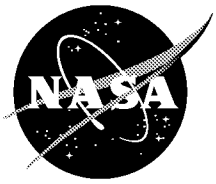
NASA/TM—2000–209891, Vol. 205



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

Forrest G. Hall and Karl Huemmrich, Editors

Volume 205

BOREAS TF-9 SSA-OBS Branch Level Flux Data

Mark. B. Rayment and Paul G. Jarvis
University of Edinburgh, UK

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

November 2000

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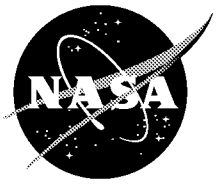

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BOREAS TF-9 SSA-OBS Branch Level Flux Data

Mark B. Rayment, Paul G. Jarvis

Summary

The BOREAS TF-9 team collected data that describe carbon dioxide and water vapor fluxes from foliage at the BOREAS SSA-OBS site from 07-April through 23-November-1996. The data are available in tabular ASCII files.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS TF-09 SSA-OBS Branch Level Flux Data

1.2 Data Set Introduction

A system of large cuvettes was used to measure whole branch CO_2 and H_2O vapor exchange of four black spruce (Picea mariana [Mill] BSP) branches at the BOReal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA) Old Black Spruce (OBS) site.

1.3 Objective/Purpose

The objective of this study was to measure and model the CO_2 exchanges of boreal black spruce forest branches over the course of an entire growing season. These measurements will be used to parameterize models and to assist scaling up procedures from leaf level to stand level (eddy covariance) measurements.

1.4 Summary of Parameters and Variables

Measurements include CO_2 and H_2O fluxes, photosynthetic photon flux density (PPFD), air and leaf temperatures, relative humidity, air humidity deficit, and CO_2 concentration.

1.5 Discussion

The branch bags consisted of two 5-mm-thick acrylic end pieces, oval in shape (600-mm major axis, 300-mm minor axis, 0.14-m^2 area), separated by five thin (5-mm diameter) stainless steel rods. One end was made such that it could slide up or down the rods in order to adjust the bag length to suit the individual branch. An ovaloid shape was chosen to minimize dead volume within the bag, to minimize the bag's surface area to volume ratio (minimizing any adsorption/desorption effects), to minimize attenuation of incoming light, and for aesthetic reasons. The bag itself was effected by covering the structure with polypropylene film (ICI Propafilm, 34-mm thickness, ICI PLC, London) and sealing along the edge of the end piece with silicone sealant. The bottom of the bag was left unsealed to allow placement of the bag upon the branch; afterward, it and the branch entry point were sealed in a similar fashion. A 12-volt electric fan (RS 583-050, RS Components Ltd., Northants) was mounted at the trunk end of each bag, and blew air at a high flow rate (40 dm^3/s, approximately 18 to 26 air changes min-1) through the bag via large shrouded inlet and outlet ports. When a gas exchange measurement was to be made, the ventilation fan was switched off, thin flap valves dropped over the inlet and outlet and were shut tight with small electromagnets, and an internal circulating fan was switched on. Air was circulated (5 dm^3/min) at all times between all bags and the box containing the infrared gas analyzer (IRGA) and control system through loops of tubing (5-mm i.d. Dekabon, Furon, Gembioux, Belgium), and at measurement time a small amount of air (0.2 dm^3/min) was diverted from the appropriate loop to the IRGA (LI-6262, LI-COR, Inc., Lincoln, NE) operating in absolute mode. Within each bag, relative humidity and air temperature were measured (Vaisala HMB 30A, Vaisala (UK) Ltd., Cambridge), as was leaf temperature (thin Cu-Con thermocouple referenced to the air temperature sensor) and, for a period, bag internal vs. external temperature (Cu-Con thermocouple). Light incident upon each branch was measured with a Macam light sensor (Macam SD101QV, Macam, Livingstone) mounted directly onto the branch, midway along its length. Sensor outputs were recorded through a Campbell AM416 multiplexer to a Campbell CR21X data logger (Campbell Scientific, Ltd., Shepshed, Leics.), which also initiated the measurement sequence.

Each bag was closed for 5 minutes in turn, during which time the sensors were read every 20 seconds; thus, each bag was measured every 20 minutes. Gas exchange was calculated from the slope of the regression of gas concentration upon time (excluding the readings from the initial 40 s for CO_2 and the initial 80 s for H_2O vapor in order to ensure that the IRGA was entirely flushed of the previous sample) and the volume of the system (106.3, 134.3, 91.9, and 106.3 dm^3 for bags 1 to 4, respectively). The air sample bleed to the IRGA during the measurement period was negligible (~1 dm^3) compared to the bag volume and was ignored in calculations. All bags were leak tested by shading the branch to its light compensation point, blowing into the bag to create a high internal/external concentration differential, closing the inlet and outlet ports, and monitoring bag concentration over a period of time.

