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nd the SSA-OJP

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

Forrest G. Hall and Sara K. Conrad, Editors

Volume 239

BOREAS TGB-8 Starch Concentration Data over the SSA-OBS and the SSA-OJP

Manuel Lerdau
State University of New York, Stony Brook

November 2000

Available from:

BOREAS TGB-8 Starch Concentration Data over the SSA-OBS and the SSA-OJP

Manuel Lerdau

Summary

The BOREAS TGB-8 team collected data to investigate the controls over NMHC fluxes from boreal forest tree species. This data set includes measurements of starch concentrations in foliar samples at mature jack pine and black spruce sites. The data were collected at the OJP and OBS tower flux locations in the BOREAS SSA. These areas contained mature stands of jack pine and black spruce and were the focal sites in the BOREAS program for studies of biosphere/atmosphere exchange from these two habitat types. The OBS site is situated in a black spruce/sphagnum bog with the largest trees 155 years old and 10-15 m tall. The OJP site is in a jack pine forest, 80 to 120 years old, which lies on a sandy bench of glacial outwash with the largest tree standing 15 m tall. Temporally, the data cover the period of 24-May-1994 to 19-Sep-1994. The data are stored in tabular ASCII files.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification
BOREAS TGB-08 Starch Concentration Data over the SSA-OBS and the SSA-OJP

1.2 Data Set Introduction
The mechanistic controls over nonmethane hydrocarbon (NMHC) fluxes from boreal forest trees were investigated. These studies could be used to modify existing ecosystem models to include NMHC emissions and their response to seasonality and resource variability (primarily water and nitrogen).

1.3 Objective/Purpose
The objective was to measure the starch concentrations in needles from the BOReal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA)-Old Black Spruce (OBS) and SSA-Old Jack Pine (OJP).

1.4 Summary of Parameters
Starch concentrations.

1.5 Discussion
The research was ordered around three general questions: (1) To what extent are leaf carbon balance and isoprene synthase activity (the enzyme responsible for isoprene emission) predictors of NMHC flux? (2) How do leaf carbon balance and isoprene synthase activity depend on nitrogen/water availability and carbon source/sink parameters? and (3) How do we modify the FORES-BGC ecosystem model, based on question 1 and 2, to predict canopy-level NMHC fluxes? Studies included seasonal monitoring of NMHC emissions and its relationship to plant phenology, photosynthesis, respiration, isoprene synthase activity, and leaf starch concentrations.

1.6 Related Data Sets
BOREAS TGB-08 Photosynthetic Rate Data over the SSA-OBS and the SSA-OJP
BOREAS TGB-08 Monoterpene Concentration Data over the SSA-OBS and the SSA-OJP

2. Investigator(s)

2.1 Investigator(s) Name and Title
Manuel Lerdau

2.2 Title of Investigation
The Relationship Between Non-Methane Hydrocarbon Emission and Leaf Carbon Balance in the Boreal Forest: An Approach for Mechanistic Ecosystem Modeling

2.3 Contact Information

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Greenbelt, MD 20771
(301) 286-7858
(301) 286-0239 (fax)
Jeffrey.Newcomer@gsfc.nasa.gov

3. Theory of Measurements

None given.

