is an add-on to the planetary science research programs listed in Section 2. All Fellows are originally selected and funded through a parent proposal to, and subsequent award from, one of these program elements.

In the event that a proposer's institution does not allow nontenured faculty or postdoctoral researchers to independently apply for NASA grants, the proposal may include a mentor as the "Institutional PI" with the nontenured faculty or postdoctoral researcher as the "Science PI," as outlined in Section 1.4.2 of the *NASA Guidebook for Proposers.*

Annual progress reports should be sent to the cognizant program officer for the parent award, with a copy sent to the Fellowship program officer listed in the *Summary of Key Information* in Section 5.

4.2 Consideration for Selection as an Early Career Fellow

Interested researchers must meet all eligibility requirements in Section 2 to be considered as an Early Career Fellow. To be considered for the Fellowship, eligible scientists must submit a standard research proposal (referred to as the parent proposal) to one of the participating programs listed in Section 2. In addition, the proposer must select the Early Career Fellowship checkbox on the *Cover Page* of this parent proposal. Proposers are encouraged to include a short statement as part of their CV describing their qualifications for the Fellowship and specific information regarding how the Fellowship would impact their future career plans.

The parent proposal must adhere strictly to the deadlines and instructions for the participating program to which it is submitted. The parent proposal will be reviewed along with all other proposals submitted to the respective participating program as part of the normal peer review process. Selection of the parent proposal by the participating program is a prerequisite for consideration as an Early Career Fellow. Program Officers will nominate from one to three selected proposers (per participating program) as Early Career Fellows.

Since this program is an add-on to the planetary science research programs listed in Section 2, there is no absolute standard for budget requests. Proposers are encouraged to request the funding that they need to carry out their research program, roughly in line with the typical support offered by the research program to which they propose. Proposers are eligible to apply independently for Planetary Major Equipment funds (Appendix C.23), Education/Public Outreach funds (Section I(c) of the *ROSES Summary of Solicitation*), travel grants, Participating Scientist Programs, and other NASA opportunities as they arise.

4.3 Submission of Proposals for Start-up Funds

Current Fellows (named in response to a proposal submitted under a prior year solicitation) are eligible to apply for start-up funds under this program. The start-up package is intended to aid

Fellows in establishing a research group or laboratory in their new position, enabling Fellows to continue their NASA-funded investigation. The funds may be used to purchase laboratory equipment, provide salary for the Fellow, as well as students and research associates, and cover other expenses associated with establishing research efforts.

Fellows selected under the 2006, 2007, 2008, or 2009 ROSES NRAs are eligible to apply for up to $100K in laboratory start-up funds. This funding is not guaranteed and is subject to peer review. To obtain the start-up funds, the Fellow must submit a proposal describing how the funds will be used. The Fellow must also obtain a tenure-track or equivalent position at the institution of his or her choice. Fellows should submit their proposals for start-up funds under the sponsorship of their new institution.

To request start-up funds, Fellows should provide a short proposal detailing the research group they plan to establish upon gaining a tenure-track or equivalent position. The proposal must describe any needed equipment and facilities and anticipated staffing plans (including the role of undergraduate students, graduate students, and postdoctoral researchers). The proposal must contain a strategy describing how the Fellow plans to sustain the research group or laboratory over the long term. A detailed budget with a narrative justification is required as part of the proposal. Fellows should also describe how the planned research group will benefit NASA and further its goals.

Proposals for start-up funds are submitted directly to this Early Career Fellowships program (and not to the parent planetary science research program). Note that proposals for start-up funds must be submitted by either of two annual proposal due dates given in Tables 2 and 3 of the *ROSES Summary of Solicitation*.

5. Summary of Key Information

Please note that proposals for new Early Career Fellowships are not independent of the other planetary science research program elements and that the constraints and requirements may vary with the associated science research program. For example, Cosmochemistry proposals have a different due date from Outer Planet Research proposals, and the typical funding levels vary as well. Refer to the information in the corresponding science research program element for questions about those programs and specific constraints and requirements for proposals to those programs.

Expected program budget for first year of new awards	N/A; all funds are distributed by the corresponding science research program element
Number of new awards pending adequate proposals of merit	1 to 3 per science research program element
Maximum duration of awards	3 years for Fellowship start-up funds, if selected
Due date for Notice of Intent to propose (NOI)	No Notices of Intent are requested for this program element.

Due date for proposals	For consideration as a Fellow (new applicants), submit a standard research proposal to the participating program by the deadline specified for the participating program. See Tables 2 and 3 in the *ROSES Summary of Solicitation* for the appropriate science research program element. Proposals for start-up funds from current Fellows selected in prior years are due twice annually; see Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	7 pp, for proposals from current Fellows for start-up funds; see also Chapter 2 of the *2009 NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-ECF (for current Fellow applications for start up funds; otherwise please see the specific science research program element.)
NASA point of contact concerning this program	Dr. Curt Niebur Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0390 E-mail: curt.niebur@nasa.gov

C.23 PLANETARY MAJOR EQUIPMENT

1. Scope of Program

This program element allows proposals for new or upgraded analytical, computational, telescopic, and other instrumentation required by investigations sponsored by the Planetary Science Research Program's science research programs as offered in this solicitation, entitled:

- Cosmochemistry (Appendix C.2);
- Laboratory Analysis of Returned Samples (Appendix C.3);
- Planetary Geology and Geophysics (Appendix C.4);
- Planetary Astronomy (Appendix C.5);
- Planetary Atmospheres (Appendix C.6);
- Outer Planets Research (Appendix C.7);
- Lunar Advanced Science and Exploration Research (Appendix C.8);
- Near Earth Object Observations (Appendix C.9);
- Mars Fundamental Research (Appendix C.13);
- Astrobiology: Exobiology and Evolutionary Biology (Appendix C.17); and
- Origins of Solar Systems (Appendix E.3).

Planetary Major Equipment (PME) proposals may be submitted only in conjunction with new science research proposals to this NRA or as an augmentation to Planetary Science Research Program multiple year awards. A PME proposal that is not affiliated with such a new or existing NASA science research proposal is nonresponsive to this program element and will be rejected without review.

Instrumentation purchases or upgrades that may be requested through this program are to be of a substantial nature; that is, over $25K. Types and/or classes of instruments that are considered appropriate to be proposed for this program element include: solid source, light element, and noble gas mass spectrometers; scanning electron microscopes; transmission electron microscopes; secondary ion mass spectrometers; activation analysis equipment; X-ray fluorescence analyzers; molecular characterization tools; liquid or gas chromatographs; static high pressure instrumentation; telescopic instrumentation; high resolution infrared spectrometers; instrumentation for planetary atmospheres laboratory studies; and instrumentation for measurements of gas phase reaction rates, photochemical reaction rates, branching rates, and/or collision, disassociation, ionization, and/or recombination cross-sections.

Instrumentation, equipment, and services that are excluded from proposals to this program element include personal computers or computer peripherals (unless these are integral parts of the instrumentation requested), miscellaneous support equipment, support contracts, and the repair of equipment where the repair does not also involve significant enhancement of the instrument's basic capabilities. No funds may be requested to support maintenance and continued operations of any instrument. Proposals that seek to design, develop, test, or evaluate new instruments that are intended for commercial sale will be rejected without review.

2. Instrument Management and User Access

Requests for fabrication or purchase of an instrument should specify how the instrument is to be used, i.e., in terms of the three categories defined below:

- Investigator Instrument. An investigator instrument is defined as an instrument acquired or developed by the proposer to support the PI's research where the PI has full authority for its exclusive use and where there are no commitments to make the instrument available to other investigators.

- Investigator Facility Instrument. An investigator facility instrument is defined as an instrument acquired or developed by an investigator to support the PI's research where an identified portion of its time is to be reserved for use by the PI, but where an additional specified portion of its time will be made available to other knowledgeable NASA-supported planetary program investigators, and where all details or access, method of use, charging, and data rights are determined by the PI in negotiation with potential users.

- Regional Facility Instrument. A regional facility instrument is defined as an instrument of considerable cost or one that is limited to one location by virtue of its use on a specific facility but has been acquired by a PI to support the PI's research. A significant, specified portion of a regional facility instrument's time will be reserved for use by the PI, but a significant, specified portion of its time must also be available to other NASA-supported planetary program investigators. Unlike an investigator facility instrument, however, all details of access, announcement of availability, assistance to be provided on its use and methods of use (whether hands on or by a facility-based operator), charges, and data rights must be documented and agreed to by NASA and the sponsoring institution before NASA support is provided.

Collective use by other members of the scientific community is encouraged. Such proposals must include a description of the management plan for this instrument that includes a statement of the percentage of the instrument's time that would be available to other users, and a general statement regarding aspects of user access, such as time of day when access would be granted, whether access would be "hands on" or only by an operator or collaborator in the proposer's group, any costs to be charged for use, how such costing would be handled, and how users would apply to gain access (*e.g.*, by personal communication, formal proposal, or other method).

It is expected that title to any equipment obtained through this program shall vest with the proposing institution in accordance with the provisions of §1260.74 of NASA's *Grants and Cooperative Agreement Handbook* found online at http://prod.nais.nasa.gov/pub/pub_library/grcover.htm. However, in the cases where the equipment upgrade is for a facility owned by the Government, NASA reserves the right to negotiate title of the equipment for the best interests of the user community.

3. Costs

Whether the proposed instrument is to be purchased by the investigator from a commercial vendor or is to be designed and built by or for the investigator him/herself, only those costs directly associated with the acquisition, installation, and check-out of the instrument may be proposed through this program element. Costs for maintenance and operation beyond the check-out period must be requested in research proposals submitted to the appropriate Planetary Science research program elements described in this or future NRAs. No salary support can be provided for the investigators under this program element. Each relevant cost should be fully explained and substantiated, and a quotation provided for any major equipment purchased from a commercial vendor. If acquisition or development of an instrument or facility will require more than one year, the proposal should cover the complete project but make clear distinction between efforts in each year.

Cost-sharing and substantial institutional contributions are encouraged. It should be noted that cost sharing between NASA and other Federal agencies is encouraged to the extent that NASA's share of the cost will ensure adequate access to the finished instrumentation by NASA investigators; this acquisition/access aspect of any proposed effort involving cost-sharing must be discussed in the proposal. The proposal must document whether any other agency has been approached or has made tentative commitments and provide the name and telephone number of the appropriate officer who can discuss his/her agency's interest.

Proposals selected for PME support will be funded through augmentation to the science research program proposal. Final reports should be sent to the cognizant science research program officer, with a copy sent to the PME Program Officer listed in the table at the end of this section.

4. Programmatic Information

4.1 Submission of PME proposals

To submit a request for PME funds in conjunction with a new proposal, include up to five additional pages of description of the instrument request, including how this purchase will contribute to the research described in the science research proposal. Include also a page of instrument specifications and at least one quote for the instrument or major components. In addition, the proposer should select the PME checkbox on the Cover Page for the affiliated science research program (see Chapter 2 of the *NASA Guidebook for Proposers* as referenced in Section 5 below). The PME request should be listed as Equipment in the budget information, typically for year one only.

To submit a request for PME funds in conjunction with an existing science research award in one of the Planetary Science Research Programs noted above, prepare a complete proposal in full compliance with all applicable instructions and deadlines associated with the science research program to which you are proposing. The only exception is that the *Scientific/Technical/Management* section of the proposal is limited to seven pages instead of fifteen. Such PME proposals should contain sufficient background information on the affiliated research so that each can be reviewed without also rereviewing the existing science research award. The proposer should select the PME checkbox on the *Cover Page* of this submission.

All proposals must include a convincing case for instrument funding, addressing as many of the following as applicable: why the instrument is necessary for the investigator's research or how it would enhance that research, citing specific examples; why the enhanced capability is important to planetary science in general; and, if an instrument is proposed for the benefit of the science community, how the enhanced capability would benefit the larger planetary science community. All proposals should address how the requested instrument relates to existing capabilities, both in the investigator's own laboratory and other facilities.

4.2 Evaluation Criteria and Review of PME Proposals

PME proposals will be reviewed as part of the science research program peer reviews, in the context of their respective science research proposals. Evaluation factors will be those listed in each science research program element, with the following additions:

- In evaluating the intrinsic merit of the request, additional factors that will be considered of equal weight are the scientific merit of the science research proposal and the value that the new or enhanced capability would add to science and/or education beyond that offered specifically to planetary science.
- In considering the relevance of the request to NASA's planetary science objectives, attention will be focused on the added value that would be gained by the addition of the instrument capability to ongoing and anticipated research of the proposer, in particular, and to NASA's objectives in general.

Those proposals that most clearly meet the evaluation criteria will be considered by the Planetary Science Research Program Officers when developing their recommendations for selection.

5. Summary of Key Information

Expected annual program budget for new awards	~ $1.5M
Number of new awards pending adequate proposals of merit	~ 5-10
Maximum duration of awards	Usually only one year
Due date for Notice of Intent to propose (NOI)	No Notices of Intent are requested for this program element.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	7 pp for stand-alone proposals affiliated with an existing research award; 5 pp for addenda to new proposals in other science research programs; see also Chapter 2 of the *NASA Guidebook for Proposers*

Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	Please refer to the specific science research program element.
NASA point of contact concerning this program	Dr. Jeffrey Grossman **[Changed March 30, 2010]** Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1218 Email: HQ-PME@mail.nasa.gov

C.24 MOON AND MARS ANALOG MISSIONS ACTIVITIES

1. Scope of Program

1.1 Programmatic Overview

NASA Analog Missions research addresses the need for integrated interdisciplinary field experiments as an integral part of preparation for planned human and robotic missions to the Moon and Mars. The focus of this program will be on providing high-fidelity scientific investigations, scientific input, and science operations constraints in the context of planetary field campaigns. Funding provided in this program element is intended to enable researchers to conduct scientific investigations and integrate their instruments, projects, and/or protocols into field activities designed to help NASA plan for future exploration of the Moon, Mars, and other planetary bodies with both robots and humans.

Through this research program element, investigators will be selected to carry out specific scientific research analogous to investigations anticipated for missions to the Moon and Mars. Areas of specific interest to the Science Mission Directorate (SMD) include, but are not limited to:

1) Understanding and optimizing human and robotic performance to maximize scientific return;
2) Defining science requirements for early lunar missions with humans, including requirements for mobility, navigation, communications, *in situ* analysis, surface laboratory functionality, crew scheduling, and sample acquisition, handling, documentation, and curation;
3) Developing surface science scenarios for use in architecture planning and science payload manifesting; and
4) Illuminating areas of critical importance for robotic precursor missions, including robotic operations of/with human-oriented systems during periods when humans may not yet be present.

Although this is primarily a Planetary Sciences call, proposals in other areas of SMD research such as Heliophysics, Astrophysics, and Earth Science will be considered, to the extent that they reflect NASA's strategic scientific goals at the Moon and Mars.

1.2 Program Goals for Analog Mission Fidelity

Proposals that directly address lunar scientific questions or Mars science using the Moon as an operational analog will be given priority for funding at this time. NASA is in need of data to support surface science and operations scenarios as it moves forward in its architecture and requirements definition processes. Additional opportunities for research in areas relevant specifically to Mars are available within other ROSES program elements.

Individual analog experiments typically strive for high-fidelity in one or more Fidelity Areas:

1. Science – Fidelity in this area means that publishable, high quality science is being done during or after the field activity that results in an advancement of knowledge in a scientific field such as astrobiology, geology, geochemistry, astronomy, etc. High fidelity science drives the choice of field site according to the site's similarity to specific physical or environmental features on another planet.

   NASA's scientific goals at the Moon follow closely those identified in the National Research Council Decadal Survey in Planetary Science[1] and in its report on the Scientific Context for the Exploration of the Moon[2]. Specifically, NASA seeks to support those investigations that will shed light on methodologies, techniques, instrumentation, or other aspects of the following scientific goals at the Moon:

   - Precise geochronology – sampling of impact melt sheets, lava flows, floors or ejecta of impact basins for detailed geochemical and isotopic analysis (either *in situ* or returned samples)
   - Evolved gas and volatile analysis
     - Cryogenically and stratigraphically preserved sampling from regolith (on Earth, permafrost could be analogous)
     - Determining presence of refractory volatile-bearing species including water-bearing minerals, complex organics, and clathrates.
     - Determining elemental composition, especially hydrogen, for immediate surroundings of sampling sites.
     - Determining local stratigraphy for sample context;
   - High-resolution geological and geochemical mapping – subsurface drilling and identification of unusual samples
   - Geophysical analysis – crust, mantle, and core – sampling and high-resolution gravity measurements, installation of seismic and heat flow instrumentation
   - Analysis of density, composition, and time variability of atmosphere – deployment of network of surface mass spectrometers to monitor migration of volatiles
   - Analysis of dust – deployment of dedicated dust analysis packages. Sample collection to preserve dust particle size distributions and properties
   - Other Earth Science, Astronomy, and Astrophysics goals that further our ability to conduct science from the Moon.

2. Science Operations – Fidelity in this area means that the constraints placed on the execution of science tasks in the field are functionally similar to those of an actual mission, enabling the testing, validation, or development of new concepts of operations that may heavily impact the design of surface infrastructure elements. Some examples of science operations include
   a. Crew scheduling for IVA and EVA
   b. Decision-making protocols

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[1] *New Frontiers in the Solar System: An Integrated Exploration Strategy*, National Academies Press, 2003 (http://www.nap.edu/catalog/10432.html)
[2] *The Scientific Context for the Exploration of the Moon*, National Academies Press, 2007 (http://www.nap.edu/catalog/11954.html)

c. Traverse planning
d. Sample acquisition, storage, documentation, and high-grading protocols
e. Communications and data flow protocols to support science
f. Navigation unique to science support
g. Concepts for power distribution to support science
h. The use of robotic assistants
i. Science backroom design and support for surface science activities.

High fidelity science operations requires high enough fidelity in the science itself to ensure realism, but does not necessarily require the same level of similarity to other planets as required by a focus on science fidelity.

3. Technology – Fidelity in this area means that the technologies in the field are physically, as opposed to only functionally, similar to those being designed for deployment. The field activity with the highest degree of technology fidelity is a field test of flight hardware such as the final tests of the Mars Exploration Rover engineering model before launch. High fidelity technology drives the choice of field sites toward similar terrains and broad physical characteristics such as slopes, rock abundance, surface area, and vegetation. Some examples of technology systems of greatest interest to both the Exploration Systems Mission Directorate (ESMD) and SMD for the optimization of science productivity include:
    a. Rovers (all sizes, all degrees of autonomy, pressurized and unpressurized)
    b. Habitats
    c. Space suits
    d. Landers
    e. Cranes or other surface material handling systems
    f. Power systems
    g. Communication and navigation systems
    h. Intelligent systems and human/robotic interfaces
    i. Sample acquisition and handling systems
    j. Instrument packages.

    Field activities with a high degree of technology fidelity tend to attract the attention of the public and the media. It is the intention of this program to have some degree of technology fidelity in every activity, and therefore, proposers should describe their plan for engaging the public and media during their field deployment.

4. Mission Operations – Fidelity in this area means that the functional aspects of other non-science mission operations are highly consistent with real planetary missions. High fidelity mission operations requires heavy support of simulated ground teams and great attention to communications and scheduling. Some elements of mission operations include
    a. High level Concepts of Operations (con-ops)
    b. Mission control center support
    c. Communications protocols and light-time delays
    d. Consumables and element status tracking
    e. Crew health and safety, remote medicine, psychology.

1.3 <u>Eligibility</u>

NASA will consider proposals for investigations in conjunction with field activities that integrate science with exploration and operations research, provided the proposals meet the requirements specified in Section 2.3.

Questions or comments may be directed to the MAMMA Program Executive, using the contact information provided in Section 3.

1.4 <u>Types of Investigations Supported</u>

Proposals are solicited under this program element for one of three types of funding opportunities for investigation in any or all of the Fidelity Areas described in Section 1.2.

TYPE 1: Field testing of individual scientific experiments or validation of concepts, as specified in Section 1 above. Typical award size for these investigations is between $50,000 - $80,000, which is an increase over the initial pilot program award size. The increase is designed to facilitate greater flexibility in the selection of field sites and potential technology partners for the deployment and execution of funded experiments.

TYPE 2: Support of larger integrated field activities that combine three or more areas of fidelity in integrated field experiments. Typical award size for these investigations is approximately $100,000.

TYPE 3: Participate in ongoing field campaigns sponsored by NASA's Exploration Systems Mission Directorate (ESMD) including Desert Research and Technology Studies (D-RATS) and the Lunar Surface Operations-In-Situ Resource Utilization field tests. The goal is to provide feedback and inputs to the design of hardware and operational procedures being developed for human planetary exploration. Awards are typically to cover researcher time in the field, associated field travel costs, and time to synthesize the field results to provide feedback to NASA in a timely manner in order to influence ongoing lunar architecture work. Typical award size for these investigations is less than $25,000. Awards are contingent upon ESMD analog field campaign activities.

This funding profile is intended to encourage partnerships between scientific PIs and exploration systems technology development teams, while also serving as an investment in remote field investigation sites that can be developed for use by integrated analog teams.

As stated in Section 1.1, the intent of this solicitation is to provide high-fidelity scientific investigations, scientific input, and science operations constraints in the context of a scientific field campaign. Examples of supported activities for Type 1 investigations include, <u>but are not limited to:</u>

1. Validation of specific surface science scenarios to assist NASA in its requirements definition for surface systems and operations. Science operations scenarios can include
    a. Traverse planning

    b. Traverse documentation
    c. Tele-robotic operations – scouting, sample return, sample handling, etc.
    d. Laboratory analysis for subsequent traverse and sample acquisition strategies
    e. Surface sample curation
    f. Operations timelines for science activities such as drilling, trenching, cryogenic or aseptic sampling, etc.
2. Mounting and deployment of sample collection systems or in situ analysis instruments onto exploration technology hardware or mock surface systems.
3. Collection of instrument data and simulation of scientific data and information flow for real-time mapping, navigation, documentation, sample acquisition, traverse planning, etc.
4. Field-testing of prototype instrument packages being currently developed through any of NASA's other ROSES programs, such as Lunar Sortie Science Opportunities (LSSO), Lunar Advanced Science and Exploration Research (LASER), Planetary Instrument Definition and Development Program (PIDDP), Astrobiology Science and Technology for Exploring Planets (ASTEP), Astrobiology Science and Technology Instrument Development (ASTID), Planetary Atmospheres, Cosmochemistry, etc.
5. Testing of specific geological hypotheses requiring human observation in the field, especially if carried out in partnership with robotic or tele-robotic field tools.
6. Development of training strategies for future lunar astronaut crews and ground support teams.

Examples for Type 2 activities are integrated field activities such as the Haughton Mars Project (http://www.marsonearth.org/), Pavilion Lake Research Project (http://www.pavilionlake.com/), or other field campaigns that combine many investigations from two or more Fidelity Areas.

Type 3 activities should result in feedback provided to NASA regarding concepts of operations and hardware (including instrumentation) as NASA plans for future human lunar exploration. Work funded through this solicitation will assist NASA with developing an improved understanding of numerous system-wide and operational challenges that must be addressed to enable the joint human-robotic exploration of planetary surfaces. Topics to be tested may include, but are not limited to, crew scheduling for intravehicular activity (IVA) and extravehicular activity (EVA), decision-making protocols, traverse planning, sample handling, communications and data flow protocols to support science, navigation unique to science support, concepts for power distribution to support science, the use of robotic assistants, science backroom design and support for surface science activities.

Type 3 investigations will be conducted during D-RATS (Desert Research and Technology Studies) at Black Point Lava Flow.

Preparatory "dry run" test activities for assessing both hardware systems and operational procedures readiness will be conducted at the NASA Johnson Space Center PATS (Planetary Analog Test Site) or "rock yard" in Houston, TX, during mid-July to mid-August, 2011. The actual D-RATS remote analog field campaign will be conducted during mid-August to mid-September, 2011, at the Black Point Lava Flow (BPLF) test site location north of Flagstaff, AZ.

Small portable hand-held field rugged analytical scientific instruments for geologic sample analysis can be provided by proposers for field use and evaluation.

Selected participants may spend up to the indicated two-week period at the Black Point Lava Flow test site location provided that meaningful fieldwork activities are being conducted. Proposers are encouraged to coordinate proposed activities with the D-RATS Science Team under the leadership of Dr. Gary Lofgren (NASA Johnson Space Center, 281-483-5042 or Gary.E.Lofgren@nasa.gov). The NASA ESMD Lead for the D-RATS activity is Doug Craig (NASA Headquarters, 202-358-4491 Douglas.A.Craig@nasa.gov).

Selected interested participants are also encouraged to plan to serve in a support role for staffing and/or advising real-time science “backroom” communications activities between Science Team operations and the ongoing activities being conducted by the astronaut/geology crewmembers in the Lunar Electric Rover (LER) vehicle during traverse activities at the BPLF test site.

2. Programmatic Information

2.1 Special Requirements for Proposals

Proposals should follow the guidelines set for all ROSES proposals as given in the *NASA Guidebook for Proposers*. All proposals must demonstrate relevance to OSEWG (Optimizing Science and Exploration Working Group) priorities, as summarized above and published on the OSEWG website (http://www.lpi.usra.edu/osewg/).
Proposals for Type 1 and 2 awards are limited to 15 pages.
Proposals for Type 3 awards are limited to 5 pages.

In addition to the guidebook requirements, proposals should clearly indicate whether they are Type 1, 2, or 3.

Type 1 proposals should also specify:

- Areas of fidelity from Table 1 that are addressed by the project
- Specific field activity, site(s), and dates being targeted for their investigation(s), as well as a clear schedule for field preparations, training, and deployment strategy
- Evidence of coordination with field campaign leaders if proposed investigation(s) are to be conducted in conjunction with established field campaign(s)
- Field resource requirements
  - Duration, timing, and scheduling of investigations
  - Power requirements
  - Communications requirements (bandwidth, type of communications, etc.)
  - Logistics Support Requirements
- Level and type of integration with hardware or operations (rover and mounting), including any specific teams, whether desired or already formed
- The science objectives and expected science return of the proposed investigation – type and amount of data, validation of science requirements, expected publications, etc.
- Specific deliverables at the conclusion of the field activity

- Relevance to the priorities of the OSEWG
- Source, type, and amount of external funding already received or expected, if any, for the hardware, software, or operational concepts being tested
- Risks to the investigation, including weather scrubs, hardware failures, power failures, etc.
- Clear budget including field deployment costs, logistics support, direct labor, overhead, subcontracts, special equipment, travel, education and public outreach, other costs, General and Administrative Expenses, fees, etc.
- Plan for interfacing with public and media.

In addition to all items listed for Type 1 proposals, Type 2 proposals should also include:

- A detailed description of proposed site (if a specific site is proposed), its characteristics and history, including any and all facilities, existing logistics, or other support that can be leveraged
- A Table of all investigations (or type of investigations) supported and their Fidelity Areas
- The strategy and methods for integrating proposed field activities
- A description of possible openings for outside participation (e.g. other funded MMAMA scientists, industry partners, international partners, etc.)
- Detailed media and public engagement plan (more detailed than Type 1), including staff, budget, etc. specific to media and public relations
- Strengths and challenges for sustainability of the proposed activity over the four-year award period (elaboration on risks required for Type 1)

Type 3 proposals should include:

- Background information pertaining to previous field experience
- Rationale for interest in participating in the ESMD analog field campaigns
- Identification of field site of interest
- Area(s) of scientific expertise with notional concepts for scientific field research that could be conducted at the analog site
- Discussion of how field science investigations could be accomplished within the constraints of the ESMD-led field campaign

2.2 Availability of Funding

This program element is supported and managed by the Planetary Sciences Division within the NASA Science Mission Directorate. A total of $700K has been identified for this program element, to be split between the three types of awards. Based on the proposals received, it is expected that 4-8 awards will be made for the smaller individual investigations (Type 1), with up to two larger infrastructure awards (Type 2), and 4-8 Type 3 awards.

2.3 Evaluation of Proposals

All proposals will be evaluated with respect to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*. In addition to the factors specified in the guidebook, the intrinsic merit of a proposal shall include the following additional factors where relevant:

- The extent that the proposal demonstrates adequate external financial and programmatic support to ensure that the field experiments can be completed
- The extent that the proposal clearly and specifically describes the integration between science, exploration, and/or operational tests, demonstrations, or experiments
- The extent that the proposal demonstrates relevance to the OSEWG
- The extent that the proposal demonstrates relevance to the goals of the Science Mission Directorate at the Moon and/or Mars.

2.4 Future Solicitations

It is expected that NASA will repeat this program element in ROSES 2011 at either the same or a higher funding level. One objective of NASA's Science Mission Directorate is to provide a mechanism for science to play an integral role in the requirements for human exploration through this and other opportunities.

2.5 Selection of Proposals

NASA expects to announce the results of this selection by January 2011. Funding should be expected no earlier than late February 2011, but could take longer to award. Proposers should plan accordingly.

2.6 Awards

Approximately 4-8 awards will be selected for Type 1 and Type 3 awards. No more than two larger infrastructure awards (Type 2) will be selected. Awards will be selected for up to four-year studies.

2.7 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

3. Summary of Key Information

Expected annual program budget for new awards	~ $0.7 M
Number of new awards pending adequate proposals of merit	Type 1: ~ 4-8 Type 2: ~1-2 Type 3: ~ 4-8
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15pp for Type 1 and Type 2 proposals. 5pp for Type 3 proposals.
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov(help desk available at support@grants.govor (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-MMAMA
NASA point of contact concerning this program / MAMMA Program Executive	Dave Lavery Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4684 E-mail: HQ-MMAMA@mail.nasa.gov

C.25 VENUS CLIMATE ORBITER PARTICIPATING SCIENTIST PROGRAM

1. Scope of Program

The objectives of the Venus Climate Orbiter Participating Scientist Program (VCO PSP) are to enhance, aid in data archival, and supplement Venus science to be performed by the Venus Climate Orbiter (VCO, or AKATSUKI). The VCO PSP In-Residence expects to select up to two Participating Scientist in Residence (PSiR) at JAXA, with full support for four years and up to six Participating Scientists, at U.S. institutions, for the same duration.

1.1 Overview

The VCO PSP investigations aim to understand the atmospheric circulation using global atmospheric mapping by utilizing VCO's five cameras (from ultraviolet to infrared wavelengths), and by measuring the vertical structure of the atmosphere with radio occultation techniques. VCO's systematic and continuous observations should provide a complete dataset of the Venusian atmospheric dynamics that complements the Venus Express observations and prior Venus missions.

1.2 Participating Scientist Program

This program is intended to support the Venus Climate Orbiter Mission. Selected Participating Scientists (PSs) will become members of the VCO science team and be required to fulfill responsibilities similar to those of current science team members. The selected PSs should coordinate their activities and analyses with the present Principal Investigators and Co-Investigators on Venus Climate Orbiter to achieve the essential scientific objectives of the investigation within the scope and resources of the project and ensure dissemination of the results of the investigation to the scientific community and the general public.

VCO Participating Scientists in residence (PSiR) at JAXA with full support is part of this opportunity. It is not required but desirable that the VCO PSiR have knowledge of the Japanese language. Up to two Participating Scientist in residence will be selected to reside in Japan (ISAS) and work with the VCO Science Team to reduce and help archive the data.

Each PS will:

- Plan and advocate for the proposed PS scientific investigation as a Science Team Member;
- Participate in VCO science team meetings;
- Perform initial data analysis to support operations and carry out subsequent analysis necessary to complete the proposed scientific investigation;
- Prepare, validate, and deliver data products, documentation, and other pertinent investigation information for which they are responsible to the Planetary Data System

(PDS) in PDS format, including participating in the VCO Data Archive Working Group;

- Publish the results in peer-reviewed journals in accordance with NASA and VCO project data release and publication policies; and
- Support the education and public outreach efforts of the VCO's E/PO team.

1.3 Science Priorities for this Solicitation

Proposers should submit a science investigation that addresses one or more of the VCO mission-level science objectives listed below. Selected investigators should be encouraged to work in a collaborative manner with other VCO science team members after selection. All team members should be bound by the VCO Project "Rules of the Road" document that describes the data access rights, data-sharing responsibilities, and data release policies of the VCO science team. This document should be available on the NSPIRES http://nspires.nasaprs.com index page for this program element, when it becomes available. In the course of carrying out their scientific investigation, if a PS has to generate higher-level instrument products that an instrument PI is not already planning to produce and archive, the Participating Scientist proposal must indicate that the PS should archive those products in the PDS.

Participating Scientists may propose any investigation at Venus that addresses one or more of the VCO mission-level science objectives, which are listed here:

1. Understand and characterize the conditions and processes of the Venus atmosphere, such as the mechanism of super-rotation, meridional circulation, meso-scale processes, cloud physics, lightening, etc;
2. Determine the internal structure, density, atmospheric dynamics at Venus;
3. Determine the climate evolution of Venus;
4. Determine weather variations on Venus utilizing data from VCO and past Venus missions;
5. Determine the ionospheric variability in the Venusian environment;
6. Detection of active volcanism;
7. Map variations on surface composition;
8. Map distribution of interplanetary dust by utilizing VCO's zodiacal-light data.

Although NASA is open to considering any outstanding proposals that meet these criteria, there are a few types of investigations that are particularly desired through this solicitation:

- Venus weather
- Evolution of climate on Venus
- Atmospheric dynamics, including modeling
- Ionspheric dynamics, evolution and structure of Venus environment

2. Proposal Submission

VCO PSP Notices of Intent are due June 11, 2010 and proposals are due August 6, 2010. Please check Tables 2 and 3 of the ROSES solicitation for the most up to date information and links to amended or clarified Solicitations. We anticipate selections approximately three months after proposals are received.

