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Te[illegible] Report S[illegible] on the B[illegible]osystem-A[illegible]sphere Study (BOREAS)

[illegible]ll and Sara K. Conrad, Editors

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[illegible]AS TGB-12 Isotropic Carbon Dioxide [illegible]

[illegible]e, E. Sundquist, and G. Winston

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Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Sara K. Conrad, Editors

Volume 247

BOREAS TGB-12 Isotropic Carbon Dioxide Data over the NSA

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BOREAS TGB-12 Isotopic Carbon Dioxide Data over the NSA

Sue Trumbore, Eric Sundquist, Greg Winston

Summary

The BOREAS TGB-12 team made measurements of soil carbon inventories, carbon concentration in soil gases, and rates of soil respiration at several sites to estimate the rates of carbon accumulation and turnover in each of the major vegetation types. This data set contains information on the carbon isotopic content of carbon dioxide sampled from soils in the NSA-OBS, NSA-YJP, and NSA-OJP sites. Data were collected from 14-Nov-1993 to 10-Oct-1996. The data are stored in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS TGB-12 Isotopic Carbon Dioxide Data over the NSA

1.2 Data Set Introduction

The data collected by the BOReal Ecosystem-Atmosphere Study (BOREAS) Trace Gas Biogeochemistry (TGB)-12 team include CO_2 flux rates and concentrations in the soil atmosphere at selected sites, as well as ^{14}C measurements of CO_2. Our measurements were designed to cover the winter period.

1.3 Objective/Purpose

The objectives were: To estimate rates of carbon input, turnover, and accumulation in the soils of each of the major vegetation types at the BOREAS study sites. The primary tool was the measure of ^{14}C content in soils, litter, and soil atmospheres, and the measurement of CO_2 emissions from the soil. To relate our estimates of dynamics of soil carbon to ecosystem models of the carbon cycle, to other measures of C cycling dynamics, to regional models of soil carbon accumulation, and to spatial and temporal models of soil moisture and drainage.

1.4 Summary of Parameters

^{14}C data are presented in Delta notation (the per mil difference in the ratio of $^{14}C/^{12}C$ in the sample from that of an absolute standard - 1895 wood). We also express what fraction of the bulk soil was used for radiocarbon measurement - plant macrofossils, chemically extracted clay, etc.).

1.5 Discussion

Winter fluxes of CO_2 are often assumed to be zero in northern environments. Our goal in this series of measurements was to quantify the importance of winter CO_2 emissions to the annual carbon balance at the Northern Study Area (NSA) Young Jack Pine (YJP), Old Jack Pine (OJP), and Old Black Spruce (OBS) tower sites. In addition, radiocarbon measurements of ^{14}C in CO_2 were used to determine whether winter and summer respiration had different sources. Sites were the same ones used by TGB-01 and TGB-03 for studies of soil respiration during May to October.

The steady-state ^{14}C content of the atmosphere is determined by the exchange of carbon in CO_2 with that in ocean and biospheric reservoirs. Because of the relatively rapid cycling of carbon between the atmosphere and living biomass, most short-lived plant tissues maintain a ^{14}C specific activity that equals that of atmospheric CO_2. CO_2 derived from old organic matter that has resided in soils for several hundred years will have lower radiocarbon content than that derived from more recently fixed carbon.

1.6 Related Data Sets

BOREAS TGB-12 Radon222 Activity Data over the NSA
BOREAS TGB-12 Radon222 Flux Data over the NSA
BOREAS TGB-12 Soil Carbon Data over the NSA
BOREAS TGB-12 Soil Carbon and Flux Data of NSA-MSA in Raster Format
BOREAS TGB-01 Soil CH4 and CO2 Profile Data over the NSA
BOREAS TGB-01 NSA SF6 Chamber Flux Data over the NSA

2. Investigator(s)

2.1 Investigator(s) Name and Title

Susan Trumbore
Earth System Science
University of California Irvine

2.2 Title of Investigation

Input, Accumulation and Turnover of Carbon in Boreal Forest Soils

2.3 Contact Information

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3. Theory of Measurements

Soil fluxes were measured using chamber methods, which involve enclosing the airspace over soil and monitoring the mixing ratio of gases within the chamber over time. For radiocarbon, we needed to trap the CO_2 out of the chamber headspace to collect enough carbon for the ^{14}C measurement. Specifics are given in Winston et al. (1997) and Section 4, below.

