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

Forrest G. Hall and Andrea Papagno, Editors

Volume 131
BOREAS TE-2 Foliage Respiration Data

M.G. Ryan and M. Lavigne

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

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BOREAS TE-2 Foliage Respiration Data

Michael G. Ryan, Michael Lavigne

Summary

The BOREAS TE-2 team collected several data sets in support of its efforts to characterize and interpret information on the respiration of the foliage, roots, and wood of boreal vegetation. This data set contains measurements of foliar respiration conducted in the NSA during the growing season of 1994. The data are stored in tabular ASCII files.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS TE-02 Foliage Respiration Data

1.2 Data Set Introduction

Field studies of tree foliar respiration were conducted at the BOReal Ecosystem-Atmosphere Study (BOREAS) Northern Study Area (NSA) during the growing season of 1994.

1.3 Objectives/Purpose

The objectives of the work were to:

- Characterize respiration of foliage at the primary forested BOREAS sites in the northern and southern study areas (Old Jack Pine (OJP), Old Black Spruce (OBS), and Old Aspen (OA)) with respect to biomass, foliar age, and nutrient content, and determine whether respiration rates, corrected to a common temperature, differed among species and sites or varied seasonally.
- Determine if there was any relationship between foliage respiration and nitrogen, phosphorus, or carbohydrate content in foliage.

- Use our estimates of foliage respiration, estimates of foliage biomass or area, and canopy temperature throughout the year to estimate the annual carbon cost for foliage respiration.

1.4 Summary of Parameters

Each data record includes the BOREAS Tower Flux (TF) site, tree species measured, day of year measurements were taken, sample number, canopy third where sample was taken, foliage age class, leaf area of sample, dry weight of foliage in sample, dry weight of stem or petiole in sample, total dry weight in sample, leaf temperature, respiration, respiration per area at 10 °C, respiration per dry weight at 10 °C, percent nitrogen in dry weight, percent phosphorus in dry weight, nitrogen per area, percent starch in dry weight, and percent sugar in dry weight.

1.5 Discussion

In the NSA, the Terrestrial Ecology (TE)-02 team measured foliage respiration rates for alder (Alnus crispa), aspen (Populus tremuloides), black spruce (Picea mariana), jack pine (Pinus banksiana), and lichen in 1994 during June, July, and August, corresponding with the BOREAS Intensive Field Campaigns (IFCs).

1.6 Related Data Sets

BOREAS TE-02 Wood Respiration Data
BOREAS TE-02 Root Respiration Data
BOREAS TE-02 Stem Growth and Sapwood Data
BOREAS TE-02 Continuous Wood Respiration Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. Michael G. Ryan
Dr. Michael Lavigne

2.2 Title of Investigation

Autotrophic Respiration in Boreal Ecosystems

2.3 Contact Information

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Andrea.Papagno@gsfc.nasa.gov

3. Theory of Measurements

Respiration oxidizes sugars, producing energy, water, and CO_2 and absorbing oxygen. In most plant cells, the ratio between the oxygen absorbed and CO_2 produced in respiration is close to one. Therefore, because small changes in CO_2 concentration in the air are easier to measure than small changes in the oxygen content of the air, respiration is typically measured as CO_2 evolution from plant tissues. CO_2 evolution is typically measured with an infrared gas analyzer (IRGA), operating in one of three modes: open, closed, or differential. The system that we used to measure foliage respiration was an open system, which estimates molar flux of CO_2 from plant tissue respiration as the difference between the CO_2 concentration entering and exiting the chamber times the molar flow rate of air through the chamber [Field et al., 1991]. Respiration rates are typically expressed as moles CO_2 per kg of dry weight per second, or, for foliage, moles CO_2 per m^2 leaf area per second. Because many factors can influence the rate of foliar dark respiration if measured during daylight after shading, we made all of our measurements at night at least 2 hours after sunset.

4. Equipment

4.1 Instrument Description

4.1.1 Collection Environment

Foliage respiration measurements were made on plants in the field at night. All other measurements took place under laboratory conditions.

4.1.2 Source/Platform

We accessed the canopy with scaffolding towers that were relocated for each IFC. For the overstory, foliage respiration rates were sampled by canopy position (canopy thirds) and foliage age; 15-30 samples were measured at each site for each IFC, distributed among the accessible trees. From each scaffold tower, we sampled 3-8 trees.