2.1 Proposal Guidelines

Only the Principal Investigator from each proposal selected through this program will be designated as a Participating Scientist on the VCO mission; any Co-Investigators or collaborators on the proposal will be designated as VCO science team Co-Investigators or collaborators according to VCO "Rules of the Road." Proposals may include funded Co-Investigators and/or unfunded collaborators only if they are critical to complete the proposed science investigation. The participation of graduate students and postdoctoral researchers is encouraged in all proposals, however they should be working under the supervision of Participating Scientist while in VCO PSP. Collaborators would provide focused contributions to specific tasks and may be from any institution.

All proposals should contain the elements described in Section 2 of the *NASA Guidebook for Proposers.* Proposals should identify scientific ideas, including knowledge of terrestrial analogs (if appropriate), and unique theoretical and analytical capabilities that best meet the scientific objectives of the VCO mission as described in this solicitation. Key projected milestones, accomplishments, and deliverables during each year of the proposed investigation should be identified.

3. Programmatic Information

3.1 Eligibility to Propose

Current VCO PIs and Co-Is are not eligible to propose to this solicitation. Current VCO Collaborators are eligible to propose to this solicitation.

3.2 Duration of Award

Selected investigators are expected to be funded for the period of December 2010 through September, 2014, i.e. a few months before the Venus encounter and more than three years after the encounter.

3.3 Budget Information

Proposers must provide a detailed budget covering the entire time period from December 2010 through September 2014. The budget must follow the guidelines described in the *NASA Guidebook for Proposers*, and the budget must include funding for training and data analysis to support the proposed science investigation.

The budget should include funds to travel to one VCO science team meeting in FY 2011, two in FY 2012, two in FY 2013, and one in FY 2014. Participating Scientists closely tied to a particular instrument are also encouraged, but not required, to include travel funds in their budget to visit that instrument PI's institution for one to two visits or instrument team meetings per year. For proposal purposes, proposers should assume that the operations training sessions and VCO science team meetings would take place in Los Angeles, CA, although the actual location may be different.

Budgets should include salary, all page charges for publication and reprints, attendance at conferences, all travel, and other necessary expenses.

Funding of multiyear projects is contingent upon availability of funds and annual assessment of performance and relevance of the research effort to the VCO mission and program requirements.

3.4 Evaluation Factors

Evaluation criteria are given in the *NASA Guidebook for Proposers*. These criteria are intrinsic merit, relevance, and cost realism/reasonableness.

In addition to the factors for each criterion given in the *NASA Guidebook for Proposers*, the criterion for intrinsic merit specifically includes the following factors:

• The material contribution of the investigator's proposed presence and involvement in mission planning and mission operations to obtaining data to support the investigation;
• The value added to the science mission planned by the existing VCO science team and the extent that the proposed investigation complements the currently planned science investigations; and
• The role of the investigator in improving existing and planned VCO data products.

3.5 Guidelines for Non-U.S. Proposals and Proposals Including Non-U.S. Participation

NASA welcomes proposals from outside the U.S., but all proposals with non-U.S. participants must be compliant with the policies stated in the *NASA Guidebook for Proposers.* Foreign entities are generally not eligible for funding from NASA and should propose to participate on a no-exchange-of-funds basis. Therefore, unless otherwise noted, proposals from foreign entities should not include a cost plan unless the proposal involves collaboration with a U.S. institution, in which case a cost plan for only the participation of the U.S. entity must be included.

Proposals from U.S. entities that include foreign participation must be endorsed by the respective Government agency or funding/sponsoring institution in the country from which the foreign entity is proposing. Such endorsement should indicate that the proposal merits careful consideration by NASA, and, if the proposal is selected, sufficient funds should be made available by the respective foreign government agency or funding/sponsoring institution to undertake the activity as proposed.

3.6 Progress Reports and Deliverables

After selection, each Participating Scientist shall provide an Implementation Plan to the VCO Project Scientist, including a schedule for deliverables (software, data products, reports, plans), and details regarding plans for data analysis, computing facilities, ground data system support, software development, support of instrument calibration, data archiving, and participation in E/PO activities. The Participating Scientists shall provide semiannual reports to the VCO Project Scientist and the NASA Headquarters Program Officer that include: accomplishments over past six-month period; plans for the next period; issues; concerns; schedule performance; financial performance; recovery plans; and status of publications and other deliverables.

4. Summary of Key Information

Expected total program budget for first year of new awards	~$4.0 M
Number of new awards pending adequate proposals of merit	~6-8
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	June 11, 2010
Due date for proposals	August 6, 2010.
Planning date for start of investigation	December 2010
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *2010 NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *2010 NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *2010 NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of	http://grants.gov (help desk available

proposal via Grants.gov	at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-VCOPSP
NASA point of contact concerning this program	Adriana C. Ocampo Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2152 E-mail: aco@nasa.gov

APPENDIX D. ASTROPHYSICS RESEARCH PROGRAM

D.1 OVERVIEW

1. Introduction

The objectives of research solicited in program elements described in Appendices D.2 through D.11 of this NRA are focused on achieving the goals of the Science Mission Directorate's Astrophysics Research Program as defined in *The Science Plan for NASA's Science Mission Directorate (2007-2016)* (hereafter the *NASA Science Plan* available at http://nasascience.nasa.gov/about-us/science-strategy). Proposers to the elements described in Appendix D are encouraged to read this *NASA Science Plan* to gauge the relevance of their research to NASA.

The program elements are described below. Abstracts of previously selected investigations may be found online at http://nspires.nasaprs.com/.

2. Astrophysics Data Analysis

The Astrophysics Data Analysis program (Appendix D.2) supports the broad range of data analysis efforts relating to past or current NASA astrophysics space missions regardless of the physical phenomena studied. Since there are changes to the type of research solicited under this program element of the NRA, interested proposers are urged to read Appendix D.2 carefully to ensure that the research that they are proposing is appropriate.

3. Astrophysics Research and Analysis

The Astrophysics Research and Analysis program (Appendix D.3) supports investigations in the areas of suborbital flights, detector development, supporting technology development, laboratory astrophysics, and limited ground based observing. Basic research proposals are solicited for investigations that are relevant to NASA's programs in astronomy and astrophysics and include research over the entire range of photons, gravitational waves, and particles of astronomical origin.

4. Astrophysics Theory

The Astrophysics Theory program (Appendix D.4) supports theoretical investigations or modeling of the astrophysical phenomena targeted by past, current, or future NASA astrophysics space missions. It no longer supports laboratory work related to NASA strategic goals in gravitation and fundamental physics – those efforts are now supported in the Astrophysics Research and Analysis program (Appendix D.3). Theoretical work pertaining to atomic and molecular astrophysics and other topics directly related to Laboratory Astrophysics should also be proposed to the Astrophysics Research and Analysis program (Appendix D.3).

5. Astrophysics Guest Investigators

Five program elements support science investigations that require and/or support new data obtained with currently operating NASA astrophysics space missions. Guest investigator programs are included for the Galaxy Evolution Explorer (GALEX) (Appendix D.5), the Swift gamma-ray burst explorer (Appendix D.6), the Suzaku mission (Appendix D.7), the Fermi Gamma-ray Space Telescope (Appendix D.8), and the Kepler mission (Appendix D.9). One program element supports science investigations of U.S. PIs that require data obtained with the Canadian MOST observatory (Appendix D.10). Guest investigator programs for the Hubble Space Telescope (http://www.stsci.edu/), the Chandra X-ray Observatory (http://cxc.harvard.edu/), and the Spitzer Space Telescope (http://www.spitzer.caltech.edu/) are solicited separately by the respective science centers of those missions.

6. Strategic Astrophysics Technology

The newly established Strategic Astrophysics Technology program (Appendix D.11) supports focused development efforts for key technologies to the point at which they are ready to feed into major missions in the three science themes of the Astrophysics Division: Exoplanet Exploration, Cosmic Origins, and the Physics of the Cosmos. This program is specifically designed to address middle technology readiness level (TRL) “gaps” between levels 4 and 6: the maturation of technologies that have been established as feasible, but which are not yet sufficiently mature to incorporate into flight missions without introducing an unacceptable level of risk.

7. Origins of Solar Systems

The portion of this program that relates to the detection and characterization of planetary systems that is directly tied to the NASA strategic goal to search for Earth-like planets is solicited in the program element described in the Origins of Solar Systems program (Appendix E.3).

D.2 ASTROPHYSICS DATA ANALYSIS

1. Scope of Program

Over the years, NASA has invested heavily in the development and execution of an extensive array of space astrophysics missions. The magnitude and scope of the archival data from those missions enables science that transcends traditional wavelength regimes and allows researchers to answer questions that would be difficult, if not impossible, to address through an individual observing program. To capitalize on this invaluable asset and enhance the scientific return on NASA mission investments, the Astrophysics Data Analysis Program (ADAP) provides support for investigations whose focus is on the analysis of archival data from NASA space astrophysics missions.

1.1 Research Objectives

The Astrophysics Data Analysis Program (ADAP) solicits research whose primary emphasis is the analysis of NASA space astrophysics data that are archived in the public domain at the time of proposal submission. Most of these data have undergone considerable reduction and refinement by way of calibrations and ordering and extensive data analysis software tools often exist for these data.

The following is a representative, but not exhaustive, list of NASA space astrophysics missions for which suitable public data archives are available:

- Beppo Satellite di Astronomia X (BeppoSAX)
- Compton Gamma-Ray Observatory (CGRO)
- Cosmic Background Explorer (COBE)
- Extreme Ultraviolet Explorer (EUVE)
- Far Ultraviolet Spectroscopic Explorer (FUSE)
- Galaxy Evolution Explorer (GALEX)
- Gravity Probe B
- High Energy Astronomy Observatories (HEAO-1, 2, and 3)
- High Energy Transient Explorer 2 (HETE-2)
- Infrared Astronomical Satellite (IRAS)
- Infrared Space Observatory (ISO)
- International Gamma-ray Astrophysics Laboratory (INTEGRAL)
- International Ultraviolet Explorer (IUE)
- Keck Interferometer (KI) and Palomar Testbed Interferometer (PTI) Archives
- Keck Observatory Archive (KOA) at the NASA Exoplanet Science Institute (NExScI)
- Kepler
- Midcourse Space Experiment (MSX)
- Roentgen Satellite (ROSAT)
- Rossi X-ray Timing Explorer (RXTE)
- Shuttle-based Astrophysical Observatories: the Hopkins Ultraviolet Telescope (HUT), the Wisconsin Ultraviolet Photopolarimetry Experiment (WUPPE), the Ultraviolet

Imaging Telescope (UIT), the Broad-Band X-Ray Telescope (BBXRT), and ORFEUS-SPAS I and II
- Spitzer Space Telescope
- Submillimeter Wave Astronomical Satellite (SWAS)
- Swift
- Two Micron All Sky Survey (2MASS)
- Ulysses [galactic cosmic ray and gamma ray data only]
- X-ray Multi-Mirror-Newton (XMM-Newton)
- Wilkinson Microwave Anisotropy Probe (WMAP).

Researchers interested in analyzing datasets from missions or projects other than those listed above are encouraged to contact the ADAP Program Officer before writing their proposal to confirm that their planned research program is compliant with this solicitation.

Most NASA space astrophysics data may be found in one or more of the following NASA astrophysics data centers:

- Astrophysics Data System (ADS) (http://adswww.harvard.edu/);
- High Energy Astrophysics Science and Analysis Data Center (HEASARC) (http://heasarc.gsfc.nasa.gov/);
- Infrared Science Archive (IRSA) (http://irsa.ipac.caltech.edu/);
- Legacy Archive for Microwave Background Data Analysis (LAMBDA) (http://cmbdata.gsfc.nasa.gov/);
- Multimission Archive at Space Telescope (MAST) (http://archive.stsci.edu/); and
- NASA Exoplanet Science Institute (NExScI; formerly the Michelson Science Center) (MSC) (http://nexsci.caltech.edu/);
- NASA/IPAC Extragalactic Database (NED) (http://nedwww.ipac.caltech.edu/).
- National Virtual Observatory (NVO) (http://www.us-vo.org/).

1.2 Noteworthy Opportunities in ADAP 2010

Archival data from the Kepler mission are now available in the public domain and analyses of these data are eligible for funding under the ADAP for the first time. High quality, uninterrupted, evenly-spaced time series data for over 7000 stars taken with the Kepler spacecraft have been released via MAST. These stars were originally on the Kepler target list, but have been dropped because they are too variable for the purposes of detecting extrasolar planets. These data may be downloaded at the Kepler archive page (http://archive.stsci.edu/kepler/). These data, and future dropped targets, present a treasure trove of unique information in the form of continuous optical photometry across a range of astrophysically interesting objects.

Also, with the end of the cryogenic phase of Spitzer Space Telescope operations in May 2009, proposals for Spitzer archival research are no longer supported through the mission's General Observing program. Instead, proposals involving analysis of data from the Spitzer cryogenic mission archive will henceforth be eligible for funding under the ADAP.

1.3 Limitations of the Program

1.3.1 *Use of theory, modeling, or other relevant data*

In support of any ADAP proposal – but only as a secondary emphasis, and only as needed to interpret and analyze NASA's archival data – the proposed research may include the use and application of: (a) theoretical research or numerical modeling; (b) existing data from ground-based telescopes, suborbital platforms, or non-NASA space missions; and/or (c) available laboratory astrophysics data. Proposals may also request support for a modest level of development of new algorithms and/or enhancements of computational techniques provided that those activities are science driven and necessary to achieve the proposed analyses. The burden is on the proposer to make a convincing case that any such data and/or development activities are invoked only insofar as they are required to accomplish the analysis of the NASA archival data, and are not themselves the primary focus of the investigation.

Requests for support for new ground-based observations are acceptable under the ADAP provided that the requests are clearly described, that the observations are important to the success of the proposed ADAP effort, and that their expense (including salary, travel, etc.) constitutes no more than ten percent (10%) of the proposal's total budget.

1.3.2 *Analysis of data from Hubble Space Telescope (HST) or Chandra X-Ray Observatory (CXO)*

Proposals for archival research based exclusively on the data from either HST or CXO are not eligible for funding under the ADAP. Such proposals are solicited through the associated NASA-chartered science operations centers and funded under each mission's General Observing (GO) program. However, proposals for archival research that involves a combination of data from these Great Observatories, or data from one of these observatories in combination with the data from other NASA missions (e.g. see above list), are eligible for funding under ADAP.

1.3.3 *Atomic and Molecular Databases*

Databases of fundamental atomic, molecular, nuclear, and solid state parameters that are complete, critically evaluated, and readily accessible to the community represent a powerful tool for analyzing NASA space astrophysics data. Consequently, the ADAP accepts proposals for the development of publicly accessible compilations of existing fundamental atomic, molecular, and nuclear parameters (both experimental and theoretical), as well as the associated computational tools necessary to effectively apply those data to the analysis of astronomical observations. This opportunity is intended to support only the development of new databases or significant enhancements/upgrades to existing databases, not simple maintenance of established databases. In addition, proposers are cautioned that new measurements or calculations of such parameters are not eligible for support under the ADAP.

1.3.4 *Support for Approved RXTE, XMM-Newton, or INTEGRAL Guest Investigators.*

Direct support for US investigators who compete and win observing time on the RXTE, XMM-Newton, and INTEGRAL missions is expected to be reduced or unavailable in upcoming budgets. Consequently, scientists with approved guest investigator programs using RXTE, XMM-Newton, or INTEGRAL at the time of ADAP proposal submission are eligible to propose for data analysis support under the ADAP even if the observations have yet to be executed or the data are still within their proprietary period.

1.3.5 *Exclusions*

Proposers to this NRA should note that the ADAP is not intended to support:

- Investigations whose primary emphasis is fundamental theoretical research or the development of numerical models without specific application to the analysis of NASA archival data. Such research is supported under NASA's Astrophysics Theory Program (ATP; Appendix D.4);
- Investigations involving new measurements or calculations of fundamental atomic, molecular, or nuclear parameters. Such research is supported under the Laboratory Astrophysics element of NASA's Astrophysics Research and Analysis program (APRA; Appendix D.3);
- Investigations whose primary focus is the analysis of datasets from astrophysics projects or space missions that had no significant NASA contribution (e.g. Hipparcos, Sloan Digital Sky Survey, other ground-based observational data not specifically included in §1.1).
- Investigations whose primary focus is on Solar System objects or on the solar-terrestrial interaction (other NASA programs support this kind of research, see Appendices B and C);
- Proposals primarily for the general education and/or training of students (Note, however, that this does not preclude the involvement of undergraduate or graduate students in the proposed research);
- Proposals for organizing and/or hosting scientific meetings; or
- Proposals for the acquisition of substantial computing facilities or resources beyond nominal workstation or network requests.

Prospective proposers should also be aware that considerable research has already been done using NASA space astrophysics data sets by the original mission science teams, as well as by previously selected participants in the ADAP (see, for example, abstracts of currently and previously funded ADAP projects at http://nspires.nasaprs.com/). Therefore, ADAP proposals must demonstrate how the proposed research clearly extends the frontier of existing knowledge in a fundamental and important manner. If a new proposal for this program element is itself based on a previously funded research effort, the proposal must identify that work and clearly summarize all significant results from it.

1.4 Identification of Proposal Data Set(s) and Research Areas

The Cover Page (see the *NASA Guidebook for Proposers*) for ADAP proposals provides for designation of the data set(s) proposed for analysis and also for the Research Area, as defined below, which designates the primary focus of the proposal. Identification of the appropriate Research Area is important as it facilitates the assignment of each proposal to the appropriate review panel (a secondary Research Area may also be designated).

Individuals submitting proposals for fundamental physics or any other research area that is not related to a class of astronomical objects should not select a Research Area. Instead, the entry in the Research Area field should be left in its default state ("Please Select One.").

NASA reserves the right to reassign a proposal to a different primary or secondary Research Area. The nine defined Research Areas are:

1. *Star Formation and Pre-Main Sequence Stars* (including star-forming clouds, protoplanetary and debris disks, protostars, and T Tauri stars);
2. *Stellar Astrophysics* (e.g., main sequence stars, supergiants, Wolf-Rayet stars, brown dwarfs)
3. *Post-Main Sequence Stars and Collapsed Objects* (including white dwarfs, planetary nebulae, novae and supernovae, neutron stars, black holes and gamma-ray bursts);
4. *Binary Systems* (including cataclysmic variables, x-ray binaries, and black hole binaries);
5. *Interstellar Medium and Galactic Structure* (including dark clouds, interstellar dust, H II regions, diffuse galactic emission, open and globular clusters);
6. *Normal Galaxies*;
7. *Active Galaxies and Quasars* (including interacting galaxies, starburst galaxies, Seyfert galaxies, radio galaxies, AGNs, and quasars);
8. *Large Scale Cosmic Structures* (including clusters of galaxies, galaxy environment and evolution, intracluster medium, diffuse x-ray background, and cosmology); and
9. *Atomic/Molecular Databases* (including critically evaluated, publicly available compilations of fundamental atomic, molecular, solid state, and nuclear parameters and the tools necessary to apply these data to the analysis of astrophysical observations).

2. Current Profile of the ADAP

2.1 ADAP 2009 Submission statistics

In 2009, a total of 165 proposals were submitted in response to the ADAP solicitation, a 74% increase in the number of proposals submitted to the program compared to the previous year. This increase was largely attributable to the incorporation of Spitzer archival research into the program in 2009.

The distribution of those proposals over the various Research Areas covered by the ADAP is shown in Figure 1 below. Also shown in the figure is the distribution of requested durations (1-, 2-, 3-, or 4-years) of the proposals in each Research Area. Note: proposals in the Binary Systems and Atomic/Molecular Databases Research areas (not broken out separately in the figure) were grouped into one of the other Research Areas as appropriate based on the subject matter of the proposal.

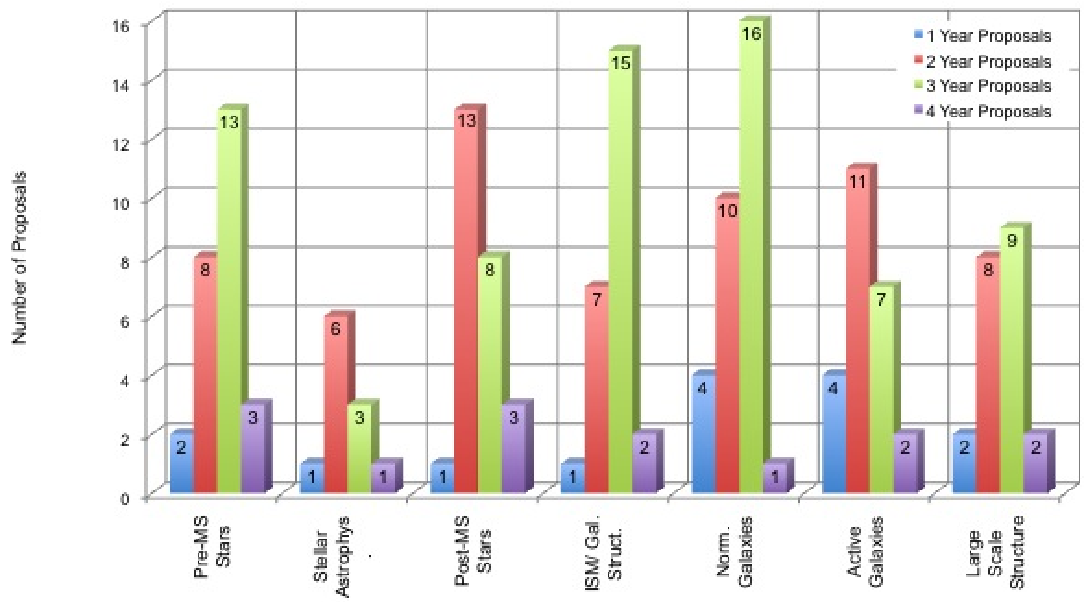


Figure 1. The distribution of 2009 ADAP proposals, broken down by proposed funding duration, across the Research Areas covered by the program. Proposals in the Binary Systems and Atomic/Molecular Databases Research Areas are grouped into one of the Research Areas shown based on their subject matter.

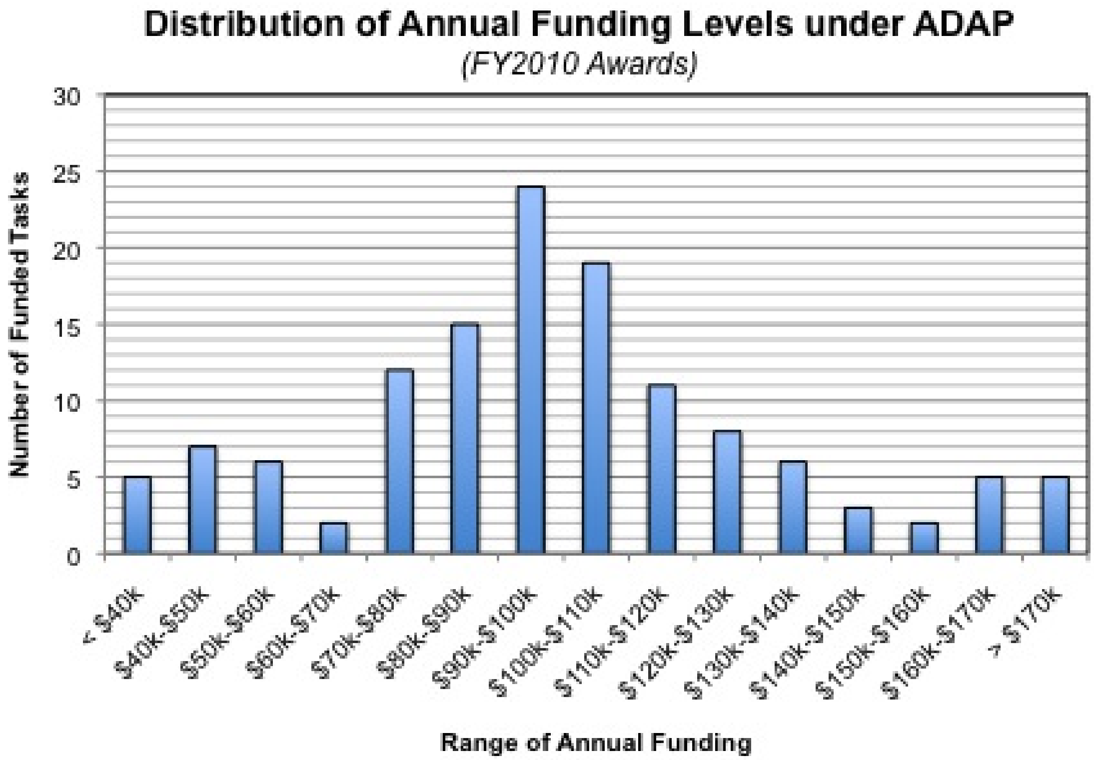


Figure 2. The distribution of annual awards for funded ADAP tasks in FY 2010. Data include both ADAP09 new starts and ongoing tasks from previous solicitations.

2.2 Distribution of annual funding levels for ADAP tasks

With an annual budget of $14.3M, the ADAP typically supports around 125 investigations in any given year (includes new starts plus continuing investigations). Although the average annual ADAP award is approximately $100,000, actual award amounts span the range from less than $40,000 per yr to more than $170,000 per yr. The plot in Figure 2 above shows the distribution of annual awards for the ADAP in FY2010.

3. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $ 5.0M
Number of new awards pending adequate proposals of merit	~ 40 - 50
Maximum duration of awards	4 years; shorter term proposals are welcome; four-year proposals must be well-justified. Proposals solely for the purposes of database development have a maximum duration of 3 years.
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the astrophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-ADAP

NASA point of contact concerning this program	Dr. Douglas M. Hudgins Astrophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0988 E-mail: HQ-ADAP@mail.nasa.gov

D.3 ASTROPHYSICS RESEARCH AND ANALYSIS

1. Scope of Program

1.1 Overview

The Astrophysics Research and Analysis (APRA) program solicits basic research proposals for investigations that are relevant to NASA's programs in astronomy and astrophysics and includes research over the entire range of photons, gravitational waves, and particles of cosmic origin. Awards may be for up to four years' duration (up to five years for suborbital investigations), but shorter-term proposals are typical; 4-year or 5-year proposals must be well justified. Proposals for suborbital investigations are particularly encouraged.

Proposals for developing experimental concepts for future NASA fundamental physics missions or for small technology efforts for the Laser Interferometer Space Antenna (LISA) are now solicited in this APRA program. The experimental fundamental physics component of the previous years' Astrophysics Theory and Fundamental Physics (ATFP) program has been deleted from that program, which now solicits only theory proposals and which is now named the "Astrophysics Theory" program (see Appendix D.4 of this NRA).

1.2 Categories of Proposals

The APRA program seeks to support research that addresses the best possible (i) state-of-the-art detector technology development for instruments that may be proposed as candidate experiments for future space flight opportunities; (ii) science and/or technology investigations that can be carried out with instruments flown on suborbital sounding rockets, stratospheric balloons, or other platforms; and (iii) supporting technology, laboratory research, and/or (with restrictions) ground-based observations that are directly applicable to space astrophysics missions. To meet these goals, proposals are solicited in the following five broad categories:

- Detector Development
- Suborbital Investigations
- Supporting Technology
- Laboratory Astrophysics
- Ground-Based Observations.

Specific Considerations and Exclusions:

- Investigators proposing stand-alone detector development should propose to the Detector Development category, whereas proposals for which detector development is integrated into a suborbital program should be submitted to the Suborbital Investigations category.
- The Laboratory Astrophysics component of this program element includes theoretical investigations in the area of Atomic and Molecular Astrophysics. However, all other theoretical investigations are solicited separately under the Astrophysics Theory program described in Appendix D.4 of this NRA.
- Projects directed mainly toward the analysis of archival data are solicited under the Astrophysics Data Analysis program described in Appendix D.2 of this NRA. Proposals

for development of new data analysis methods for future space missions should be directed to the Astrophysics Theory program (see Appendix D.4).

- Proposers to the Ground-Based Observations component of APRA must be ineligible by virtue of their institutional affiliation to receive direct support from the National Science Foundation for ground-based astronomy. Proposals for any ground-based gamma-ray burst investigations are no longer eligible for support within the APRA program. Proposals for such investigations should be submitted to the relevant mission Guest Investigator program(s). Ground-based particle observations are not supported by this program element.
- If a proposal is offered as a direct successor to a previous NASA award, it should include a description of the predecessor effort, including any significant findings, and describe how the proposed work extends the previous accomplishments. See Section 1.5 of the *NASA Guidebook for Proposers* for more details.
- In past years, SR&T-class programs have permitted grants to be made separately to the Principal and Co-Investigators of the same proposal, but at different institutions, in order to avoid the overhead costs associated with subawards. However, this practice has been discontinued except in those cases where a Co-Investigator is affiliated with a U.S. Government Laboratory (see Section 2.3.11(b)(iii) of the *NASA Guidebook for Proposers*), in which case NASA separately funds that Co-Investigator through a direct transfer of funds. In all other cases, the PI institution is expected to fund participating Co-I(s). (For Suborbital Investigations, see also Section 1.2.2 below.)

1.2.1 *Detector Development*

This APRA category solicits investigations that either advance our understanding of the fundamental operational aspects of detectors or develop new types of detectors to the point where they can be proposed in response to future announcements of flight opportunities. Either new measurement concepts or methods to improve the performance of existing detectors may be proposed, provided they would be candidates for use in space. Among the characteristics typically desirable in space-quality detection systems are high sensitivity to relevant signals, low mass, low sensitivity to particle radiation, low power consumption, compactness, ability to operate in a vacuum (such that high-voltage arcing is minimized), vibration tolerance, ease and robustness of integration with instrumentation, and ease of remote operation, including reduced transient effects and ease of calibration.

This program does not support development of detectors that are intended primarily for ground-based astronomy. However, observing with ground-based facilities may be proposed to verify new detectors or overall system performance, if adequately justified as an integral part of a detector development program.

Proposals for new detectors will be evaluated in the context of currently available space astronomy detector technologies. The emphasis of this solicitation is on technologies that address problems related to achieving the NASA-sponsored astronomy and astrophysics missions and goals in its current Strategic Plan. Proposers are encouraged to identify potential mechanisms that could facilitate transfer of these detector technologies to other users, including Homeland

Security and/or the private sector, for possible application beyond the immediate goals of NASA's programs.

1.2.2 *Suborbital Investigations*

This APRA category supports science investigations and/or technology development utilizing payloads flown on sounding rockets, balloons, commercial reusable suborbital rockets, or similar-class payloads flown as flights of opportunity. Suborbital payloads may be recovered, refurbished, and reflown, in order to complete an investigation. A discussion of the plans for management and for reduction and analysis of the data should be given. Although most awards are for three or four years' duration, a five-year proposal may be accepted to develop a completely new, highly meritorious investigation through its first flight.

Budgets are expected to cover complete investigations, including payload development and construction, instrument calibration, launch, and data analysis. The number of investigations that can be supported is limited and heavily dependent on the funds available to this program. Note that NASA does not carry reserves to accommodate any cost overrun incurred by a particular investigation, including the loss of the payload owing to a rocket or balloon system failure. Therefore, failure to achieve the proposed goals within the proposed time and budget could require either descoping the initially proposed investigation, delaying it, canceling a particular launch date opportunity, or canceling the investigation altogether.

Investigators proposing payloads to be flown on sounding rockets should answer the program-specific questions on the APRA proposal cover pages. This information is needed by the Sounding Rocket Program Office to generate a rough order of magnitude cost estimate for the operational requirements associated with a proposed investigation, and is used for planning purposes. The required information includes the envisioned vehicle type, payload mass, trajectory requirements, launch site, telemetry requirements, attitude control or pointing requirements, and any plans for payload recovery and reuse.

The Balloon Program is planning to provide a shared platform capable of carrying multiple, independent, piggyback-like instruments, in order to offer suborbital flight opportunities to more users. The intent is to support more small instruments for science investigations, technology development, and/or training of young scientists and engineers. Investigators should identify, on the proposal cover page, which of these three categories is the main focus of the proposal. The following table summarizes the standard services and anticipated constraints for a flight supporting about six instruments:

Balloon Altitude:	Flight Duration:	Per instrument Weight/Size:	Data Rate/Power:	Launch location:
30-37 km	6-24 hours	136 kg; 0.4 cubic meters; Standard interface	> 50 kbs LOS; 50-100 watts, regulated 28 V battery nominal	Ft. Sumner (Spring or Fall) Palestine (Summer)

Projects needing unique engineering and/or technical support services and/or vehicles should contact the Balloon Program Office directly at the coordinates given below for an estimate of the Government Furnished Equipment (GFE) cost of the desired support.

Prior to the finalization of ROSES-2010 for release, sufficient technical information on commercial reusable suborbital research (CRuSR) vehicles for writing and evaluating proposals was not available to proposers. Once that technical information is available, ROSES-2010 will be amended to solicit proposals for investigations using CRuSR vehicles through the Astrophysics Research and Analysis program.

Additional information on CRuSR vehicles, including technical capabilities, operational constraints, and anticipated costs to researchers, is available at http://suborbitalex.arc.nasa.gov/.