Measurements of soil gas concentrations may be combined with estimates of the rate of diffusion in soils to determine the contribution to surface CO_2 emissions derived from various soil depths (see Davidson and Trumbore, 1995, for an example). To do this in BOREAS, we measured CO_2, temperature, and moisture profiles, as well as ^{222}Rn for estimating soil diffusivity. Special pits were instrumented with thermistors (for monitoring soil temperature), Time Domain Reflectometry (TDR) probes (for monitoring soil water content), and soil gas probes (1/8" stainless steel tubing, perforated at one end and inserted 50 to 100 cm laterally into the soil pit wall, capped with 1/8" swagelock union fittings sealed with a septum). Further details are given in Winston et al. (1997) and in Section 4, below.

Calculation of a radiocarbon age requires the assumption that the ^{14}C content of the carbon originally fixed in plant tissues equaled that of the atmospheric CO_2 in 1950 (0.95 times the activity of oxalic acid, or Modern). In fact, the ^{14}C content of the atmosphere has varied with time because of changes in the production rate of ^{14}C (cosmic ray flux and magnetic field variations) and because of changes in the distribution of carbon among ocean, biosphere, and atmospheric reservoirs. These variations, deduced from the ^{14}C content of cellulose of known age taken from the annual growth rings of trees, are generally less than 10% over the past 7,000 years. More recent changes in the ^{14}C content of atmospheric CO_2 have resulted from dilution by ^{14}C-free fossil-fuel-derived carbon and by the production of ^{14}C during atmospheric testing of thermonuclear weapons (bomb ^{14}C). The latter effect dominates other natural and fossil fuel effects, as the atmospheric burden of ^{14}C was approximately doubled in the few years preceding the implementation of the Nuclear Test Ban Treaty in 1964. This isotopic spike in the global carbon system provides a means for radiocarbon to be a useful tracer of carbon cycle processes on the scale of decades.

We express ^{14}C data in the geochemical Delta notation, the deviation in parts per thousand (per mil) from an absolute standard (95 times the activity of NBS oxalic acid measured in 1950). In this notation, zero equals the ^{14}C content of 1895 wood, positive values indicate the presence of 'bomb' radiocarbon, and negative values indicate the predominance of C fixed from the atmosphere more than several hundred years ago.

For seeds, deciduous leaves, etc., that represent a single year's growth, the ^{14}C content of recent samples may be used to determine the age of a sample to within a year or two (for samples in the 'bomb' period, <30 years old). The ^{14}C content of the sample is compared to the ^{14}C record of atmospheric C in the Northern Hemisphere (see Burcholadze reference, below, as an example). Evergreen needles, that may average several years' growth, will have higher ^{14}C signatures than deciduous leaves that grew since 1964.

For samples prior to 1960, radiocarbon ages in years may be calculated from the given Delta values as -8033*(ln(Delta*.995/1000 +1)). The conventional radiocarbon age must be converted to a calibrated age using the tree-ring-based calibration curves, which correct for known variations in atmospheric ^{14}C over time Both ages are usually rounded to the nearest decade or pentade.

One application of radiocarbon to soil science lies in the relatively straightforward ^{14}C dating of charcoal and plant macrofossils to determine the accumulation rate of C in vertically aggrading soils (like peats, or moss layers). Unlike the closed systems represented by intact macrofossils, such as seeds or pollen, bulk soil organic matter is a heterogeneous reservoir with a variety of turnover times, to which carbon is continuously added (as new plant matter) and lost (as leached organic carbon or CO_2). The radiocarbon content of soil organic matter cannot be interpreted as a 'date,' but represents the average age of a carbon atom in this reservoir.