4.1.3 Source/Platform Mission Objectives

Not applicable.

4.1.4 Key Variables

Respiration, respiration per area at 10 °C, respiration per dry weight at 10 °C, percent nitrogen in dry weight, percent phosphorus in dry weight, nitrogen per area, percent starch in dry weight, and percent sugar in dry weight.

4.1.5 Principles of Operation

Foliar CO_2 efflux was measured in the NSA using an open photosynthesis system [Field et al., 1991]. Foliage temperature was measured concurrently with a fine-wire thermocouple. Immediately after sampling, foliage was removed from the branch, stored at < 2-5 °C for 10-48 hours, and

measured for leaf area. For aspen, alder, and hazel, leaf area was determined with a leaf area meter. For spruce and pine, leaf area was determined by volume displacement [Chen et al., 1997]. The samples were then dried at 65 °C for 48 hours, weighed, and stored for analysis of nutrients (nitrogen and phosphorus) and carbohydrates.

4.1.6 Sensor/Instrument Measurement Geometry

None.

4.1.7 Manufacturer of Instrument

Leaf Area Meter
Delta-T Leaf Area Meter
Dynamax, Inc.
10808 Fallstone
Suite 350
Houston, TX 77099 USA
(281) 564-5100

Photosynthesis System
LCA3 or LCA4
Analytical Development Company (ADC)
Hoddeston, Herts., UK
Distributed by:
Dynamax, Inc.
10808 Fallstone
Suite 350
Houston, TX 77099 USA
(281) 564-5100

Bubble Flow Meter
Model 650 Digital Flowmeter
Fisher Scientific
2000 Park Lane Drive
Pittsburgh, PA 15275
(800) 766-7000

4.2 Calibration

4.2.1 Specifications

We calibrated the IRGA to a concentration standard supplied by BOREAS prior to a measurement period and every 48 hours during measurements. Typically, the analyzer drifted less than 1% between calibrations.

4.2.1.1 Tolerance

None given.

4.2.2 Frequency of Calibration

We calibrated the IRGA to a concentration standard supplied by BOREAS prior to a measurement period and every 48 hours during measurements.

4.2.3 Other Calibration Information

We also calibrated the molar flow of ideal gas roughly every month with a bubble column. We used standard meteorological pressure (reported at Thompson), corrected for elevation, and temperature from a copper-constantan thermocouple to calculate molar flow from the volume flow for this calculation.

5. Data Acquisition Methods

We measured foliage respiration rates for the overstory in 1994 in June, July, and August, corresponding with the BOREAS IFCs at OBS, OJP, and OA in the NSA. At the aspen site, foliage respiration rates were also measured for Alnus crispa in the NSA in July and August. We estimated foliage respiration rate as CO_2 efflux from foliage at night (2300-0300 local standard time). We accessed the canopy with scaffolding towers that were relocated for each IFC. For the overstory, foliage respiration rates were sampled by canopy position (canopy thirds) and foliage age; 15-30 samples were measured at each site for each IFC, distributed among the accessible trees. From each scaffold tower, we could sample 3-8 trees. For the understory, we measured flux from five sun and five shade leaves. Foliar CO_2 efflux was measured in the NSA using an open system [Field et al., 1991] ADC LCA3 or LCA4 (Analytical Development Company, Hoddeston, Herts., UK). Foliage temperature was measured concurrently with a fine-wire thermocouple.

Immediately after sampling, foliage was removed from the branch, stored at < 2-5 °C for 10-48 hours, and measured for leaf area. For aspen, alder, and hazel, leaf area was determined with a leaf area meter. For spruce and pine, leaf area was determined by volume displacement [Chen et al., 1997]. The samples were then dried at 65 °C for 48 hours, weighed, and stored for analysis of nutrients (N and P) and carbohydrates. In expressing flux rates, leaf area is given as hemisurface area (one-half of the total surface area) [Chen et al., 1997]. Nitrogen and phosphorus were measured with a micro-Kjeldahl procedure [Lachat Instruments, 1992a, b]. Soluble sugar and starch were extracted from plant material as described by Tissue and Wright [1995]. Starch and sugar concentration was determined colorimetrically using the phenol-sulfuric acid method of Dubois et al. [1956]. Total nonstructural carbohydrate was calculated as the sum of the soluble sugar and starch. For each sample period and site, each measurement was adjusted to a reference temperature (10 °C) using the average increase of respiration with a 10 °C increase in temperature.