Investigators proposing suborbital payloads are strongly urged to discuss prospective investigations with operations personnel at the NASA Wallops Flight Facility (for sounding rockets and balloons) or at NASA Ames Research Center (for CRuSR) to ensure that probable operational costs are properly anticipated. Questions concerning potential sounding rocket investigations may be addressed to:

Mr. Philip Eberspeaker
Sounding Rocket Program Office
Code 810
Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-2202
Email: Philip.J.Eberspeaker@nasa.gov

Questions concerning potential balloon-borne investigations may be addressed to:

Mr. David L. Pierce
Balloon Program Office
Code 820
Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-1453
Email: David.L.Pierce@nasa.gov

Questions concerning potential CRuSR investigations may be addressed to:

Mr. Mike Skidmore
Commercial Reusable Suborbital Research Program Office
Mail Stop 240-10
Ames Research Center
National Aeronautics and Space Administration

Moffett Field, CA 94035
Telephone: (650) 604-6069
Email: Mike.Skidmore@nasa.gov

Owing to the anticipated greater degree of complexity, the scientific/technical/ management section of proposals for a suborbital investigation may be 20 pages long instead of the default 15 pages specified in the *NASA Guidebook for Proposers.*

Suborbital investigations provide unique opportunities not only for executing intrinsically meritorious science investigations, but also for advancing the technology readiness levels of future space flight detectors and supporting technologies, and preparing future leaders of NASA space flight missions such as junior researchers and graduate students. For suborbital proposals, specific factors that will be considered when evaluating a proposal's intrinsic merit are the scientific merit, the degree to which it advances the technology readiness level of a detector or supporting technology, and the degree to which it advances the readiness of junior researchers or graduate students to assume leadership roles on future NASA space flight missions.

Absolute Photometric Calibrations

In order to leverage NASA's investment in current and future astrophysics missions, we particularly encourage suborbital proposals to establish absolute photometric calibrations that are tied to laboratory standards. Calibration plans should be formulated to ensure that the proposed suborbital investigations facilitate consistent absolute calibrations across the electromagnetic spectrum with accuracies at the percent level or better. One investigation designed to establish the absolute flux of standard stars in the 0.35 – 1.7 micron range is currently supported.

Special Instructions for Multiple-Institution Proposals for Suborbital Investigations

Proposals for suborbital investigations often involve the development of payloads that require major hardware collaborations amongst several organizations. In such cases, lead Principal Investigators (PIs) may propose a direct subcontracting arrangement between his/her organization and the Co-Investigator (Co-I) institution(s), in which case all the nominal instructions in the *NASA Guidebook for Proposers* (see further below) apply.

Alternatively, NASA recognizes that some cost savings may be achieved by providing separate awards to each collaborating institution, where the lead investigator from each Co-Investigator institution serves as the "Institutional PI" for the award to his/her institution (see Section 1.4.2 in the *NASA Guidebook for Proposers*). In order to provide for such multiple-award flexibility, the following instructions should be followed for proposals that involve major hardware contributions from multiple institutions:

- Only the "lead proposal" for the overall investigation, submitted by a single PI, will be reviewed. This lead proposal must include:
    - A clear statement in the first sentence of the *Proposal Summary* that identifies the proposal as the lead proposal.

    - The *Cover Page/Proposal Summary/Budget Summary* of the lead proposal, showing only the summary of the budget requested by the lead organization.
    - The PI's work statement and budget justification (narrative and details), plus appended *Task Statements* and the budget justifications (narrative and details) from all other collaborating Co-I institutions (see further below) as part of its budget justification.
    - A table in the budget details that shows the costs for the lead organization, plus those for each Co-I institution, which together must add to the total yearly requests for the entire, integrated investigation for its complete period of performance.

- Each collaborating Co-I institution proposal must:
    - Have a *Proposal Title* that is identical to the title of the lead proposal, except that "[Institution Name] Co-I" is added to the end.
    - Have a *Proposal Summary* that clearly cross-references the PI of the lead proposal in the first sentence.
    - Complete the *Cover Page/Proposal Summary/Budget Summary* and include all materials indicated in the *NASA Guidebook for Proposers*.
    - Contain, in lieu of the scientific/technical/management section, a *Task Statement*, not to exceed five pages, that describes the contribution of the Co-I institution and the role of the Co-I(s) to the overall investigation. In the case of multiple Co-Is from the same institution, a single Co-I serving as the "Institutional PI" must be identified.
    - Include a full institutional budget covering the Co-I institution's proposed activities.
    - Be submitted electronically through the institution's Authorized Organizational Representative (AOR), with the Co-I (Institutional PI) from that institution listed as the PI.

1.2.3 *Supporting Technology*

This APRA category supports investigations of technologies not yet ready for incorporation into new detector or space mission systems, but that offer promise of potential breakthroughs that could lead to future advances in instrumentation useful for NASA's space astronomy and astrophysics programs. This program includes small technology efforts for future missions such as the International X-ray Observatory or the Laser Interferometer Space Antenna.

1.2.4 *Laboratory Astrophysics*

This APRA category supports basic science investigations that do not require the space environment for completion, but which have the potential to enable or contribute significantly to space astronomy and astrophysics goals. Examples of such investigations include (i) the measurement of fundamental atomic, molecular, and nuclear parameters important for the analysis of NASA's space data and (ii) laboratory examination of processes that are relevant to astrophysical phenomena observed by NASA missions.

In this solicitation, in addition to the individual-investigator proposals that represent the core of the Laboratory Astrophysics program, we particularly encourage proposals that address the grand challenge of understanding carbon in the universe. Over the past two decades, astronomical observations at wavelengths from the infrared through the ultraviolet have demonstrated that large, aromatic molecules and carbon-rich dust are abundant and widespread throughout the observable universe. Consequently, these species possess profound astrophysical significance and impact the observations of NASA space astrophysics missions across the electromagnetic spectrum. With the new observational capabilities offered by the recently-serviced Hubble Space Telescope and the Herschel Space Observatory, as well as the advent of SOFIA and JWST in the next five years, the challenge of understanding the physical, chemical, and spectroscopic characteristics of complex organic molecules and carbon-rich dust in space has never been more timely.

It is expected that a research effort designed to achieve a goal as ambitious as understanding carbon in the universe will require a wide-ranging, coherent, and integrated program that combines laboratory studies, theoretical computations, and astronomical modeling carried out in conjunction with, and informed by, astronomical data. Therefore, we anticipate that any such proposals will be of a substantially larger scope than the typical Laboratory Astrophysics proposal, and will involve the efforts of a diverse team of scientists, and a budget commensurate with such a broad-based effort. We anticipate making 1 or 2 awards in this area depending on the quality of proposals and availability of funds. Relevant programs that demonstrate the potential for international collaboration in this area are especially encouraged.

1.2.5 *Ground-Based Observations*

This APRA category will consider proposals for ground-based observations only if they are in <u>direct</u> support of NASA space astronomy and astrophysics missions and/or goals. Note that proposers eligible for support by the National Science Foundation may <u>not</u> apply to this NASA program.

2. <u>Programmatic Information</u>

2.1 <u>General Information</u>

The following table provides the approximate amount of FY 2012 funding and the number of new investigations that may be selected for the five APRA categories pending the availability of funds and an adequate number of proposals of adequate merit.

APRA Category	Approximate Funds for New Selections [$M]	Approximate Number of New Selections
Detector Development	3	8
Suborbital Investigations	11	14
Supporting Technology	1.8	10
Laboratory Astrophysics	1.2	9
Ground-Based Observations	0.1	1

2.2 Student Participation

The participation of graduate students is strongly encouraged, especially if the project can be concluded within the nominal tenure of graduate training. In such cases, brief details of the educational goals and training of the participants should be included in the proposal.

2.3 Request for reviewer names

Proposers are strongly encouraged to provide names and contact information of up to five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information should be included in the proposal summary in the Notice of Intent.

3. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	See Section 2.1
Number of new awards pending adequate proposals of merit	See Section 2.1
Maximum duration of awards	4 years (5 years for suborbital investigations)
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation* of this NRA.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation* of this NRA.
Planning date for start of investigation	1 January after the proposal due date (except that NASA Centers may plan for a start at the beginning of the fiscal year).
Page limit for the central Science-Technical-Management section of proposal	15 pp (20 pp for suborbital proposals); see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the astrophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.

Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-APRA
NASA point of contact concerning this program	Dr. Linda Sparke Astrophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-7335 E-mail: HQ-APRA@mail.nasa.gov

Questions about the APRA Program should be directed to the point of contact above. Questions about specific discipline areas may be directed to the relevant Program Officers listed below, along with their areas of expertise, all of whom share the same mailing address. If uncertain whom to address, contact the APRA Program Officer above.

Astrophysics Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001

NAME	PROGRAM RESPONSIBILITY	TELEPHONE	E-MAIL
Dr. Ilana Harrus	Gamma-ray Astrophysics	(202) 358-1250	Ilana.M.Harrus@nasa.gov
Dr. Louis J. Kaluzienski	X-ray Astrophysics	(202) 359-0365	Louis.J.Kaluzienski@nasa.gov
Dr. Mario Perez	Ultraviolet and Visible Astrophysics	(202) 358-1535	Mario.Perez@nasa.gov
Dr. Eric P. Smith	Infrared, Submillimeter, and Radio Astrophysics	(202) 358-2439	Eric.P.Smith@nasa.gov

Dr. W. Vernon Jones	Particle Astrophysics	(202) 358-0885	W.Vernon.Jones@nasa.gov
Dr. Michael Salamon	Gravitational Astrophysics	(202) 358-0441	Michael.H.Salamon@nasa.gov
Dr. Douglas Hudgins	Laboratory Astrophysics	(202) 358-0988	Douglas.M.Hudgins@nasa.gov

D.4 ASTROPHYSICS THEORY

1. Scope of Program

The Astrophysics Theory program (ATP) supports efforts to develop the basic theory for NASA's space astrophysics programs. Abstracts of previously selected ATP projects may be found online at http://nspires.nasaprs.com/. The periods of performance of investigations for this research element may range from one to four years. Most selected proposals will have a duration of three years, but four-year proposals may be selected if the need for the longer duration is sufficiently well justified.

Proposals submitted for this program must both:

- be directly relevant to space astrophysics goals by facilitating the interpretation of data from space astrophysics missions or by leading to predictions that can be tested with space astrophysics observations; and
- consist predominantly of theoretical studies or the development of theoretical models.

ATP proposals satisfying both of the above requirements may involve development of data analysis methods for astrophysics missions and may incidentally include actual data analysis as a test of the theory or the method.

Proposals to the ATP program may not:

- consist primarily of data reduction or data analysis (such proposals should be directed to the mission-specific programs or the Astrophysics Data Analysis program (ADP) described in Appendix D.2 in this solicitation);
- propose theoretical work pertaining to atomic and molecular astrophysics and other topics directly related to Laboratory Astrophysics (these should be proposed to the Astrophysics Research and Analysis (APRA) program element described in Appendix D.3);
- develop experimental payloads to test theories of gravitation and fundamental physics (such proposals should be submitted to the Astrophysics Research and Analysis program element described in Appendix D.3);
- address theoretical topics that are predominantly unrelated to the needs of NASA's space astrophysics programs (such proposals should be directed to other appropriate Federal agencies);
- deal strictly or predominantly with Solar System objects or solar-terrestrial interaction studies, including solar energetic particles (see Appendices B and C for appropriate programs);
- propose to develop technologies or experimental concepts for future NASA missions (these proposals should be submitted to the Astrophysics Research and Analysis program element described in Appendix D.3 or the Strategic Astrophysics Technology program element described in Appendix D.11);
- primarily aim at studying new mission concepts in preparation for future competitive solicitations;
- request support for organizing and/or hosting scientific meetings; or

- request support for substantial computing facilities or resources (Note: Requests for personal computers, at amounts typically under $5K, will be allowed, so long as they are used exclusively for the research being proposed).

2. Proposal Category and Research Areas

ATP proposals will only be accepted from individual Principal Investigators (PIs) whose proposed work has a clear, single focus. Group proposals, i.e., those in which several researchers submit an omnibus proposal of related, but separate, theoretical research investigations under a designated PI, are not solicited for the ATP and will be considered unresponsive to this solicitation. However, individual theory PIs may include as many Co-Investigators and Collaborators as they wish on their proposals.

Investigators may submit more than one proposal to the ATP if the research program of each proposal is significantly distinct and if the implied work does not over commit the personnel involved. If a proposal is submitted as a successor to work supported by an earlier proposal, the new proposal must identify the related work and clearly summarize all significant results from it.

For the purposes of conducting the peer review, every proposal for this ATP must identify one (or more, if appropriate) of the Topic Categories from the list below in both its Notice of Intent to propose and in the proposal submission itself. The primary use of these Topic categories is to facilitate the assignment of the proposal to an appropriate review panel. NASA reserves the right to assign a proposal to a different category.

1. *Star Formation* (e.g., star forming clouds, protoplanetary and debris disks, protostars, astrochemistry);
2. *Stellar Astrophysics* (e.g., asteroseismology, convection, stellar evolution, brown dwarfs, mass loss, circumstellar disks);
3. *Collapsed Objects and X-ray Astrophysics* (e.g., white dwarfs, neutron stars, cataclysmic variables, X-ray binaries, black-hole binaries, sources for IXO or Black Hole Finder Probe);
4. *Supernovae and Gamma Ray Bursts;*
5. *Interstellar Medium, Cosmic Rays and Galactic Structure* (e.g., SN remnants, dark clouds, interstellar dust, H II regions, diffuse galactic emission, planetary nebulae, stellar clusters);
6. *Normal Galaxies* (e.g., quiescent galaxies, interacting galaxies, starburst galaxies);
7. *Active Galaxies and AGNs* (e.g., population studies, accretion discs, jets);
8. *Large Scale Cosmic Structures and Dark Matter* (e.g., clusters of galaxies, galaxy environment and evolution, intracluster medium, diffuse photon backgrounds);
9. *Dark Energy and the Cosmic Microwave Background* (e.g., theoretical studies of cosmological observation techniques, theoretical cosmology, dark energy models);
10. *Gravitational Astronomy* (e.g., gravitational wave sources, computation of gravitational radiation waveforms, data analysis methods for LISA signals); and
11. *Other Astrophysics Theory* (NASA HQ will assign the proposal to what it deems is the most appropriate review panel).

3. Additional Programmatic Information

3.1 Availability of High-End Computational Resources

Those investigators whose research requires high-performance computing should refer to the *Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to the Astrophysics Theory program to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at the Ames Research Center's Advanced Supercomputing Division.

3.2 Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $4M
Number of new awards pending adequate proposals of merit	~ 35
Maximum duration of awards	4 years; shorter term proposals are encouraged; four-year proposals must be well justified
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	No earlier than 6 months after the proposal due date, but no later than July 1, 2011
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the astrophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.

Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-ATP
NASA point of contact concerning this program	Dr. Thierry M. Lanz Astrophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-3989 E-mail: HQ-ATP@mail.nasa.gov

D.5 GALEX GUEST INVESTIGATOR – CYCLE 7

1. Scope of Program

As of this writing, NASA anticipates that the GALEX Cycle 7 GI program will be unchanged from Cycle 6. However, the Far UV detector is currently not obtaining science-quality data, and some Cycle 6 GI observations are not being obtained. The Cycle 7 GI program may be delayed, depending on how much of a backlog builds up before the detector returns to normal operations. If the Far-UV detector cannot be returned to obtaining scientifically useful observations, the Cycle 7 GALEX GI program will probably be reduced in total observing time, in funding available for Guest Investigations, and in number of supported observing modes. Any changes to the Cycle 7 program will be announced at least 90 days prior to the proposal deadline through an amendment to ROSES.

1.1 Overview

This program element solicits proposals for the acquisition and analysis of new scientific data from the Galaxy Evolution Explorer (GALEX). The GALEX mission is designed to map the global history and probe the causes of star formation over the redshift range $0 < z < 2$, a time span that traces 80% of the life of the universe, when galaxies have evolved dramatically, and when most stars, elements, and galaxy disks formed. This solicitation is for Cycle 7 of the GALEX Guest Investigator (GI) Program, to be carried out beginning on or around January 1, 2011, and lasting approximately 12 months (http://galexgi.gsfc.nasa.gov/). GI programs may address any area of astrophysics; they are not restricted to galaxy evolution studies.

Proposals submitted in response to this program may be for new observations with GALEX or for analysis of GALEX archival data. New observations may be for standard observing proposals or for Legacy proposals. Standard Proposals are for small focused investigations and will generally be less than 100 ksec, while Legacy Proposals are for large, coherent projects of general and lasting importance to a wide astrophysical audience, with corollary data or other additional benefit to the community, and will probably require more than 100 ksec. During GI Cycle 7, approximately two-thirds of the GALEX observing time will be used by the GALEX science team to carry out the mission's primary science investigations (http://galexgi.gsfc.nasa.gov/docs/galex/piscience/TMPsf3e3sieql.htm). The remaining observing time during Cycle 7 will be available to the scientific community through this solicitation for investigations that do not duplicate the GALEX science team investigations. Proposals may also be submitted to use archival GALEX data for investigations, and may make use of any publicly available GALEX data.

1.2 The GALEX Mission

GALEX provides ultraviolet imaging in two broad bands, Far-UV (FUV, 1350-1800 Å) and Near-UV (NUV, 1800-2800 Å), and low-resolution (R = 150-300) grism spectroscopy. The images cover a circular field of view of 1.25°, at a spatial resolution of ~4 arc sec FWHM, with sufficient sensitivity to study a wide variety of objects within and outside of our Galaxy. GALEX is a Principal Investigator (PI)-class mission, developed in collaboration among the California

Institute of Technology (Caltech), Pasadena; the Laboratoire d'Astrophysique Spatiale, Marseilles, France; the University of California at Berkeley; The Johns Hopkins University, Baltimore, Maryland; and the Yonsei University, South Korea. The GALEX PI, Dr. Christopher Martin of Caltech, is responsible to NASA for the mission design, development, and operations. GALEX is controlled from the GALEX Scientific Operations Center located on the Caltech campus.

The GALEX prime mission achieves its scientific objectives by performing several complementary imaging and spectroscopic surveys. The original four imaging surveys include one intended to cover ~90% of the safely observable sky at moderate sensitivity (the All-observable-Sky Imaging Survey), two other imaging surveys covering smaller areas to increasing sensitivities, and a survey of nearby galaxies. Spectroscopic surveys are matched to subsets of the imaging surveys. Further information on the design and contents of these surveys may be found at the GALEX website (http://www.galex.caltech.edu/). Although the PI team surveys are designed to study galaxy evolution, the satellite and accompanying rich data sets should prove invaluable for exploring many astrophysical problems. Proposers to this Cycle 6 GI program are encouraged to take full advantage of the capabilities of GALEX (within operational constraints) to address important problems in astrophysics, for example, large scale structure, Active Galactic Nuclei populations, massive star evolution, supernova remnants, interstellar and intergalactic material, young stellar objects and their environments, planets and their satellites, or comets.

2. Programmatic Information

2.1 Proposal Submission and Evaluation

Proposers are asked to submit proposal materials electronically, as detailed below.

2.1.1 *Submission of Proposals to the GALEX Cycle 7 GI Program*

NASA will review proposals for this program in a two-phase process. In Phase 1, proposals will be evaluated with respect to their intrinsic merit and relevance to NASA's objectives. Observing proposals selected in the Phase 1 review will be awarded observing time on GALEX and become candidates for funding subject to the Phase 2 review process. Selected archival proposals will become candidates for funding subject to the availability of proposed targets in the GALEX public data archive. For both observing and archival proposals, the cost of the investigation will be evaluated in the second phase; no budgets are required for Phase 1 proposals.

Prospective proposers to Cycle 7 of the GALEX GI Program must adhere to the following 2-part procedure for the submission of Phase 1 proposals. Both submissions are due by the due date for this program element (see Tables 2 and 3 in the *ROSES Summary of Solicitation*):

- Prepare and submit the Phase 1 scientific and technical proposal as a PDF file to the Remote Proposal System at http://heasarc.gsfc.nasa.gov/RPS/. Proposers who are familiar with LaTeX or Word may retrieve and prepare proposals using template Cycle 7 proposal forms available on the GALEX GI Website (http://galexgi.gsfc.nasa.gov/). Proposers need not use the LaTeX or Word templates, but must adhere to the page limits, font sizes, etc., as given on the Web site. An acknowledgement of receipt will be sent to the proposal submitter by E-mail.

- Prepare and submit a cover sheet and the required minimum set of GALEX target data to RPS (http://heasarc.gsfc.nasa.gov/RPS/).

All electronic proposal materials must arrive by 4:30 p.m. Eastern time on the due date for this program given in Tables 2 and 3 of the *Summary of Solicitation* for this NRA in order to be included in the proposal review for this cycle of the GALEX GI program. Note: The 4:30 p.m. Eastern time deadline supersedes the deadline stated in the *NASA Guidebook for Proposers* and in the *ROSES Summary of Solicitation*.

Phase 1 proposals submitted to the GALEX GI program (Cycle 7) may not be submitted via NSPIRES or Grants.gov.

2.1.2 *Evaluation and Selection of Proposals submitted to the GALEX GI Program*

Phase 1 proposals will be evaluated with respect to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers* (excluding cost), where it is understood that the intrinsic merit of a proposal shall include the following factors:

- The overall scientific merit of the proposed investigation;
- The suitability of using the GALEX observatory and/or data products for the proposed investigation;
- The degree to which the investigation uses GALEX's unique capabilities;
- The feasibility of accomplishing the objectives of the investigation; and
- The feasibility and suitability of the proposed analysis techniques.

Legacy proposals will also be judged on the factor:

- Provisions to provide Legacy data and enhanced data products to the community in a timely fashion.

Based upon the results of the above reviews, the GALEX Program Officer identified below will recommend a set of proposals to the Selecting Official for selection.

2.2 Available Funding

Selected investigators at U.S. institutions, including U.S. Co-Investigators on selected non-U.S. proposals, will be eligible for funding. For Phase 2, the selected investigators will receive a funding guideline from NASA based on the scope of the approved observing program and the available budget for the GALEX Cycle 7 GI Program. Eligible investigators may submit Phase 2 proposals for funding. Instructions for submitting electronic Phase 2 proposals through NSPIRES and the due date for submission will be provided to eligible investigators with the funding guideline.

It is estimated that the funding available for this program will be approximately $2M and that this level of funding will support about 35 research investigations. The maximum period of performance that may be proposed is one year. A budget summary and narrative description of how the award will be used must be submitted with the Phase 2 proposal. Phase 2 proposals must be submitted by an Authorized Organizational Representative (AOR) of the proposing institution.

2.3 Supplemental Information

Further details of the proposal submission requirements and process may be found at the GALEX GI Program Web site (http://galexgi.gsfc.nasa.gov/), which includes a detailed mission description; technical information about GALEX and instrument; instrument and observer handbooks; tools for determining the feasibility of potential observations; information on the GALEX PI team science investigations; listings of observed and planned targets and of data sets available for archival proposals; sample data sets; detailed information regarding proposal submission, evaluation, selection, and implementation; and instructions for completing the required proposal forms.

2.4 Schedule

The schedule for submission of electronic Phase 1 proposals and target information is given in Tables 2 and 3 of the *ROSES Summary of Solicitation*. All electronic proposal materials must arrive by 4:30 p.m. Eastern time on the due date for this program.

2.5 Contact Information:

Scientific and technical questions concerning this program element should be directed to:

Dr. Susan G. Neff
GALEX Mission Scientist
Laboratory for Observational Cosmology
Code 665
NASA Goddard Space Flight Center
Greenbelt, MD 20771-0001
Telephone (301) 286-5137
Email: Susan.G.Neff@nasa.gov

Programmatic information may be obtained from the GALEX Program Officer:

Dr. Douglas Hudgins
Astrophysics Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
Telephone: (202) 358-0988
Email: douglas.m.hudgins@nasa.gov
[Changed April 14, 2010]

Technical information may be obtained from the GALEX GI website and/or help desk:

GALEX GI Help Desk
Laboratory for Observational Cosmology
Code 665
NASA Goddard Space Flight Center
Greenbelt, MD 20771-0001
Telephone (301) 286-5689
Email: GALEX.helpdesk@galexgi.gsfc.nasa.gov

3. Summary of Key Information

Expected program budget for first year of new awards	~ $2M
Number of new awards pending adequate proposals of merit	~ 35
Maximum duration of awards	1 year
Due date for Notice of Intent to propose (NOI)	No Notices of Intent are requested for this program element.
Due date for proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA. Note: Proposals are due by 4:30 p.m. Eastern time on the due date.
Planning date for start of investigation	Funds will be awarded when the data are made available to the PI. NASA Center proposers should use March 1, 2011 (2 months after start of Cycle 7 observing) as a planning date for start of investigation.
Page limit for the central Science-Technical-Management section of Phase 1 proposal	See the GALEX GI Program Web site at http://galexgi.gsfc.nasa.gov/.
Relevance	This program is relevant to the astrophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *2009 NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/ and the GALEX GI Program Web site http://galexgi.gsfc.nasa.gov/.
Submission medium	Electronic proposal submission of Phase 1 proposal is required; no hard copy is required or permitted. See also Section 2.1.1.
Address for submission of electronic Phase 1 proposal	See Section 2.1.1.

Web site for submission of Phase 1 proposal via NSPIRES	Option not available
Web site for submission of Phase 1 proposal via Grants.gov	Option not available
Funding opportunity number for downloading an application package from Grants.gov	Option not available
NASA point of contact concerning this program	Dr. Douglas Hudgins Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1535 Email: mario.perez@nasa.gov **[Changed April 14, 2010]**

D.6 Swift Guest Investigator – Cycle 7

1. Scope of Program

1.1 Overview

The Swift Guest Investigator (GI) Program solicits proposals for basic research relevant to the Swift gamma-ray burst mission. The primary goal of this mission is to determine the origin of gamma-ray bursts (GRBs) and use these bursts to probe the early universe. Swift is also a valuable asset for obtaining multiwavelength images, spectra, and light curves on interesting Targets of Opportunity (ToOs) and other nontransient sources.

Cycle 7 observations and funding will commence on or around April 1, 2011, and last approximately 12 months. As was the case in Swift GI Cycles 4 through 6, observing time will be made available to scientists at U.S. and non-U.S. institutions to study a wide variety of astrophysical sources. Cycle 7 will also provide an opportunity for principal investigators (PIs) to propose ToOs for GRBs discovered by other space-based missions or ground-based instruments. Consistent with Explorer Program policy, there will be no proprietary data rights to observations conducted with Swift. All science data will be made freely available through the Swift Quick Look web site (http://swift.gsfc.nasa.gov/cgi-bin/sdc/ql) as soon as they are received and processed. Funding through the NASA Swift GI Program is available only to scientists at U.S. institutions who are identified as the principal investigators. U.S. based co-investigators on foreign-led proposals do not qualify for funding. Funding for accepted target proposals will be initiated only after the relevant observations have begun.

The Swift GI program is intended to provide the following to participating scientists:

1. Funding (U.S. PIs only) for:
   - Theoretical investigations that will advance the Swift mission science return;
   - Correlative GRB observations involving new or enhanced IR ground-based capabilities for investigating high redshift bursts;
   - Other correlative GRB projects; and
   - New Swift GRB projects.

2. Observations (and funding for U.S. PIs) for:
   - non-ToO observations of non-GRB targets, and ToOs; and
   - “Fill-in” targets

1.2 The Swift Mission

Swift is a Medium-class Explorer mission developed at the NASA Goddard Space Flight Center. The lead domestic partners include Pennsylvania State University and Los Alamos National Laboratory. Groups in the United Kingdom and Italy made significant contributions to the hardware development and are active participants in the operations, including provision of the Italian ground station at Malindi. The Swift Mission Operations Center (MOC) is at

Pennsylvania State University, and the Swift Science Center (SSC) is at NASA Goddard Space Flight Center.

The Swift mission was launched on November 20, 2004, from Cape Canaveral Air Force Station, Florida. Swift was launched into a low Earth orbit with an inclination of 21 degrees and an altitude of 600 km. The baseline mission duration was two years, but the mission has been extended at least another four years beyond this initial period because of its continuing scientific productivity. The orbital lifetime of the satellite is estimated to be approximately 20 years.

The Swift spacecraft carries three science instruments: a wide-field gamma-ray Burst Alert Telescope (BAT) and two sensitive, co-aligned narrow-field instruments – the X-ray Telescope (XRT) and the Ultraviolet/Optical Telescope (UVOT). The spacecraft can be autonomously pointed to direct the XRT and UVOT toward events detected by the BAT. The BAT is a wide-field gamma-ray imager that detects GRBs and rapidly sends positions of arc-minute accuracy to the spacecraft and to the ground. The BAT operates in the 15–350 keV range and has a 1.4 steradian (half-coded) field-of-view. It has a GRB detection sensitivity ~2 times better than the Burst and Transient Source Experiment (BATSE) that flew on the Compton Gamma-Ray Observatory (CGRO). In addition to detecting GRBs, the BAT is performing a survey of the hard X-ray sky to a sensitivity of ~1 mCrab (2×10^{-11} erg cm^{-2} s^{-1}). It also scans most of the sky each 90-minute orbit and serves as a sensitive monitor for high-energy transients. Positions and spectra of transients detected by the BAT are telemetered to the ground and distributed immediately to the community.

In response to GRB alerts from the BAT, the spacecraft reorients on a time scale of ~1 minute to point the XRT and UVOT instruments at a GRB or other transient. These instruments perform multiwavelength measurements of the bright early afterglow (and also later-time afterglow) emission to provide sub-arcsecond positions, precise photometry, and fine spectroscopy. The XRT is a Wolter 1 grazing incidence telescope that operates in the 0.2–10 keV band and has a field-of-view of 23.6 arcminutes with an angular resolution of 18 arcseconds (Half Power Diameter) and positional determination accuracy of better than 5 arcseconds. The detector is a cooled CCD, providing spectroscopy with a resolution $E/\Delta E$ ~10 at 1 keV and an effective area of 120 cm^2. The UVOT is a Ritchey-Chrétien folded-optics telescope operating in the 170–650 nm band. It has a field-of-view of 17 arcminutes x 17 arcminutes, with an angular resolution of 2.5 arcseconds and positional determination accuracy of 0.3 arcseconds. UVOT provides a sensitivity to afterglows of 22nd magnitude for a 1,000 second integration in its V filter, one of six filters for color photometry. It also has a white-light filter and two grisms for fine spectroscopy ($E/\Delta E$ ~ 300) of sources brighter than 17th magnitude. The narrow-field instruments yield an accurate position and X-ray spectra of the afterglow within a few minutes of the burst. This information is distributed immediately over the Internet. Data from continued observations of the afterglow are made available via Circulars and Reports on the Gamma-ray bursts Coordinates Network (GCN, http://gcn.gsfc.nasa.gov/) and on a public web site (http://swift.gsfc.nasa.gov/docs/swift/archive/). Notification of transient source detections is made through IAU Circulars (http://cfa-www.harvard.edu/iau/services/IAUC.html) and Astronomer's Telegrams (ATELs, http://www.astronomerstelegram.org/). Data from serendipitous source detections in the field-of-view of both instruments are routinely sent to the ground for analysis.

Further information on the Swift mission may be found at http://swift.gsfc.nasa.gov/.

1.3 Types of Proposals

This Swift GI Program solicits proposals in the following areas:

- New Swift GRB projects not requiring GI-specified observatory pointing;
- Correlative GRB observations involving new or enhanced IR ground-based capabilities for investigating high-redshift bursts or other correlative GRB projects involving non-Swift instruments and observatories;
- Theoretical investigations that will advance the Swift mission science return;
- Non-GRB non-ToO observations that benefit from Swift's unique capability of simultaneous multiwavelength coverage;
- ToO observations which promise large scientific return and capitalize on Swift's unique capabilities of rapid repointing and multiwavelength observations; and
- Fill-in targets to be observed in what would otherwise be gaps in the planned science timeline.

1.3.1 *New Swift GRB project*

GIs may propose to initiate their own GRB projects that supplement or enhance the Swift science return with their unique facilities, missions, capabilities, or methods. The extent to which the proposed research will enhance the science return from Swift and the demands placed upon mission resources by an investigation will be considered in the proposal evaluation process. Proposals in this category can also include changes or additions to current Swift strategies to detect and observe GRBs (Swift detected or elsewhere) and can propose innovative GRB data reduction and interpretation methods that increase our understanding of GRBs. Proposals that require changes to Swift on board capabilities or operational procedures may require special scrutiny during the review process by the Swift team for technical feasibility, and may require formal approval by the Swift Configuration Control Board before implementation. Investigators considering such proposals are strongly urged to consult with the Swift team prior to proposal submission.

1.3.2 *Swift GRB Correlative Observations*

GRB correlative observations substantially augment the science return from Swift. The Swift instruments make unique measurements of GRB afterglows starting immediately following the burst. However, it is not possible to follow up all GRBs on all time scales, since viewing constraints and scheduling conflicts will preclude some Swift observations. Also, the onboard capability, although significant, does not cover all of the scientifically valuable measurements that need to be made. Candidate correlative observations that will add significantly to the Swift science include radio imaging and photometry, infrared spectroscopy (for high-z bursts redshifted out of the band pass of the UVOT), deep optical imaging and spectroscopy of the afterglow and possible host galaxy, surpassing the capability of the UVOT to reach 22nd V magnitude in 1,000 seconds, and rapid optical observations with time scales shorter than the 1-minute Swift response time.

GRBs at high redshift are particularly compelling due to their distance and rely especially on high quality infrared observations for distance estimates, since the optical counterpart is redshifted out of Swift/UVOT's wavelength range. To encourage the development of rapid IR ground-based response to potentially high redshift GRBs, special consideration will be given to such projects. Proposals to bring new or enhanced ground-based IR capabilities online may require funding above the average award (e.g., in the $100K range). Such budget requests will be considered provided they are strongly justified. A six-page limit for the scientific justification applies to proposals submitted in this "high-z GRB" proposal category.