4. Equipment

4.1 Sensor/Instrument Description
None given.

4.1.1 Collection Environment
Samples were collected under all environmental conditions.

4.1.2 Source/Platform
Trees.

4.1.3 Source/Platform Mission Objectives
To measure average starch concentrations in SSA-OBS and SSA-OJP.

4.1.4 Key Variables
Starch concentration.

4.1.5 Principles of Operation
None given.

4.1.6 Sensor/Instrument Measurement Geometry
None given.

4.1.7 Manufacturer of Sensor/Instrument
Campbell Scientific

AADCO Instruments
Silver Springs, FL

Supelco
Bellafonte, PA

Tekmar
Cincinnati, OH

SKC, Inc.
Eighty Four, PA

Finnigan
San Jose, CA

J&W Scientific
Folsom, CA

Hewlett Packard

LACHAT Inst.
Mequon, WI

4.2 Calibration

4.2.1 Specifications
None given.

4.2.1.1 Tolerance
None given.

4.2.2 Frequency of Calibration
None given.

4.2.3 Other Calibration Information
None given.

5. Data Acquisition Methods

Starch Assay Required Solutions

1. Amyloglucosidase (Boehringer Mannheim) (Desiccator in freezer) 2.5 mg/mL Na-Acetate buffer. Make fresh each day and keep on ice.
2. Na-Acetate buffer (50 mM $NaC_2H_3O_2$; 0.68 g/100 mL dH_2O. Titrate of pH 4.8 with glacial acetic acid (starts at ~pH 7.1) and vacuum filter. Keeps for 1 month.
3. PGO (peroxidase glucose oxidase, Sigma # 510-6)) capsules (Desiccator in fridge). Add on PGO capsule to 20 mL COLD dH_2O and gently mix. Keeps for 1 month.
4. Glucose standards (1000 µM, 18.02 mg/100 mL ddH_2O). Everything for these must be sterile. Vacuum filter and dilute into standards of 100, 200, 400, 600, and 800 µM. Vacuum filter and keep in freezer. Keeps for 1 week.
5. N buffer (0.1 M NaH_2PO_4; 2.76 g NaH_2PO_4/200 mL dH_2O). Titrate to pH 6.5 with NaOH (HCl to reverse) (pH starts at ~4.7). Use ~5 M NaOH, otherwise one adds too much volume.
6. DMAB (3-dimethylaminobenzoic acid, $C_9H_{11}NO_2$, FW=165.2 Sigma D-0787) stock solution. 496 mg/100 mL N buffer. Stir and gently heat to bring into solution for about 30 minutes. Vacuum filter. Keeps for about 1 month.
7. MBTH (3-methyl, 2-benzo thiazolinone hydrazone$C8H9N3S*HCl$, FW= 215.7, Sigma M-8006, stored in freezer desiccator) stock solution. Stir to bring into solution. 14 mg/100 mL N buffer. Vacuum filter. If this becomes tan/lt. brown discard. Keeps for 3 weeks to 1 month.

Procedure

1. Dry plant material for 1 hour at 100 °C, then store at 60 °C until analysis.
2. Grind tissue in mortar until it becomes a fine powder.
3. Place ~15 mg ground tissue in a 1.7 mL-screwtop epitube and record weight.
   *** Store at 60 °C if stopping here ***
4. Solubilize free sugars. Cool epitubes in freezer, then add 1 mL of cold dH_2O.
5. Vortex tubes until all tissue is evenly suspended.
6. Place epitubes at 5 °C for 20 minutes.
7. Centrifuge epitubes for 15 minutes at max speed in benchtop centrifuge.
8. Pipette off and discard supernatent while keeping pellet.
9. Add 1 mL dH_2O to epitubes, screw caps on tightly and vortex.
10. Solubilize the starch. Autoclave for 45 mins at 121 °C and 1.2 bars. Screw caps on (very tightly; otherwise, fluid boils out.
11. Vortex tubes until all tissue is evenly suspended.
12. Centrifuge epitubes for 15 minutes at max speed in benchtop centrifuge.
    *** Freeze if stopping here ***

13 Convert starch to glucose that can be analyzed. All pipette tips, epitubes, and epitube caps must be sterile. Renumber a second set of epitubes (snap top is acceptable) and add the following:
    a) 200 μL 50 μM Na-Acetate buffer.
    b) 100 μL of Amyloglucosidase solution.
    c) 100 μL of sample supernatent.
    Also make a blank epitube by adding 100 μL dH$_2$O rather than sample.

14 Incubate in the 55 °C drying oven for 1 hr.

15 Stop the reaction. Heat epitubes in the 100 °C drying oven for 5 minutes.

16 16. Centrifuge epitubes for 15 minutes at max speed in benchtop centrifuge.
    *** Freeze if stopping here ***

```
Final glucose    (μM)μL of      μL MilliQ
Conc.            glucose stock  H2O
-------------    -------------  ---------
0                0              1000
100              100            900
200              200            800
400              400            600
600              600            400
800              800            200
1000             1000           0
```