Temperature response of foliage respiration was measured in July for the overstory species in the NSA. We harvested five shoots of each species from midcanopy at about 0300, recut the stems under water, and stored samples in the dark at 15 °C for about 6 hours. Temperature response was determined by measuring foliar respiration at 5, 15, and 25 °C with a temperature-controlled cuvette [Hubbard et al., 1995]. We did not measure temperature response in June and August because previous studies with conifer foliar respiration showed that temperature response varied little throughout the growing season (M.G. Ryan, unpublished data). The increase of respiration with a 10 °C increase in temperature in July was 2.1 for black spruce, 2.0 for jack pine, and 2.1 for aspen.

6. Observations

6.1 Data Notes

None.

6.2 Field Notes

None.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The measurement sites and associated North American Datum of 1983 (NAD83) coordinates are:

- OA canopy access, site id T2Q6A, Lat/Long: 55.88691°N, 98.67479°W, Universal Transverse Mercator (UTM) Zone 14, N: 6,193,540.7, E: 520,342
- OBS canopy access tower, site id T3R8T, Lat/Long: 55.88007°N, 98.48139°W, UTM Zone

14, N: 6,192,853.4, E: 532,444.5

- OJP, site id T7Q8T, Lat/Long: 55.92842Q°N, 98.62396°W, UTM Zone 14, N: 6,198,176.3, E: 523,496.2

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

These data are point source 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

We measured foliage respiration rates for the overstory in 1994 during June, July, and August, corresponding with the BOREAS IFCs at NSA-OBS, NSA-OJP, and NSA-OA.

7.2.2 Temporal Coverage Map

None given.

7.2.3 Temporal Resolution

We accessed the canopy with scaffolding towers that were relocated for each IFC. For the overstory, foliage respiration rates were sampled by canopy position (canopy thirds) and foliage age; 15-30 samples were measured at each site for each IFC, distributed among the accessible trees. From each scaffold tower, we could sample 3-8 trees. For the understory, we measured flux from five sun and five shade leaves.

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
SPECIES
SAMPLE_ID
CANOPY_LOCATION
SAMPLE_GROWTH_YEAR
FOLIAGE_AREA
DRY_FOLIAGE_WEIGHT
DRY_STEM_WEIGHT
TOTAL_DRY_WEIGHT
LEAF_TEMP
RESPIRATION
RESPIRATION_PER_AREA_10C
RESPIRATION_PER_DRY_WEIGHT_10C
```

NITROGEN_CONTENT
PHOSPHOROUS_CONTENT
NITROGEN_DENSITY
SUGAR_CONTENT
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.
DATE_OBS	The date on which the data were collected.
SPECIES	Botanical (Latin) name of the species (Genus species).
SAMPLE_ID	The sample identifier used by data collectors (see documentation for a detailed description).
CANOPY_LOCATION	Location in the canopy from which the sample was taken.
SAMPLE_GROWTH_YEAR	The year in which the collected sample first grew.
FOLIAGE_AREA	The hemi-surface foliar area of the broadleaf minus its petiole or of all the needles in the needle growth year.
DRY_FOLIAGE_WEIGHT	The dry weight of the foliar leaf (without the petiole) or the foliar needles (without the stem).
DRY_STEM_WEIGHT	The dry weight of the stem or petiole.
TOTAL_DRY_WEIGHT	The total dry weight of the broadleaf and petiole or the total of all the needles and needle stems in the needle growth year.
LEAF_TEMP	The leaf or shoot temperature
RESPIRATION	Respiration of CO2 under dark conditions.
RESPIRATION_PER_AREA_10C	Respiration of CO2 under dark conditions and at 10 degrees Celsius per unit area of the sample.
RESPIRATION_PER_DRY_WEIGHT_10C	Respiration of CO2 under dark conditions and at 10 degrees Celsius per unit of dried sample weight.
NITROGEN_CONTENT	The nitrogen content of the sample based on dried sample weight.

PHOSPHOROUS_CONTENT	The phosphorous content of the sample based on dried sample weight.
NITROGEN_DENSITY	Nitrogen per unit hemi-surface area.
SUGAR_CONTENT	The sugar content of the sample based on dried sample weight.
STARCH_CONTENT	The starch content of the sample based on dried sample weight.
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]
SPECIES	[none]
SAMPLE_ID	[none]
CANOPY_LOCATION	[none]
SAMPLE_GROWTH_YEAR	[unitless]
FOLIAGE_AREA	[meters^2]
DRY_FOLIAGE_WEIGHT	[grams]
DRY_STEM_WEIGHT	[grams]
TOTAL_DRY_WEIGHT	[grams]
LEAF_TEMP	[degrees Celsius]
RESPIRATION	[micromoles][meter^-2][second^-1]
RESPIRATION_PER_AREA_10C	[micromoles][meter^-2][second^-1]
RESPIRATION_PER_DRY_WEIGHT_10C	[micromoles][kilogram][second^-1]
NITROGEN_CONTENT	[percent]
PHOSPHOROUS_CONTENT	[percent]
NITROGEN_DENSITY	[grams][meter^-2]
SUGAR_CONTENT	[percent]
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	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
SPECIES	[Human Observer]
SAMPLE_ID	[Human Observer]
CANOPY_LOCATION	[Human Observer]
SAMPLE_GROWTH_YEAR	[Human Observer]

