NASA/TM—2000–209891, Vol. 138

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

Forrest G. Hall and Shelaine Curd, Editors

Volume 138
BOREAS TE-5 Leaf Gas Exchange Data

J. Ehleriinger, J.R. Brooks, and L. Flanagan

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

October 2000

The NASA STI Program Office … in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA Scientific and Technical Information (STI) Program Office plays a key part in helping NASA maintain this important role.

The NASA STI Program Office is operated by Langley Research Center, the lead center for NASA's scientific and technical information. The NASA STI Program Office provides access to the NASA STI Database, the largest collection of aeronautical and space science STI in the world. The Program Office is also NASA's institutional mechanism for disseminating the results of its research and development activities. These results are published by NASA in the NASA STI Report Series, which includes the following report types:

- TECHNICAL PUBLICATION. Reports of completed research or a major significant phase of research that present the results of NASA programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA's counterpart of peer-reviewed formal professional papers but has less stringent limitations on manuscript length and extent of graphic presentations.
- TECHNICAL MEMORANDUM. Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.
- CONTRACTOR REPORT. Scientific and technical findings by NASA-sponsored contractors and grantees.
- CONFERENCE PUBLICATION. Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or cosponsored by NASA.
- SPECIAL PUBLICATION. Scientific, technical, or historical information from NASA programs, projects, and mission, often concerned with subjects having substantial public interest.
- TECHNICAL TRANSLATION. English-language translations of foreign scientific and technical material pertinent to NASA's mission.

Specialized services that complement the STI Program Office's diverse offerings include creating custom thesauri, building customized databases, organizing and publishing research results . . . even providing videos.

For more information about the NASA STI Program Office, see the following:

- Access the NASA STI Program Home Page at http://www.sti.nasa.gov/STI-homepage.html
- E-mail your question via the Internet to help@sti.nasa.gov
- Fax your question to the NASA Access Help Desk at (301) 621-0134
- Telephone the NASA Access Help Desk at (301) 621-0390
- Write to:
  NASA Access Help Desk
  NASA Center for AeroSpace Information
  7121 Standard Drive
  Hanover, MD 21076-1320

NASA/TM—2000–209891, Vol. 138

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

Forrest G. Hall and Shelaine Curd, Editors

Volume 138

BOREAS TE-5 Leaf Gas Exchange Data

Jim Ehleriinger, University of Utah, Salt Lake City
J. Renee Brooks, University of South Florida, Tampa
Larry Flanagan, University of Lethbridge, Lethbridge, Alberta, Canada

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

October 2000

Available from:

NASA Center for AeroSpace Information
7121 Standard Drive
Hanover, MD 21076-1320
Price Code: A17

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Price Code: A10

BOREAS TE-5 Leaf Gas Exchange Data

Jim Ehleringer, J.Renee Brooks, Larry Flanagan

Summary

The BOREAS TE-5 team collected measurements in the NSA and SSA on gas exchange, gas composition, and tree growth. The leaf photosynthetic gas exchange data were collected in the BOREAS NSA and the SSA from 06-Jun-1994 to 13-Sep-1994 using a LI-COR 6200 portable photosynthesis system. The data were collected to compare the photosynthetic capacity, stomatal conductance, and leaf intercellular CO_2 concentrations among the major tree species at the BOREAS sites. The data are average values from diurnal measurements on the upper canopy foliage (sun leaves). The data are available in tabular ASCII files.

Table of Contents

1) Data Set Overview
2) Investigator(s)
3) Theory of Measurements
4) Equipment
5) Data Acquisition Methods
6) Observations
7) Data Description
8) Data Organization
9) Data Manipulations
10) Errors
11) Notes
12) Application of the Data Set
13) Future Modifications and Plans
14) Software
15) Data Access
16) Output Products and Availability
17) References
18) Glossary of Terms
19) List of Acronyms
20) Document Information

1. Data Set Overview

1.1 Data Set Identification

BOREAS TE-05 Leaf Gas Exchange Data

1.2 Data Set Introduction

Leaf photosynthetic gas exchange data were collected in the field using a LI-COR 6200 portable photosynthesis system. The data are average values from diurnal measurements on the upper canopy foliage (sun leaves).