The breakdown of C into faster- and slower-cycling pools may be determined by combining several approaches; see the articles in Section 17 for more information (this is an evolving research field and no one approach is accepted as valid for all soils).

4. Equipment

4.1 Sensor/Instrument Description

Because all of the equipment used in this project is common to many other projects and no special procedures were used, description detail has been minimized in this section, and the reader is referred to the appropriate publications.

- Davidson and Trumbore, 1995
- Stephens and Sundquist, 1998
- Trumbore and Harden, 1997
- Winston et al., 1997
- Harden et al., 1997

Flux chambers were used to measure CO_2 fluxes and to collect CO_2 for radiocarbon measurements. See Stephens and Sundquist (1998) and Winston et al (1997) for details. Stainless steel (1/8 inch) probes were used to collect soil atmosphere samples from different depths. Samples for CO_2 concentration measurement were removed by syringe; larger volume samples for ^{14}C determination were collected by attaching pre-evacuated, electropolished, stainless steel cans of 500cc volume.

Lab Equipment - Carlo Erba NA1500 carbon and nitrogen combustion analyzer; vacuum lines for purification of CO_2 from combusted samples and graphite target preparation. The accelerator mass spectrometer (AMS) used for ^{14}C measurement is described in Southon et al. (1992) and Trumbore (1998).

$^{14}CO_2$ efflux from soil: Samples for ^{14}C measurement of total soil respiration are collected from the headspace of a dynamic chamber using molecular sieve 13X traps. First, atmospheric CO_2 trapped during chamber emplacement is removed by circulating headspace air at flow rates of ~500 cm^3/min through a soda lime column. Scrubbing continues until the equivalent of two chamber volumes has been passed over the soda lime. The molecular sieve trap then replaces the soda lime scrubber and CO_2 is trapped from circulating chamber air until enough has been collected for isotopic (^{13}C and ^{14}C) measurements. Trapping times vary from about 10 minutes to an hour, depending on the soil CO_2 emission rate. CO_2 is released from the trap at 500 °C, and purified cryogenically. One aliquot of the sample is measured for ^{13}C content by stable isotope mass spectrometry. A second aliquot is reduced to graphite for ^{14}C measurement by AMS. Comparison of ^{13}C data for ambient air (sampled at the same site) with the ^{13}C content of soil organic matter is used to correct the ^{14}C data for small amounts of ambient air remaining in the sample.

4.1.1 Collection Environment

Samples were collected mostly in over two winters, though summer measurements were also made for isotopes.

4.1.2 Source/Platform

Ground.

4.1.3 Source/Platform Mission Objectives

None given.

4.1.4 Key Variables

The key variables are the CO_2 concentration, CO_2 flux and del ^{14}C of CO_2.

4.1.5 Principles of Operation

None given.

4.1.6 Sensor/Instrument Measurement Geometry

None given.

4.1.7 Manufacturer of Sensor/Instrument

A LI-COR CO_2 analyzer was used to measure CO_2 fluxes in the field. The gas chromatography system described by TGB-01 (Crill) was used to determine CO_2 concentrations in soil air.

4.2 Calibration

4.2.1 Specifications

See Winston et al., 1997.

4.2.1.1 Tolerance

See Winston et al., 1997.

4.2.2 Frequency of Calibration

See Winston et al., 1997.

4.2.3 Other Calibration Information

See Winston et al., 1997.