1.6 Related Data Sets

BOREAS TF-09 SSA-OBS Tower Flux, Meteorological, and Soil Temperature Data
BOREAS TE-10 Leaf Gas Exchange Data
BOREAS TE-11 Leaf Gas Exchange Measurements
BOREAS TE-12 Leaf Gas Exchange Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Mr. Mark B. Rayment and Prof. Paul G. Jarvis
Institute of Ecology and Resource Management
University of Edinburgh UK

2.2 Title of Investigation

The CO_2 Exchanges of Boreal Black Spruce Forest

2.3 Contact Information

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3. Theory of Measurements

The net carbon uptake of a tree depends on the assimilation of carbon dioxide by photosynthesis in the leaves and the carbon dioxide emissions resulting from respiratory processes in the leaves and woody tissues of the tree. Transpiration of water occurs mainly from the foliage. Enclosures surrounding branches remain open for the majority of the time and are periodically closed, at which time the rate of change of gas concentration allows calculation of an integrated measure of the net exchange of gases between the branch and the atmosphere.

4. Equipment

4.1 Sensor/Instrument Description

4.1.1 Collection Environment

Measurements were collected from early April through late November; temperatures ranged from below freezing to over 30 °C during that period.

4.1.2 Source/Platform

The branch bags surrounded individual spruce branches. The bags were supported in position by elastic ropes attached to the trunk above the bag and, where necessary, to a support projecting from the canopy access tower. This arrangement allowed the bags to move freely as the trees and branches moved with the wind. Each of the bags was positioned on a south-facing branch to minimize shading by the tower. The bags could be reached from the canopy access tower, made of 5- by 9-foot scaffolding.

Instruments:

- Gas concentration: IRGA LI-6262 (LI-COR, Inc., Lincoln, NE) operating in absolute mode.
- Relative humidity and air temperature: Vaisala HMB 30A (Vaisala (UK) Ltd., Cambridge).
- Leaf temperature: thin Cu-Con thermocouple referenced to the air temperature sensor.
- Incident PPFD: Macam SD101QV light sensor mounted directly onto the branch, midway along its length.
- Logger: Campbell AM416 multiplexer and Campbell CR21X data logger.
- Tubing: 5-mm i.d. Dekabon.

4.1.3 Source/Platform Mission Objectives

The objective was to measure branch-scale CO_2 and water vapor fluxes and related environmental variables in black spruce at the southern edge of the boreal forest.

4.1.4 Key Variables

CO_2 and water vapor fluxes. Supporting meteorological variables: PPFD, air temperature, leaf temperature, CO_2, and water vapor concentration.

4.1.5 Principles of Operation

The LI-COR LI-6262 IRGA is a closed-path instrument with reference and sample cells with an infrared source at one end and a detector at the other. Different gases absorb infrared of different frequencies, and filters are used to select a narrow band that corresponds to an absorption band of the gas of interest. The LI-6262 measures CO_2 and H_2O concentrations. A gas of known concentration is passed through a reference cell, and the gas whose concentration is to be measured is passed through the sample cell. The amount of infrared reaching the detector in each cell is a function of the gas concentration in the cell. The difference in voltage produced by the detectors of the reference and sample cells is then a function of the difference in concentration of the gas in the cells. Other sensors were common meteorological sensors used in a standard fashion. For principles of operations of these sensors, please see a relevant textbook; e.g., Pearcy et al. (1991).

4.1.6 Sensor/Instrument Measurement Geometry

Two branch bags were installed on each of two trees at the SSA-OBS site in early April 1996. Two bags were positioned in the upper canopy (at 7.85 m above the ground for branch number 1 and 8.25 m for branch number 3) and two in the lower canopy (at 5.22 m for branch number 2 and 5.48 m for branch number 4); the trees' diameters at breast height (DBH) were 10 cm and 9 cm. The bags were supported in position by elastic ropes attached to the trunk above the bag and, where necessary, to a support projecting from the canopy access tower. This arrangement allowed the bags to move freely as the trees and branches moved with the wind. Each of the bags was positioned on a south-facing branch to minimize shading by the tower. Humidity, air and leaf temperatures, and PPFD were measured within the bag, close to or in contact with the leaves. Gas concentration was measured on a sample of air circulated between the bag and the IRGA. The IRGA was positioned in an insulated box mounted on the canopy access tower.