1.3 Objective/Purpose

The data were collected to compare the photosynthetic capacity, stomatal conductance and leaf intercellular CO_2 concentrations among the major tree species at the BOREAS sites. The leaf intercellular CO_2 concentrations obtained from our gas exchange studies were also compared to calculated values based on our measurements of leaf carbon isotope ratios.

1.4 Summary of Parameters

- CO_2 flux
- Chamber CO_2 concentration
- Chamber CO_2 pressure
- Intercellular CO_2 pressure
- Leaf surface area
- Leaf water potential

1.5 Discussion

These measurements were collected at the Southern Study Area (SSA) in 1994 during each Intensive Field Campaign (IFC) at the Old Jack Pine (OJP) and Old Black Spruce (OBS) sites. Measurements were also made at the Old Aspen (OA) site during IFC-2 (summer). At the Northern Study Area (NSA), measurements were collected in 1994 during IFC-1 and IFC-2 at the OJP, T6R5S TE Upland Black Spruce (UBS), and T2Q6A TE OA sites.

1.6 Related Data Sets

BOREAS TE-05 CO2 Concentration and Stable Isotope Composition
BOREAS TE-05 Diurnal CO2 Canopy Profile Data
BOREAS TE-05 Soil Respiration Data
BOREAS TE-05 Leaf Carbon Isotope Data
BOREAS TE-05 Surface Meteorological and Radiation Data
BOREAS TE-05 Tree Ring and Carbon Isotope Ratio Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

J.R. Ehleringer
University of Utah
TE-05
Department of Biology
Salt Lake City, UT 84112

Dr. Larry Flanagan
Department of Biological Sciences
University of Lethbridge

2.2 Title of Investigation

Vegetation-Atmosphere CO_2 and H_2O Exchange Processes: Stable Isotope Analyses

2.3 Contact Information

Contact 1:

J. Renee Brooks
Department of Biology
University of South Florida
Tampa, FL 33620 USA
(813) 974-7352
(813) 974-3263 (fax)
jrbrooks@chuma.cas.usf.edu

Contact 2:
Dr. Larry Flanagan
Department of Biological Sciences
University of Lethbridge
4401 University Drive
Lethbridge, Alberta
T1K 3M4, CANADA
(403) 380-1858
(403) 329-2082 (fax)
larry.flanagan@uleth.ca

Contact 3:
Shelaine Curd
Raytheon ITSS
Code 923
NASA GSFC
Greenbelt, MD 20771
(301) 286-2447
(301) 286-0239 (fax)
Shelaine.Curd@gsfc.nasa.gov

3. Theory of Measurements

Measurements were made using a LI-COR 6200 portable photosynthesis system, an instrument that uses a closed loop technique. This is a standard instrument for field measurements of leaf photosynthesis gas exchange. Theoretical details of the measurements and instruments can be obtained from the manufacturer: LI-COR, Inc., P.O. Box 4425, 4421 Superior Street, Lincoln, NE 68504, USA, toll-free telephone 1 (800) 447-3576 (USA and Canada), telephone (402) 467-2819.

4. Equipment

4.1 Sensor/Instrument Description

Measurements were made using a LI-COR 6200 portable photosynthesis system, an instrument that uses a closed loop technique. This is a standard instrument for field measurements of leaf photosynthesis gas exchange.

4.1.1 Collection Environment

Environmental conditions on sampling day should be included in the BOREAS TE-05 meteorological data.

4.1.2 Source/Platform

LI-COR 6200 portable photosynthesis system.

4.1.3 Source/Platform Mission Objectives

The data were collected to compare the photosynthetic capacity, stomatal conductance and leaf intercellular CO_2 concentrations among the major tree species at the BOREAS sites.

4.1.4 Key Variables

CO_2 Flux Stomatal Conductance Intercellular CO_2 Concentration Vapor Pressure Photosynthetic Photon Flux Density (PPFD)

4.1.5 Principles of Operation
None given.

4.1.6 Sensor/Instrument Measurement Geometry
None given.

4.1.7 Manufacture of Sensor/Instrument
LI-COR, Inc.
P.O. Box 4425
4421 Superior St.
Lincoln, NE 68504
1 (800) 447-3576 (USA and Canada)
(402) 467-2819

4.2 Calibration
The infrared gas analyzer of the LI-COR 6200 portable photosynthesis system was calibrated using primary standard gas mixtures from Matheson Gas. These gas mixtures were compared to BOREAS project calibration standards.

