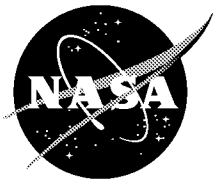
NASA/TM—2000–209891, Vol. 238



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

Forrest G. Hall and Sara K. Conrad, Editors

Volume 238

BOREAS TGB-8 Photosynthetic Rate Data over the SSA-OBS and the SSA-OJP

Manuel Lerdau
State University of New York, Stony Brook

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

November 2000

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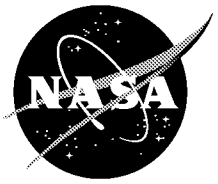

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BOREAS TGB-8 Photosynthetic Rate Data over the SSA-OBS and the SSA-OJP

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 photosynthetic rates 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 Photosynthetic Rate 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 photosynthesis at 30 °C and 1000 mmol/m^2/s 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

Average daily photosynthesis and standard deviation of photosynthesis.

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 Monoterpene Concentration Data over the SSA-OBS and the SSA-OJP
BOREAS TGB-08 Starch 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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(301) 286-0239 (fax)
Jeffrey.Newcomer@gsfc.nasa.gov

3. Theory of Measurements

Sample Selection

For the photosynthesis/hydrocarbon measurements, 10 trees of each species were chosen that had sunlit leaves accessible within 3 m of the ground. All measurements were conducted on sunlit leaves that had developed the previous year. Tissue chemistry and gas exchange sampling on sunlit leaves from branches much higher in the canopy showed that there was no significant effect of branch height on photosynthetic rate or on tissue composition (ANOVA, $p>0.05$, data not shown). The black spruce trees used in the bog transect/tissue chemistry sampling were chosen on the basis of having sunlit leaves accessible within 2 m of the ground.

Sample Procedure

Hydrocarbon emissions: Samples were collected by enclosing branches in a temperature- and light-controlled cuvette connected to a plant gas exchange system (Campbell MPH 1000, Campbell Scientific, Logan, UT) and flowing hydrocarbon-free air over the needles. Temperature was controlled by use of thermoelectric coolers provided by Campbell Scientific, and light intensity was controlled by mounting a projector bulb at a right angle to the top of the glass-topped cuvette. The light was then reflected off of a cold mirror (45° cold mirror, 15-33233, OCLI, Santa Rosa, CA) mounted at a 45° angle to the cuvette. The mirror transmitted light at wavelengths >720 nm and reflected light of shorter wavelengths. Hydrocarbon-free air was produced by pumping ambient air through a clean-air generator (Aadco 5L, AADCO Instruments, Silver Springs, FL) and adding CO_2 back to the entering air stream. All flows and environmental conditions were monitored by the sensors and mass flow controllers of the Campbell MPH 1000.

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

The purpose of the trees and branches for this experiment was to support the measurement equipment.

4.1.4 Key Variables

Photosynthetic rate.

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
None given.

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

Samples were collected by enclosing branches in a temperature- and light-controlled cuvette connected to a plant gas exchange system (Campbell MPH 1000, Campbell Scientific, Logan, UT) and flowing hydrocarbon-free air over the needles. Temperature was controlled by use of thermoelectric coolers provided by Campbell Scientific, and light intensity was controlled by mounting a projector bulb at a right angle to the top of the glass-topped cuvette. The light was then reflected off of a cold mirror (45° cold mirror, 15-33233, OCLI, Santa Rosa, CA) mounted at a 45° angle to the cuvette. The mirror transmitted light at wavelengths >720 nm and reflected light of shorter wavelengths. Hydrocarbon-free air was produced by pumping ambient air through a clean-air generator (Aadco 5L, AADCO Instruments, Silver Springs, FL) and adding CO_2 back to the entering air stream. All flows and environmental conditions were monitored by the sensors and mass flow controllers of the Campbell MPH 1000.

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
SAMPLE_MONTH
SPECIES
SAMPLE_AMOUNT
MEAN_PHOTOSYNTHETIC_RATE
STD_ERR_PHOTOSYNTHETIC_RATE
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.
SAMPLE_MONTH	The month during which the data were measured.
SPECIES	Botanical (Latin) name of the species (Genus species).
SAMPLE_AMOUNT	The number of trees sampled.
MEAN_PHOTOSYNTHETIC_RATE	Average measured photosynthesis at 30C.
STD_ERR_PHOTOSYNTHETIC_RATE	Standard error for the concentration measurements.
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]
SAMPLE_MONTH	[none]
SPECIES	[none]
SAMPLE_AMOUNT	[counts]
MEAN_PHOTOSYNTHETIC_RATE	[micromoles][meter^-2][second^-1]
STD_ERR_PHOTOSYNTHETIC_RATE	[micromoles][meter^-2][second^-1]
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]
SAMPLE_MONTH	Investigator
SPECIES	Investigator
SAMPLE_AMOUNT	Investigator
MEAN_PHOTOSYNTHETIC_RATE	Campbell MPH 1000
STD_ERR_PHOTOSYNTHETIC_RATE	Investigator
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
SAMPLE_MONTH	N/A	N/A	None	None	None	None
SPECIES	N/A	N/A	None	None	None	None
SAMPLE_AMOUNT	10	10	None	None	None	None
MEAN_PHOTOSYNTHETIC_RATE	2.5	10.5	None	None	None	None
STD_ERR_PHOTOSYNTHETIC_RATE	2	6	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	25-MAR-97	25-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,SAMPLE_MONTH,SPECIES,SAMPLE_AMOUNT,MEAN_PHOTOSYNTHETIC_RATE,
STD_ERR_PHOTOSYNTHETIC_RATE,CRTFCN_CODE,REVISION_DATE
'SSA-OBS-FLXTR','TGB08-CON01','April','Picea mariana',10,4.7,3.0,'CPI',25-MAR-97
'SSA-OBS-FLXTR','TGB08-CON01','August/September','Picea mariana',10,10.5,5.0,
'CPI',25-MAR-97
'SSA-OBS-FLXTR','TGB08-CON01','July','Picea mariana',10,9.8,5.0,'CPI',25-MAR-97
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by the BOREAS Information System (BORIS) was the average photosynthetic rate for a given site in 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
None given.

9.1.1 Derivation Techniques and Algorithms
None given.

9.2 Data Processing Sequence
None given.

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

These data could be useful in refining plant growth and respiration models by comparing the model results with actual measurements.

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 photosynthetic rate 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 given.

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

20. Document Information

20.1 Document Revision Date

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

Manuel Lerdau: Department of Ecology and Evolution, State University of New York, Stony Brook, NY 11794-5245 Marcy Litvak and Russell Monson: Department of Environmental, population and Organismic Biology, University of Colorado, Boulder, CO 80309

If using data from the BOREAS CD-ROM series, also reference the data as:

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20.5 Document Curator

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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 photosynthetic rates 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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