For all correlative investigations funded by Swift, rapid public availability of the resulting data is in the interest of the Swift mission and the astronomical community, and is strongly encouraged. Public data availability for correlative studies should be discussed in these proposals and will be considered in the evaluation of these proposals.

1.3.3 *Theoretical Investigations*

Theoretical studies which have the potential to significantly enhance the scientific impact of the Swift mission. GI proposals for such theoretical investigations are also solicited and should specifically address how the anticipated results will advance Swift science objectives.

1.3.4 *Non-GRB, non-ToO observations*

A total of 2 million seconds of observing time will be made available during Cycle 7 for non-GRB, non-ToO pointed observations. Swift observations in this category will be performed only as the result of an uploaded ground command through the normal planning process; slewing to the target will not occur autonomously. Non-ToO observations will have a lower scheduling priority than GRBs or ToOs and will be observed on a best-effort basis when time is available in the observing schedule. Hence, successful non-GRB/non-ToO GIs should be aware that they are not assured 100% of the time awarded. Every effort will be made to observe 80% or more of an accepted program within schedule limitations of the mission. A single observation is defined as one requested pointing to a target. Proposers should be aware that, due to Swift's low Earth orbit (95 minute orbit period) and scheduling priorities for other objects, any long observation may be broken up into several different pointings on different orbits. Observations longer than a few kiloseconds (ks) might be split into several days.

Non-ToO proposals are subject to the following limitations:

- The requested time per observation must be between a minimum of 1 ks and a maximum of 40 ks;
- Monitoring programs are defined as programs requiring two or more observations of the same object, each of which is considered a "visit"; and
- No more than 1,500 visits will be permitted in Cycle 7 (total for all proposal categories, including both monitoring and nonmonitoring requests).

Time-constrained observations are defined as observations that have to be performed within a certain time window. These can be ToOs or non-ToOs, either monitoring (more than one visit to a source) or nonmonitoring observations, but not "fill-in" observations. This includes phase-constrained proposals, coordinated observing campaigns with ground-based or satellite-based facilities, etc. Note that the unique scheduling requirements of Swift put severe constraints on time-constrained programs. Time-constrained observations are subject to the following limitations:

- The window duration must exceed 3 hours; and
- No more than 500 time-constrained visits will be performed during Cycle 7.

For coordinated and constrained observations, it is the proposer's responsibility to inform the Swift Science Operations Team of the observing time windows at least one week before observations start. Proposers must clearly describe how their proposal capitalizes on the unique capabilities of Swift.

There will be no time carried over from Cycle 7 to Cycle 8, except when observing for an awarded program has commenced during Cycle 7. GIs whose observing programs have not begun in Cycle 7 will be required to repropose if they wish to acquire observing time. Targets whose observations have commenced in Cycle 7 will be awarded carry-over time in Cycle 8 until the proposed observations are substantially complete. Similarly, Cycle-6-accepted proposals that have not been initiated by the start of Cycle 7 will not be carried over. Cycle 6 GIs who are concerned that their programs may not be started before the end of Cycle 6 should repropose for Cycle 7.

1.3.5 *ToO Observations*

GIs are allowed to propose for ToOs in response to transient phenomena, including GRBs found by other observatories (but not including GRBs found by Swift). A total of at most 1 million seconds of observing time will be made available to ToO proposals, subject to the constraints listed below. Swift ToO observations will only be performed as the result of an uploaded command by the Mission Operations Center and will not be slewed to autonomously. ToO observations will have a lower scheduling priority than GRBs and will be observed on a best-effort basis. Because of this restriction, successful ToO GIs should be aware that they are not assured 100% of the time awarded, even if their ToO is triggered. Every effort will be made to observe 80% or more of an accepted program. GIs submitting ToO proposals should note that:

- Each proposal should describe how it capitalizes on the unique capabilities of Swift;
- Proposals must give exact, detailed trigger criteria and a realistic estimate of the probability of triggering the ToO during Cycle 7; and
- Proposals must assign a priority to each ToO target based on the time criticality of the observation. From the time of the trigger, the priorities are defined as
    - Highest Priority: Observation should be performed within 4 hours;
    - High Priority: Observation should be performed within 24 hours;
    - Medium Priority: Observation can be performed within days to a week; or

- Low Priority: Observations can be performed within weeks.

Because new GRBs are constantly being discovered, the Swift observing schedule is revised on a daily basis. Note that Highest priority ToOs are particularly difficult to handle at night and on weekends when the Mission Operations Center is not staffed. These should be avoided in all but the most urgent cases (e.g., transient events like a Galactic SN, a very bright GeV gamma-ray burst, or a giant SGR flare).

It is the responsibility of the PI to alert the Swift Observatory Duty Scientist when trigger conditions for their accepted ToO have been met. This is done through the Swift ToO Request Form at https://www.swift.psu.edu/secure/toop/too_request.htm. It is highly recommended that ToO proposers register as Swift ToO users in advance at https://www.swift.psu.edu/secure/toop/too_newuser.htm. Registration is required in order to submit a ToO Request.

ToO proposals must have an astrophysical trigger. Once the trigger criteria have been met for an approved target, the PI should check if the target location is more than 5 hours in RA from the Sun and more than 20 degrees from the Moon before requesting Swift observations (http://heasarc.gsfc.nasa.gov/Tools/Viewing.html). ToO observations that require more than 6 ks on a given day and are closer to the Sun than 5 hours RA will be less likely to be approved unless they are of exceptionally high scientific priority. Observations greater than 9 hours in RA from the Sun are particularly desirable. The purpose of the anti-Sun restriction for ToOs is to maximize the amount of time Swift is pointed toward the night sky in order to optimize optical follow-up observations of BAT-detected GRBs.

Accepted Cycle 7 ToO proposals may be triggered until March 31, 2012. GIs whose ToO programs do not trigger in Cycle 7 will be required to re-propose in later cycles should they wish to acquire observing time on their targets of interest.

Note that unsolicited ToO requests for exceptional transients will continue to be possible through the Swift ToO web site even for those not accepted into the GI Program. The decision on whether or not to observe a ToO of either category will be made by the Swift Principal Investigator or his official designee. Such ToO requests are unfunded.

1.3.6 *Swift "Fill-in" Targets*

PIs may submit a list of targets for consideration as "Fill-in" targets. Their purpose is to provide a set of peer-reviewed targets to be used to fill in gaps in the planned science timeline. These must not be ToOs, must have no observational constraints, and can only be observed once (no multiple observations of the same target). The requested total integration time per target must be between a minimum of 1 ks and a maximum of 40 ks. Each proposer will be limited to a maximum of 50 targets. Accepted targets will be added to the Swift observing program at the discretion of the science operations team. They will be scheduled as needed, around the higher priority GRB follow-up observations, ToO and non-ToO observations, to maximize the Swift science program. A budget ceiling of $20K for the total cost to NASA (including overhead) applies for all proposals submitted in the "Fill-In" category. Funding will be contingent upon at least one target being observed for no less than 80% of the requested time. PIs should have no expectation that their entire list of "Fill-in" targets will be observed. Due to the nature of Swift science planning, Swift GI "Fill-in" observations will be scheduled only about 24 hours prior to observation, and PIs will not be notified until observations have been completed for a given target. Scheduling information will be available to PIs via the daily observing plan (http://www.swift.psu.edu/operations/obsSchedule.php).

To reiterate:

- Fill-in targets are not ToOs and cannot be triggered;
- Fill-in targets cannot be time constrained;
- No monitoring is allowed with fill-in targets. Proposers cannot request multiple target visits; and
- Fill-in targets are scheduled at the convenience of the science planners. There is no guarantee that any of the targets in any fill-in program will be scheduled or completely observed in this Cycle.

2. Programmatic Information

2.1 General Information

It is anticipated that approximately $1.6M will be available through this solicitation for the support of approximately 50 Guest Investigations of one-year duration each. Swift non-GRB pointed observations are open to all scientists at U.S. or non-U.S. institutions. Swift GI funding is open to all individuals who are identified as principal investigators and employed at U.S. institutions, including Swift science team members. Scientists participating in the Swift mission, including Associate Scientists and members of the Follow-up Team who are not funded by the Project, are eligible for support under this GI Program. Swift science team members who already receive support from the Project must provide a compelling justification for the award of additional funds under the GI Program.

2.2 Proposal Submission and Evaluation

2.2.1 *Submission of Proposals to the Swift GI Program*

The Swift GI program uses a two-phase proposal process. A Phase 1 proposal shall comprise the science/technical justification, a brief management section if funding is requested, a total budget cap, and a corresponding basis for this budget cap. The science/technical justification should contain a brief description of previous Swift programs carried out by the PI. Only proposers whose Phase 1 proposals are accepted will be invited to submit budget proposals in Phase 2. All proposal materials will be submitted electronically.

Each proposer who anticipates requesting funding must plan an investigation that can be accomplished within a budget ceiling of $40K (total cost to NASA, including overhead). The budget ceiling for "Fill-in" proposals is $20K. These ceilings will be strictly enforced to ensure that the total cost to NASA of the entire suite of selected proposals does not exceed available resources. Proposals in the "high-z GRB" category are exempt from the budget ceiling, but should provide a detailed cost justification section. The amount of the anticipated funding request must be entered into the box provided for this purpose on the Remote Proposal System (RPS) Cover Form. The detailed cost evaluation will be deferred until Phase 2 (except for the "high-z GRB" proposals). The funding amount requested in the Phase 2 cost proposal may not exceed the amount proposed in Phase 1.

Proposers to the Swift GI Program must adhere to the following proposal submission procedures:

- All Proposers must submit their Phase 1 proposals electronically through the ARK/RPS website at http://heasarc.gsfc.nasa.gov/ark/rps/. Instructions for doing so are provided at the SSC web site, http://swift.gsfc.nasa.gov/;
- Target forms for all observation proposals are to be submitted through ARK/RPS;
- Due to the nature of prospective investigations within the Swift GI program, the Scientific/Technical/Management section of proposals is limited to 4 pages (6 pages for "high-z GRB" proposals), instead of the default 15 pages specified in the *NASA Guidebook for Proposers*. The requirement for a table of contents in the body of the proposal is waived. No supporting material (e.g., CV, pending/current support) is required or allowed;
- Optional Latex and MS Word templates for the Scientific/Technical/Management section are provided on the SSC web site at http://swift.gsfc.nasa.gov/; and
- The Scientific/Technical/Management section must be uploaded to the RPS website as a PDF file.

All proposal materials must be submitted electronically by 4:30 p.m. Eastern time on the due date for this program given in Section 3 in order to be included in the proposal review for this cycle of the Swift Guest Investigator program. Note that the 4:30 p.m. deadline supersedes the deadline stated in the *Guidebook for Proposers* and in the *ROSES Summary of Solicitation.*

NASA uses a single, uniform set of instructions for the submission of ROSES proposals. These instructions are given in the *NASA Guidebook for Proposers* (http://www.hq.nasa.gov/office/procurement/nraguidebook/). Swift GI Proposers should follow these instructions, except where they are overridden by the instructions given in the *ROSES Summary of Solicitation* or in this Appendix.

2.2.2 *Evaluation of Proposals submitted to the Swift GI Program*

Proposals will be evaluated by a peer evaluation panel with respect to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*, where it is understood that the intrinsic merit of a proposal shall include the following factors:

- The suitability of using the Swift observatory and data products for the proposed investigation;
- The extent to which the investigation complements and enhances the anticipated science return from the Swift mission;
- The degree to which the proposed investigation places demands upon mission resources;

- The degree to which the proposed investigation capitalizes on the unique capabilities of Swift; and
- For theoretical investigations, the degree to which the investigation directly advances Swift science goals.

2.2.3 *Submission and Evaluation of Phase 2 proposals*

Subject to the availability of funding, successful Phase 1 proposers will be contacted by the Swift Program Officer and invited to submit a cost proposal in Phase 2. Upon notification of selection of a Phase 1 proposal, a proposer must respond as follows:

> Follow the instructions for submitting a Phase 2 proposal given in the selection notification from the Phase 1 review. Phase 2 (cost) proposals must be submitted through the NASA NSPIRES electronic proposal website (http://nspires.nasaprs.com) by an Authorized Organizational Representative (AOR) of the proposing organization according to the instructions in the *Summary of Solicitation* of this NRA. The cost proposal will consist of a Budget Details (maximum of two pages) section and a Narrative section (maximum of two pages).

NASA program personnel will evaluate the Phase 2 cost proposals against the third evaluation criterion, cost realism and reasonableness. Comparison of the proposed cost to available funds will be performed as specified in Section C.2 of the *NASA Guidebook for Proposers.*

2.3 Supplemental Information

Further details concerning the proposal submission requirements and process can be found at the Swift Science Center website http://swiftsc.gsfc.nasa.gov/. This website provides a detailed mission description; technical information about the Swift mission, instruments, and observation feasibility; and instructions for completing the required proposal forms.

3. Summary of Key Information

Expected program budget for new awards	~ $1.6 M
Number of new awards pending adequate proposals of merit	~ 50
Maximum duration of awards	1 year
Due date for Notice of Intent to propose (NOI)	Option not available
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*. Note: Proposals are due by 4:30 p.m. Eastern time on the due date.
Planning date for start of investigation	Funds will be awarded when the data are made available to the PI. NASA Center proposers should use June 1, 2011 (2 months after start of Cycle 7 observing) as a planning date for start of investigation.

Page limit for the central Science-Technical-Management section of proposal	4 pp for all proposal categories except for proposals submitted in the "High-z GRB" category, which are allowed to have up to 6pp. Latex and MS Word templates (available for download at: http://swift.gsfc.nasa.gov/) can be used for the proposals. No supporting material (e.g., CV, pending/ current support) will be considered for Phase 1.
Relevance	This program is relevant to the astrophysics strategic goals and subgoals in NASA's *Strategic Plan;* see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *2010 NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of Notice of Intent to propose (NOI)	Option not available
Web site for submission of Phase 1 proposal and required forms	http://swift.gsfc.nasa.gov/ (Help Desk available at http://heasarc.gsfc.nasa.gov/cgi-bin/Feedback)
Web site for submission of Phase 1 proposal via NSPIRES	Option not available
Web site for submission of Phase 1 proposal via Grants.gov	Option not available
Swift Program Scientist	Dr. Ilana Harrus Astrophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1250 Email: ilana.m.harrus@nasa.gov
Technical questions concerning this program element may be directed to the Swift Guest Investigator Program	Dr. Stefan Immler Swift Guest Investigator Program Code 661 Goddard Space Flight Center National Aeronautics and Space Administration Greenbelt, MD 20771-0001 Telephone: (301) 286-0072 Email: swifthelp@athena.gsfc.nasa.gov

D.7 SUZAKU GUEST OBSERVER – CYCLE 6

NOTICE: The conduct of Cycle 6 of the Suzaku Guest Observer program will not be determined until after the Astrophysics Senior Review for Operating Missions. The results should be known by the end of May 2010. If Cycle 6 of the Suzaku Guest Observer program will be conducted, then ROSES 2010 will be amended to confirm the due date. The due date will be no earlier than 90 days after the amendment.

1. Scope of Program

1.1 Overview

This program element solicits proposals for participation through NASA in the conduct of space science observations and subsequent analysis of the resultant scientific data from the joint Japanese-U.S. Suzaku X-ray observatory. The primary goal of the Suzaku mission is to investigate the nature and physics of astrophysical objects as revealed through detailed observations of their high-energy emission. A broad range of astrophysical objects will be studied, including stars, X-ray binaries, diffuse galactic emission, active galactic nuclei, and clusters of galaxies.

Cycle 6 observations will commence on or around April 1, 2010, and last approximately 12 months. NASA is responsible for allocating the U.S. share of Suzaku observing time during the mission via this and subsequent solicitations. All of the U.S.-allocated observing time will be awarded competitively. Allocation of the Japanese observing time will be the responsibility of the Institute of Space and Astronautical Science of the Japanese Aerospace Exploration Agency (ISAS/JAXA). This program element solicits proposals for observations using the X-ray Imaging Spectrometer and/or Hard X-ray Detector instrument on Suzaku. Proposals may be submitted for observing time only; proposals for complementary observations or theoretical investigations are not solicited.

1.2 The Suzaku Mission

1.2.1 *Mission Overview*

Suzaku is Japan's fifth x-ray astronomy mission and the third for which the U.S. has provided a significant part of the scientific payload. Its five large-area telescopes focus x-rays from a wide energy range onto four x-ray sensitive charge-coupled devices (CCDs) and a microcalorimeter (now no longer operational). In addition, Suzaku carries a nonimaging Hard X-ray Detector. Suzaku will observe a variety of x-ray sources over a very broad spectral band with moderate spatial resolution and moderate spectral resolution. It is anticipated that Suzaku will typically perform one pointing every 1 – 2 days. These combined capabilities enable a diverse and exciting program of astrophysical research.

The four, nearly identical x-ray CCD cameras, of which three are currently operational, are known as the X-ray Imaging Spectrometers (XISs) and are provided by a hardware team from

Kyoto University, Osaka University, Ehime University, Rikkyo University, Kogakuin University, the Massachusetts Institute of Technology (MIT), and ISAS. Each CCD camera head is based upon a single 1024 x 1024 pixel CCD chip, manufactured at MIT Lincoln Laboratory. The field-of-view of each camera is 18 x18 arcminutes. The CCD spatial resolution is defined by the X-Ray Telescope (~2 arcminute half-power diameter). Three units (two active) have a front-side illuminated chip, each with a bandpass of 0.4 to 12 keV; the fourth unit has a back-side illuminated chip covering the 0.2 to 12 keV band. The XIS spectral resolution is ~130 eV at 6 keV and scales as the square-root of the photon energy.

The high-throughput X-Ray Telescopes (XRTs) utilize multiply-nested, thin foil, conical mirrors. The XRTs are supplied by the NASA Goddard Space Flight Center (GSFC), Nagoya University, Tokyo Metropolitan University, and ISAS and provide a spatial resolution of ~2 arcminutes (half-power diameter) and a broad bandpass of 0.1-12 keV.

The Hard X-ray Detector (HXD) is a low background, collimated detector, covering the 10-600 keV band. It is provided by the University of Tokyo, Japan's Institute of Chemistry and Physics (RIKEN), Japan's National Laboratory for High Energy Physics (KEK), Hiroshima University, Saitama University, Kanazawa University, Osaka University, Aoyama Gakuen University, the Stanford Linear Accelerator Center (SLAC), and ISAS. Its spectral resolution ranges from ~9 percent at 662 keV to ~30 percent at 10 keV. The detector array consists of silicon PIN diodes (sensitive below 70 keV) and GSO well-type phoswich counters (sensitive above 40 keV). Below 100 keV, fine collimators limit the field of view to 34 arcminutes x 34 arcminutes full width at half maximum (FWHM).

For more information about the instruments, please see the Suzaku Technical Description, which can be obtained from the Suzaku Guest Observer Facility at http://suzaku.gsfc.nasa.gov/.

1.2.2 *Operations*

The Suzaku spacecraft was launched July 10, 2005, 1:30 UT, from Uchinoura Space Center (USC) in Japan. An ISAS M-V rocket placed Suzaku into an approximately circular orbit of inclination about 31 degrees at an altitude of about 550 km. Direct contact between the satellite and the ground station at USC is possible for five orbits per day. The XIS and HXD science instruments are expected to last about five years. Based upon an anticipated data rate of ~1.2 Gigabytes/day, the final mission archive will contain on the order 2 Terabytes of raw data.

Suzaku operations are managed by Japanese astronomers and engineers at ISAS. They schedule observations, direct the satellite, collect the data, and monitor the health of the spacecraft and its payload. All data are copied and sent to the U.S. Suzaku Guest Observer Facility (GOF) at GSFC. There they are processed, distributed to U.S. Guest Observers, and archived.

1.2.3 *Observing Time Allocation*

In Cycle 6, 2 Msec of observing time will be reserved for ongoing and new Key Projects (see Section 2.1.1). The remainder will be allocated as follows:
    40 percent for U.S. investigations;

55 percent for Japanese investigations; and
5 percent for joint U.S./Japanese investigations.

1.2.4 *General Observing Constraints*

Cycle 6 of the Suzaku Guest Observer program is anticipated to commence in April 2011. Proposals (except those for Key Projects; see 2.1.3) may be submitted only for projects that may be completed within a period of one year; Regular Project and Long Program proposals (see 2.1.1) requesting observations beyond the period of the present cycle will not be considered under this solicitation. Investigators whose observing proposals are chosen will receive the data that result from their proposal in a form suitable for analysis. There will be no proprietary period for data resulting from Long Program and Key Project proposals. All other data will be placed in a public archive one year following receipt of data in a usable form by the PI.

It is anticipated that Suzaku will typically perform one pointing every day or two. The number of pointings is limited by the long (up to one orbit) settling time required by the attitude control system after a maneuver to a new pointing position. In order to maintain a satellite observing efficiency of ~ 50 percent, the nominal minimum allowable observing time on a particular target is 10,000 seconds. Proposers may request any exposure time ≥10,000 seconds. Note that a justification of the requested exposure time based upon the scientific objective(s), the source brightness, and any other relevant factors must be derived and explicitly described in the proposal.

Except as noted above, there are no restrictions regarding the amount of observing time or the number of targets requested in Guest Observer proposals. A proposal may be submitted for a single target with a relatively short observation time or for a larger program involving multiple targets or a greater amount of observing time. All proposals will be evaluated together in the same peer review, and it is expected that a mix of large, medium, and small programs will be selected. It is anticipated that about 70 investigations containing approximately 100 new observations will be selected from proposals received in response to this solicitation.

Time-critical observations, i.e., observations with scheduling constraints, impose a particular burden on Suzaku mission planning. (For further discussion of such observations, see the Suzaku Technical Description, Section 4, which is available from the Suzaku GOF at http://suzaku.gsfc.nasa.gov/). In particular, for "short-lived" phenomena, i.e., phenomena where timing within a spacecraft orbit matters, the ability to observe an event may only be assessed a few weeks prior to scheduling. Too many such time-critical observations would compromise the ability of the mission planning and operations team to effectively schedule the full set of requested observations. As all time-critical observations drive the scheduling process and, therefore, must receive highest scheduling and scientific priority, their total share must be kept relatively small. For Suzaku, time-critical observations must be accepted as priority A targets. This includes both truly time-critical observations (observations requiring a specific day, such as coordinated observations) and less constrained time-critical observations (such as monitoring observations or those that require a specific orbital phase or roll angle).

The Suzaku Guest Observer program recognizes the category of Target of Opportunity Observations (ToOs) of rapidly evolving phenomena whose occurrence is not predictable. Proposals for ToOs of specific targets are allowed for Suzaku, but not those of generic ToOs (e.g., "the next Galactic supernova"). Details regarding the circumstances in which a ToO is "triggered" must be included in the scientific justification and on the target form. ToO proposals must also include an estimated duration of the event, as well as an estimated probability for triggering the observation; the latter will be used in the accounting of total allocated time. ToOs remain reserved only for the observing cycle in effect; ToOs not carried out during the current cycle may be reproposed for subsequent cycles. Data from preapproved ToOs will be proprietary to the Principal Investigator (PI) for one year. Note that a proposal may not include both ToOs and regular observations, even of the same object.

Additionally, a mechanism exists for requesting ToOs for cosmic objects or events unanticipated by any proposal. A small percentage of observing time (~ 4 percent) has been set aside for this. Data for such serendipitous ToOs will be placed immediately into the public archive. Further details about proposing for ToOs, both in response to this solicitation and for unanticipated events, can be found in the Suzaku Technical Description.

It is anticipated that investigations will be selected covering a variety of topics, including solar system objects, stars, x-ray binaries, supernova remnants, galaxies, clusters of galaxies, active galactic nuclei, and the x-ray background. Details about sources observed prior to Cycle 6, as well as tools for searching the observation database, are available from the Suzaku GOF homepage at http://suzaku.gsfc.nasa.gov/. Proposers should check whether their targets of interest have either been observed or are planned to be observed. If this is the case, the need for additional observations of those sources must be justified.

1.2.5 *The U.S. Suzaku Guest Observer Facility*

Telemetry converted to Flexible Image Transport System (FITS) format, together with satellite attitude and position information, will be sent from Japan to the Suzaku GOF at GSFC. The GOF will distribute the data electronically and support U.S. Guest Observers with their analysis of these data. The Suzaku GOF is a part of the Office of General Investigator Programs at the Astrophysics Science Division, NASA Goddard Space Flight Center, in Greenbelt, Maryland. The Suzaku GOF can also provide additional technical information if needed for the preparation of proposals. In addition, it receives, validates, and distributes data and calibrations; provides data analysis software; provides expert help and documentation; and creates the U.S. Suzaku archive.

2. Programmatic Information

2.1 Proposal Submission and Evaluation

NASA will review proposals for this program in a two-phase process. In Phase 1, proposals will be evaluated with respect to their intrinsic merit and relevance to NASA's objectives. Proposals recommended by the Phase 1 peer review panel will subsequently be considered by a joint Japanese/U.S. merging committee to eliminate duplication of targets submitted to both programs (see Section 2.1.3). Proposals selected in the Phase 1 review will be recommended for Suzaku observing time and become candidates for funding subject to the Phase 2 review process and the availability of program funds. The reasonableness and realism of the proposed cost of the investigation will be evaluated in the second phase.

2.1.1 *Phase 1 Proposal Categories*

Proposals for observing time on Suzaku may be submitted within one of three categories: Regular Projects, Long Programs, and Key Projects. Regular Projects are defined as investigations requesting a total observing time, T, between 10,000 and 300,000 seconds. They may involve observations of a single or multiple targets, and all observations must be completed within a single observing cycle. Long Programs are defined as investigations for which $300{,}000 \leq T \leq 1{,}000{,}000$ seconds. As with Regular Projects, Long Programs may comprise observations of one or more targets and the observations must be completed within one observing cycle. This category was created to enable long exposures of single objects, mapping of extended regions, or diffuse objects, and other large programs to maximize the scientific return from the mission. Key Projects are defined as comprehensive investigations sampling objects of a particular class or surveying a large region of the sky that take maximal advantage of the unique attributes of Suzaku to address astrophysical problems of recognized importance. To facilitate such investigations, Key Projects may entail observations that span more than one observing cycle. However, acceptance of specific targets or observations will be limited, in a particular cycle, to those that can be completed within a single year. In contrast to Regular Projects, the data from Long Program and Key Project investigations will be released to the public immediately upon production of the calibrated data.

2.1.2 *Who May Propose*

The intent of this program is to enhance U.S.-Japanese scientific cooperation, in keeping with the bilateral agreement between the U.S. and Japan. Thus, only PIs affiliated with U.S. institutions and located in the U.S. are eligible to propose for Suzaku guest investigations through NASA. The requirement of affiliation with a U.S. institution does not extend to Co-Investigators. It is possible that some targets will be shared by U.S. and Japanese teams, but either a U.S. or a Japanese "Prime" PI will always be named.

A small amount of time will be reserved for joint U.S.-Japanese collaborative projects. This observing time will be used primarily to resolve conflicts between the U.S. and Japanese programs or assigned to proposals that exhibit a strong spirit of collaboration between U.S. and Japanese scientists. Individuals wishing to propose a joint U.S.-Japanese collaborative project may request time from either the U.S. or Japanese program. In all cases, proposals involving a U.S.-Japanese collaborative project to observe a common target (or set of targets) must be submitted to <u>either</u> the U.S. <u>or</u> Japanese program, depending upon the national affiliation of the identified PI. A consortium of investigators from the U.S. and Japan may choose to split a large observing program into two separate programs for submission to their respective agencies. In doing so they should also, in the spirit of the above rules, split their source lists; each individual proposal submitted to each agency must be capable of being evaluated on its own merit. The joint U.S.-Japanese observing time will be allocated during the merging of the Japanese and U.S.

programs and will utilize proposals that have been highly ranked in the U.S. or Japanese peer reviews.

Following selection, the Suzaku mission timeline team will deal only with the person identified as the PI or lead Co-Investigator. It will be his/her duty to respond to any questions about detector usage or observational modes. In the event that the data are to be shared by U.S. and Japanese teams, it is expected that the respective PIs will consult regarding observing configuration issues, although a single primary PI will be designated as responsible for communicating with the mission planning team.

2.1.3 *Submission of Phase 1 Proposals to the Suzaku Cycle 6 GO Program*

Prospective proposers to the Suzaku GO program must adhere to the following procedures for the submission of Phase 1 proposals:

> Complete and electronically submit all required forms at the Suzaku Web site at http://suzaku.gsfc.nasa.gov/. No hard copy submission is required. Note that the scientific justification must not exceed four pages for Regular Project proposals, of which no more than three may be devoted to proposal text, and no more than two to tables and figures. The limit is six and eight pages, respectively, for Long Program and Key Project proposals. Proposals should include a description of the scientific objectives and a demonstration of the feasibility of the proposed observations and utilization of the unique capabilities of Suzaku for carrying out the investigation.

All electronic proposal materials must arrive at the above address by 4:30 p.m. Eastern time on the due date for this program given in Tables 2 and 3 of the *ROSES Summary of Solicitation* in order to be included in the proposal review for this cycle of the Suzaku GO program. Note: The deadline of 4:30 p.m. on the due date replaces the deadline stated in the *NASA Guidebook for Proposers* and in the *ROSES Summary of Solicitation*.

Phase 1 proposals submitted to the Suzaku Cycle 6 Guest Observer program may not be submitted via NSPIRES or via Grants.gov.

2.1.4 *Evaluation and Selection of Phase 1 Proposals*

Proposals submitted to NASA in response to this solicitation will be evaluated with respect to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers* (excluding cost), where it is understood that the intrinsic merit of a proposal shall include the following factors:

- The suitability of using the Suzaku observatory and data products for the proposed investigation;
- The degree to which the investigation uses Suzaku’s unique capabilities;
- The feasibility of accomplishing the objectives of the proposed investigation with the requested observations, including the degree to which the proposal satisfies Suzaku’s observational constraints; and
- The feasibility and suitability of the proposed analysis techniques.

There are two steps in the evaluation of Suzaku observation (Phase 1) proposals submitted in response to this Announcement. First, a NASA peer panel will review them according to the specified evaluation criteria. Second, a Japanese/U.S. merging committee, comprised of members of the U.S. and Japanese Suzaku Project team and representatives of the U.S. Guest Observer community (selected from the NASA peer panel), will eliminate the duplication between targets submitted to the U.S. and Japanese programs.

The task of the Suzaku International Merging Committee is to integrate the two national observing proposal sets into the observing program. This observing program should be devoid of unnecessary duplications among the nationally defined observing programs. Selections made between overlapping proposals will use the priorities assigned by the NASA and Japanese review committees. In addition to integrating the two national observing proposal sets, the International Merging Committee will select the specific Key Project observations to be carried out during each cycle, based upon presentations by the PIs of approved but uncompleted Key Projects from previous cycles and those of new Key Project proposals submitted to, and approved by, the respective national proposal reviews.

A substantial oversubscription of Suzaku observing time is expected. With the above process, most of the reduction in the oversubscription will occur at the national level of proposal review. The most important criterion for the assessment by the national proposal evaluation committees is the scientific merit of the proposed research. However, the factors cited above, including the feasibility of the proposed observations, as well as observational constraints that may overburden Suzaku mission planning, will also be taken into account in the final selections.

2.1.5 *Submission and Evaluation of Phase 2 Proposals*

Subject to the availability of funding, successful Phase 1 proposers will be contacted by the Suzaku Program Officer and invited to submit a Phase 2 proposal, including a cost proposal for evaluation during Phase 2. Upon notification of selection of a Phase 1 proposal, a proposer must respond as follows:

- Follow the instructions received in the Phase 1 selection notification for submitting a Phase 2 proposal, including budget (not to exceed one year in duration), Phase 2 proposals must be submitted through NSPIRES by an Authorized Organizational Representative (AOR) of the proposing organization.
- As part of the Phase 2 proposal, investigators may request support for correlative observations at other wavelengths, providing that they were proposed and accepted as part of the Phase 1 proposal. Funding for such correlative studies will be considered only insofar as they directly support a specific investigation using Suzaku.

A review team comprised of a subset of the Phase 1 peer evaluation panel will be convened by NASA to review the Phase 2 cost proposals against the third evaluation criterion, cost realism and reasonableness. Comparison of the proposed cost to available funds will be performed by NASA program personnel, as specified in Section C.2 of the *NASA Guidebook for Proposers*.

2.2 Supplemental Information

2.2.1 *Available Funding*

The level of funding available for the support of Cycle 6 Guest Observers is subject to the results of the Astrophysics Division Senior Review of Operating Missions planned for the first quarter of 2010 and will be announced at the time of solicitation of Phase 2 proposals.

2.2.2 *Sources of Further Information*

Further details of the proposal submission requirements and process may be found at the Suzaku GOF homepage at http://suzaku.gsfc.nasa.gov/. The Suzaku GOF homepage includes a detailed mission description; technical information about the Suzaku mission, instruments, and feasibility; detailed information regarding proposal submission, evaluation, selection, and implementation; and instructions for completing the required proposal forms.

Technical questions concerning this program element may be directed to Dr. Koji Mukai of the Suzaku Guest Observer Facility. Programmatic information may be obtained from the Suzaku Program Officer, Dr. Louis J. Kaluzienski of NASA Headquarters. Contact information may be found in Section 3.

3. Summary of Key Information

Expected program budget for first year of new awards	TBD pending results of 2010 Astrophysics Senior Review
Number of new awards pending adequate proposals of merit	TBD pending results of 2010 Astrophysics Senior Review
Maximum duration of awards	1 year
Due date for Notice of Intent to propose (NOI)	Not requested
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	4 pp. (Regular Project)/6 pp. (Long Program)/8 pp. (Key Project) (this supersedes the 15-page length limit given in the *NASA Guidebook for Proposers*)
Relevance	This program is relevant to the astrophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.

Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of Phase 1 proposal and required forms	http://suzaku.gsfc.nasa.gov/ (help desk available at http://heasarc.gsfc.nasa.gov/cgi-bin/Feedback)
Web site for submission of Phase 1 proposal via NSPIRES	Option not available
Web site for submission of Phase 1 proposal via Grants.gov	Option not available
Funding opportunity number for downloading an application package from Grants.gov	Option not available
NASA point of contact concerning this program	Programmatic: Dr. Louis J. Kaluzienski Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0365 Email: HQ-Suzaku@mail.nasa.gov Technical: Dr. Koji Mukai Suzaku Guest Observer Facility Code 662 Building 34, Room S333 NASA Goddard Space Flight Center Greenbelt, MD 20771-0001 Telephone: (301) 286-9447 Email: Koji.Mukai@.nasa.gov

D.8 FERMI GUEST INVESTIGATOR – CYCLE 4

NOTICE: This version of Appendix D.8: Fermi Guest Investigator – Cycle 4 is released with the ROSES 2010 NASA Research Announcement. This is a placeholder and an amendment to ROSES 2010 will be released in the Fall 2010 with details of the solicitation. Proposals will be due no earlier than 90 days after the release of the amendment.

1. Scope of Program

1.1 Overview

The Fermi Guest Investigator (GI) program solicits proposals for basic research relevant to the Fermi mission. The primary goal of this mission is to perform 20 MeV to >300 GeV gamma-ray measurements over the entire celestial sphere, with sensitivity a factor of 30 or more greater than that obtained by earlier space missions. A secondary goal includes the study of transient gamma-ray sources with energies extending from 10 keV up to 300 GeV.

The Fermi GI program is intended to encourage scientific participation by providing funding to carry out investigations using Fermi data, to conduct correlative observations at other wavelengths, to develop data analysis techniques applicable to the Fermi data, and to carry out theoretical investigations in support of Fermi observations.

Investigators may apply for radio or optical observing time through joint programs with the National Radio Astronomy Observatory (NRAO) or the National Optical Astronomy Observatory (NOAO), or for high-end computing resources.

Investigators may propose Fermi pointed observations, but such observations will require strong scientific justification through extensive simulations and calculations because default survey mode observations will satisfy the scientific requirements of nearly all studies.

The Fermi GI program is open to all investigators, but NASA funding is available only to investigators at U.S. institutions.

During this and all future cycles of the GI program, all Fermi gamma-ray data will be non-proprietary and will be publicly released immediately after ground processing. Release of summary data from the Large Area Telescope (LAT) shall be the same as in previous cycles.

1.2 The Fermi Mission

Fermi is an international and multiagency observatory-class mission that studies the cosmos in the <10 keV to >300 GeV energy range. The primary instrument, the Large Area Telescope (LAT), has a peak effective area (>8000 cm^2), angular resolution (<3.5º at 100 MeV, <0.15º above 10 GeV), field-of-view (>2 sr), and deadtime (<100 μs per event) that provides a factor of 30 or more advance in sensitivity compared to previous missions. The Fermi Gamma-ray Burst Monitor (GBM) also provides the capability for studying transient phenomena, with a field-of-view larger than the LAT and a spectral range that extends from the LAT's lower limit down to less than 10 keV. Although pointed observations are possible, the observatory primarily scans the sky continuously because of the LAT's large field-of-view. In survey mode - the main mode of operation - Fermi provides nearly uniform sky exposure every ~3 hours.

Documents providing a more complete description of Fermi can be found at http://fermi.gsfc.nasa.gov/ssc

The product of a collaboration between NASA, the U.S. Department of Energy, and several international partners, the LAT is a pair-conversion telescope. Gamma rays pair-produce in tungsten foils, silicon strip detectors track the resulting pairs, and the resulting particle shower deposits energy in a CsI calorimeter. An anticoincidence detector provides discrimination against the large flux of charged particles incident on the LAT. The anticoincidence detector is segmented to eliminate the self-vetoing problem encountered by EGRET.

Astrophysical photons are only a small fraction of all the events detected by the LAT on orbit. Most events are primary cosmic rays and their associated secondary charged and neutral particles produced in the surrounding spacecraft and the Earth's atmosphere. Therefore, event filtering on board reduces the ~3 kHz detected event rate to ~350 Hz. Events that survive the onboard filter are telemetered to the ground. Further ground processing yields a "true" celestial photon average rate of about 1 to 2 Hz.

The GBM detects gamma-ray bursts. Consisting of 12 NaI(Tl) (10-1000 keV) and 2 BGO (0.2-30 MeV) detectors, the GBM extends Fermi's burst spectral sensitivity from ~10 keV to ~30 MeV and monitors more than 8 sr of the sky, including the LAT's field-of-view. Bursts are localized by comparing rates in different detectors and rapidly distributed via the Gamma-ray bursts Coordinates Network (GCN). An initial location, computed automatically, is sent within several seconds, and is expected to have an accuracy of 5 to 10 degrees for strong bursts (fluence > ~10 photons cm^{-2}). A more accurate location (~3 degrees for strong bursts) is sent within 24 hours. The threshold of the onboard trigger is a flux of about 0.7 photons cm^{-2} s^{-1} (50 to 300 keV band), for a 1-second burst, and uses a variety of energy band and time windows.

Fermi was launched on June 11, 2008, into a circular, initial orbit of ~565 km altitude at an inclination of 25.6°. The mission design lifetime is 5 years, with a goal of 10 years. After a checkout period, science operations began on August 14, 2008.

The GI community is supported by the Fermi Science Support Center (FSSC), which is managed by NASA's Goddard Space Flight Center. All publicly available data products, software, calibration files, and technical documents that have been developed jointly with the instrument teams are available through the FSSC (see http://fermi.gsfc.nasa.gov/ssc/).

1.3 Types of Proposals

The Cycle 4 Fermi GI program solicits proposals in the following areas:

1. The analysis of LAT or GBM data from the beginning of science operations or development of data analysis techniques;
2. Requests for LAT pointed observations (but proposers should be aware that compelling science justification will be required in view of the probably low additional scientific benefit of such observations – see the Fermi Users' Group (FUG) analysis at http://fermi.gsfc.nasa.gov/ssc/proposals/pointing_analysis/). The total time allocated to pointed observations will be between 0 and 15%. Pointed observations will follow the same open data policy as sky survey data, i.e., they will become public immediately;
3. Analysis of correlative multiwavelength observations with other instruments and observatories that are directly relevant to Fermi science objectives (see FUG recommendation at http://fermi.gsfc.nasa.gov/ssc/resources/multi/); and
4. Theoretical investigations that will advance the science return of the Fermi mission.

1.3.1 *Analysis of all LAT gamma-ray and GBM event data*

The LAT team's science goals are (1) development of event-reconstruction and background-rejection techniques; (2) production of a comprehensive full-sky catalog of gamma-ray sources; and (3) a description of the diffuse gamma-ray emission. Proposed Fermi investigations should avoid duplication of the first two of these goals. The extent to which the proposed research will enhance the science return from Fermi will be considered in the proposal evaluation process (see Section 2.2 below).

The LAT's primary science data product is a list of events detected within the LAT's field-of-view. These events can be used to detect sources and study their temporal and spectral properties. Fermi observes the sky in a survey mode that provides nearly uniform sky exposure every ~3 hours; this mode will suffice for nearly all scientific observations. GIs may request funding to analyze any accumulated data, and may receive funding even if they did not request a specific observation.

The GBM provides event lists accumulated during a burst, permitting both temporal and spectral studies. In addition, background count rates with differing temporal and spectral resolution are also available, enabling background studies and source detection through occultation steps.

The GBM science team is already funded to provide the community with a catalog of GRBs, including localizations and spectra. Proposals construed by peer reviewers as duplicative of this goal may, therefore, be deemed to have lower priority than those perceived as addressing other objectives.

New data analysis techniques that will maximize the mission's scientific yield are also encouraged. While the Fermi mission will provide a basic set of analysis tools applicable to the Fermi data, specialized techniques might address such specific scientific issues as blind pulsar period searches, the discovery of faint transients, and the detection of sources through occultation steps in the GBM background light curves. GI proposals for new data analysis techniques are solicited and should specifically address how the proposed techniques will advance Fermi science objectives.

1.3.2 *Requests for LAT pointed observations*

As noted before, GIs may also request pointed observations to accumulate sky exposure of a particular source at a rate higher than provided by survey mode observations. Similarly, GIs may request Target-of-Opportunity observations. Because pointed observations will rarely provide any advantage over survey mode, requests for pointed observations must provide a compelling scientific justification for interrupting survey mode. It will be incumbent upon the proposer to demonstrate that a pointed observation is required to achieve the scientific objectives. Proposers thinking of requesting pointed observations are strongly encouraged to contact the FSSC (http://fermi.gsfc.nasa.gov/ssc/help/).

1.3.3 *Multiwavelength observations*

Because correlative observations will substantially augment the science return from Fermi, such proposals are encouraged. Examples of correlative observations that will add significantly to the Fermi science include monitoring of blazars, follow-up observations of gamma-ray bursts, and determination of pulsar ephemerides. To foster correlative observations, the Fermi GI program can award optical and radio observations through Fermi's joint programs with NRAO and NOAO (see http://fermi.gsfc.nasa.gov/ssc/proposals/nrao.html and http://fermi.gsfc.nasa.gov/ssc/proposals/noao.html).

The LAT instrument team will post the light curves (including spectral information) of the sources listed at http://fermi.gsfc.nasa.gov/ssc/data/policy/LAT_Monitored_Sources.html. The LAT instrument team will also announce the discovery of bright transients, and will provide light curves and locations for these new sources.

1.3.4 *Theoretical investigations*

Theoretical studies related to the observations conducted with Fermi hold the potential to significantly enhance the scientific impact of the mission. GI proposals for such theoretical investigations are also solicited and should specifically address how the anticipated results will advance Fermi science objectives.

1.4 Classes of Proposals

In Cycle 4 there will be two proposal classes: (1) Regular proposals with research plans that can be completed in one year and (2) Large proposals whose research plans are more expansive and may take up to three years to complete. The number of large projects funded, and corresponding budgets awarded in any given year, will be limited. On-going Large projects will be reviewed each year to determine if appropriate progress is being made toward the proposed objectives. PIs of approved Large projects must submit a progress report annually on the proposal due date rather than on the anniversary of the award date. Because of the significant resources allocated to large projects, those that do not make progress consistent with the proposed investigation may be reduced or terminated.

1.5 Proposal Page Limits

The page limit for the central Science-Technical-Management section of Phase 1 proposals is 4 pages for Regular proposals and 6 pages for Large proposals. These page limits include figures and references. An additional page is required to describe the technical justification of optical or radio data requested through the joint programs with NOAO and NRAO.

Proposals should be single-spaced, typewritten, English-language text, formatted using one or two columns, and using an easily read font having no more than ~10 characters per inch (typically 12-point font). No smaller font should be used. In addition, the proposal shall have no more than 5.5 lines per inch of text. Pages should have at least 1-inch (2.5 cm) margins on all sides. For detailed requirements on the formatting, please refer to the *NASA Guidebook for Proposers* available at http://www.hq.nasa.gov/office/procurement/nraguidebook/

2. Programmatic Information

2.1 General Information

It is anticipated that approximately $8 M will be available through this solicitation for the support of approximately ~75 Guest Investigations of one-year duration each and up to 3 new Large projects. Grants for Regular proposals will average $50,000-$80,000 with a firm ceiling of $100,000 and for Large proposals the grants will average $100,000-$150,000 per year with a firm ceiling of $200,000 per year. Grants for triggered analyses (e.g., transients meeting specific criteria) will be released only after such triggers occur. Fermi GI funding is open to all individuals employed at U.S. institutions. Grants for proposals with a foreign-based PI and US-based Co-Is will be eligible for funding at a typical level of $10,000-$15,000 with a firm ceiling $20,000. Fermi science team members already receiving support from the Project are eligible for support but must provide a compelling justification for the award of additional funds under the GI Program. It is the intent of this program that most of the available GI funding be awarded to proposers not formally associated with Fermi.

2.2 Proposal Submission and Evaluation

2.2.1 *Submission of Phase 1 Proposals to the Fermi GI Program*

The Fermi GI program will use a two-phase proposal process. The first phase will be the submission and evaluation of the science/technical justification that includes a brief management section, a total budget cap (as described below), and a corresponding basis for this budget cap. In the second phase only proposers whose Phase 1 proposals are accepted will submit detailed budget proposals. All proposal materials will be submitted electronically.

Each proposer who anticipates requesting funding must provide a budget cap, i.e., an approximate estimate of the total cost to NASA (including overhead) of his/her proposed investigation. This budget cap may not exceed the ceiling amounts discussed above. A more detailed cost evaluation will be deferred until Phase 2. A box for entering the total budget cap is provided on the Remote Proposal System (RPS) Cover Form.

Proposers to the Fermi GI Program must adhere to the following procedures for proposal submission:

- Proposers will submit their Phase 1 proposals electronically through the RPS website at: http://heasarc.gsfc.nasa.gov/ark/rps/. Instructions for doing so are provided at the FSSC web site at: http://fermi.gsfc.nasa.gov/ssc/proposals/.
- Target lists are submitted through the RPS form. All sources that will be analyzed, whether using Fermi data or correlated multiwavelength observations, must be included in the target list.
- Due to the nature of prospective investigations within the Fermi GI program, the Scientific/Technical/Management section of proposals is limited to 4 pages for Regular proposals and 6 pages for Large proposals, instead of the default 15 pages specified in the *NASA Guidebook for Proposers*. Figures and references are included within this page limit. An additional page must be added to describe the technical details of proposed joint program radio or optical observations. The standard ROSES requirement for a table of contents in the body of the proposal is waived.
- The Scientific/Technical/Management section will be uploaded to the RPS website as a PDF file.

All proposal materials must be submitted electronically by 4:30 p.m. Eastern Time on the due date for this program given in Tables 2 and 3 of the *ROSES Summary of Solicitation* in order to be included in the proposal review for this cycle of the Fermi Guest Investigator program. Note that the 4:30 p.m. deadline replaces the deadline stated in the *NASA Guidebook for Proposers* and in the *ROSES Summary of Solicitation*.

NASA uses a single, uniform set of instructions for the submission of ROSES proposals. These instructions are given in the *NASA Guidebook for Proposers* (http://www.hq.nasa.gov/office/procurement/nraguidebook/). Fermi GI proposers should follow these instructions, except where they are overridden by the instructions given in the *ROSES Summary of Solicitation* or in this Appendix.

2.2.2 *Evaluation of Phase 1 Proposals submitted to the Fermi GI Program*

A peer evaluation panel will review all proposals with respect to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*, where it is understood that the intrinsic merit of a proposal shall include the following factors:

- The suitability of using the Fermi observatory and data products for the proposed investigation;
- The extent to which the investigation enhances the anticipated science return from the Fermi mission; and
- The degree to which the proposed investigation places demands upon mission resources (this is particularly relevant for pointed observations).

It is understood that the relevance of a proposal shall include the following factor:

- For data analysis development and theoretical investigations, the degree to which the investigation directly advances Fermi science goals.

2.2.3 *Submission and Evaluation of Phase 2 proposals*

Subject to the availability of funding, successful Phase 1 proposers will be contacted by the Fermi Program Scientist and invited to submit a cost proposal in Phase 2. Upon notification of selection of a Phase 1 proposal, a proposer must respond as follows:

- Follow the instructions for submitting a Phase 2 proposal given in the selection notification from the Phase 1 review. Phase 2 (cost) proposals must be submitted through the NASA NSPIRES electronic proposal website (http://nspires.nasaprs.com/) by an Authorized Organizational Representative (AOR) of the proposing organization.
- The total budget may not exceed the budget cap the proposer provided in the Phase 1 proposal.
- Budget Details are limited to 2 pages, and the Budget Narrative is limited to 1 page.

NASA program personnel will evaluate the Phase 2 cost proposals against the third evaluation criterion, cost realism and reasonableness, and will also compare the proposed cost to available funds, as specified in Section C.2 of the *NASA Guidebook for Proposers*.

2.3 Supplemental Information

Further details concerning the proposal submission requirements and process can be found at the Fermi Science Support Center website http://fermi.gsfc.nasa.gov/ssc/. This website provides a detailed mission description; technical information about the Fermi mission, instruments, and observation feasibility; and instructions for completing the required proposal forms.

3. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have at least 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	\$8 M (This might permit, for example, the selection of ~75 Regular proposals with average awards of \$50-80K with a ceiling of \$100K, together with ~3 Large proposals with average awards of \$100-150K per year, with a ceiling of \$200K per year.)
Number of new awards pending adequate proposals of merit	~75 Regular proposals; ~3 Large proposals
Maximum duration of awards	1 year for Regular proposals; up to 3 years for Large proposals (see Section 1.3)
Due date for Notice of Intent to propose (NOI)	Option not available
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*. Note: Proposals are due by 4:30 p.m. Eastern time on the due date.
Planning date for start of investigation	4-7 months after proposal due date.
Page limit for the central Science-Technical-Management section of Phase 1 proposal	4 pp for regular proposals, 6 pp for large proposals; 1 additional page is required to describe joint program observations (see Section 1.5). Page limits include figures and references. This instruction supersedes the limits given in the *NASA Guidebook for Proposers.*
Relevance	This program is relevant to the astrophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required in PDF format; no hard copy is required. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of Notice of Intent to propose (NOI)	Option not available
Web site for submission of Phase 1 proposal and required forms	http://fermi.gsfc.nasa.gov/ssc/proposals/ (Help Desk available at http://heasarc.gsfc.nasa.gov/ark/rps/help/)
Web site for submission of Phase 1 proposal via NSPIRES	Option not available
Web site for submission of Phase 1 proposal via Grants.gov	Option not available
Fermi Science Support Center helpdesk	http://fermi.gsfc.nasa.gov/ssc/help/

Programmatic information may be obtained from the Fermi Program Scientist	Dr. Ilana M. Harrus Astrophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1250 E-mail: Ilana.M.Harrus@nasa.gov
Technical questions concerning this program element may be directed to the Fermi Science Support Center	Dr. Chris Shrader Fermi Guest Investigator Program Code 661 Goddard Space Flight Center National Aeronautics and Space Administration Greenbelt, MD 20771-0001 Telephone: (301) 286-8434 Help Desk: http://fermi.gsfc.nasa.gov/ssc/help/
Questions concerning Fermi capabilities may be directed to the Fermi Project Scientist	Dr. Julie McEnery Code 661 Goddard Space Flight Center National Aeronautics and Space Administration Greenbelt, MD 20771 Telephone: 301-286-1632 Email: Julie.E.McEnery@nasa.gov

D.9 KEPLER GUEST OBSERVER – CYCLE 3

1. Scope of Program

1.1 Overview

This program element solicits proposals for the acquisition and analysis of new scientific data from the Kepler mission, which is the tenth mission launched under NASA's Discovery Program. During its 3.5-year prime mission, Kepler will continuously monitor a ~100 square degree field-of-view (FOV) in the Cygnus region (α=19^h 22^m 40^s, δ=44° 30' 00"), with the objective of photometrically detecting transits of Earth-size planets in the habitable zones (HZ) of stars in the solar neighborhood. The instrument's high-precision photometry capability, with two available cadence modes (1 minute and 30-minute), provides a powerful tool for asteroseismology research and other variability analyses of both Galactic and extragalactic sources.

We expect observations associated with the Kepler Guest Observer (GO) Cycle 3 solicitation will begin following the summer quarterly roll on or near June 28, 2011. Proposals submitted to this program should be for new observations only and should address areas of astrophysics outside of the exoplanet Key Project study (see Section 1.3.1) already planned for the mission.

1.2 Changes Since ROSES 2009

- Procedures for submitting the target form have been amended to minimize the number of admissible submission table formats.
- URLs have been updated for new MAST and GO Office material.
- Mission characteristics have been rewritten to prevent the incorrect interpretation that GO programs are limited to m_V = 9 - 16 objects.
- Instrument sensitivity has been described using Kepler cadences rather than generic exoplanet transit time.
- Proposers are directed to the target search form at MAST to determine target availability flags, not the Kepler Target Catalog.
- The policy of exclusive data periods for data shared across multiple Kepler programs is described.
- Contact details for the Kepler GO Office have been updated.

1.3 The Kepler Mission

1.3.1 *Kepler Mission Key Project*

The primary scientific objectives of the Kepler mission are to:

- Provide a statistically significant value for the frequency of Earth-size and larger planets in and near the habitable zone;
- Characterize the size and orbital distributions of such planets; and
- Identify correlations between the presence and characteristics of planetary systems with stellar properties of the host star.

The search for Earth-size and larger planets through transit events about solar-type stars will involve continuous monitoring of over 160,000 stars, consisting largely of F through K main sequence stars, through mission life. A detailed discussion of the Kepler mission and its scientific objectives can be found at http://kepler.nasa.gov/. Background information on NASA's Discovery Program is available at http://discovery.nasa.gov/.

1.3.2 *Instrumentation and Technical Capabilities*

Kepler is in a heliocentric orbit, which insures a thermally stable environment and provides the ability to remain on a single pointing for the mission duration. Quarterly rolls are performed – one roll every ~93 days – to reorient the solar arrays. With each roll, the stars in the FOV land on different regions of the detector relative to their preroll position, introducing possible artificial discontinuities in the light curve that must be eliminated during data reduction.

Kepler will achieve a benchmark photometric precision on a $m_V = 12$ G2V star of 66 parts-per-million (ppm) in 30 minutes of integration and 400 ppm in a 1 minute integration. While stars brighter than $m_V = 11$ will saturate some pixels, Kepler performs well on stars as bright as $m_V = 7$ provided the large number of pixels needed to capture saturated flux can be justified by science gained. Kepler also has many faint-target scientific applications where $m_V = 20$ objects yield a photometric precision of 3% over 30 minutes and 20% over 1 minute. The broad photometric bandpass has a half-maximum transmission range of 430 to 840 nm. The instrument has neither changeable filters nor dispersing elements. The detector has a pixel scale of ~3.98 arcseconds. Image quality varies with position in the focal plane, with the 95% encircled energy diameter ranging from 3.1 to 7.5 pixels, with a median of 4.2 pixels. The percentage of point-source flux concentrated in the center pixel is between 20% and 62%, with a median value of 45%. Because of a very stable focal plane, a precision better than 1 milli-arcsecond over periods of three months is provided by the relative centroid positions of guide stars.

1.3.3 *Observing Modes and Data Products*

Much of the data from the full focal plane are not saved due to constraints imposed by onboard storage and communications. Instead, data for specific targets are saved and transmitted as subimages, with a default area of 20-72 pixels, depending on source brightness. This buffer size can be varied to accommodate extended or very bright objects.

All observations are taken at one of two temporal resolution settings: long (30-minute) or short (1-minute) cadence. A fixed number of targets have been reserved for Cycle 3 GO observations and are available to successful proposers to this Cycle 3 solicitation: 3000 long cadence and 25 short cadence targets, assuming a default 32-pixel target size. Extended or bright objects requiring larger subimages decrease the total number of targets available to the GO program and must be justified carefully.

Data distribution and archival services will be done through the Space Telescope Science Institute's MAST (Multimission Archive at STScI). Final data products available to GO observers will include original and calibrated pixel values and light curves for each target. The calibration will correct for bias level, smear, galactic cosmic rays, flat fielding, dark current, background, and instrument noise. Aperture photometry will be used to generate the light curves.

Data will be delivered to the observer in FITS format. A thorough understanding of the noise sources and systematic errors will be needed by observers who plan to generate their own light curves from the original (uncalibrated) data, particularly for data taken over a period of ~93 days, data sequences spanning one or more quarterly spacecraft rolls, and/or the study of variability phenomena having amplitudes less than 100 ppm. For such conditions, the light curves provided from the pipeline software should be used with great caution because the data reduction technique used to eliminate artifacts in the light curves (caused by spacecraft roll, differential velocity aberration, and jitter) may also reduce or remove legitimate low amplitude variability having timescales exceeding several days.

2 Guest Observer Targets

2.1 Target Selection Tools

Pointed observations away from the single stare position of the mission cannot be accommodated by Kepler; GO targets are limited to the objects available in the fixed FOV. Small gaps between the 21 detector modules result in additional loss of available objects that would otherwise be within the Kepler FOV. A target search tool, http://archive.stsci.edu/kepler/kepler_fov/search.php, determines if an object of a particular coordinate lies within the observable FOV. Determining whether or not desired targets fall on active regions of the focal plane is the responsibility of the proposer.

The Kepler Input Catalogue (KIC) provides physical data for over 15 million stars (down to a magnitude limit of 19) present in the Kepler FOV. These data result from a compilation of existing databases (e.g., 2MASS) and extensive ground-based imaging and spectroscopy surveys of the Kepler FOV performed by the Kepler Science Team. The KIC can be accessed through MAST (http://archive.stsci.edu/kepler/kic10/search.php).

2.2 Permitted GO Science Areas

GO programs may not involve observations of targets being monitored in the mission's Key Project (KP) involving the transit survey (see Section 1.2.1) of solar-like stars. Protected Key Project targets are specified in the availability flag of the Kepler Target Search output. (available at the MAST; http://archive.stsci.edu/kepler); this database will include all targets that have been observed to date. Proposers can determine whether specific sources are available to the GO program in Cycle 3 by browsing the availability flag provided by the target search form described in Section 2.1

In addition to the Key Project, there are other organized research projects associated with the Kepler mission, including studies involving asteroseismology, cluster stars, gyrochronology, and astrometry. However, only the active Key Project targets are protected from GO observation. In the event of overlap between GO and non-Key Project mission studies, the data will be distributed to both parties and the involved GO investigator(s) will not have exclusive access to their data (in such cases, collaborations may be appropriate, but not required). Proposals with novel scientific objectives or approaches that expand the current range of science issues to be addressed using Kepler data, capitalize on the mission's unique capabilities, and minimize replication of ongoing investigations, are encouraged.

All Kepler science data targets, regardless of whether they are GO targets, Kepler Key Project exoplanet targets, or other Kepler team science targets, will flow through the Kepler science processing and analysis pipeline. The Kepler pipeline converts raw detector coordinates and count rates to sky positions and calibrated fluxes. It also performs a sensitive search for candidate planetary transit events in all light curves.

GO science investigations focused on exoplanet searches are not allowed in Cycle 3, and the exoplanet targets chosen by the Kepler team are not available to the GO program. However, there is a small chance that a GO target will show evidence of a transiting exoplanet in pipeline analysis. Any target that shows the presence of a transiting planet, including a GO target, will be investigated by the Kepler Project, and, if a planet is found, it will be researched, announced, and published by the Project. The associated GO will be invited to participate in the exoplanet investigation and will be suitably acknowledged in any resultant publication.

Members of the Kepler Project will not conduct any investigation upon GO target data that is not directly related to the search for exoplanets.

2.3 On-source Monitoring Times

Cycle 3 targets can be proposed for monitoring up to a maximum of 1 year. Both long and short cadence target list uploads to the spacecraft will happen on a quarterly basis. Long cadence targets may be changed on a quarterly basis, while short cadence targets can be changed on a monthly basis. The ability to swap targets after some integral numbers of days provides the ability for observation of a total number of targets over the course of a year larger than the 3025 target "slots" allocated to the GO program. Specification of target swapping during the course of the year and other details regarding planned observing modes need to be included in the proposal using a target table, an example of which is given below. All Cycle 3 GO observations terminate one year after the Cycle 3 observations begin. Observers whose science objectives require observing timelines longer than one year may submit proposals to future cycles justifying the need for continuation of observations.

2.4 Target Table

All proposals are required to include a target table with the format shown in Table 1 to specify desired observing modes and other needed parameters. A definition of each column and a template for insertion into the proposal may be downloaded from the Kepler GO office website at http://keplergo.arc.nasa.gov/ProposalPreparationTargetTable.shtml . In addition to appearing as text within the proposal, this table must also be submitted electronically (see Section 3.4) to the Kepler GO office. Table 1 below includes example entries.

Table 1: Required format of target table

KepID	RA Dec (J2000) hh:mm:ss ±dd:mm:ss	m_{kep}	On-source Monitoring												Flag	Comment
			Q1			Q2			Q3			Q4				
			1	2	3	4	5	6	7	8	9	10	11	12		
3219876		17.2	30	30	30	30	30	30	30	30	30	30	30	30	0	
4036834		18.8	0	0	0	0	0	0	1	1	1	0	0	0	0	
USNO1333-0321992	18:44:37 +43:21:40	19.8	1	1	1	0	0	0	30	30	30	30	30	30		Not in KIC (faint target)
3838567		9.2	30	30	30	30	30	30	30	30	30	30	30	30	1	Previously observed in cycle 1 (see science justification)
4996742		18.2	0	0	0	0	0	0	0	1	0	0	0	0	0	
9108691		16.9	0	0	0	0	0	0	0	0	1	0	0	0	0	
1575678		18.3	0	0	0	0	0	0	0	0	0	1	0	0	0	
2299687		17.5	0	0	0	0	0	0	0	0	0	0	1	0	0	
V2400 Cyg	19:41:42 +40:07:03	17.9	30	30	30	30	30	30	30	30	30	30	30	30		Custom aperture: 9x9 pixels. Confused source (see science justification)

3. Programmatic Information

3.1 Proposal Evaluation

Proposals submitted to NASA in response to this solicitation will be evaluated with respect to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*, which are intrinsic merit, relevance, and cost realism/reasonableness. In addition to the factors for intrinsic merit given in the *NASA Guidebook for Proposers*, intrinsic merit includes the following factors:

- The suitability of using the Kepler observatory and data products for the proposed investigation;
- The degree to which the investigation uses Kepler's unique capabilities;
- The feasibility of accomplishing the objectives of the proposed investigation with the requested observations, including the degree to which the proposal satisfies Kepler's observational constraints; and
- The feasibility and suitability of the proposed analysis techniques.

3.2 Period of Performance and Availability of Funds

Cycle 3 Guest Observer observations are expected to start on June 28, 2011. All Cycle 3 GO observations will cease one year after the start date. Cycle 3 funding will start upon availability of data to the PI. Kepler GO data will be made available via MAST. The exclusive data use period will depend on the total length of the observation. Data for an individual target will become public either (a) one year following its initial availability in MAST or (b) six months after the last Cycle 3 observation of that target is available in MAST, whichever comes last. The exclusive period may be longer than that given by the criteria above if the GO target is shared with another project, however, the period will never be shorter. Following the exclusive data use period, the data will be placed into the public archive at MAST.

3.3 Eligibility

Application to the Kepler GO program is open to all investigators, including those from outside the U.S. Under NASA's no-exchange-of-funds policy, investigators who are not affiliated with a U.S. institution are not eligible for funding through this program.

3.4 Submission of Notices of Intent and Proposals to the Kepler Cycle 3 GO Program

In order to expedite the proposal review process and the timely selection of scientific peer review panels, investigators intending to submit proposals for participation in this program are asked to submit a Notice of Intent (NOI) to propose by the deadline to the NSPIRES web address given in Section 4. A NOI submission is not required, but even minimal information (e.g., proposal topic, investigator names, and affiliated institutions) can be of considerable value in helping NASA plan for an expeditious peer review of proposals. The NOI is not used to do a preliminary proposal assessment.

Prospective proposers to the Kepler GO program must adhere to the following procedures for the submission of proposals:

- Proposals should include a description of the scientific objectives, a demonstration of the feasibility of the proposed observations, and how the proposal will utilize the unique capabilities of Kepler to carry out the investigation.
- The scientific justification section of the proposal, which consists of text, tables (excluding the target table), figures, and references, must not exceed six pages.
- A complete table of proposed targets (see Section 2.4) must also be included in the body of the proposal.
- For cases for which funding is being requested, proposers should provide complete budgets and detailed justification, All proposers, regardless of whether or not funds are requested, should include information regarding the level of effort and responsibilities of each investigator involved in the project. Requested budgets should be based on the level of effort required to achieve the scientific objectives, rather than based exclusively on the quantity of requested data. For example, two proposals could request the same number of targets, but require very different budgets if one project uses pipeline-generated light curves but the other requires creating light curves from uncalibrated data files.
- For the purpose of submitting proposals through NSPIRES, proposers from non-U.S. institutions must affiliate in NSPIRES with the Kepler Guest Observer Office, which will submit the proposal on their behalf.
- Complete and electronically submit the proposal through NSPIRES (http://nspires.nasaprs.com). Hard-copy submissions are not permitted.
- A separate electronic version of the target table must be submitted to the Kepler GO Office by the proposal deadline. An Excel template for the target table, which is suitable for direct insertion into the proposal, instructions about the required file format for submission to the GO Office, and information regarding the file-naming convention for the target table file are available at http://keplergo.arc.nasa.gov/ProposalPreparationContent.shtml.
- Format such as font and margin sizes, etc. should follow those specified in the *NASA Guidebook for Proposers:* http://www.hq.nasa.gov/office/procurement/nraguidebook.
- All electronic proposal materials (proposal and separate electronic target file submitted to NSPIRES and the Kepler GO office, respectively) must arrive at the designated destinations by 11:59 p.m. Eastern time on the due date given in Section 4 in order to be included in the proposal review for this cycle of the Kepler GO Program.

3.5 Sources of Additional Information

The Kepler Guest Observer Office (http://keplergo.arc.nasa.gov), located at NASA Ames Research Center, provides support to Guest Observers and to proposers of this solicitation, such as technical information about the Kepler mission and instrument, and other information supporting proposal preparation, including an FAQ link and template files for proposal preparation. Contact information may be found in Section 4.