4.1.7 Manufacturer of Instrument

LI-COR LI-6262
P.O. Box 4425/4421
Superior Street
Lincoln, NE 68504
USA

Vaisala HMB 30A
Vaisala (UK) Ltd.
Cambridge
UK

Macam SD101QV light sensor
Macam
Livingstone
UK

Campbell AM416 multiplexer and Campbell CR21X data logger
Campbell Scientific
P.O. Box 551
Logan, UT 84321
USA

Dekabon tubing
J.P. Deane & Co. Ltd.
91, Ormonde Crescent
Glasgow G44 3SW
UK

4.2 Calibration

4.2.1 Specifications

The LI-6262: The output linearization of this instrument was calibrated by the manufacturer and was last performed in July 1993. The field calibration fixes the lower and upper ends of the linearization function and is carried out by passing CO_2 and water vapor free air through the reference cell (the instrument is used in the absolute mode) and setting the CO_2 and water vapor channels to zero. The upper point is set by passing dry air of known CO_2 or of known water vapor concentration through the sample cell and adjusting the appropriate channel to read the correct value. CO_2 standard gases were cross-referenced to the BOREAS primary standards, and a LI-COR LI-610 dewpoint generator was used to produce air of known water vapor density.

The Vaisala temperature and humidity probes either were bought new or were returned to the manufacturer for calibration immediately prior to installation.

The Macam PPFD sensors were purchased new immediately prior to installation, and the manufacturer's calibration factors were used.

All bags were leak tested by shading the branch to its light compensation point, blowing into the bag to create a high internal/external concentration differential, closing the inlet and outlet ports, and monitoring bag concentration over a period of time.

The LI-6262 was usually calibrated every 4 to 7 days. Typical CO_2 drift was 1-ppm drift in span and offset. Typical drift for the water vapor was 0.1 kPa in span and offset.

4.2.1.1 Tolerance

None.

4.2.2 Frequency of Calibrations

The LI-6262 was usually calibrated every 4 to 7 days.

4.2.3 Other Calibration Information

None.

5. Data Acquisition Methods

When a gas exchange measurement was to be made, the ventilation fan was switched off, thin flap valves dropped over the inlet and outlet and were shut tight with small electromagnets, and an internal circulating fan was switched on. Air was circulated (5 dm^3/min) at all times between all bags and the box containing the IRGA and control system through loops of tubing, and at measurement time a small amount of air (0.2 dm^3/min) was diverted from the appropriate loop to the IRGA operating in absolute mode. Within each bag, relative humidity and air temperature were measured, as was leaf temperature and, for a period, bag internal vs. external temperature. Light incident upon each branch was measured with a Macam light sensor mounted directly onto the branch, midway along its length.

Each bag was closed for 5 minutes in turn, during which time the sensors were read every 20 seconds; thus, each bag was measured every 20 minutes. Gas exchange was calculated from the slope of the regression of gas concentration upon time (excluding the readings from the initial 40 s for CO_2 and the initial 80 s for H_2O vapor in order to ensure that the IRGA was entirely flushed of the previous sample) and the volume of the system (106.3, 134.3, 91.9, and 106.3 dm^3 for bags 1 to 4, respectively). The air sample bleed to the IRGA during the measurement period was negligible (~1 dm^3) compared to the bag volume and was ignored in calculations.

A Campbell Scientific 21x data logger was used to log the data together with a Campbell AM416 multiplexer. The raw signal from each sensor was converted into the appropriate units in the data logger program. The data logger also initiated the measurement sequence.

6. Observations

6.1 Data Notes

Values given are on a PROJECTED leaf area basis; that is, values should be adjusted by a shape factor to express rates on a total surface or hemisurface area basis. For black spruce, hemisurface area was last reported to be 1.27 x projected area; i.e., these rates would be divided by 1.27 to given rates on a hemisurface area basis.

6.2 Field Notes

None given.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

All data were collected at the BOREAS SSA-OBS site. North American Datum of 1983 (NAD83) coordinates for this site are latitude 53.98717° N, longitude 105.11779° W, and elevation of 628.94 m.

Branches had total projected needle areas of 3115, 2014, 1657, and 2342 cm^2, for chambers one through 4, respectively.

7.1.2 Spatial Coverage Map

None.

7.1.3 Spatial Resolution

The values are point measurements from trees near the locations given in Section 7.1.1.

7.1.4 Projection

None.

7.1.5 Grid Description

None.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

The data were collected from 06-April to 22-November-1996. Data were collected continuously with gaps between 18- and 26-June and 03- and 07-July.