5. Data Acquisition Methods

^{14}C. Carbon-14 is measured by accelerator mass spectrometry of graphite targets prepared from CO_2 (see one of several references, including Trumbore, 1995). Samples (of 1-2 mg carbon equivalent) are combusted in vacuum in quartz tubes with cupric oxide wire at 900 °C. The resulting CO_2 is purified cryogenically, then reduced to graphite coating cobalt powder in a sealed Pyrex tube at 500-550 °C with zinc and titanium hydride powder. AMS measurements were made at the Lawrence Livermore National Laboratory Center for Accelerator Mass Spectrometry. One sigma precision is usually +/- 8-10 per mil (0.8-1.0 % Modern) and overall accuracy (based on repeated measurements of substandards prepared in the same way as samples) is 1.0-1.5% of Modern (10-15 per mil).

6. Observations

6.1 Data Notes

None given.

6.2 Field Notes

None given.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The North American Datum of 1983 (NAD83) coordinates for the sites are:

```
Site       Latitude   Longitude
-------    ---------  ---------
NSA-OBS    55.88007N  98.48139W
NSA-YJP    55.89575N  98.28706W
NSA-OJP    55.92842N  98.62396W
```

7.1.2 Spatial Coverage Map

Not applicable

7.1.3 Spatial Resolution

These data are point measurements at the given locations.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

The data were collected over the period of 14-Nov-1993 to 10-Oct-1996. Data collection was not continuous; most CO_2 fluxes were measured in winter.

7.2.2 Temporal Coverage Map

None.

7.2.3 Temporal Resolution

None given.

7.3 Data Characteristics

7.3.1 Parameter/Variable

The parameters contained in the data files on the CD-ROM are:

```
         Column Name
------------------------------
SITE_NAME
SUB_SITE
DATE_OBS
CO2_FLUX
DEL_14C
SITE_COMMENTS
CRTFCN_CODE
REVISION_DATE
```

7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

```
         Column Name                            Description
------------------------------ -------------------------------------------------
SITE_NAME                      The identifier assigned to the site by BOREAS, in
                               the format SSS-TTT-CCCCC, where SSS identifies the
                               portion of the study area: NSA, SSA, REG, TRN, and
                               TTT identifies the cover type for the site, 999 if
                               unknown, and CCCCC is the identifier for site,
                               exactly what it means will vary with site type.
SUB_SITE                       The identifier assigned to the sub-site by BOREAS,
                               in the format GGGGG-IIIII, where GGGGG is the
                               group associated with the sub-site instrument,
                               e.g. HYD06 or STAFF, and IIIII is the identifier
                               for sub-site, often this will refer to an
                               instrument.
DATE_OBS                       The date on which the data were collected.
CO2_FLUX                       Carbon Dioxide flux.
DEL_14C                        The del 14C is a relative difference between the
                               sample and the 95% oxalic acid 1 standard,
                               relative to the 95% oxalic acid 1 standard.
SITE_COMMENTS                  Descriptive information to clarify or enhance the
                               site information.
CRTFCN_CODE                    The BOREAS certification level of the data.
                               Examples are CPI (Checked by PI), CGR (Certified
```

	by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
CO2_FLUX	[micromoles][meter^-2][second^-1]
DEL_14C	[per mil]
SITE_COMMENTS	[none]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

7.3.4 Data Source

The sources of the parameter values contained in the data files on the CD-ROM are:

Column Name	Data Source
SITE_NAME	Not applicable
SUB_SITE	Not applicable
DATE_OBS	Investigator
CO2_FLUX	LI-COR
DEL_14C	Accelerator mass spectrometry
SITE_COMMENTS	Investigator
CRTFCN_CODE	Not applicable
REVISION_DATE	Not applicable

7.3.5 Data Range

The following table gives information about the parameter values found in the data files on the CD-ROM.