4. Summary of Key Information

Expected program budget for new awards	~ $1.2M
Number of new awards pending adequate proposals of merit	~30 investigations representing ~3000 long-cadence and ~25 short-cadence targets per quarter.
Maximum duration of awards	1 year
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	Funds will be awarded when the data are made available to the PI. NASA Center proposers should use October 1, 2011 (2 months after the start of Cycle 3 observing) as a planning date for start of investigation.
Page limit for the central Science-Technical-Management section of proposal	No more than six pages for the science justification section, including text, tables, figures, references and other supporting materials. The target table, budget justification and science justification combined must not exceed 15 pp; see Section 3.4.
Relevance	This program is relevant to the astrophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-KEPLER
NASA point of contact concerning this program	Dr. Douglas Hudgins Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0988 Email: douglas.m.hudgins@nasa.gov **[Changed April 14, 2010]**
Submission of electronic version of target table	http://keplergo.arc.nasa.gov/ProposalPreparationTargetTable.shtml
Kepler Guest Observer Office	Webpage: http://keplergo.arc.nasa.gov E-mail: keplergo@mail.arc.nasa.gov
Technical questions concerning this program element may be directed to the Kepler Guest Observer Office	Dr. Martin Still Kepler Guest Observer Office NASA Ames Research Center, MS 244-30 Moffett Field, CA 94035-1000 Telephone: (650) 604-2018 E-mail: mailto:keplergo@mail.arc.nasa.gov

D.10 MOST U.S. GUEST OBSERVER– CYCLE 3

NOTICE: NASA expects to solicit proposals for Cycle 3 of the MOST U.S. Guest Observer program in 2010. An amendment to ROSES 2010 will be released with details of the solicitation after final decisions have been made regarding schedule and the availability of funds. Proposals will be due no earlier than 90 days after release of the amendment. The text given below (which is the ROSES 2009 text for MOST U.S. Guest Observer – Cycle 2) will be superseded.

1. Scope of Program

1.1 Overview

NASA solicits proposals for the acquisition and analysis of new scientific data from the MOST (Microvariability and Oscillations of STars) observatory through a partnership between NASA and the Canadian Space Agency (CSA). The MOST mission is designed to conduct photometric studies with high precision sufficient to perform stellar asteroseismology studies and other variability analyses of stars and exoplanet systems. Awards given in response to this MOST U.S. Guest Observer (GO) program - Cycle 2 solicitation will begin on or around February 1, 2010, and awards will have a 12-month duration. GO investigations may address any area of astrophysics and are not restricted to asteroseismological studies.

Selected Cycle 2 GO targets will be observed in the period during February 2010 – January 2011. NASA and members of the MOST Science Team will jointly be involved in the review of proposals submitted in response to this solicitation. All of the U.S.-allocated observing time will be awarded competitively. Proposals may be submitted for observing time on MOST only; proposals for complementary observations on other satellites or observatories, theoretical investigations, or analysis of MOST archival data are not solicited in this call.

1.2 The MOST Mission

1.2.1 *Mission overview*

MOST is Canada’s first space telescope. The instrument, housed in a suitcase-sized microsatellite, was launched via a Russian three-stage rocket on June 30, 2003, from the Plesetsk Cosmodrome in northern Russia. MOST was injected into a low-Earth polar orbit in a Sun-synchronous mode remaining over the terminator of the Earth.

The MOST instrument, an optical 15-cm telescope with two E2V 1024 × 1024 frame-transfer CCD detectors and an array of Fabry microlenses, is optimized to perform nearly uninterrupted ultra-high-precision photometry on relatively bright stars ($m_V \leq 11.5$ mag) for as long as two months. The original scientific goals of the mission included the detection and characterization of (1) acoustic oscillations in solar-type and magnetic peculiar stars to probe structures and ages, (2) reflected light from giant exoplanets orbiting solar stars to reveal planet sizes and atmospheric compositions, and (3) turbulent variations in massive evolved (Wolf-Rayet) stars to understand feedback into the interstellar medium. The mission has surpassed its original performance baselines, largely due to significant improvements in the MOST spacecraft pointing since launch and upgrades to the onboard software. The exceptional on-orbit performance has allowed the MOST team to use the spacecraft for science programs and targets that were not possible in the original mission design.

MOST operations are managed by Canadian astronomers and engineers and funded by the Canadian Space Agency (CSA). The MOST team schedules observations, directs the satellite, collects the data, and monitors the health of the spacecraft and its payload. Data are downlinked to ground stations at the University of British Columbia (UBC) in Vancouver, the University of Toronto Institute for Aerospace Studies (UTIAS), and the University of Vienna's Institute for Astronomy (IfA).

1.2.2 *Orbit and continuous viewing zone*

MOST's polar Sun-synchronous orbit over the terminator of the Earth results in a Continuous Viewing Zone (CVZ) – a roughly equatorial band 54° wide, between declinations -18º and +36º, within which a target field can remain visible for up to 8 weeks. The range of time during which a target field is in the CVZ depends to first order on its Right Ascension (RA) and to second order on its declination within the CVZ limits. As a reference, a star with a right ascension of ~ 6h 40m and a declination of +9º will be at the center of the CVZ on January 1 of each year. There are also some restrictions on the spacecraft roll angle due to Sun Sensor operational constraints and spacecraft thermal constraints, which place some additional limits on CVZ access, mostly near January and July. A simple online target selection tool is available on the "Target Stars" page of the MOST Mission website at http://www.astro.ubc.ca/MOST to validate potential targets.

Fields outside the CVZ can be observed by MOST, but without continuous coverage per 101-min satellite orbit. In fact, it is possible to share each MOST orbit with 2 – 3 target fields depending on the time-sampling requirements set by the science. For timescales a few times longer than 100 min., the coverage is still nearly continuous compared to what is possible from a single ground-based site.

The MOST spacecraft faces an annual "eclipse season," during which the satellite is in the Earth's shadow for up to twelve minutes every orbit and hence is subject to larger-than-normal thermal changes per orbit. The eclipse season starts around May 19 and lasts until about July 24 of each year; it does not affect photometric performance significantly, but may limit target field selection at angles far outside the CVZ.

1.2.3 *Instrument focal plane and exposure times*

MOST was equipped with two identical CCDs – one dedicated to science and one as a startracker. In January 2005, the startracker CCD function was lost due to a severe charged particle hit. However, the mission has continued, with the Science CCD serving both science and ACS (Attitude Control System) functions. In fact, enhanced photometric performance in most magnitude ranges is obtained due to onboard image stacking and other mission operation improvements.

The CCD is passively cooled to a temperature of about –40°C, controlled to within ±0.1°C, and monitored to an accuracy of ±0.01°C. The instrument contains a single custom broadband filter which selects light in the wavelength range 350-700 nm. The CCD is equipped with an array of 36 Fabry microlenses, each of which project a large stable image of the entrance pupil of the telescope.

The Fabry image illuminated by target starlight gives the highest photometric stability possible with MOST, but only for stars brighter than about V ~ 6. There are no moving parts on the MOST instrument. The structure and optics are athermal, so that the image quality is maintained within the mission tolerances over a wide temperature range without active focusing. There is no shutter on the CCD camera; exposure times are accurately controlled by rapid frame transfer of the charges into the CCD buffer.

The open area of the CCD, not covered by the Fabry lenslet array and its mask, covers about 0.75° × 0.3°. The focal plane scale is about 3 arcsec per pixel. Star images (not positioned on a Fabry microlens) have a Full-Width-Half-Maximum (FWHM) of about 2.2 pixels, a size optimized for the MOST ACS. The spacecraft now typically achieves pointing stability of just under 1 arcsec rms, so most of the image wander is around 1/3 pixel in the MOST focal plane. Exposure times range from about 0.1 – 3.5 seconds, and are stacked onboard to achieve the required signal-to-noise. Typical sampling rates are 1 – 3 stacked exposures per minute. Direct imaging of stars, never part of the original mission design, was made possible by improvements in ACS performance after launch. Due to downlink bandpass limits and onboard buffering, the entire CCD cannot be sampled for each exposure. Several subrasters (typically 20 × 20 pixels) are downloaded, along with photometry of the Guide Stars in the field processed largely onboard the spacecraft.

Some scattered Earthshine does reach the MOST focal plane, modulated with the 101-min orbital period of the satellite. The intensity of the stray light depends on the season of observations, the position of the target field, and the roll angle of the spacecraft. The MOST team has developed data reduction pipelines to correct for the modulation of the stray light background.

Details of the processing of MOST Fabry Imaging photometry can be found in the paper: “Reduction of time-resolved space-based CCD photometry developed for MOST Fabry Imaging data” by Reegen et al. (2006, Monthly Notices of the Royal Astronomical Society, 367, 1417-1431). Details of MOST Direct Imaging photometry can be found in the paper “An Upper Limit on the Albedo of HD 209458b: Direct Imaging Photometry with the MOST Satellite” by Rowe, Matthews et al. (2006, The Astrophysical Journal, 646, 1241-1251). These and other MOST scientific papers can be downloaded from the “Science” page of the MOST Mission website at http://www.astro.ubc.ca/MOST

1.2.4 *Data processing and archiving*

All MOST science data are processed, reduced, and archived at UBC's Department of Physics and Astronomy in Vancouver, British Columbia, Canada, with physical duplicates stored at the Canadian Astronomy Data Centre (CADC) in Victoria, British Columbia.

Data for selected GO programs will be reduced and distributed to investigators by the MOST team. Those data will be archived at UBC and CADC and placed in the MOST Public Data Archive, accessible through the main MOST website (www.astro.ubc.ca/MOST), following a 1-year proprietary period that begins at the time that the data is made available to the investigator, or after the first refereed publication based on those data is accepted, whichever happens first.

1.3 The MOST U.S. Guest Observer Program

1.3.1 *U.S. GO Observing Time Allocation*

MOST observes about 12 – 16 target fields per year. A given field can contain one bright Fabry Imaging Target, several Direct Imaging Targets, and about 30 Guide Stars for which photometry is obtained. The Primary Science Target can be either a Direct Imaging Target or a Fabry Imaging Target, or the science can address a wide number of targets in a stellar cluster field in the Direct Imaging and Guide Star modes.

The observing time allocation for U.S investigations for Cycle 2 is 1 – 4 fields (separate pointings) per year. The total number of fields will depend on the total amount of time required for the successful proposals. A single proposal could represent eight weeks of MOST time, which represents the maximum annual time allocation for this GO program.

1.3.2 *General Observing Constraints and Target Selection*

Cycle 2 of the MOST U.S. GO is anticipated to commence in February 2010. Proposals may be submitted only for projects that may be completed within a period of one year; proposals for multiyear projects will not be considered under this solicitation. If the GO program continues, there will be opportunities to submit new proposals to follow up on findings from successful Cycle 1 and Cycle 2 observations with MOST.

The effectiveness of MOST derives largely from the combination of long continuous time coverage and high photometric precision. In practice, it is not recommended to plan a MOST observing run of duration less than 1 – 2 weeks, except as a trial run or for a Target of Opportunity whose scientific returns do not require long time coverage. The maximum observing time per field for an object in the MOST CVZ is 58 days (8.2 weeks) and the longest that MOST has monitored a single target field continuously so far in the mission is 48 days.

Photometry can be obtained across a range of sampling rates (cadences). Individual exposure times are approximately 1 sec (tied to the exposure times of the guide stars for attitude control), but are stacked on board to build signal-to-noise. The number of exposures in a stack is a function of the brightness of the Primary Science Target in the field and the number of stars in the field for which science photometry is downloaded (because of bandwidth limitations in the MOST downlink). Typical cadences for MOST photometry so far in the mission are around 2 – 3 stacked exposures per minute.

The number of fields that will be available to the U.S. GO program is limited (1 – 4), but as many as about 30 – 40 targets can potentially be monitored per field by including the ACS Guide Stars as photometric targets. Investigations may range from the study of a single target to many targets per field. In any case, strong proposals will optimize the amount of science that can be derived from a single pointed observation (field). Proposals to observe targets that have previously been observed by MOST and whose data are available publicly (see http://www.astro.ubc.ca/MOST/data/data.html) must justify the need for additional observations.

The MOST GO program recognizes the category of Target of Opportunity Observations (TOO) of rapidly evolving phenomena whose occurrence is not predictable. Details regarding the circumstances in which a TOO is "triggered" must be included in the proposal's Scientific Justification and on the Target form. TOO proposals must also include an estimated duration of the event, as well as an estimated probability for triggering the observations; the latter will be used in the accounting of total allocated time. TOOs remain reserved only for the observing cycle in effect; TOOs not carried out during the current cycle may be reproposed for subsequent cycles.

1.3.3 *Guest Observer Guidelines*

Selected investigations will receive data in a reduced form suitable for analysis. Following the proprietary period, those data will be placed in the MOST Public Data Archive accessible through the main MOST website (http://www.astro.ubc.ca/MOST).

It is possible that some targets may be shared by multiple proposals, but involving different scientific objectives, in which case the teams will be headed by different PIs and will be considered as separate investigations. In other cases, two or more proposals may have similar science goals for a common set of targets. In such a situation, assuming the proposals are equally meritorious, the two or more teams may be encouraged to collaborate and a single PI will be designated by the selecting official as the primary point of contact for project coordination.

1.3.4 *The U.S. MOST Guest Observer Data*

Reduced photometry will be distributed to U.S. investigators through a password-protected website maintained by the MOST project. The raw data converted to Flexible Image Transport System (FITS) format, together with satellite attitude, position information, and other spacecraft telemetry in the FITS headers, will also be delivered as backup, but any processing of the raw data should be done in consultation with the MOST Science Team.

The U.S. MOST GO office at NASA Ames Research Center provides support to investigators with technical information as needed for the preparation of proposals. All MOST data and telemetry, including those obtained through the U.S. GO program, will be stored in the Canadian archives at UBC, UTIAS, and CADC.

2. Programmatic Information

2.1 Proposal Requirements

2.1.1 *Who May Propose*

The intent of this program is to enhance U.S.–Canadian scientific cooperation. Therefore, only PIs affiliated with U.S. institutions are eligible to propose for MOST guest investigations through NASA. The requirement of affiliation with a U.S. institution does not extend to Co-Investigators (Co-I). However, under NASA's no-exchange-of-funds policy, Co-Is who are not affiliated with a U.S. institution are not eligible for funding through this program.

2.1.2 *Target Specification*

All proposals are required to include a target table with the format shown below to specify desired observing modes and other required parameters. A spreadsheet template (MS Excel file) and instructions may be downloaded from the MOST U.S. GO office website at http://mostgo.arc.nasa.gov. In addition to appearing as text within the proposal submitted via NSPIRES, this table must also be submitted electronically to mostgo@mail.arc.nasa.gov, in a MS Excel compatible format (See Section 2.2).

Field	Object	Mode	RA	Dec	m_V	Cadence	Duration	pps
Field 1			hh:mm:ss.s	±dd:mm:ss.s		xx	xx	
	Object 1	DIT	hh:mm:ss.s	±dd:mm:ss.s	xx			xx
	Object 2	FIT	hh:mm:ss.s	±dd:mm:ss.s	xx			xx
	Object 3	DIT	hh:mm:ss.s	±dd:mm:ss.s	xx			xx
	Object 4	GST	hh:mm:ss.s	±dd:mm:ss.s	xx			xx
Field 2			hh:mm:ss.s	±dd:mm:ss.s		xx	xx	
	Object 1	DIT	hh:mm:ss.s	±dd:mm:ss.s	xx			xx
	Object 2	GST	hh:mm:ss.s	±dd:mm:ss.s	xx			xx

2.2 Submission of Proposals

Prospective proposers to the MOST GO program must adhere to the following procedures for proposal submission:

- Proposals should include a description of the scientific objectives, a demonstration of the feasibility of the proposed observations, and how the proposal will utilize the unique capabilities of MOST to carry out the investigation.
- The scientific justification section of the proposal, which consists of text, tables (excluding the target table), figures, and references, must not exceed six pages. The distribution of those six-or-less pages must be as follows: The Scientific Justification must not exceed three pages. Tables, figures, and other such supporting materials may not exceed two pages. References must fit on one page.
- A complete table of proposed targets (see Section 2.2.2) must be included in the body of the proposal. The target table, together with the six-page maximum science justification section, may not exceed 15 pages.

- Proposers should provide complete budgets and detailed justification for requested funds and include information regarding the level of effort and responsibilities of each investigator involved in the project.
- Submit electronically the complete proposal through NSPIRES (http://nspires.nasaprs.com). Hard-copy submissions are not permitted.
- A separate electronic version of the target table must be submitted to the MOST U.S. GO office at mostgo@mail.arc.nasa.gov by the proposal deadline. MS Word and Excel templates for the target table suitable for direct insertion into the proposal, instructions about the required format for submission to the GO office, and information regarding the file-naming convention for the target table file are available at http://mostgo.arc.nasa.gov/proposal.html.
- Format such as font and margin sizes, etc. should follow those specified in the *NASA Guidebook for Proposers* (http://www.hq.nasa.gov/office/procurement/nraguidebook/).
- All electronic proposal materials (proposal and target spreadsheet file) must arrive at the designated destinations by 11:59 p.m. Eastern time on the due date for this program given in Section 4 in order to be included in the proposal review for this cycle of the MOST GO program.

2.3 Evaluation and Selection of Proposals

Proposals submitted to NASA in response to this solicitation will be evaluated with respect to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*, which are intrinsic merit, relevance, and cost realism/reasonableness. In addition to the factors for intrinsic merit given in the *NASA Guidebook for Proposers*, intrinsic merit includes the following factors:

- The suitability of using the MOST observatory and data products for the proposed investigation;
- The degree to which the investigation uses MOST's unique capabilities;
- The feasibility of accomplishing the objectives of the proposed investigation with the requested observations, including the degree to which the proposal satisfies MOST's observational constraints; and
- The feasibility and suitability of the proposed analysis techniques.

A peer review panel, including members of the MOST Science Team, will review proposals according to the specified evaluation criteria.

In order to expedite the proposal review process and the timely selection of scientific peer review panels, investigators intending to submit proposals for participation in this program are asked to submit a Notice of Intent (NOI) to propose by the deadline to the NSPIRES web address given in Section 3. Note that a NOI submission is not required, but even minimal information (e.g., proposal topic, investigator names, and affiliated institutions) can be of considerable value in helping NASA plan for an expeditious peer review of proposals. The NOI is not used to do a preliminary proposal assessment.

2.4 Sources of Additional Information

The MOST U.S. Guest Observer Office (http://mostgo.arc.nasa.gov), located at NASA Ames Research Center, provides support to Guest Observers and to proposers of this solicitation. Links to technical information about the MOST mission and instrument, and other information supporting proposal preparation, including an FAQ link, are provided. Contact information may be found in Section 3.

3. Point of Contact for Further Information

Technical questions concerning this program element may be directed to the MOST U.S. Guest Observer Office:

Dr. Jesse Bregman
MOST U.S. Guest Observer Office
MS 245-6
Ames Research Center
National Aeronautics and Space Administration
Moffett Field, CA 94035-1000
Telephone: (650) 604-6136
Email: mostgo@mail.arc.nasa.gov

Programmatic information may be obtained from the NASA MOST Program Scientist

Dr. Padi Boyd
Astrophysics Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: (202) 358-2368
Email: padi.boyd@nasa.gov

4. Summary of Key Information

Expected program budget for first year of new awards	TBD
Number of new awards pending adequate proposals of merit	TBD
Maximum duration of awards	1 year
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	TBD

Page limit for the central Science-Technical-Management section of proposal	No more than six pages for the science justification section, distributed as follows: 3 pp for text, 2 pp for figures and tables, and 1 p for references. The target table and six-page maximum science justification combined must not exceed 15 pp; see Section 2.3.
Relevance	This program is relevant to the astrophysics strategic goals and subgoals in NASA's *Strategic Plan;* See Table and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *2009 NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *2009 NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-MOST See also section 2.2
MOST Program Scientist	Dr. Douglas Hudgins Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0988 Email: douglas.m.hudgins@nasa.gov **[Changed April 14, 2010]**
Technical questions concerning this program element may be directed to the MOST Guest Observer Office	Dr. Jesse Bregman MOST U.S. Guest Observer Office MS 245-6 Ames Research Center National Aeronautics and Space Administration Moffett Field, CA 94035-1000 Telephone: (650) 604-6136 Email: mostgo@mail.arc.nasa.gov

D.11 STRATEGIC ASTROPHYSICS TECHNOLOGY

1. Scope of Program

1.1 Overview

Over the next decade and beyond, NASA's Astrophysics Division expects to undertake a suite of space flight missions that will explore the nature of the universe at its largest scales, its earliest moments, and its most extreme conditions; missions that will study how galaxies and stars formed and evolved to shape the universe we see today; and missions that will search out and characterize the planets and planetary systems orbiting other stars. Nevertheless, as compelling as these future missions will be, implementing them presents many daunting technological challenges. To overcome these challenges and pave the way to ever more ambitious missions, NASA's Astrophysics Division is establishing the Strategic Astrophysics Technology (SAT) program to support the maturation of key technologies to the point at which they are feasible for implementation in space flight missions.

1.2 Solicited Programs

Investigations are solicited for the focused development of technologies that feed into and enable missions in the three science program areas of the Astrophysics Division: Exoplanet Exploration, Physics of the Cosmos, and Cosmic Origins. The SAT program is not intended to support "basic" research into new technologies and demonstration of their feasibility, but to emphasize the maturation of key technologies that have already been identified and shown to be feasible.

The focus of this program can be described in terms of the "Technology Readiness Level" (TRL) of the technologies involved. NASA uses a 9-level classification system to rate the readiness of a particular technology for use in a space flight mission, as defined in Table D.11.1 below. TRL levels 1-3 are generally considered to be basic research on new technologies, while TRL levels 7-9 correspond to the development of flight hardware.

Table D.11.1. Technology Readiness Levels Summary

TRL 1	Basic principles observed and reported
TRL 2	Technology concept and/or application formulated
TRL 3	Analytical and experimental critical function and/or characteristic proof-of concept
TRL 4	Component and/or breadboard validation in laboratory environment
TRL 5	Component and/or breadboard validation in relevant environment
TRL 6	System/subsystem model or prototype demonstration in a relevant environment (ground or space)
TRL 7	System prototype demonstration in a space environment
TRL 8	Actual system completed and "flight qualified" through test and demonstration (ground or space)
TRL 9	Actual system "flight proven" through successful mission operations

These TRL definitions are articulated in more detail in NPR 7120.8 Appendix J (http://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PR_7120_0008_&page_name=AppendixJ).

Funding for low-TRL research is typically available through the APRA program, while that for high-TRL work is provided through the associated flight project. The SAT program is designed to address the mid-TRL "gap" between levels 4 and 6. The goal of the SAT program is to support the maturation of technologies whose feasibility has already been demonstrated (i.e., TRL 3) to the point where they can be incorporated into NASA flight missions (TRL 6-7).

It is not required or expected that proposers will complete this entire development process (or even advance a full step on the TRL scale) within the two-year duration of proposals solicited in this call. Nevertheless, all proposals must clearly and specifically articulate the expected final state (and TRL) of the relevant technology at the end of the two-year development program. Proposals must also define at least one objectively verifiable milestone that represents a meaningful advancement of their chosen technology that will be achieved over the course of their development program. They must also provide a schedule for achieving that (those) milestone(s) over the course of the project.

Successful proposers must submit a progress report to the appropriate Program Officer that documents progress relative to their proposed schedule at the end of the first year of funding (beginning with the date of the initial receipt of funds). NASA reserves the right to terminate a grant after the first year if NASA deems that achievement of the proposed goals according to the proposed schedule is unlikely to occur.

1.3 Technology Development Milestones

Technology milestones verify technology readiness in measured steps and quantified terms that are themselves tied to the performance needs of a specific or representative mission. It is incumbent on the proposer to select the specific or representative mission concept that anchors the proposed technology advance and associated technology milestones. The proposed technology milestones shall be anchored by a quantified mission performance error budget allocation used to guide the proposed technology advance. The level of detail contained in these error budgets should be appropriate for the mission concept maturity.

Technology milestones can be developed in terms of one or more of the following three technology maturity approaches:

1. Demonstrate technology maturity through laboratory experiments conducted to quantify performance goals traceable to an error budget allocation.
2. Validate technology demonstration models against mission error budgets, including sensitivity assessment of technology performance on error allocations.
3. Apply validated technology demonstration models to mission analyses and error budget to demonstrate that the on-orbit performance is achieved.

The expanded TRL maturity definitions provided in NPR 7120.8 Appendix J shall be used to judge completion of technology advances in terms of Hardware, Software and Exit Criteria considerations. It is incumbent upon the proposer to credibly establish and document that they have satisfied each of these three considerations fully before claiming advancement to the next TRL step. An excerpt of these detailed criteria covering the SAT scope of TRL 4 through 6 is reproduced in Table D.11.2 below for convenience.

Table D.11.2. Expanded Maturity Definitions for Mid-Range TRLs

TRL	Definition	Hardware Description	Software Description	Exit Criteria
4	Component and/or breadboard validation in laboratory environment.	A low fidelity system/component breadboard is built and operated to demonstrate basic functionality and critical test environments, and associated performance predictions are defined relative to the final operating environment.	Key, functionally critical, software components are integrated, and functionally validated, to establish interoperability and begin architecture development. Relevant Environments defined and performance in this environment predicted.	Documented test performance demonstrating agreement with analytical predictions. Documented definition of relevant environment.
5	Component and/or breadboard validation in relevant environment.	A medium fidelity system/component brassboard is built and operated to demonstrate overall performance in a simulated operational environment with realistic support elements that demonstrates overall performance in critical areas. Performance predictions are made for subsequent development phases.	End-to-end software elements implemented and interfaced with existing systems/simulations conforming to target environment. End-to-end software system, tested in relevant environment, meeting predicted performance. Operational environment performance predicted. Prototype implementations developed.	Documented test performance demonstrating agreement with analytical predictions. Documented definition of scaling requirements.
6	System/sub-system model or prototype demonstration in an operational environment.	A high fidelity system/component prototype that adequately addresses all critical scaling issues is built and operated in a relevant environment to demonstrate operations under critical environmental conditions.	Prototype implementations of the software demonstrated on full-scale realistic problems. Partially integrate with existing hardware/software systems. Limited documentation available. Engineering feasibility fully demonstrated.	Documented test performance demonstrating agreement with analytical predictions.

Each proposal must include a work plan that fully articulates the technical parameters to be demonstrated for all technical milestones identified. This work plan should include the measurements to be made, analyses to be applied, success criteria, and documentation to be provided. The work plan and associated milestones will be critically evaluated as part of the peer-review process. The work plans for selected proposals will also be reviewed by the appropriate Program Officer or his/her designee(s) to ensure that they contain an adequate level of detail to demonstrate each milestone. Milestone achievements are to be reported in a format that varies between the three Programs: see Sections 2, 3, and 4 below for details.

1.4 Specific Considerations and Exclusions.

The SAT program is not intended to support "basic" research into new technologies and demonstration of their feasibility. Support for such activities is available through NASA's Astrophysics Research and Analysis (APRA) program described in Appendix D.3 of this ROSES 2010 NRA.

Proposers are responsible for making a compelling case that (a) their current technology is at least at TRL 3 and less than TRL 6 and (b) their technology maturation project addresses an important challenge specifically associated with successfully executing future space-based measurements with the accuracy and precision required to achieve the scientific goals of the associated future mission.

If a proposal is offered as a direct successor to a previous NASA award, it should include a description of the predecessor effort, including any significant findings, and describe how the proposed work extends the previous accomplishments. See Section 1.5 of the *NASA Guidebook for Proposers* for more details.

As stated in the second bullet-point of Section IV(d) of the *ROSES Summary of Solicitation*, the proposing PI organization must subcontract the funding of all proposed Co-Is who reside at other non-Government organizations, even though this may result in a higher proposal cost because of subcontracting fees. NASA will fund Co-Investigators affiliated with U.S. Government Laboratories separately through a direct transfer of funds.

1.5 Categories of Proposals

To meet the goals, proposals are solicited in the following three science areas, each of which is described in greater detail below:

- Technology Development for Exoplanet Missions (TDEM)
- Technology Development for Physics of the Cosmos Program (TPCOS)
- Technology Development for the Cosmic Origins Program (TCOP)

Proposed technologies may be relevant to more than one of these three areas. Consequently, NASA reserves the right to reassign a proposal to any of the three Programs for the purposes of review and funding.

2. Technology Development for the Exoplanet Exploration Program (TDEM)

Over the next decade and beyond, the Exoplanet Exploration Program (ExEP) expects to undertake a series of space flight missions that will be designed to search for and ultimately characterize planets and planetary systems orbiting other stars. As compelling as these future ExEP missions will be, implementing them presents many daunting technological challenges. The Technology Development for Exoplanet Missions (TDEM) program is designed to support the maturation of key technologies that will overcome these challenges and pave the way to ever more ambitious exoplanet exploration missions.

2.1 TDEM Areas of Emphasis

Investigations are solicited that will undertake focused technology development addressing specific technologies that feed into key exoplanet exploration measurement techniques. Consequently, the program will be tightly focused on technologies that address the measurement challenges specifically associated with detecting and characterizing extrasolar planets and planetary systems. The measurement techniques upon which future ExEP missions are likely to be based include astrometry, coronagraphy, interferometry, and precision photometry. Detailed discussions of the current technology needs can be found in a variety of current ExEP reports and documents are available at http://exep.jpl.nasa.gov/reportsAndDocuments. The TDEM program is not intended to support general technology maturation activities that do not address the specific requirements of exoplanet missions.

Areas of technology development that are of particular interest to the TDEM program include (but are not necessarily limited to):

1. *Starlight Suppression Demonstrations*
Demonstration of technologies that will enable a space observatory to reject scattered starlight to the degree that the light of an exoplanet can be separated from that of its parent star (10^6 contrast ratio at infrared wavelengths; 10^9 contrast ratio at visible wavelengths).

2. *Wavefront Sensing and Control*
In order to achieve the requisite degree of starlight rejection, the light paths within both coronagraphic and interferometric systems must be controlled to sub-nanometer precision. Advances in control algorithms, sensing technology, and deformable mirror technology are, therefore, central to implementing such instruments on a space-based platform.

3. *Advanced Optics*
Advanced optics, including coronagraphic masks and stops, shaped external occulters, interferometric spatial filters, and coherent arrays of single-mode fibers, all provide methods of diffracting and filtering starlight to reduce the measurement noise, allowing planets to be detected in closer proximity to their host star. These components and subsystems allow faint planets to be detected when they are barely resolved from their host stars at the diffraction limit of the observatory and offset the need for larger apertures.

4. *Structures, Materials, and Mechanisms*
The need to achieve high levels of starlight suppression requires that the observatory system exhibit an extreme degree of stability over extended periods of time (hours, days). Low thermal expansion materials, micro dynamically stable mechanical interfaces, as well as vibration damping approaches, all require precision testing (from material coupons to substructure assemblies) for characterization and model validation.

5. *System Performance Assessment*
Testing new subsystems, instruments, and observatory designs on the ground for performance verification may not be feasible even if they are small enough to fit in existing vacuum chambers. Thus, future exoplanet missions will have to rely on high-fidelity, very high density models that capture the physics properly, and seamlessly integrate thermal, mechanical, and optical models, to infer expected picometer-level on-orbit performance based on nanometer-level ground measurements.

Due to the limited budget available for TDEM selections, suborbital programs are not solicited at this time, but may be in future TDEM solicitations. This program is also not intended to support general technology maturation activities without specific application to exoplanet missions, or for the development or maintenance of testing facilities and/or tools that substantively reproduce the capabilities of existing ExEP infrastructure. Information about existing ExEP testbeds and tools that are available to the community can be obtained by contacting the TDEM Program Officer.

The ExEP model for advancement of technologies is founded on the following three interrelated components:

1. Demonstration of milestone performance must be stable and repeatable, thereby demonstrating that the result is not spurious or transient;
2. Modeling of the milestone demonstration must be consistent with the demonstrated result, thereby establishing that the behavior is thoroughly understood; and
3. Error budget for the milestone must be consistent with the models.

Tasks proposed under the auspices of the TDEM element may involve one or all of these elements. Error budgets have been developed for a number of different ExEP mission architectures and are available to potential TDEM proposers by contacting the TDEM Program Officer (see Section 6).

Over the years, the ExEP has developed a number of advanced testing and modeling tools to support the development of exoplanet exploration technologies. These tools are available to the community and proposers are encouraged to take advantage of them as appropriate. An informational workshop will be held in advance of the proposal deadline to provide information for proposers wishing to take advantage of one or more of the available ExEP test facilities and/or tools, and to provide guidance for developing quantitative, practical technology milestones for their proposed task. Information about the scheduling of the workshop and instructions for participation will be posted at http://exep.jpl.nasa.gov/news.

2.2 TDEM-Specific Reporting Requirements

For all technical milestones identified in a proposal, the PI will be expected to prepare a workplan that fully articulates the technical parameters to be demonstrated, the measurements to be made, analysis to be applied, success criteria, and documentation to be produced. That workplan will then be reviewed by a NASA-Headquarters appointed independent board. It may be iterated until an agreement between the technologists, the reviewers, and NASA is reached. When the PI believes that his/her team has achieved all of the requirements set forth for a milestone, they will be required to write a milestone report that addresses all of the aspects identified in the original workplan. The milestone report will then be subject to independent review and interaction by the same groups involved in the initial workplan.