17 Convert the glucose to a colored product that can be read spectrophotometrically. The best approach is to have the color reaction take place directly in the microtiter well, avoiding having to transfer samples into the wells. In this process, the total mixture of solutions above must be divided by 5 so the sample volume loaded into the well is 100 μL. If needed, the well volume can be brought up to 200 μL with 100 μL of Na-Acetate buffer to dilute samples to a readable level. Care must be taken to mix all the solutions in the well completely. Load two wells per sample.
    a) 35 μL MBTH
    b) 35 μL DMAB
    c) 15 μL diluted sample or standard
    d) 15 μL PGO enzyme

18 Incubate the epitubes or microtiter plate (cover with parafilm) for 25 minutes (can be longer, BUT be consistent) at 37 °C in a water bath. The sample solutions should turn purple.

19 Measure absorbance at 595 nm on a standard spectrophotometer.

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 measurement sites are:

```
SSA-OBS    53.99° N, 105.12° W
SSA-OJP    53.92° N, 104.69° W
```

7.1.2 Spatial Coverage Map
None given.

7.1.3 Spatial Resolution
These data are point source measurements taken near the given coordinates.

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 from 24-May-1994 to 19-Sep-1994.

7.2.2 Temporal Coverage Map
None given.

7.2.3 Temporal Resolution
Monthly averages of the data were submitted.

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
SPECIES
SAMPLE_MONTH
NEEDLE_AGE
SAMPLE_AMOUNT
MEAN_STARCH_CONTENT
STD_ERR_STARCH_CONTENT
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.
SPECIES	Botanical (Latin) name of the species (Genus species).
SAMPLE_MONTH	The month during which the data were measured.
NEEDLE_AGE	Age of the sampled needles, (0 = current year, 1 = 1 year old, 2 = 2 years old, etc.).
SAMPLE_AMOUNT	The number of trees sampled.
MEAN_STARCH_CONTENT	The mean starch content of the sample.
STD_ERR_STARCH_CONTENT	Standard error for the starch content of the sample.
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]
SPECIES	[none]
SAMPLE_MONTH	[none]
NEEDLE_AGE	[years]
SAMPLE_AMOUNT	[counts]
MEAN_STARCH_CONTENT	[percent]
STD_ERR_STARCH_CONTENT	[percent]
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                         [Assigned by BORIS Staff]
SUB_SITE                          [Assigned by BORIS Staff]
SPECIES                           Investigator
SAMPLE_MONTH                      Investigator
NEEDLE_AGE                        Investigator
SAMPLE_AMOUNT                     Investigator
MEAN_STARCH_CONTENT               None given
STD_ERR_STARCH_CONTENT            None given
CRTFCN_CODE                       [Assigned by BORIS Staff]
REVISION_DATE                     [Assigned by BORIS Staff]
```

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	SSA-OBS-FLXTR	SSA-OJP-FLXTR	None	None	None	None
SUB_SITE	TGB08-CON01	TGB08-CON01	None	None	None	None
SPECIES	N/A	N/A	None	None	None	None
SAMPLE_MONTH	N/A	N/A	None	None	None	None
NEEDLE_AGE	1	2	None	None	None	None
SAMPLE_AMOUNT	10	10	None	None	None	None
MEAN_STARCH_CONTENT	17	733	None	None	None	None
STD_ERR_STARCH_ CONTENT	38	396	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	26-MAR-97	26-MAR-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 records from a sample data file on the CD-ROM.