```
FOLIAGE_AREA                    [Laboratory Equipment]
DRY_FOLIAGE_WEIGHT              [Laboratory Equipment]
DRY_STEM_WEIGHT                 [Laboratory Equipment]
TOTAL_DRY_WEIGHT                [Laboratory Equipment]
LEAF_TEMP                       [Thermometer]
RESPIRATION                     [Laboratory Equipment]
RESPIRATION_PER_AREA_10C        [Laboratory Equipment]
RESPIRATION_PER_DRY_WEIGHT_10C  [Laboratory Equipment]
NITROGEN_CONTENT                [Laboratory Equipment]
PHOSPHOROUS_CONTENT             [Laboratory Equipment]
NITROGEN_DENSITY                [Laboratory Equipment]
SUGAR_CONTENT                   [Laboratory Equipment]
STARCH_CONTENT                  [Laboratory Equipment]
CRTFCN_CODE                     [BORIS Designation]
REVISION_DATE                   [BORIS Designation]
```

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-9OA-9TETR	NSA-OJP-FLXTR	None	None	None	None
SUB_SITE	9TE02-FLR01	9TE02-FLR01	None	None	None	None
DATE_OBS	01-JUN-94	14-SEP-94	None	None	None	None
SPECIES	N/A	N/A	None	None	None	None
SAMPLE_ID	N/A	N/A	None	None	None	None
CANOPY_LOCATION	Bottom	Top	None	None	None	None
SAMPLE_GROWTH_YEAR	1990-1994	<=1994	None	None	None	None
FOLIAGE_AREA	.00089	.02386	-999	None	None	None
DRY_FOLIAGE_WEIGHT	.089	4.773	-999	None	None	None
DRY_STEM_WEIGHT	0	1.926	-999	None	None	None
TOTAL_DRY_WEIGHT	.089	4.927	-999	None	None	None
LEAF_TEMP	7.1	21.2	-999	None	None	None
RESPIRATION	.08	3.87	-999	None	None	None
RESPIRATION_PER_AREA_10C	.07	3	-999	None	None	None
RESPIRATION_PER_DRY_WEIGHT_10C	.28	42.45	-999	None	None	None
NITROGEN_CONTENT	.46	3.77	-999	None	None	None
PHOSPHOROUS_CONTENT	.03	.291	-999	None	None	None
NITROGEN_DENSITY	.6	2.6	-999	None	None	None
SUGAR_CONTENT	0	21.27	-999	None	None	None
STARCH_CONTENT	2.35	20.63	-999	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	22-OCT-98	22-OCT-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,SPECIES,SAMPLE_ID,CANOPY_LOCATION,SAMPLE_GROWTH_YEAR,
FOLIAGE_AREA,DRY_FOLIAGE_WEIGHT,DRY_STEM_WEIGHT,TOTAL_DRY_WEIGHT,LEAF_TEMP,
RESPIRATION,RESPIRATION_PER_AREA_10C,RESPIRATION_PER_DRY_WEIGHT_10C,
NITROGEN_CONTENT,PHOSPHOROUS_CONTENT,NITROGEN_DENSITY,SUGAR_CONTENT,
STARCH_CONTENT,CRTFCN_CODE,REVISION_DATE
'NSA-9OA-9TETR','9TE02-FLR01',02-JUN-94,'Populus tremuloides','8','Middle',
'1994',.00553,.273,0.0,.273,13.9,2.24,1.68,34.11,2.84,.223,1.4,12.05,3.89,'CPI',
22-OCT-98
'NSA-9OA-9TETR','9TE02-FLR01',02-JUN-94,'Populus tremuloides','9','Middle',
'1994',.00472,.238,0.0,.238,13.8,2.4,1.82,36.08,2.94,.232,1.5,10.7,4.14,'CPI',
22-OCT-98
```