7.2.2 Temporal Coverage Map

All data were collected at the BOREAS SSA-OBS site.

7.2.3 Temporal Resolution

Each observation took 5 minutes to complete data collection cycled through each of the four bags so that observations of any given bag occur every 20 minutes.

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
TIME_OBS
CHAMBER_NUM
CO2_FLUX_CHAMBER
H2O_FLUX_CHAMBER
DOWN_PPFD_CHAMBER
AIR_TEMP_CHAMBER
LEAF_TEMP_CHAMBER
AIR_HUM_DEFICIT_CHAMBER
REL_HUM_CHAMBER
CO2_CONC_CHAMBER
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.
TIME_OBS	The Greenwich Mean Time (GMT) of the start of the data collection.
CHAMBER_NUM	Identification number of chamber.
CO2_FLUX_CHAMBER	The chamber CO2 flux.
H2O_FLUX_CHAMBER	The water vapor flux measured in the chamber.
DOWN_PPFD_CHAMBER	The incoming photosynthetic photon flux density measured in the chamber.
AIR_TEMP_CHAMBER	The temperature of the air in the chamber.
LEAF_TEMP_CHAMBER	The temperature of leaves in the chamber.
AIR_HUM_DEFICIT_CHAMBER	The air humidity deficit measured in the chamber
REL_HUM_CHAMBER	The relative humidity of the air in the chamber.
CO2_CONC_CHAMBER	The CO2 concentration in the chamber.
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]
TIME_OBS	[HHMM GMT]
CHAMBER_NUM	[unitless]
CO2_FLUX_CHAMBER	[micromoles][meter^-2][second^-1]
H2O_FLUX_CHAMBER	[millimoles][meters^-2][second^-1]
DOWN_PPFD_CHAMBER	[micromoles][meters^-2][second^-1]
AIR_TEMP_CHAMBER	[degrees Celsius]
LEAF_TEMP_CHAMBER	[degrees Celsius]
AIR_HUM_DEFICIT_CHAMBER	[parts per thousand]
REL_HUM_CHAMBER	[percent]
CO2_CONC_CHAMBER	[parts per million]
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.]
SUB_SITE	[Assigned by BORIS.]
DATE_OBS	[Supplied by Investigator.]
TIME_OBS	[Supplied by Investigator.]
CHAMBER_NUM	[Supplied by Investigator.]

```
CO2_FLUX_CHAMBER               [LI-COR LI-6262 IRGA]
H2O_FLUX_CHAMBER               [LI-COR LI-6262 IRGA]
DOWN_PPFD_CHAMBER              [Macam SD101QV light sensor]
AIR_TEMP_CHAMBER               [Vaisala temperature and humidity probes]
LEAF_TEMP_CHAMBER              [Cu-Con thermocouple]
AIR_HUM_DEFICIT_CHAMBER        [Vaisala temperature and humidity probes]
REL_HUM_CHAMBER                [Vaisala temperature and humidity probes]
CO2_CONC_CHAMBER               [LI-COR LI-6262 IRGA]
CRTFCN_CODE                    [Assigned by BORIS.]
REVISION_DATE                  [Assigned by BORIS.]
```

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-OBS-FLXTR	None	None	None	None
SUB_SITE	9TF09-FLX02	9TF09-FLX02	None	None	None	None
DATE_OBS	07-APR-96	23-NOV-96	None	None	None	None
TIME_OBS	0	2355	None	None	None	None
CHAMBER_NUM	1	4	None	None	None	None
CO2_FLUX_CHAMBER	-5.95	1.57	None	None	None	None
H2O_FLUX_CHAMBER	-.16	2	None	None	None	None
DOWN_PPFD_CHAMBER	0	1838	None	None	None	Blank
AIR_TEMP_CHAMBER	-33.8	47.8	None	None	None	None
LEAF_TEMP_CHAMBER	-34.5	48.7	None	None	None	None
AIR_HUM_DEFICIT_CHAMBER	-1.33	77.41	None	None	None	Blank
REL_HUM_CHAMBER	0	111.5	None	None	None	None
CO2_CONC_CHAMBER	133	661	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	02-SEP-98	02-SEP-98	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,TIME_OBS,CHAMBER_NUM,CO2_FLUX_CHAMBER,
H2O_FLUX_CHAMBER,DOWN_PPFD_CHAMBER,AIR_TEMP_CHAMBER,LEAF_TEMP_CHAMBER,
AIR_HUM_DEFICIT_CHAMBER,REL_HUM_CHAMBER,CO2_CONC_CHAMBER,CRTFCN_CODE,
REVISION_DATE
'SSA-OBS-FLXTR','9TF09-FLX02',01-JUN-96,0,1,-3.13,.001,902.0,27.5,28.3,15.34,
63.41,352.0,'CPI',02-SEP-98
'SSA-OBS-FLXTR','9TF09-FLX02',01-JUN-96,5,2,-3.94,-.001,1299.0,26.4,26.4,9.44,
78.93,314.0,'CPI',02-SEP-98
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by the BOREAS Information System (BORIS) was data collected at a given site on a given date.