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	NSA-9BS-T12GR	NSA-YJP-FLXTR	None	None	None	None
SUB_SITE	TGB12-FLX01	TGB12-FLXCB	None	None	None	None
DATE_OBS	14-NOV-93	10-OCT-96	None	None	None	None
CO2_FLUX	0	1.41666667	None	None	None	Blank
DEL_14C	-71.16	188.81	-999	None	None	Blank
SITE_COMMENTS	N/A	N/A	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	26-AUG-96	03-SEP-97	None	None	None	None

Minimum Data Value -- The minimum value found in the column.
Maximum Data Value -- The maximum value found in the column.
Missng Data Value -- The value that indicates missing data. This is used to indicate that an attempt was made to determine the parameter value, but the attempt was unsuccessful.

```
Unrel Data Value   -- The value that indicates unreliable data.  This is used
                      to indicate an attempt was made to determine the
                      parameter value, but the value was deemed to be
                      unreliable by the analysis personnel.
Below Detect Limit -- The value that indicates parameter values below the
                      instruments detection limits.  This is used to
                      indicate that an attempt was made to determine the
                      parameter value, but the analysis personnel determined
                      that the parameter value was below the detection
                      limit of the instrumentation.
Data Not Cllctd    -- This value indicates that no attempt was made to
                      determine the parameter value.  This usually
                      indicates that BORIS combined several similar but
                      not identical data sets into the same data base table
                      but this particular science team did not
                      measure that parameter.

Blank -- Indicates that blank spaces are used to denote that type of value.
N/A   -- Indicates that the value is not applicable to the respective column.
None  -- Indicates that no values of that sort were found in the column.
--------------------------------------------------------------------------------
```