8. Data Organization

8.1 Data Granularity

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

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.

9.1.1 Derivation Techniques and Algorithms

None given.

9.2 Data Processing Sequence

9.2.1 Processing Steps

Flux rates are given in the output from the IRGA. We divided by sample dry weight or sample leaf area to put rates on a weight or area basis.

9.2.2 Processing Changes

None given.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

Not applicable.

9.3.2 Calculated Variables

Not applicable.

9.4 Graphs and Plots

Not applicable.

10. Errors

10.1 Sources of Error

Variability of the samples is estimated with the standard deviation of the mean. Samples were selected to represent the range of variability in respiration rates as well as to provide an estimate of mean per leaf area respiration rates. Samples were taken from several trees reachable from the canopy access scaffolding tower. In the NSA, the scaffolding tower was moved between IFCs. Therefore, any seasonal variability is confounded with tree-to-tree spatial heterogeneity in foliar respiration rates. Respiration rates per unit of leaf nitrogen should be more conservative than respiration rates per unit leaf weight or per unit leaf area. The flux of carbon dioxide from respiration of leaves is typically less than 10 percent of the rates of carbon dioxide fixed in photosynthesis. Because the IRGA could typically resolve a difference in concentration of carbon dioxide of one µmol/mol, lower respiration rates have more uncertainty in the measurement. We compensated for this effect by enclosing a large amount of foliage (about 1-4 g dry weight) in the cuvette.

10.2 Quality Assessment

10.2.1 Data Validation by Source

None given.

10.2.2 Confidence Level/Accuracy Judgment

Flux rates of CO_2, nitrogen and phosphorus concentrations, starch and sugar content, and dry weight are likely estimated for the sample within +/- 5 percent.

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 given.

12. Application of the Data Set

These data can be used to study the foliage respiration rates of boreal vegetation.

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 foliage respiration 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

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17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

ADC - Analytical Development Company
ASCII - American Standard Code for Information Interchange
BOREAS - BOReal Ecosystem-Atmosphere Study
BORIS - BOREAS Information System
CD-ROM - Compact Disk-Read-Only Memory
CO_2 - Carbon Dioxide
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 - Hypertext Markup Language
IFC - Intensive Field Campaign
IRGA - Infrared Gas Analyzer
MIX - Mixed
NAD83 - North American Datum of 1983
NIR - Near Infrared Radiation
NOAA - National Oceanic and Atmospheric 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
PAR - Photosynthetically Active Radiation
PPFD - Photosynthetic Photon Flux Density
SSA - Southern Study Area
TE - Terrestrial Ecology
TF - Tower Flux site
URL - Uniform Resource Locator
UTM - Universal Transverse Mercator
YA - Young Aspen
YJP - Young Jack Pine

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13. ABSTRACT *(Maximum 200 words)*

The BOREAS TE-2 team collected several data sets in support of its efforts to characterize and interpret information on the respiration of the foliage, roots, and wood of boreal vegetation. This data set contains measurements of foliar respiration conducted in the NSA during the growing season of 1994. The data are stored in tabular ASCII files.

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