8.2 Data Format

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.

9.1.1 Derivation Techniques and Algorithms

None.

9.2 Data Processing Sequence

A linear fit was made between the gas concentrations and time; data were rejected if the sum of the squares of the residuals was less than 0.9 and the calculated flux was nonzero.

9.2.1 Processing Steps

BORIS staff processed these data by:

- Reviewing the initial data files and loading them online for BOREAS team access.
- Designing relational data base tables to inventory and store the data.
- Loading the data into the relational data base tables.
- Working with the team to document the data set.
- Extracting the data into logical files.

9.2.2 Processing Changes

None.

9.3 Calculations

Flux calculations: flux = (concentration change * molar volume)/(time interval * leaf area)

9.3.1 Special Corrections/Adjustments

None.

9.3.2 Calculated Variables

None.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

Major sources of error include sensor drift, measurement of branch bag volume, and measurement of leaf area.

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 to check for spikes, values that are four standard deviations from the mean, long periods of constant values, and missing data.

11. Notes

11.1 Limitations of the Data

Potential users of these data should be aware of the limitations of gas exchange as a means of investigating photosynthesis and of the implications of these measurements having been made on entire, enclosed branches.

11.2 Known Problems with the Data

All known bad data have been removed from the files.

11.3 Usage Guidance

Potential users of these data should be aware of the limitations of gas exchange as a means of investigating photosynthesis and of the implications of these measurements having been made on entire, enclosed branches. They should also be aware that these data have been submitted to BORIS out of courtesy rather than contractual obligation and should therefore seek the permission of the investigators before publishing analyses derived from them. These data remain the property of the University of Edinburgh and of the UK Natural Environment Research Council.

11.4 Other Relevant Information

None.

12. Application of the Data Set

This data set is useful for the examination of effects of environmental variables on photosynthesis and transpiration at the scale of individual branches.

13. Future Modifications and Plans

Although these data represent the most recent data set, believed to be error free, some data might, in the future, be found to be in error.

14. Software

14.1 Software Description

The logger program was written with Campbell PC208. Flux and humidity-based calculations and initial screening of the data were carried out with a program written in Microsoft Visual Basic. Final data screening was carried out in Statistical Analysis System (SAS).

14.2 Software Access

None given.

15. Data Access

The SSA-OBS branch-level flux 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.

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.

Pearcy, R.W., J. Ehleringer, H.A. Mooney, and P.W. Rundel. 1991. Plant Physiological Ecology: Field methods and instrumentation. Chapman and Hall, London and New York.

Rayment, M.B. 1998. Ph.D. Thesis. University of Edinburgh.

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

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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.

19. List of Acronyms

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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
DBH     - Diameter at Breast Height
EOS     - Earth Observing System
EOSDIS  - EOS Data and Information System
GIS     - Geographic Information System
GMT     - Greenwich Mean Time
GSFC    - Goddard Space Flight Center
HTML    - HyperText Markup Language
IRGA    - Infra-Red Gas Analyzer
NASA    - National Aeronautics and Space Administration
NSA     - Northern Study Area
OBS     - Old Black Spruce
ORNL    - Oak Ridge National Laboratory
PANP    - Prince Albert National Park
PPFD    - Photosynthetic Photon Flux Density
SAS     - Statistical Analysis System
SSA     - Southern Study Area
TE      - Terrestrial Ecology
TF      - Tower Flux
URL     - Uniform Resource Locator
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Users of these data should be aware that these data have been submitted to BORIS out of courtesy rather than contractual obligation and should therefore seek the permission of the investigators before publishing analyses derived from them. These data remain the property of the University of Edinburgh and of the UK Natural Environment Research Council.

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

Rayment, M.B and P.G. Jarvis, "The CO_2 Exchanges of Boreal Black Spruce Forest." In Collected Data of The Boreal Ecosystem-Atmosphere Study. Eds. J. Newcomer, 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. CD-ROM. NASA, 2000.

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The BOREAS TF-9 team collected data that describe carbon dioxide and water vapor fluxes from foliage at the BOREAS SSA-OBS site from 07-April through 23-November-1996. The data are available in tabular ASCII files.

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