The humidity sensor was calibrated using a LI-COR dew point generator. Other components of the LI-COR 6200 (e.g., flow meters) were calibrated at the LI-COR factory before the field season began.

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
None given.

5. Data Acquisition Methods

None given.

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

Samples were collected at NSA OJP, SSA OJP, SSA OBS, and NSA UBS in 1993 and all the sites listed below in 1994. The North American Datum of 1983 (NAD83) coordinates of the sites are:

- NSA OJP flux tower site: Lat/Long=55.927°N, 98.62°W, Universal Transverse Mercator (UTM) Zone 14, N:6,197,997 E:523,501.
- SSA OJP flux tower site: Lat/Long=53.916°N, 104.69°W, UTM Zone 13, N:5,951,000 E:479,400.
- NSA OA canopy access tower site (auxiliary site number T2Q6A, BOREAS Experiment Plan, Version 3), Lat/Long = 55.88°N, 98.67°W.
- SSA OA flux tower site: Lat/Long=53.629 N, 106.197 W, UTM Zone 13, N:5,942,688 E:420,874.
- NSA UBS canopy access tower site (auxiliary site number T6R5S, BOREAS Experiment Plan, Version 3), Lat/Long = 55.70°N, 98.51°W.
- SSA OBS flux tower site: Lat/Long = 53.985°N, 105.122°W, UTM Zone 13, N:5,981,904 E:492,000.

7.1.2 Spatial Coverage Map

Not applicable.

7.1.3 Spatial Resolution

These 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

These measurements were collected from 06-Jun-1994 to 13-Sep-1994.

7.2.2 Temporal Coverage Map

Not available.

7.2.3 Temporal Resolution

The data are average values from diurnal measurements on the upper canopy foliage (sun leaves). These measurements were collected at the SSA during each 1994 IFC at the OJP and OBS sites. Measurements were also made at the OA site during IFC-2 (summer 1994). Measurements were collected at the NSA during 1994 IFC-1 and IFC-2 at the OJP, UBS, and OA.