```
SITE_NAME,SUB_SITE,SPECIES,SAMPLE_MONTH,NEEDLE_AGE,SAMPLE_AMOUNT,
MEAN_STARCH_CONTENT,STD_ERR_STARCH_CONTENT,CRTFCN_CODE,REVISION_DATE
'SSA-OBS-FLXTR','TGB08-CON01','Picea mariana','April',2,10,166.0,252.0,'CPI',
26-MAR-97
'SSA-OBS-FLXTR','TGB08-CON01','Picea mariana','Aug/Sept',1,10,355.0,225.0,'CPI',
26-MAR-97
'SSA-OBS-FLXTR','TGB08-CON01','Picea mariana','Aug/Sept',2,10,477.0,286.0,'CPI',
26-MAR-97
```

8. Data Organization

8.1 Data Granularity
The smallest unit of data tracked by the BOREAS Information System (BORIS) was the starch concentration data for a given site on a given month.

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

9.1.1 Derivation Techniques and Algorithms
None given.

9.2 Data Processing Sequence

9.2.1 Processing Steps
None given.

9.2.2 Processing Changes
None given.

9.3 Calculations

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
None given.

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
The 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.

11.4 Other Relevant Information
None.

12. Application of the Data Set

None given.

13. Future Modifications and Plans

None given.

14. Software

14.1 Software Description
None given.

14.2 Software Access
None given.

15. Data Access

The starch concentration 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

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.

Sellers, P. and F. Hall. 1994. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1994-3.0, NASA BOREAS Report (EXPLAN 94).

Sellers, P. and F. Hall. 1996. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1996-2.0, NASA BOREAS Report (EXPLAN 96).

Sellers, P., F. Hall, and K.F. Huemmrich. 1996. Boreal Ecosystem-Atmosphere Study: 1994 Operations. NASA BOREAS Report (OPS DOC 94).

Sellers, P., F. Hall, and K.F. Huemmrich. 1997. Boreal Ecosystem-Atmosphere Study: 1996 Operations. NASA BOREAS Report (OPS DOC 96).

Sellers, P., F. Hall, H. Margolis, B. Kelly, D. Baldocchi, G. den Hartog, J. Cihlar, M.G. Ryan, B. Goodison, P. Crill, K.J. Ranson, D. Lettenmaier, and D.E. Wickland. 1995. The boreal ecosystem-atmosphere study (BOREAS): an overview and early results from the 1994 field year. Bulletin of the American Meteorological Society. 76(9):1549-1577.

Sellers, P.J., F.G. Hall, R.D. Kelly, A. Black, D. Baldocchi, J. Berry, M. Ryan, K.J. Ranson, P.M. Crill, D.P. Lettenmaier, H. Margolis, J. Cihlar, J. Newcomer, D. Fitzjarrald, P.G. Jarvis, S.T. Gower, D. Halliwell, D. Williams, B. Goodison, D.E. Wickland, and F.E. Guertin. 1997. BOREAS in 1997: Experiment Overview, Scientific Results and Future Directions. Journal of Geophysical Research 102(D24): 28,731-28,770.

17.3 Archive/DBMS Usage Documentation
None.

18. Glossary of Terms

None given.

19. List of Acronyms

```
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
EI       - Electron Ionization
EOS      - Earth Observing System
EOSDIS   - EOS Data and Information System
FID      - Flame Ionization Detector
GC/MS    - Gas Chromatograph/Mass Spectrometer
GIS      - Geographic Information System
GSFC     - Goddard Space Flight Center
HTML     - Hyper-Text Markup Language
NAD83    - North American Datum of 1983
NASA     - National Aeronautics and Space Administration
NMHC     - Nonmethane Hydrocarbon
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
TF       - Tower Flux
TGB      - Trace Gas Biogeochemistry
TKN      - Total Kjeldahl Nitrogen
URL      - Uniform Resource Locator
```

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When using these data, please include the following acknowledgment as well as citations of relevant papers in Section 17.2:

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20.5 Document Curator

20.6 Document URL

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M. Lerdau: State University of New York, Stony Brook; S.K. Conrad: Raytheon ITSS

12a. DISTRIBUTION / AVAILABILITY STATEMENT

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12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The BOREAS TGB-8 team collected data to investigate the controls over NMHC fluxes from boreal forest tree species. This data set includes measurements of starch concentrations in foliar samples at mature jack pine and black spruce sites. The data were collected at the OJP and OBS tower flux locations in the BOREAS SSA. These areas contained mature stands of jack pine and black spruce and were the focal sites in the BOREAS program for studies of biosphere/atmosphere exchange from these two habitat types. The OBS site is situated in a black spruce/sphagnum bog with the largest trees 155 years old and 10-15 m tall. The OJP site is in a jack pine forest, 80 to 120 years old, which lies on a sandy bench of glacial outwash with the largest tree standing 15 m tall. Temporally, the data cover the period of 24-May-1994 to 19-Sep-1994. The data are stored in tabular ASCII files.

14. SUBJECT TERMS

BOREAS, trace gas biogeochemistry.

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