Each year, PIs of selected tasks will be required to submit a written progress report and meet with ExEP officials, either in person or remotely, to discuss the progress of their task.

3. Technology Development for Physics of the Cosmos Missions (TPCOS)

The science objective of the Physics of the Cosmos Program is to "understand the origin and destiny of the Universe, phenomena near black holes, and the nature of gravity" (see the *NASA Science Plan* at http://nasascience.nasa.gov/about-us/science-strategy/). Missions that are directed to advances in cosmology, high-energy astrophysics, and fundamental physics are nominally within the scope of this program.

Areas of technology development that are of particular interest to the PCOS Program include, but are not limited to:

1. Technologies for High Energy Astrophysics
High energy astrophysics includes the areas of X-ray, gamma-ray, and particle astrophysics. Technologies that will help enable future missions include, *but are not limited to*: X-ray optics, microcalorimeters, gratings, pixel sensor arrays; Si, Ge, liquid Xe, CdTe/CZT gamma-ray detectors, gamma-ray polarimeters;

microelectromechanical systems, digital micromirror devices, scintillator materials and readout devices.

2. *Technologies for Dark Energy Characterization*
Currently the three leading techniques for measuring the characteristics of dark energy using the optical and near-IR bands are Baryon Acoustic Oscillations, Type Ia Supernovae, and Weak Lensing. Optimization of the physics return with these methods would be enhanced by improvements in the technologies of optical and NIR detectors, particularly in near-IR pixel arrays where inter-pixel capacitance, charge persistence and other effects negatively impact performance. Advances in photometric calibration systems could also benefit a dark energy space mission (JDEM).

3. Technologies for Gravitational Astrophysics
With the measurement of the sub-Hertz gravitational wave spectrum, space-based gravity wave detectors will open a completely new window to the Universe. The key elements of such detectors include gravitational reference sensors, drag-free systems, and optical interferometers. The technologies associated with these include optical metrology, phasemeters, microthrusters, and highly stable laser systems.

4. Technologies for Fundamental Physics
Ultra-high precision tests for deviations from Einstein's General Theory of Relativity or the Standard Model of particle physics could revolutionize our understanding of physics. These include searches for violations of the general theory or relativity or fundamental symmetries, and variation of the fundamental constants in time or with gravitational potential. Increased precision in such tests may be enabled by the development of technologies for atomic clocks, atomic interferometers, laser combs, quantum sensors, and other precision metrologies.

Due to the limited budget available, proposals requiring a dedicated suborbital flight (balloon or rocket) for technology tests or risk reduction are not solicited at this time, but may be in future solicitations. However, proposals that require suborbital balloon or rocket flights may be considered if they piggyback with a payload of an already approved suborbital mission. To learn about potential opportunities for suborbital piggyback payloads, please contact:

Mr. David Pierce
Balloon Program Office
Code 820
Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-1453
Email: David.L.Pierce@nasa.gov

The proposal must explain how a potential future mission that primarily addresses PCOS science goals will be enabled or enhanced by this work.

The annual report should contain documentation of the progress towards the milestones identified in the proposal.

4. Technology Development for the Cosmic Origins Program (TCOP)

The Cosmic Origins Program seeks to investigate how planets, stars, galaxies and cosmic structure come into being and when and how the elements of life in the Universe arose. In general, areas of astronomy and astrophysics not explicitly called out in the previous program definitions fall within the Cosmic Origins Program. Areas of long-lead and mission enabling technology development that are of particular interest to the Cosmic Origins Program include (but are not necessarily limited to):

1. *Large, Normal Incidence Optics*
Missions within the Cosmic Origins Program rely heavily on their ability to collect enough light energy with appropriate angular resolution to address important Cosmic Origins questions. Therefore, a premium is placed on the ability to manufacture, test and control optics of sizes greater than ~2 meters in diameter. Keys to advancements in this arena are new techniques and technologies for reducing areal density of optics, production times; manufacturing ultra-precise, low-mass deployable structures to reduce launch volume for large-aperture space telescopes and interferometers; cryogenic optics; and mechanisms and methods for improving control of the surface figure.

2. *Detectors*
Highly sensitive detectors and large arrays of detectors are fundamental to Cosmic Origins mission's capabilities. Detectors that work from the extreme ultraviolet to the submillimeter portion of the spectrum, and their associated technologies (e.g., manufacturability, read-out electronics, packaging) will be critical to achieving the goals of future Cosmic Origins investigations.

The annual report for selected efforts should contain documentation of the progress towards the milestones identified in the proposal. Due to the limited budget available, suborbital programs are not solicited at this time, but may be in future solicitations.

5. Programmatic Information

5.1 General Information

The period of performance for proposals submitted in response to this solicitation may not exceed 2 years. The following table provides the approximate amount of funding available for new awards, distributed over fiscal years 2012 and 2013. It also gives the number of new investigations that may be selected for the three SAT categories pending the availability of funds and an adequate number of proposals of sufficient merit.

SAT Category	Approximate Funds for New Selections [$M]	Approximate Number of New Selections
TDEM	~$2.6M/yr	~3-10
TCOP	~$3.0M/yr	~1-2
TPCOS	~$2.4M/yr	~1-6

5.2 Student Participation

Where appropriate, participation of graduate students is encouraged, especially if the project can be concluded within the nominal tenure of graduate training. In such cases, brief details of the educational goals and training of the student participants should be included in the proposal.

5.3. Request for reviewer names

Proposers are strongly encouraged to provide names and contact information of up to five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information should be included in the proposal summary in the Notice of Intent.

5.4. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

6. Summary of Key Information

Expected program budget for first year of new awards	See Section 5.1
Number of new awards pending adequate proposals of merit	See Section 5.1
Maximum duration of awards	2 years; shorter term proposals will be accepted, but are not encouraged
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.

Planning date for start of investigation	January 1, 2012 (except that NASA Centers may plan for a start at the beginning of the fiscal year).
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the astrophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-SAT
NASA point of contact concerning this program	The relevant Program Officers listed below with their areas of expertise, all share the same mailing address: Astrophysics Division Science Mission Directorate NASA Headquarters 300 E St. SW Washington, DC 20546-0001

Name	Program	Telephone	Email
Dr. Douglas Hudgins	TDEM	(202) 358-0988	Douglas.M.Hudgins@nasa.gov
Dr. Michael Salamon	TPCOS	(202) 358-0441	Michael.H.Salamon@nasa.gov
Dr. Eric P. Smith	TCOP	(202) 358-2439	Eric.P.Smith@nasa.gov

APPENDIX E: CROSS-DIVISION RESEARCH

E.1 OVERVIEW

The Science Mission Directorate (SMD) sponsors program elements that apply across more than one of its four science research areas as defined in Section I of the *ROSES Summary of Solicitation*. Such cross-division program elements are listed here in Appendix E of this ROSES NRA. At the time of the initial release of this NRA, there are five such programs:

The Applied Information Systems Research (AISR) program (Appendix E.2) seeks innovative ideas for applying advances in information science and technology to increase productivity of SMD research endeavors in Earth Science, Heliophysics, Planetary Science, and/or Astrophysics. If it is determined that funding is available for AISR, an amendment calling for proposals will be released no earlier than summer of 2010, otherwise it will not be competed in 2010.

The Origins of Solar Systems program (Appendix E.3) solicits basic research proposals to conduct scientific investigations related to understanding the formation and early evolution of planetary systems and to provide the fundamental research and analysis necessary to detect and characterize other planetary systems.

The Opportunities in the SMD Education and Public Outreach program (Appendix E.4) supports proposals for investigations or projects that use SMD content and support NASA education and public outreach objectives. It solicits proposals that address substantial and substantive educational needs or problems and offer solutions of significant impact.

Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6) are opportunities for Principal Investigators (PIs) of selected research investigations to receive Education or Outreach awards as supplements to their research award. SMD-funded researchers can design an outreach or education effort that capitalizes upon their own talents, interests, and scientific expertise.

Any other cross-division programs that are defined during calendar year 2010 will be issued as amendments to ROSES, typically 90 days in advance of their established Proposal Due Dates. Such new programs will be managed by only one SMD Program Officer as designated in the "Summary of Key Information" section that concludes each program element; the Program Officer will be organizationally located in one of the SMD divisions, and all questions may be directed to him/her. At the time of selection, the designated Selecting Official will consult all of the SMD science divisions that have programmatic interest in the program.

E.2 APPLIED INFORMATION SYSTEMS RESEARCH

NOTICE: NASA is determining whether or not the Applied Information Systems Research (AISR) program will be able to solicit proposals in 2010. If it is determined that funding is available, an amendment will be released no earlier than summer of 2010. Any solicitation will be announced as an amendment to ROSES-2010 with details of the solicitation. Proposals will be due no earlier than 90 days after release of the amendment.

The purpose of the Applied Information Systems Research (AISR) program is to exploit advances in computer and information science and technology to enhance science productivity of the Science Mission Directorate (SMD). AISR seeks innovative ideas for applying advanced information and related technologies to increase life cycle effectiveness and efficiency of research endeavors conducted by SMD research programs in Earth Science, Heliophysics, Planetary Science, and Astrophysics.

AISR provides adaptation and application of emerging information technologies, concepts, methodologies, etc. to demonstrate their feasibility and potential to increase science return, as well as to inform missions and research disciplines of promising techniques and capabilities worthy of broader application and/or further development through full maturity.

Point of Contact for Further Information

Mr. Joseph H. Bredekamp
Heliophysics Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
Telephone: (202) 358-2348
Email: joe.bredekamp@nasa.gov

E.3 ORIGINS OF SOLAR SYSTEMS

Correction May 5, 2010: The planning date for start of investigation has been changed from January 1, 2010 to January 1, 2011.

1. Scope of Program

The Origins of Solar Systems program solicits basic research proposals to conduct scientific investigations related to understanding the formation and early evolution of planetary systems and to provide the fundamental research and analysis necessary to detect and characterize other planetary systems. These investigations may involve analytical and numerical modeling, laboratory research, and observational studies in the following areas: star formation and the relationship to planetary system formation, solar nebula processes, accumulation and dynamical evolution, analysis of primitive materials, and the detection and characterization of other planetary systems.

The investigations supported through this program are expected to directly support the goal of understanding the formation of planetary systems. Therefore, proposals to the Origins of Solar Systems program should clearly fall into one or more of the following categories:

- Investigations to detect and characterize extra-solar planets;
- Observations related to the formation and evolution of planetary systems;
- Theoretical investigations related to the formation and evolution of planetary systems; and
- Studies of chemical and atomic processes related to the formation of planetary systems.

This Origins of Solar Systems program realizes the existing potential for complementary interdisciplinary efforts to solve key scientific questions. To achieve this goal, proposals are encouraged that involve joint research efforts by investigators from different scientific communities, for example, studies of nebular chemistry and dynamics to understand the composition of primitive volatile-rich Solar System bodies or collaborations between observational astronomers and modelers to study the initial collapse of a protostellar cloud to form a nebula.

For more information about the type of research previously supported by this program, abstracts for currently funded investigations are available online at http://nspires.nasaprs.com/ (select "Selected Proposals").

2. Programmatic Information

2.1 Coordination between Planetary Science and Astrophysics Research Programs

The Origins of Solar Systems program supports research needed to advance our knowledge of the structure, formation, and evolution of our own solar system, as well as other planetary systems. For administrative purposes, investigations aimed primarily at finding and characterizing extra-solar planetary systems will be managed by the Astrophysics Research

Program. The remainder of the Origins of Solar Systems program will be managed by the Planetary Science Research Program.

2.2 Investigations of Signals from Intelligent Life

Research aimed at identification and characterization of signals from extra solar intelligent life previously included in this program is covered by the Astrobiology: Exobiology and Evolutionary Biology (Appendix C.17) and Astrobiology Science and Technology Instrument Development (ASTID, Appendix C.19) program elements. Proposal in this research area should be submitted to those ROSES elements.

2.3 Duration of Awards

The periods of performance of investigations for this research element may range from one to four years. Most selected proposals will have a duration of three years, but four-year proposals may be selected if the need for the longer duration is sufficiently well justified.

2.4 Additional Funding for Relevant Instrumentation

The Planetary Major Equipment Program described in Appendix C.23 of this ROSES NRA allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by investigations for certain programs sponsored by the Planetary Science Research Program, including this one. New analytical instrumentation requests, as well as requests for upgrades to existing instruments costing more than $25,000, should be identified and requested in a special section of each proposal, to be titled "Major Equipment Request." However, note that a Planetary Major Equipment proposal must be affiliated with a “parent” research proposal in order to be considered; see Appendix C.23 for details.

2.5 Availability of High-End Computational Resources

Those investigators whose research requires high-performance computing should refer to the *Summary of Solicitation*, Section I(d), “NASA-provided High-End Computing Resources.” This section describes the opportunity for successful proposers to the Origins of Solar Systems program to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center’s Computational and Information Sciences and Technology Office or at the Ames Research Center’s Advanced Supercomputing Division.

2.6 Selecting Official

The Selecting Official for investigations that are managed by the Planetary Science Division is the Director of the Planetary Science Division. The Selecting Official for investigations that are managed by the Astrophysics Division is the Director of the Astrophysics Division.

3. Education and Public Outreach Opportunities

NASA policy strongly encourages participation in Education and Public Outreach (E/PO) activities by members of the science community. You may be eligible to propose a supplemental Education or Outreach effort if your research proposal is selected for award. The research award must have more than 12 months remaining at the time of submission of the supplement proposal. For additional details concerning the submission of Outreach or Education supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators (Appendix E.5) and Supplemental Education Awards for ROSES Investigators (Appendix E.6).

4. Summary of Key Information

Expected program budget for first year of new awards	~ $3.0M
Number of new awards pending adequate proposals of merit	~ 20-30
Maximum duration of awards	4 years; shorter term proposals (1-3 years) are typical; four-year proposals must be well justified
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.
Due date for proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.
Planning date for start of investigation	January 1, **2011 [corrected May 6, 2010]**
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the planetary science and astrophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-OSS

NASA points of contact concerning this program	Dr. Max Bernstein **[changed March 30, 2010]** Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0879 Email: HQ-OSS@mail.nasa.gov Dr. Mario Perez Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1535 Email: HQ-OSS@mail.nasa.gov

E.4 OPPORTUNITIES IN EDUCATION AND PUBLIC OUTREACH FOR EARTH AND SPACE SCIENCE

Clarified on March 12, 2010. References and links to the Explanatory Guide to Proposal Evaluation Factors for this program element have been updated to the latest version (1.1).

1. Background

NASA's founding legislation, the Space Act of 1958, directs the Agency to expand human knowledge of Earth and space phenomena and to preserve the role of the United States as a leader in aeronautics, space science, and technology. High achievement in science, technology, engineering, and mathematics (STEM) education and public scientific literacy is essential to the accomplishment of NASA's mission.

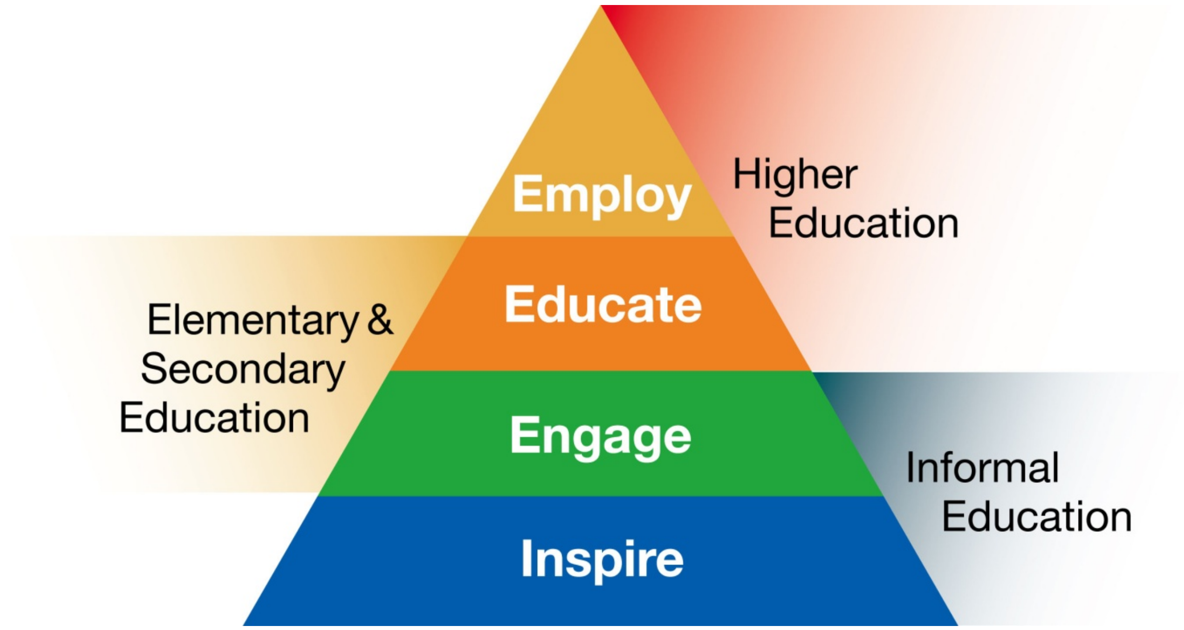
The NASA Science Mission Directorate's (SMD's) vision for Education and Public Outreach is:

> *To share the story, the science, and the adventure of NASA's scientific explorations of our home planet, the solar system, and the universe beyond, through stimulating and informative activities and experiences created by experts, delivered effectively and efficiently to learners of many backgrounds via proven conduits, thus providing a return on the public's investment in NASA's scientific research.*

Hereafter the phrase "education and public outreach (E/PO)" will refer to activities addressing the teaching and learning of science, technology, engineering, and mathematics at the undergraduate, secondary and elementary levels (including hands-on experiences for students), informal education, as well as public understanding and engagement in science and technology using unique resources derived from NASA Earth and space sciences.

SMD has a portfolio of investments (E/PO project activities) in Higher Education, Elementary and Secondary Education, Informal Education, and Outreach. It is a major contributor to the overall NASA education and outreach effort through development and dissemination of new educational and outreach products that utilize SMD science discoveries and by providing opportunities for students and educators, citizen scientists, and the public to engage in authentic experiences working with our data and our research communities.

The Education Strategic Framework (depicted below) provides a conceptual basis for examining, guiding, and coordinating the NASA education portfolio.



NASA is particularly interested in encouraging individuals (as students, educators, parents, civil leaders, etc.) engaged in a NASA educational project in one part of the Framework to connect or move up to activities in another part of Framework. The primary aim is to contribute to the Nation's STEM education and improve scientific literacy. A more detailed discussion of the Education Strategic Framework is discussed in the *NASA Education Strategic Coordination Framework: A Portfolio Approach* available at http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Strategic_Coordination_Framework.html.

In addition to education, outreach is an essential aspect of the SMD program. It directly connects to many aspects of NASA Public Affairs and NASA education efforts. It often provides an inspirational spark for participants to seek out education opportunities. The SMD Outreach Goal is to stimulate interest in science, engineering, and technology relevant to NASA SMD. Outreach can be directed at any audience, including students, teachers, citizen scientists, and the general public.

2. Scope of Program

This Opportunities in Education and Public Outreach for Earth and Space Science (EPOESS) solicitation is for project activities utilizing SMD content supporting NASA education and public outreach (E/PO) objectives. It solicits proposals that address substantial and substantive educational or outreach needs or problems and offer solutions of significant impact. Project activities are expected to be relevant to NASA SMD Education and Outreach portfolio. This relevance should be clearly demonstrated in the proposal. This program element is expected to issue additional solicitations approximately every 12-24 months.

NASA SMD Education and Outreach Portfolio	
Portfolio Area	**Project Activity Categories**
Higher Education	• Competency-building education and research based on NASA SMD activities that develops qualified undergraduate and graduate students who are prepared for employment in STEM disciplines at NASA, industry, and higher education. • Opportunities for groups of post-secondary students to engage in authentic NASA SMD related, mission-based research and development activities. • Developing NASA SMD related course resources for integration into STEM disciplines. • Improving the ability of targeted institutions to compete for NASA SMD research and development work.
Elementary and Secondary Education	• Providing professional development and training opportunities to educators, equipping them with the skills and knowledge to attract and retain students in STEM disciplines and deeper content understanding and/or competence and confidence in teaching STEM disciplines. • Providing curricular support resources that use NASA SMD content to a) enhance student skills and proficiency in STEM disciplines; b) inform students about STEM career opportunities; and/or c) communicate information about NASA’s mission activities. • Providing K-12 students with authentic first-hand opportunities to participate in NASA SMD mission activities, thus inspiring interest in STEM disciplines and careers or providing opportunities for family involvement in K-12 student learning in STEM areas.
Informal Education	• Informal education resources that use SMD content to 1) enhance participant skills and proficiency in STEM disciplines; 2) inform participants about STEM career opportunities; and 3) communicate information about NASA's mission activities. • Activities to improve the competency and qualifications of STEM informal educators, enabling informal educators to effectively and accurately communicate information about NASA SMD activities and access NASA SMD data for programs and exhibits. • Activities to develop and support qualified informal educators with experience in NASA SMD mission and related activities; or engaging informal educators using NASA SMD content to 1) enhance participant skills and proficiency in STEM disciplines; 2) inform participants about STEM career opportunities; and 3) communicate information about NASA’s SMD mission activities.

Outreach	• Activities to increase interest in science, engineering, and technology careers relevant to NASA SMD; • Activities to increase understanding by the general public of SMD science, engineering, and technologies; • Activities to increase participation of citizen scientists in SMD education opportunities; • Activities to increase public engagement in improving science, mathematics, engineering, and technology education in the United States.

Given the many accomplishments in NASA Earth and space science education and public outreach in recent years, the program places particular emphasis on systemic and/or sustainable impact from SMD investments. Project activities must have a clear linkage to the needs of the formal or informal educational systems or outreach audiences. Sources of information about SMD education and public outreach activities and products include:

- *Science Plan for NASA's Science Mission Directorate 2007 – 2016* (a.k.a. *NASA Science Plan 2007*) (http://nasascience.nasa.gov/about-us/science-strategy);
- The SMD E/PO program overview for proposers (http://nasascience.nasa.gov/researchers/education-public-outreach);
- The SMD E/PO program overview for educators (http://nasascience.nasa.gov/educators);
- The 2006 NASA Education Portfolio Data Call Report (http://www.strategies.org/Portfolio/FinalReport.html);
- The 2006 EPOESS projects (http://nspires.nasaprs.com/external/viewrepositorydocument/cmdocumentid=123678/EPOESS06%20Selection%20Abstracts%20with%20Space%20Math.pdf);
- The 2008 EPOESS projects (http://nspires.nasaprs.com/external/viewrepositorydocument/cmdocumentid=168538/EPO08 Selections.pdf);
- The 2009 EPOESS projects (http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId=%7B7F8B751D-4D39-7BEC-6ECB-9E44050FFF3F%7D&path=open);
- *SMD Education and Public Outreach Report* (http://smd-epo.hq.nasa.gov/ar.htm); and
- *SMD EPOESS Guide 1.1, Explanatory Guide to Proposal Evaluation Factors for ROSES Program Element: Opportunities in Education and Public Outreach for Earth and Space Science (EPOESS)* at http://nasascience.nasa.gov/researchers/education-public-outreach/explanatory-guide-to-smd-e-po-evaluation-factors **[Updated March 12, 2010]**.

It should be noted that this program element is only one of several ways that SMD invests in education and public outreach. Proposers are encouraged to take advantage of SMD E/PO investments in products, dissemination mechanisms, and opportunities to work with ongoing mission and non-mission E/PO projects. Proposed project activities should not duplicate existing project activities, but should complement existing E/PO project activities embedded in missions or ongoing EPOESS project activities.

Project activities that may be proposed to other SMD E/PO opportunities will not be considered under this program element. Examples of opportunities that are not solicited include: competitive research support for faculty and early-career scientists sponsored under ROSES, graduate research support sponsored under the NASA Earth and Space Science Fellowship (NESSF) Program, education and outreach activities embedded in flight missions, and E/PO supplements to individual research awards selected under ROSES.

This particular solicitation is focused on education and outreach activities in support of the SMD Earth Science, Heliophysics, Planetary Science, and Astrophysics Divisions. Proposals that address science learning needs across the Divisions are encouraged; however, proposals may target the content of a single Division (see Section 2.1 for an opportunity for Heliophysics specific proposals).

Projects may address any of the Project Activity Categories. In 2010, SMD encourages proposals in the following areas:

- In the Higher Education Outcome, efforts that would strengthen the teaching and learning of science and engineering at the undergraduate level (including minority-serving institutions and community colleges) using SMD science content and mission data and efforts that would increase the number of underrepresented minorities with graduate degrees certified to teach in the science, technology, engineering and mathematics (STEM) disciplines at the secondary level. Of particular interest are efforts that provide preservice K-12 and community college educators with research-intensive experiences on NASA Earth or space science projects.

- In the Elementary and Secondary Education Outcome, SMD is particularly interested in seeing greater utilization of existing SMD K-12 curriculum support products and mission science data. Proposals are encouraged that utilize innovative methods to incorporate SMD education resources and science and mission data into existing learning resources or programs that are widely used in K-12 formal education. Of particular interest are efforts that provide K-12 educators with research-intensive experiences on NASA Earth or space science projects.

- In the Informal Education Outcome, SMD encourages proposals that increase utilization of SMD resources in out-of-school time or after school programs. Participatory exploration efforts that utilize SMD science data are of particular interest.

- In the Outreach Outcome, SMD encourages efforts that lead to increased utilization of its education resources by formal and informal education providers. Collaborations or partnerships with community-based organizations such as Parent Teacher Associations, amateur astronomy clubs, citizen science groups, business associations, etc. are particularly encouraged.

The Planetary Science Division (PSD) is entering a period of intense mission activity between 2010 and 2012 that has been dubbed “2011 the year of the Solar System”. MESSENGER will orbit Mercury, Dawn will orbit asteroid Vesta, and EPOXI and Stardust NEXT will encounter their target comets. Launches will include Juno to Jupiter, GRAIL to the Moon, and Mars Science Lab to Mars. Meanwhile, New Horizons continues its journey to Pluto and several operating missions continue their studies: Cassini (Saturn system), LRO (Moon), MRO, Odyssey, Spirit and Opportunity (all at Mars).

The Planetary Science Division encourages submission of education and public outreach proposals that bring these planetary missions to classrooms and the public in a coordinated way and focus on scientific themes shared by multiple missions or multiple bodies. Possible themes include comparative planetology, origin and evolution of the solar system, and habitability of various bodies in the solar system.

2.1 Heliophysics Specific Proposals

The Heliophysics Division encourages the submission of education and public outreach proposals that specifically pertain to and emphasize the system-science of Heliophysics. Proposals on all levels of engagement, as outlined in Section 2, are requested. The Heliophysics Division encourages a "multimission" approach to mission E/PO activities, given the very broad nature of the science regimes studied. The range of studies undertaken in Heliophysics is immense and includes:

- Studies of geomagnetic storms (magnetic storms on Earth due to solar activity) produce the aurora, which can affect the terrestrial power-grid, and telecommunications;
- Studies of the harsh conditions in the space environment, which may pose significant risks for the journey of exploration;
- The variability of the Sun in every wavelength, and the manner by which that variability manifests itself in the solar magnetic field, bulk plasma flow (the solar wind), and energetic particles. These variations occur on timescales from fractions of a second to hundreds of years and longer; and
- The study of the sun, interplanetary space, planetary magnetospheres, and most of the rest of the universe are made up of plasma, and how this plasma interacts with, and how it is coupled to, electromagnetic forces.

A more inclusive discussion of the system science is given in the most recent Heliophysics Division roadmap *("2009 Heliophysics Roadmap")* at http://nasascience.nasa.gov/about-us/science-strategy/Heliophysics_Roadmap_2009_tagged-quads.pdf and in the SMD Science plan *("SMD Science Plan for 2007-2016")* at http://nasascience.nasa.gov/about-us/science-strategy/Science_Plan_07.pdf.

The amount of new funding for ~10 Heliophysics specific awards is anticipated to be ~$1.3M.

3. Programmatic Information

3.1 General Information

E/PO investigations or projects will be selected for a period of performance beginning in FY 2011. The periods of performance for SMD E/PO investigations or projects may range from

one to four years. Most selected proposals will have a duration of three years, but four-year proposals may be selected if the need for the longer duration is sufficiently well justified. Heliophysics specific proposals may be for one to three years.
.
The anticipated total amount of funds available for new awards under this solicitation is approximately $3.3M per year over the four-year period. This solicitation is open to a wide range of proposed costs from a few $10Ks for small focused project activities to $100Ks for large-scale project activities. Existing project activities must be clearly identified if the proposed E/PO activity leverages the capabilities of existing SMD project activities.

Awardee institutions have the responsibility for budgeting and documenting compliance with Code of Federal Regulations 14 CFR§1230, commonly referred to as "the Common Rule for the Protection of Human Subjects." Research to develop NASA-themed exhibits, programs, curriculum products, etc. may involve full human subjects review through an Institutional Review Board (IRB) or it may be exempt. An IRB also certifies when research is exempt. Research using surveys, observational or ethnographic methods, cognitive and educational tests, etc. is "exempt" unless two conditions apply: 1) the information would allow subjects to be identified, and 2) disclosure of the data would reasonably place the subject at risk of harm. It is anticipated that most Education and Outreach activities will be exempt and that non-exempt research will not involve NASA facilities, personnel, or equipment. The PI, however, should begin the process as soon as the proposal is submitted to determine whether any proposed research activities require IRB approval or is exempt. This is done by working with a Department of Health and Human Services Office of Human Research Protection (HHS OHRP) approved non-NASA IRB. Information on how to locate an approved IRB is at: http://ohrp.cit.nih.gov/search/.

3.2 Technical Reporting Requirements

The following deliverables shall be required of awarded proposals. In cases where subaward arrangements exist, consolidated reports are the responsibility of the PI. In this context, "Annual" refers to a twelve-month task effort that commences at award.

An Annual Progress Report is due 60 days prior to the anniversary date of every grant and cooperative agreement, except for the final year, when a final report, called a Summary of Research, is due within 90 days of the expiration date of the award; see Provisions 1260.22 and 1260.151(d) in the *Grants and Cooperative Agreement Handbook*. In addition, for awards in excess of $100,000, the awardees will submit a quarterly technical report that focuses on the preceding three-month's efforts. Each such report shall summarize accomplishments for the preceding three months, the status of major tasks, and the variance from planned versus actual schedule.

In addition, the project activity must collect, analyze, and report output and outcome data to a common NASA database to determine project activity effectiveness and meet the requirements of stakeholders. Instructions on submitting this information will be provided with the selection notice. It is anticipated that this will be nominally a five person-day per year effort to format and submit the data.

3.3 Evaluation and Selection of Proposals

Proposers are reminded that the evaluation criteria for this solicitation are given in Section C.2 of the *NASA Guidebook for Proposers* (see below for reference). These criteria are intrinsic merit, relevance to NASA's strategic goals and objectives, and cost realism and reasonableness. In addition to the factors described in the *NASA Guidebook for Proposers*, the evaluation of the relevance and intrinsic merit of E/PO proposals will include the Program Balance Factors [Pipeline and Diversity] described in the SMD EPOESS Guide 1.1 Explanatory Guide to Proposal Evaluation Factors for ROSES Program Element: Opportunities in Education and Public Outreach for Earth and Space Science (EPOESS) at http://nasascience.nasa.gov/researchers/education-public-outreach/explanatory-guide-to-smd-e-po-evaluation-factors **[Updated March 12, 2010]**.

Proposers are strongly encouraged to review the *Explanatory Guide*. In particular, the *Explanatory Guide* provides discussion of requirements for SMD E/PO projects. These include a clear demonstration of the target audience's need for the project activity, the active involvement of the science/technology community, in partnership with the education and outreach community, and project activity evaluation. Proposals to extend previously funded SMD E/PO efforts are also required to provide evaluation results of the prior effort.

4. Summary of Key Information

Expected program budget for first year of new awards	~ $3.3M (including $1.3M for Heliophysics specific)
Number of new awards pending adequate proposals of merit	~20-30 (including ~10 for Heliophysics specific)
Maximum duration of awards	4 years (3 years for Heliosphysics specific)
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	See the discussion of the relevance evaluation factor in the SMD EPOESS Explanatory Guide. **[Updated March 12, 2010]**
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.

Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-EPOESS
NASA point of contact concerning this program	Dr. Larry P. Cooper Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1531 Email: larry.p.cooper@nasa.gov

E.5 SUPPLEMENTAL OUTREACH AWARDS FOR ROSES INVESTIGATORS

Clarified on March 12, 2010. References and links to the Explanatory Guide to Proposal Evaluation Factors for this program element have been updated to the latest version (1.1).

1. Background

NASA's founding legislation, the Space Act of 1958, directs the Agency to expand human knowledge of Earth and space phenomena and to preserve the role of the United States as a leader in aeronautics, space science, and technology. High achievement in science, technology, engineering, and mathematics (STEM) education and public scientific literacy is essential to the accomplishment of NASA's mission.

The NASA Science Mission Directorate's (SMD's) vision for Education and Public Outreach is:

> *To share the story, the science, and the adventure of NASA's scientific explorations of our home planet, the solar system, and the universe beyond, through stimulating and informative activities and experiences created by experts, delivered effectively and efficiently to learners of many backgrounds via proven conduits, thus providing a return on the public's investment in NASA's scientific research.*

SMD has a portfolio of investments (E/PO project activities) in Higher Education, Elementary and Secondary Education, Informal Education, and Outreach. It is a major contributor to the overall NASA education and outreach effort through development and dissemination of new educational and outreach products that utilize SMD science discoveries and by providing opportunities for students and educators, citizen scientists, and the public to engage in authentic experiences working with our data and our research communities.