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
START_DATE
START_TIME
END_DATE
END_TIME
SPECIES
NUM_OBS
LEAF_AREA
SHAPE_FACTOR
MEAN_CO2_FLUX
SDEV_CO2_FLUX
MEAN_STOMATAL_CONDUCT_CO2
SDEV_STOMATAL_CONDUCT_CO2
MEAN_LEAF_TEMP
SDEV_LEAF_TEMP
CO2_CONC_CHAMBER
SDEV_CO2_CONC_CHAMBER
MEAN_CO2_PRESS_CHAMBER
SDEV_CO2_PRESS_CHAMBER
MEAN_ATMOSPHERIC_CO2_PRESS
MEAN_INTERCELL_CO2_CONC
SDEV_INTERCELL_CO2_CONC
MEAN_INTERCELL_CO2_PRESS
SDEV_INTERCELL_CO2_PRESS
MEAN_AIR_TEMP_CHAMBER
SDEV_AIR_TEMP_CHAMBER
MEAN_VAPOR_PRESS_CHAMBER
SDEV_VAPOR_PRESS_CHAMBER
LEAF_BOUND_LAYER_CONDUCT
MEAN_DOWN_PPFD
SDEV_DOWN_PPFD
CRTFCN_CODE
REVISION_DATE
COMMENTS
```

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.
START_DATE	The date on which the collection of data commenced.
START_TIME	The starting Greenwich Mean Time (GMT) for the data collected.
END_DATE	The date on which the collection of the data was terminated.
END_TIME	The ending Greenwich Mean Time (GMT) for the data collected.
SPECIES	Botanical (Latin) name of the species (Genus species).
NUM_OBS	Number of observations of the given sample used to calculate given measurements.
LEAF_AREA	The area of the leaf (or needles) enclosed in the chamber, this value is always half the total surface area of the sample.
SHAPE_FACTOR	Shape Factor.
MEAN_CO2_FLUX	Mean of the daily CO2 flux measurements.
SDEV_CO2_FLUX	Standard deviation of the daily CO2 flux measurements.
MEAN_STOMATAL_CONDUCT_CO2	The mean stomatal conductance of CO2.
SDEV_STOMATAL_CONDUCT_CO2	Standard deviation of the stomatal conductance of CO2.
MEAN_LEAF_TEMP	The mean leaf temperature.
SDEV_LEAF_TEMP	Standard deviation of the leaf temperature.
CO2_CONC_CHAMBER	The CO2 concentration in the chamber.
SDEV_CO2_CONC_CHAMBER	The standard deviation of the CO2 concentration in the chamber.
MEAN_CO2_PRESS_CHAMBER	The mean CO2 pressure in the chamber.
SDEV_CO2_PRESS_CHAMBER	The standard deviation of the CO2 pressure in the chamber.
MEAN_ATMOSPHERIC_CO2_PRESS	Mean atmospheric CO2 pressure.
MEAN_INTERCELL_CO2_CONC	Mean intercellular CO2 concentration.
SDEV_INTERCELL_CO2_CONC	Standard deviation of intercellular CO2 concentration.
MEAN_INTERCELL_CO2_PRESS	Mean intercellular CO2 pressure.
SDEV_INTERCELL_CO2_PRESS	The standard deviation of the intercellular CO2 pressure.
MEAN_AIR_TEMP_CHAMBER	The mean air temperature in the chamber.
SDEV_AIR_TEMP_CHAMBER	The standard deviation of the air temperature in the chamber.
MEAN_VAPOR_PRESS_CHAMBER	The mean vapor pressure in the chamber.
SDEV_VAPOR_PRESS_CHAMBER	The standard deviation of the vapor pressure in the chamber.
LEAF_BOUND_LAYER_CONDUCT	The one-sided leaf boundary layer conductance. This is a function of leaf size and type of chamber.
MEAN_DOWN_PPFD	The mean downward photosynthetic photon flux density.
SDEV_DOWN_PPFD	The standard deviation of the downward

	photosynthetic photon flux density.
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.
COMMENTS	Descriptive information to clarify or enhance the understanding of the other entered data.

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]
START_DATE	[DD-MON-YY]
START_TIME	[HHMM GMT]
END_DATE	[DD-MON-YY]
END_TIME	[HHMM GMT]
SPECIES	[none]
NUM_OBS	[counts]
LEAF_AREA	[millimeter^2]
SHAPE_FACTOR	[unitless]
MEAN_CO2_FLUX	[micromoles][meter^-2][second^-1]
SDEV_CO2_FLUX	[micromoles][meter^-2][second^-1]
MEAN_STOMATAL_CONDUCT_CO2	[mole][meter^-2][second^-1]
SDEV_STOMATAL_CONDUCT_CO2	[mole][meter^-2][second^-1]
MEAN_LEAF_TEMP	[degrees Celsius]
SDEV_LEAF_TEMP	[degrees Celsius]
CO2_CONC_CHAMBER	[parts per million]