7.4 Sample Data Record

The following are wrapped versions of data record from a sample data file on the CD-ROM.

```
SITE_NAME,SUB_SITE,DATE_OBS,CO2_FLUX,DEL_14C,SITE_COMMENTS,CRTFCN_CODE,
REVISION_DATE
'NSA-YJP-FLXTR','TGB12-FLX01',14-NOV-93,.07407407,,'open snow','CPI',26-AUG-96
'NSA-YJP-FLXTR','TGB12-FLX01',14-NOV-93,.09953704,,'open snow','CPI',26-AUG-96
'NSA-YJP-FLXTR','TGB12-FLX01',14-NOV-93,.10648148,,'over twig - rabbit track',
'CPI',26-AUG-96
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by the BOREAS Information System (BORIS) was the CO_2 flux measured for a given site on a given day.

8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain American Standard Code for Information Interchange (ASCII) numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

9. Data Manipulations

9.1 Formulae
None given.

9.1.1 Derivation Techniques and Algorithms
None.

9.2 Data Processing Sequence
None given.

9.2.1 Processing Steps
None given.

9.2.2 Processing Changes
None given.

9.3 Calculations
None given.

9.3.1 Special Corrections/Adjustments
None given.

9.3.2 Calculated Variables
None.

9.4 Graphs and Plots
None.

10. Errors

10.1 Sources of Error
We have assumed -25 per mil ^{13}C in correcting ^{14}C data for fractionation (error of 2 per mil in this term leads to a 4 per mil error in Del ^{14}C -- as long as vegetation is predominantly C3 photosynthetic pathway, this is not a large contributing error in ^{14}C analyses).

10.2 Quality Assessment

10.2.1 Data Validation by Source
None given.

10.2.2 Confidence Level/Accuracy Judgment
None given.

10.2.3 Measurement Error for Parameters
None given.

10.2.4 Additional Quality Assessments
None given.

10.2.5 Data Verification by Data Center
Data were examined for general consistency and clarity.

11. Notes

11.1 Limitations of the Data
None given.

11.2 Known Problems with the Data
None given.

11.3 Usage Guidance
None given.

11.4 Other Relevant Information
None.

12. Application of the Data Set

One application of radiocarbon to soil science lies in the relatively straightforward ^{14}C dating of charcoal and plant macrofossils to determine the accumulation rate of C in vertically aggrading soils (like peats, or moss layers). Unlike the closed systems represented by intact macrofossils, such as seeds or pollen, bulk soil organic matter is a heterogeneous reservoir with a variety of turnover times, to which carbon is continuously added (as new plant matter) and lost (as leached organic carbon or CO_2). The radiocarbon content of soil organic matter cannot be interpreted as a 'date,' but represents the average age of a carbon atom in this reservoir. As such, dating various layers in the soil can give modelers information about the carbon accumulation and release rates over time and potentially relate this to climate changes and effects.

13. Future Modifications and Plans

The data will be published as a USGS open file report in the future.

14. Software

14.1 Software Description
None given.

14.2 Software Access
None given.

15. Data Access

The TGB-12 isotopic carbon dioxide data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

15.1 Contact Information

For BOREAS data and documentation please contact:

ORNL DAAC User Services
Oak Ridge National Laboratory
P.O. Box 2008 MS-6407
Oak Ridge, TN 37831-6407
Phone: (423) 241-3952
Fax: (423) 574-4665
E-mail: ornldaac@ornl.gov or ornl@eos.nasa.gov

15.2 Data Center Identification

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics http://www-eosdis.ornl.gov.

15.3 Procedures for Obtaining Data

Users may obtain data directly through the ORNL DAAC online search and order system [http://www-eosdis.ornl.gov/] and the anonymous FTP site [ftp://www-eosdis.ornl.gov/data/] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

15.4 Data Center Status/Plans

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

16. Output Products and Availability

16.1 Tape Products

None.

16.2 Film Products

None.

16.3 Other Products

These data are available on the BOREAS CD-ROM series.

17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation

None given.

17.2 Journal Articles and Study Reports

Davidson, E.A. and S.E. Trumbore. 1995. Gas diffusivity and production of CO_2 in deep soils of the eastern Amazon. Tellus. 47B: 550-565.

Donahue, D.J., T.W. Linick, and A.J.T. Jull. 1990. Isotope-ratio and background corrections for accelerator mass spectrometry radiocarbon measurements. Radiocarbon 32: 135-142.

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Harden, J.W., K.P. O'Neill, S.E. Trumbore, H. Veldhuis, and B.J. Stocks. 1997. Moss and soil contributions to the annual net carbon flux of a maturing boreal forest. Journal of Geophysical Research 102(D24):28,805-28,816.

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. 2000. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM.

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17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None given.

19. List of Acronyms

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AMS     - Accelerator Mass Spectrometer
ASCII   - American Standard Code for Information Interchange
BOREAS  - BOReal Ecosystem-Atmosphere Study
BORIS   - BOREAS Information System
CD-ROM  - Compact Disk-Read-Only Memory
DAAC    - Distributed Active Archive Center
EOS     - Earth Observing System
EOSDIS  - EOS Data and Information System
GIS     - Geographic Information System
GSFC    - Goddard Space Flight Center
HTML    - Hyper-Text Markup Language
MSA     - Modeling Sub-Area
NAD83   - North American Datum of 1983
NASA    - National Aeronautics and Space Administration
NSA     - Northern Study Area
OA      - Old Aspen
OBS     - Old  Black Spruce
OJP     - Old Jack Pine
ORNL    - Oak Ridge National Laboratory
PANP    - Prince Albert National Park
SSA     - Southern Study Area
TDR     - Time Domain Reflectometry
TE      - Terrestrial Ecology
TGB     - Trace Gas Biogeochemistry
URL     - Uniform Resource Locator
USGS    - United States Geological Survey
YJP     - Young Jack Pine
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The BOREAS TGB-12 team made measurements of soil carbon inventories, carbon concentration in soil gases, and rates of soil respiration at several sites to estimate the rates of carbon accumulation and turnover in each of the major vegetation types. This data set contains information on the carbon isotopic content of carbon dioxide sampled from soils in the NSA-OBS, NSA-YJP, and NSA-OJP sites. Data were collected from 14-Nov-1993 to 10-Oct-1996. The data are stored in tabular ASCII files.

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