Outreach is an essential aspect of the SMD program. It directly connects to many aspects of NASA Public Affairs and NASA education efforts. It often provides an inspirational spark for participants to seek out education opportunities. Outreach can be directed at any audience, including students, teachers, citizen scientists, and the general public.

> The SMD Outreach Goal is to stimulate interest in science, engineering, and technology relevant to NASA SMD.

SMD Supplemental Outreach awards are provided to support the SMD Outreach goal. SMD-funded researchers can design an outreach effort that capitalizes upon their own talents, interests, and scientific expertise. By adding an Outreach component to their research investigation, they can engage the public in the excitement of NASA's scientific exploration of our home planet, the solar system, and the rest of the universe through stimulating and informative activities that reach a broad and varied audience.

Beginning in 2008, there are two pathways available to research scientists who wish to propose for the supplemental Education and Public Outreach (E/PO) awards: the Outreach pathway and the Education pathway. This program element in Appendix E.5 is for Outreach supplements. ROSES Element E.6 is for Education supplements.

Principal Investigators of research proposals selected for funding through this and previous ROSES NRAs (hereafter called the "parent research award") are eligible for a supplemental Outreach award to the parent research award if the research award has at least 12 months remaining in its period of performance on the due date of the Outreach proposal. This program element is expected to appear in every ROSES solicitation.

2. Scope of Program

This solicitation element is for project activities that utilize SMD content and contribute to achieving SMD Outreach objectives. The scope of the supplemental Outreach awards includes all aspects of public outreach. Efforts promoting participation of underrepresented groups in Earth and space science studies are encouraged.

NASA SMD Outreach Portfolio	
Portfolio Area	**Project Activity Categories**
Outreach	• Activities to increase interest in science, engineering, and technology careers relevant to NASA SMD; • Activities to increase understanding by the general public of SMD science, engineering, and technologies; • Activities to increase participation of citizen scientists in SMD education opportunities; • Activities to increase public engagement in improving science, mathematics, engineering, and technology education in the United States.

It should be noted that this program element is only one of several ways that SMD invests in education and public outreach. Proposers are encouraged to take advantage of SMD E/PO investments in products, dissemination mechanisms, and opportunities to work with ongoing mission and non-mission E/PO project activities. Proposed project activities should not duplicate existing efforts, but should complement existing E/PO project activities embedded in missions or other ongoing project activities.

Sources of information about SMD education and public outreach activities and products include:

- *Science Plan for NASA's Science Mission Directorate 2007 – 2016* (a.k.a. *NASA Science Plan 2007*) (http://nasascience.nasa.gov/about-us/science-strategy);
- the SMD E/PO program overview for proposers (http://nasascience.nasa.gov/researchers/education-public-outreach);
- the SMD E/PO program overview for educators (http://nasascience.nasa.gov/educators);
- the 2006 NASA Education Portfolio Data Call Report (http://www.strategies.org/Portfolio/FinalReport.html);

- the 2008 Outreach Supplement projects (http://nspires.nasaprs.com/external/viewrepositorydocument/cmdocumentid=196345/OUTREACH08 part1 Selections.pdf) and (http://nspires.nasaprs.com/external/viewrepositorydocument/cmdocumentid=206926/OUTRCH208 Selections.pdf); and
- *SMD Education and Public Outreach Report* (http://smd-epo.hq.nasa.gov/ar.htm).

Efforts that may be proposed to other SMD E/PO opportunities will not be considered under this program element. Examples of opportunities that are not solicited include: competitive research support for faculty and early career scientists sponsored under ROSES, graduate research support sponsored under the NASA Earth and Space Science Fellowship Program, and education and outreach activities embedded in flight missions.

3. Programmatic Information

3.1 General Information

In order to propose an Outreach activity as a supplement to a research proposal submitted in response to this NRA, the proposer must follow these instructions:

- Proposals must be submitted through NSPIRES no later than the proposal due date to be included in the current evaluation cycle. The opportunity to propose is not linked to the award date for the parent research award or to the anniversary date of the parent research award. The NSPIRES proposal opportunity will be open approximately 90 days before each proposal due date.

- Research awards associated with previously selected supplement proposals may not be used as the basis for future Outreach or Education supplement proposals.

- The PI of the science award must also be the PI of the supplement proposal. A Co-I of the supplement proposal may be designated as the E/PO lead.

- A science award may be used as for the basis of submission for both an Education and an Outreach proposal for the same due date. NASA will make the determination of which one of the two proposals it would fund, if both were selectable. Only one of the proposals would be funded.

- The evaluation of proposals will be managed by NASA Ames Research Center with oversight from the Science Mission Directorate at NASA Headquarters. The Selection Official is the SMD E/PO Lead.

- The page limit for Outreach proposals is 4 pages, excluding the required budget form and budget narrative. The on-line NSPIRES budget table will not be used to communicate to NASA the requested budget for this opportunity. A budget table following the format provided in the *SMD Outreach Supplements Guide 1.1*, Appendix K(available at http://nasascience.nasa.gov/researchers/education-public-outreach/explanatory-guide-to-smd-e-po-evaluation-factors) **[Updated March 12, 2010]** must be included within the body of the proposal document. Neither this required budget table nor the required accompanying budget justification language will count towards the 4 page limit of the proposal narrative. Shorter proposals are encouraged as long as the proposed activity is described with sufficient detail to allow an assessment of its merit.

- The proposal must be clearly identified as an Outreach pathway proposal.

- The annual cost cap for a proposal by an individual investigator is $10K per year for an Outreach pathway proposal.

- The number of years of funding that may be requested is dependent upon the number of months left on the research award (x months) at the due date of the Outreach pathway proposal:

  - If there is greater than or equal to 51 months, then the award is eligible for five years of funding. [x≥51];
  - If there is less than 51 but greater than or equal to 39 months, then the award is eligible for four years of funding. [51>x≥39];
  - If there is less than 39 but greater than or equal to 27 months, then the award is eligible for three years of funding. [39>x≥27];
  - If there is less than 27 but greater than or equal to 15 months, then the award is eligible for two years of funding. [27>x≥15]; or
  - If there is less than 15 but greater than or equal to 12 months, then the award is eligible for one year of funding. [15>x≥12].

- A “Collaborative Outreach Proposal” option is available that allows several SMD-funded ROSES researchers to collectively carry out more ambitious, expansive outreach efforts. Each collaborator must be involved in the effort and have an eligible ROSES research award. The supplemental funds are added to a single parent research award of the consortium of proposing investigators. The group submits the proposal under the parent research award of their choice and all collaborating research awards must be identified by title and PI (and Grant Number, if available). The PI of the parent research award is responsible for the overall performance of the effort and is responsible for distribution of any funding to collaborating researchers.

  A Collaborative proposal may request up to $50K annually, depending on the number of ROSES research awards being combined. Each must have at least 12 months remaining on the science award. The maximum amount of eligible funding for Collaborative proposals is determined by multiplying the number of ROSES research awards by the individual eligible award annual cap ($10K) for Outreach project activities (as determined by the award time formula above). For example, if there were six ROSES research awards in year 1, three in year 2, two in year 3, and two in year 4, the maximum funding per year for an Outreach project activity would be:

Year 1	$50K (6*10K=60K; limit of $50K)
Year 2	$30K (3*10K=30K)

Year 3	\$20K (2*10K=20K)
Year 4	\$20K (2*10K=20K)

Note: Research awards associated with a selected Collaborative proposal may not be used as a basis for a future Outreach or Education supplemental request.

- To ease the burden of NASA's administration of such small supplements, the total period of performance for any Outreach supplement is limited to that of its parent research award (for collaborative supplements, this limit applies to the research award to which the supplemental Outreach funding is added). The supplemental Outreach supplement will begin at the time it is awarded and continue through the end of its proposed period, or through the end of the parent research award, whichever comes first.

- The total funding available for new supplemental Education and Outreach supplements is approximately \$500K per year. Pending adequate proposals of merit, NASA expects to select approximately equal numbers of Outreach pathway (Appendix E.5) and Education pathway (Appendix E.6) proposals, i.e., approximately 20 new supplements per pathway per year. Collaborative proposals may be selected in lieu of a number of individual proposals.

- Awardee institutions have the responsibility for budgeting and documenting compliance with Code of Federal Regulations 14 CFR§1230, commonly referred to as "the Common Rule for the Protection of Human Subjects." Research to develop NASA-themed exhibits, programs, curriculum products etc. may involve full human subjects review through an Institutional Review Board (IRB) or it may be exempt. An IRB also certifies when research is exempt. Research using surveys, observational or ethnographic methods, cognitive and educational tests, etc. is "exempt" unless two conditions apply: 1) the information would allow subjects to be identified, and 2) disclosure of the data would reasonably place the subject at risk of harm. It is anticipated that most Outreach activities will be exempt and that non-exempt research will not involve NASA facilities, personnel or equipment. The PI, however, should begin the process as soon as the proposal is submitted to determine whether any proposed research activities require IRB approval or is exempt. This is done by working with a Department of Health and Human Services Office of Human Research Protection (HHS OHRP) approved non-NASA IRB. Information on how to locate an approved IRB is at: http://ohrp.cit.nih.gov/search/

3.2 Technical Reporting Requirements

Reporting on the results of the Outreach project activity will be included as a component of the Annual Progress Report and Final Report of the parent research award. In cases where subaward arrangements exist, consolidated project activity reports are the responsibility of the PI.

In addition, the project activity must collect, analyze, and report output and outcome data to a common NASA database to determine project activity effectiveness and meet the requirements of stakeholders. Instructions on submitting this information will be provided with the selection notice. It is anticipated that this will be nominally a one person-day effort to format and submit the data.

3.3 Evaluation and Selection of Proposals

Proposers are reminded that the evaluation criteria for this solicitation are given in Section C.2 of the *NASA Guidebook for Proposers* (see below for reference). These criteria are intrinsic merit, relevance to NASA's strategic goals and objectives, and cost realism and reasonableness. In addition, the evaluation of Outreach proposals will include the Program Balance Factors. The specific evaluation factors are described in the *SMD Outreach Supplements Guide 1.1, Outreach Projects - Explanatory Guide to Proposal Evaluation Factors for ROSES Supplemental Awards* at http://nasascience.nasa.gov/researchers/education-public-outreach/explanatory-guide-to-smd-e-po-evaluation-factors **[Updated March 12, 2010]**.

Proposers are strongly encouraged to review this *Explanatory Guide*. In particular, the *Explanatory Guide* provides discussion of requirements for SMD outreach project activities. Proposals to extend previously funded SMD E/PO efforts are also required to provide evaluation results of the prior effort.

4. Summary of Key Information

Expected program budget for first year of new awards	~ $200K
Number of new awards pending adequate proposals of merit	~ 20 (Collaborative proposals may be selected in lieu of a number of individual proposals.)
Maximum duration of awards	Linked to parent research award
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	4 pages; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	See the discussion of the relevance evaluation factor in the SMD Outreach Supplements Explanatory Guide. **[Updated March 12, 2010]**
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.

Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	Option not available
NASA point of contact concerning this program	Dr. Larry P. Cooper Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1531 Email: larry.p.cooper@nasa.gov

E.6 <u>SUPPLEMENTAL EDUCATION AWARDS FOR ROSES INVESTIGATORS</u>

Clarified on March 12, 2010. References and links to the Explanatory Guide to Proposal Evaluation Factors for this program element have been updated to the latest version (1.1).

1. Background

NASA's founding legislation, the Space Act of 1958, directs the Agency to expand human knowledge of Earth and space phenomena and to preserve the role of the United States as a leader in aeronautics, space science, and technology. High achievement in science, technology, engineering, and mathematics (STEM) education and public scientific literacy is essential to the accomplishment of NASA's mission.

The NASA Science Mission Directorate's (SMD's) vision for Education and Public Outreach is:

> *To share the story, the science, and the adventure of NASA's scientific explorations of our home planet, the solar system, and the universe beyond, through stimulating and informative activities and experiences created by experts, delivered effectively and efficiently to learners of many backgrounds via proven conduits, thus providing a return on the public's investment in NASA's scientific research.*

Hereafter the phrase "education and public outreach (E/PO)" will refer to activities addressing the teaching and learning of science, technology, engineering, and mathematics at the undergraduate, secondary and elementary levels (including hands-on experiences for students), informal education, as well as public understanding and engagement in science and technology using unique resources derived from NASA Earth and space sciences.

SMD has a portfolio of investments (E/PO project activities) in Higher Education, Elementary and Secondary Education, Informal Education, and Outreach. It is a major contributor to the overall NASA education and outreach effort through development and dissemination of new educational and outreach products that utilize SMD science discoveries and by providing opportunities for students and educators, citizen scientists, and the public to engage in authentic experiences working with our data and our research communities.

NASA is pursuing three major education goals:
- Strengthen the future workforce of NASA and the Nation.
- Attract and retain students in STEM disciplines.
- Engage Americans in NASA's mission.

SMD Supplemental Education awards are provided to support the NASA education goals. By adding an Education component to their research investigation, SMD-funded researchers can design an education effort that capitalizes upon their own talents, interests, and scientific expertise.

NASA is particularly interested in encouraging individuals (as students, educators, parents, civil leaders, etc.) engaged in a NASA educational project activity to connect or move up to other

NASA education and/or outreach activities. Details of the Education Strategic Framework are discussed in the *NASA Education Strategic Coordination Framework: A Portfolio Approach* available at http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Strategic_Coordination_Framework.html.

There are two pathways available to research scientists who wish to propose for the supplemental Education and Public Outreach (E/PO) awards: the Outreach pathway and the Education pathway. This program element in Appendix E.6 is for Education supplements. ROSES Element E.5 is for Outreach supplements.

Principal Investigators of research proposals selected for funding through this and previous ROSES NRAs (hereafter called the "parent research award") are eligible for a supplemental Education award to the parent research award if the research award has at least 12 months remaining in its period of performance on the due date of the Education proposal. This program element is expected to appear in every ROSES solicitation.

2. Scope of Program

This solicitation element is for project activities that utilize SMD content and contribute to achieving SMD Education objectives. The scope of supplemental Education awards includes all aspects of elementary/secondary and informal education and limited aspects of higher education. A higher education project activity may address undergraduate programs to enhance the science literacy of nonscientists and future K-12 teachers; increase the participation of minorities and other underutilized groups (e.g., women) in science, technology, engineering, and mathematics; or offer expanded opportunities for engagement of undergraduates in group projects that model SMD mission experiences in the application of scientific, engineering, or technical expertise.

Efforts promoting participation of underrepresented groups in Earth and space science studies at all levels of education and strengthening such learning in minority serving institutions are encouraged. Of particular interest are efforts that provide K-12 and community college educators with research-intensive experiences on NASA Earth or Space Science projects.

A supplemental project activity may not include student research support at the undergraduate, graduate, and postdoctoral levels – such support is either already a part of the parent research award or is available through other competitive opportunities.

A project activity must be relevant to the NASA SMD Education portfolio. This relevance must be clearly demonstrated in the proposal. This program element is expected to appear in every ROSES solicitation.

<table>
<tr><th colspan="2">NASA SMD Education Portfolio</th></tr>
<tr><th>Portfolio Area</th><th>Project Activity Categories</th></tr>
<tr><td>Higher Education Portfolio</td><td>Competency-building education and research based on NASA SMD activities that develops qualified undergraduate and graduate students who are prepared for employment in STEM disciplines at NASA, industry, and higher education.
Opportunities for groups of postsecondary students to engage in authentic NASA SMD related, mission-based research and development (R&D) activities.
Developing NASA SMD related course resources for integration into STEM disciplines.
Improving the ability of targeted institutions to compete for NASA SMD research and development work.</td></tr>
<tr><td>Elementary and Secondary Education Portfolio</td><td>Providing professional development and training opportunities to educators, equipping them with the skills and knowledge to attract and retain students in STEM disciplines and deeper content understanding and/or competence and confidence in teaching STEM disciplines.
Providing curricular support resources that use NASA SMD content to a) enhance student skills and proficiency in STEM disciplines; b) inform students about STEM career opportunities; and/or c) communicate information about NASA's mission activities.
Providing K-12 students with authentic first-hand opportunities to participate in NASA SMD mission activities, thus inspiring interest in STEM disciplines and careers or provides opportunities for family involvement in K-12 student learning in STEM areas.</td></tr>
</table>

Informal Education Portfolio	• Informal education resources that use SMD content to 1) enhance participant skills and proficiency in STEM disciplines; 2) inform participants about STEM career opportunities; and 3) communicate information about NASA's mission activities. • Activities to improve the competency and qualifications of STEM informal educators, enabling informal educators to effectively and accurately communicate information about NASA SMD activities and access NASA SMD data for programs and exhibits. • Activities to develop and support qualified informal educators with experience in NASA SMD mission and related activities; or engaging informal educators using NASA SMD content to 1) enhance participant skills and proficiency in STEM disciplines; 2) inform participants about STEM career opportunities; and 3) communicate information about NASA's SMD mission activities.

NASA has adopted requirements that differentiate Informal Education from Public Outreach.

> The intent of Informal Education is to increase learning; to educate students, educators, and the general public on specific science, technology, engineering, or mathematics (STEM) content areas; and to expand the nation's future STEM workforce.

In addition, to qualify as Informal Education, the effort has to meet at least two of the following criteria:

1. <u>Supplemental Materials/Handouts</u>: Standards based education materials are used to supplement and enrich the experience, visual, or activity.

2. <u>Staffing</u>: Staff/facilitators, trained or qualified in STEM/education fields, actively work with participants to further enhance their understanding and increase the educational value of the experience, visual, or activity.

3. <u>Content</u>: Educational standards and/or learning objectives play a key role in developing content and/or design. The effort explores topics in depth.

If a project activity does not meet this test, the proposer should consider submitting it under Appendix E.5: Supplemental Outreach Awards for ROSES Investigators.

It should be noted that this program element is only one of several ways that SMD invests in Education and Public Outreach. Proposers are encouraged to take advantage of SMD E/PO investments in products, dissemination mechanisms, and opportunities to work with ongoing mission and non-mission E/PO project activities. Proposed project activities should not duplicate existing efforts but should complement existing E/PO project activities embedded in missions or other ongoing projects.

Efforts that may be proposed to other SMD E/PO opportunities will not be considered under this program element. Examples of opportunities that are not solicited include: competitive research support for faculty and early career scientists sponsored under ROSES, graduate research support sponsored under the NASA Earth and Space Science Fellowship (NESSF) Program, and education and outreach activities embedded in flight missions.

Sources of information about SMD education and public outreach activities and products include:

- *Science Plan for NASA's Science Mission Directorate 2007 – 2016* (a.k.a. *NASA Science Plan 2007*) (http://nasascience.nasa.gov/about-us/science-strategy);
- the SMD E/PO program overview for proposers (http://nasascience.nasa.gov/researchers/education-public-outreach);
- the SMD E/PO program overview for educators (http://nasascience.nasa.gov/educators);
- the 2006 NASA Education Portfolio Data Call Report (http://www.strategies.org/Portfolio/FinalReport.html);
- the 2008 Education Supplement projects (http://nspires.nasaprs.com/external/viewrepositorydocument/cmdocumentid=196343/EDUC08%20part1%20Selections.pdf) and (http://nspires.nasaprs.com/external/viewrepositorydocument/cmdocumentid=206925/EDUC208%20Selections.pdf); and
- *SMD Education and Public Outreach Report* (http://smd-epo.hq.nasa.gov/ar.htm).

3. Programmatic Information

3.1 General Information

In order to propose an Education activity as a supplement to a research proposal submitted in response to this NRA, the proposer must follow these instructions:

- Proposals must be submitted through NSPIRES no later than the proposal due date to be included in the current evaluation cycle. The opportunity to propose is not linked to the award date for the parent research award or to the anniversary date of the parent research award. The NSPIRES proposal opportunity will be open approximately 90 days before each proposal due date.

- Research awards associated with previously selected supplement proposals may not be used as the basis for future Outreach or Education supplement proposals.

- The PI of the science award must also be the PI of the supplement proposal. A Co-I of the supplement proposal may be designated as the E/PO lead.

- A science award may be used as for the basis of submission for both an Education and an Outreach proposal for the same due date. NASA will make the determination of which one of the two proposals it would fund, if both were selectable. Only one of the proposals would be funded.

- The evaluation of proposals will be managed by NASA Ames Research Center with oversight from the Science Mission Directorate at NASA Headquarters. The Selection Official is the SMD E/PO Lead.

- The page limit for Education proposals is 4 pages, excluding the required budget form and budget narrative. The on-line NSPIRES budget table will not be used to communicate to NASA the requested budget for this opportunity. A budget table following the format provided in the *SMD Education Supplements Guide 1.1*, Appendix K (available at http://nasascience.nasa.gov/researchers/education-public-outreach/explanatory-guide-to-smd-e-po-evaluation-factors/) **[Updated March 12, 2010]** must be included within the body of your proposal document. Neither this required budget table nor the required accompanying budget justification language will count towards the 4 page limit of the proposal narrative. Shorter proposals are encouraged, as long as the proposed activity is described with sufficient detail to allow an assessment of its merit.

- The proposal must be clearly identified as an Education pathway proposal.

- The annual cost cap for a proposal by an individual investigator is $15K per year for an Education pathway proposal.

- The number of years of funding that may be requested is dependent upon the number of months left on the research award (x months) at the due date of the Education pathway proposal:

  - If there is greater than or equal to 51 months, then the award is eligible for five years of funding. [x≥51];
  - If there is less than 51 but greater than or equal to 39 months, then the award is eligible for four years of funding. [51>x≥39];
  - If there is less than 39 but greater than or equal to 27 months, then the award is eligible for three years of funding. [39>x≥27];
  - If there is less than 27 but greater than or equal to 15 months, then the award is eligible for two years of funding. [27>x≥15]; or
  - If there is less than 15 but greater than or equal to 12 months, then the award is eligible for one year of funding. [15>x≥12].

- A "Collaborative Education Proposal" option is available that allows several SMD-funded ROSES researchers to collectively carry out more ambitious, expansive outreach efforts. Each collaborator must be involved in the effort and have an eligible ROSES research award. The supplemental funds are added to a single research award of the consortium of proposing investigators. The group submits the proposal under the research award of their choice and all collaborating research awards must be identified by title and PI (and Grant Number, if available). The PI of the parent research award is responsible for the overall performance of the effort and is responsible for distribution of any funding to collaborating researchers.

A Collaborative proposal may request up to $50K annually, depending on the number of ROSES research awards being combined. Each must have at least 12 ~~15~~ months remaining on the science award. The maximum amount of eligible funding for Collaborative proposals is determined by multiplying the number of ROSES research awards by the individual eligible award annual cap ($15K) for an Education project activity (as determined by the award time formula above). For example, if there were six ROSES research awards in year 1, three in year 2, two in year 3, and two in year 4, the maximum funding per year for an Education project activity would be

Year 1	$50K (6*15K=90K; limit of $50K)
Year 2	$45K (3*15K=45K)
Year 3	$30K (2*15K=30K)
Year 4	$30K (2*15K=30K)

Note: Research awards associated with a selected Collaborative proposal may not be used as a basis for a future Outreach or Education supplemental proposal.

- To ease the burden of NASA's administration of such small supplements, the total period of performance for any Education supplement is limited to that of its parent research award (for collaborative supplements, this limit applies to the research award to which the supplemental Education funding is added). The supplemental Education supplement will begin at the time it is awarded and continue through the end of its proposed period, or through the end of the parent research award, whichever comes first.

- The total funding available for new supplemental Education and Outreach supplements is approximately $500K per year. Pending adequate proposals of merit, NASA expects to select approximately equal numbers of Outreach pathway (Appendix E.5) and Education pathway (Appendix E.6) proposals, i.e., approximately 20 new supplements per pathway per year. Collaborative proposals may be selected in lieu of a number of individual proposals.

Awardee institutions have the responsibility for budgeting and documenting compliance with Code of Federal Regulations 14 CFR§1230, commonly referred to as "the Common Rule for the Protection of Human Subjects." Research to develop NASA-themed exhibits, programs, curriculum products etc. may involve full human subjects review through an Institutional Review Board (IRB) or it may be exempt. An IRB also certifies when research is exempt. Research using surveys, observational or ethnographic methods, cognitive and educational tests, etc. is "exempt" unless two conditions apply: 1) the information would allow subjects to be identified, and 2) disclosure of the data would reasonably place the subject at risk of harm. It is anticipated that most education activities will be exempt and that non-exempt research will not involve NASA facilities, personnel or equipment. The PI, however, should begin the process as soon as the proposal is submitted to determine whether any proposed research activities require IRB approval or is exempt. This is done by working with a Department of Health and Human Services Office of Human Research Protection (HHS OHRP) approved non-NASA IRB. Information on how to locate an approved IRB is at: http://ohrp.cit.nih.gov/search/

3.2 Technical Reporting Requirements

Reporting on the results of the Education project activity will be included as a component of the Annual Progress Report and Final Report of the parent research effort. In cases where subaward arrangements exist, consolidated project activity reports are the responsibility of the PI.

In addition, the project activity must collect, analyze, and report output and outcome data to a common NASA database to determine project activity effectiveness and meet the requirements of stakeholders. Instructions on submitting this information will be provided with the selection notice. It is anticipated that this will be nominally a one person-day effort to format and submit the data.

3.3 Evaluation and Selection of Proposals

Proposers are reminded that the evaluation criteria for this solicitation are given in Section C.2 of the *NASA Guidebook for Proposers* (see below for reference). These criteria are intrinsic merit, relevance to NASA's strategic goals and objectives, and cost realism and reasonableness. In addition, the evaluation of Education proposals will include the Program Balance Factors. The specific evaluation factors are described in the *SMD Education Supplements Guide 1.1*, *Education Projects - Explanatory Guide to Proposal Evaluation Factors for ROSES Supplemental Awards* at http://nasascience.nasa.gov/researchers/education-public-outreach/explanatory-guide-to-smd-e-po-evaluation-factors **[Updated March 12, 2010]**.

Proposers are strongly encouraged to review this *Explanatory Guide*. In particular, the *Explanatory Guide* provides discussion of requirements for SMD education project activities. Proposals to extend previously funded SMD E/PO efforts are also required to provide evaluation results of the prior effort.

4. Summary of Key Information

Expected program budget for first year of new awards	~ $300K
Number of new awards pending adequate proposals of merit	~ 20 (Collaborative proposals may be selected in lieu of a number of individual proposals.)
Maximum duration of awards	Linked to parent research award
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	4 pages; see also Chapter 2 of the *NASA Guidebook for Proposers*

Relevance to NASA	See the discussion of the relevance evaluation factor in the SMD Education Supplements Explanatory Guide. **[Updated March 12, 2010]**
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	Option not available
NASA point of contact concerning this program	Dr. Larry P. Cooper Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1531 Email: larry.p.cooper@nasa.gov

AMENDMENT NO. 1 TO THE NASA RESEARCH ANNOUNCEMENT (NRA) ENTITLED "RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES) 2010," NNH10ZDA001N, RELEASED FEBRUARY 12, 2010

New proposal opportunity in Appendix A.38: Science Definition Team for the Climate Absolute Radiance and Refractivity Observatory (CLARREO) Mission.

The CLARREO mission addresses the need to rigorously observe climate change on decade time scales and to use decadal change observations as a critical method to determine the accuracy of climate change projections, such as those in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (http://www.ipcc.ch/).

The objective of Appendix A.38 is to solicit a Science Definition Team (SDT) to engage in the science definition and planning for the CLARREO mission. The primary role of the SDT will be to provide expert guidance to the CLARREO project in the areas of science objectives; science requirements; measurement requirements; algorithm development; data products; mission success criteria; potential descope options; and calibration, validation, and liaison with the broader science and applications communities.

No Notices of Intent to propose are requested. Proposals are due July 1, 2010. Table 2 and Table 3 of the Summary of Solicitation for this NRA have been updated to reflect this change.

Questions concerning the CLARREO Science Team may be addressed to Kenneth Jucks, Earth Science Division, Science Mission Directorate, NASA Headquarters, Washington, DC 20546-0001; Telephone: (202) 358-0476; E-mail: kenneth.w.jucks@nasa.gov.

AMENDMENT NO. 2 TO THE NASA RESEARCH ANNOUNCEMENT (NRA) ENTITLED "RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES) 2010," NNH10ZDA001N, RELEASED FEBRUARY 12, 2010

Due Date delayed for C.20 Astrobiology Science and Technology for Exploring Planets (ASTEP) Program.

Astrobiology Science and Technology for Exploring Planets (ASTEP) program solicits proposals for investigations focused on exploring the Earth's extreme environments in order to develop a sound technical and scientific basis to conduct astrobiological research on other solar system bodies.

This amendment delays the proposal due date for Appendix C.20, Astrobiology Science and Technology for Exploring Planets (ASTEP) Program. Programmatic schedule conflicts at NASA Headquarters have postponed the ASTEP peer review and hence the date when SMD must have proposals. A corresponding deferral of the ASTEP due date will provide the community additional time to prepare proposals. The proposal due date for ASTEP has been changed to Friday, July 16, 2010. Table 2 and Table 3 of the Summary of Solicitation for this NRA have been updated to reflect this change.

Questions concerning ASTEP may be addressed to Mary Voytek, Planetary Science Division, Science Mission Directorate, NASA Headquarters, Washington, DC 20546-0001; Telephone: (202) 358-1577; Email: mary.voytek-1@nasa.gov

Amendment No. 3 to the NASA Research Announcement (NRA) entitled "Research Opportunities in Space and Earth Sciences (ROSES) 2010," NNH10ZDA001N, Released February 12, 2010

New proposal opportunity in Appendix C.25 the Venus Climate Orbiter Participating Scientist Program (VCO PSP).

This amendment establishes a new program element in Appendix C.25 entitled "Venus Climate Orbiter Participating Scientist Program (VCO PSP)." The objectives of the VCO PSP are to enhance, aid in data archival, and supplement Venus science to be performed by the Venus Climate Orbiter (VCO, or AKATSUKI). The VCO PSP investigations aim to understand the atmospheric circulation using global atmospheric mapping by utilizing VCO's five cameras (from UV to IR wavelengths), and by measuring the vertical structure of the atmosphere with radio occultation techniques. VCO's systematic and continuous observations should provide a complete dataset of the Venusian atmospheric dynamics that complements the Venus Express observations and prior Venus missions. Up to two Participating Scientists in residence will be selected to reside in Japan (ISAS) and work with the VCO Science Team to reduce and archive data.

Notices of Intent are due June 11, 2010 and proposals are due August 6, 2010 and Tables 2 and 3 of the Summary of Solicitation for this NRA have been updated to reflect the creation of this program.

Questions concerning this program may be addressed to Adriana Ocampo, Planetary Science Division, Science Mission Directorate, NASA Headquarters, Washington, DC 20546-0001; Telephone: (202) 358-2152; Email: aco@nasa.gov.

AMENDMENT NO. 4 TO THE NASA RESEARCH ANNOUNCEMENT (NRA) ENTITLED "RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES) 2010," NNH10ZDA001N, RELEASED FEBRUARY 12, 2010

Final text for Appendix A.24: Enhancing the Capability of Computational Earth System Models and NASA Data for Operation and Assessment.

This solicitation offers investigators an opportunity to analyze, assess, and increase the impact of NASA data in research and operational environments, particularly in the areas of weather prediction, climate projection assessment, and global carbon cycle modeling in anticipation of carbon management regulations. This solicitation seeks three areas of proposals: (a) Acceleration of Operational Use of Research Data including Joint Center for Satellite Data Assimilation (JCSDA), (b) data for IPCC climate projection assessment, and (c) computational support of Earth system modeling.

Amendment 4 releases the final version of the text of Appendix A.24, which replaces the draft text in its entirety. Notices of Intent to are due July 15, 2010 and Proposals are due September 17, 2010.

Questions concerning this program may be addressed to Tsengdar Lee, Earth Science Division, Science Mission Directorate, NASA Headquarters, Washington, DC 20546-0001; Telephone: (202) 358-0860; E-mail: tsengdar.j.lee@nasa.gov.

AMENDMENT NO. 5 TO THE NASA RESEARCH ANNOUNCEMENT (NRA) ENTITLED "RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES) 2010," NNH10ZDA001N, RELEASED FEBRUARY 12, 2010

Major revision of Appendix A.4: Land-Cover and Land-Use Change (LCLUC).

This solicitation is focused on two major themes: 1) Synthesis of prior Land Use and Land Cover Change studies and 2) Vulnerability, Impacts, and Adaptation (VIA), as related to climate interactions with land-use changes around the world, for example addressing the vulnerability of current land use systems and related social systems and their adaptability to climate variability and change and other major global stressors.

Amendment 5 makes two changes: 1) The vulnerability, impacts and adaptation (VIA) theme is now focused on wetlands. VIA proposals should focus on changes in wetlands areas in response to changes in climate, economic development, policies and their interactions. 2) Both themes emphasize the social science component of this program element. For a proposal to be competitive, it must include a social science component, such as the use of socio-economic data associated with a land-use or socio-economic model as an integral part of the study, preferably based on available data or data being collected by an ongoing study funded by another agency. Note that the remote sensing component is a necessary attribute for each proposal.

Due dates are unchanged: Step-1 proposals are due December 1, 2010 and Step-2 proposals are due June 1, 2011.

Questions concerning this program may be addressed to Garik Gutman, Earth Science Division, Science Mission Directorate, NASA Headquarters, Washington, DC 20546-0001; Telephone: (202) 358-0276; E-mail: ggutman@nasa.gov.