SDEV_CO2_CONC_CHAMBER	[parts per million]
MEAN_CO2_PRESS_CHAMBER	[Pascals]
SDEV_CO2_PRESS_CHAMBER	[Pascals]
MEAN_ATMOSPHERIC_CO2_PRESS	[unitless]
MEAN_INTERCELL_CO2_CONC	[parts per million]
SDEV_INTERCELL_CO2_CONC	[parts per million]
MEAN_INTERCELL_CO2_PRESS	[Pascals]
SDEV_INTERCELL_CO2_PRESS	[Pascals]
MEAN_AIR_TEMP_CHAMBER	[degrees Celsius]
SDEV_AIR_TEMP_CHAMBER	[degrees Celsius]
MEAN_VAPOR_PRESS_CHAMBER	[Pascals]
SDEV_VAPOR_PRESS_CHAMBER	[Pascals]
LEAF_BOUND_LAYER_CONDUCT	[mole][meter^-2][second^-1]
MEAN_DOWN_PPFD	[microEinsteins][meter^-2][second^-1]
SDEV_DOWN_PPFD	[microEinsteins][meter^-2][second^-1]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]
COMMENTS	[none]

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]
START_DATE	[Human Observer]
START_TIME	[Human Observer]
END_DATE	[Human Observer]
END_TIME	[Human Observer]
SPECIES	[Human Observer]
NUM_OBS	[Human Observer]
LEAF_AREA	[Laboratory Equipment]
SHAPE_FACTOR	[Laboratory Equipment]
MEAN_CO2_FLUX	[Laboratory Equipment]
SDEV_CO2_FLUX	[Laboratory Equipment]
MEAN_STOMATAL_CONDUCT_CO2	[Laboratory Equipment]
SDEV_STOMATAL_CONDUCT_CO2	[Laboratory Equipment]
MEAN_LEAF_TEMP	[Thermometer]
SDEV_LEAF_TEMP	[Thermometer]
CO2_CONC_CHAMBER	[Laboratory Equipment]
SDEV_CO2_CONC_CHAMBER	[Laboratory Equipment]
MEAN_CO2_PRESS_CHAMBER	[Laboratory Equipment]
SDEV_CO2_PRESS_CHAMBER	[Laboratory Equipment]
MEAN_ATMOSPHERIC_CO2_PRESS	[Laboratory Equipment]
MEAN_INTERCELL_CO2_CONC	[Laboratory Equipment]
SDEV_INTERCELL_CO2_CONC	[Laboratory Equipment]
MEAN_INTERCELL_CO2_PRESS	[Laboratory Equipment]
SDEV_INTERCELL_CO2_PRESS	[Laboratory Equipment]
MEAN_AIR_TEMP_CHAMBER	[Thermometer]
SDEV_AIR_TEMP_CHAMBER	[Thermometer]
MEAN_VAPOR_PRESS_CHAMBER	[Laboratory Equipment]
SDEV_VAPOR_PRESS_CHAMBER	[Laboratory Equipment]
LEAF_BOUND_LAYER_CONDUCT	[Laboratory Equipment]
MEAN_DOWN_PPFD	[Laboratory Equipment]
SDEV_DOWN_PPFD	[Laboratory Equipment]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[Human Observer]
COMMENTS	[Human Observer]

7.3.5 Data Range

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

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	NSA-9BS-9TETR	SSA-OJP-FLXTR	None	None	None	None
SUB_SITE	9TE05-LGS01	9TE05-LGS01	None	None	None	None
START_DATE	06-JUN-94	13-SEP-94	None	None	None	None
START_TIME	400	1500	None	None	None	None
END_DATE	07-JUN-94	13-SEP-94	None	None	None	None
END_TIME	430	2300	None	None	None	None

SPECIES	N/A	N/A	None	None	None	None
NUM_OBS	5	64	None	None	None	None
LEAF_AREA	370	4170	None	None	None	None
SHAPE_FACTOR	4	4.1	-999	None	None	None
MEAN_CO2_FLUX	.0000014	.000015	None	None	None	None
SDEV_CO2_FLUX	.00000064	.00000284	None	None	None	None
MEAN_STOMATAL_ CONDUCT_CO2	.017	.272	None	None	None	None
SDEV_STOMATAL_ CONDUCT_CO2	.0064	.047	None	None	None	None
MEAN_LEAF_TEMP	19	32.45	None	None	None	None
SDEV_LEAF_TEMP	.5	6.33	None	None	None	None
CO2_CONC_CHAMBER	303.6	351.7	None	None	None	None
SDEV_CO2_CONC_ CHAMBER	2.3	16.48	None	None	None	None
MEAN_CO2_PRESS_ CHAMBER	35.95	38.739	-999	None	None	None
SDEV_CO2_PRESS_ CHAMBER	.313	1.73	-999	None	None	None
MEAN_ATMOSPHERIC_CO2_ PRESS	97700	98800	-999	None	None	None
MEAN_INTERCELL_CO2_ CONC	194	264.44	None	None	None	None
SDEV_INTERCELL_CO2_ CONC	8.6	53.7	None	None	None	None
MEAN_INTERCELL_CO2_ PRESS	21.23	27.71	-999	None	None	None
SDEV_INTERCELL_CO2_ PRESS	3.514	5.696	-999	None	None	None
MEAN_AIR_TEMP_ CHAMBER	19	31.7	None	None	None	None
SDEV_AIR_TEMP_ CHAMBER	.5	5.77	None	None	None	None
MEAN_VAPOR_PRESS_ CHAMBER	626.172	1779	None	None	None	None
SDEV_VAPOR_PRESS_ CHAMBER	62.9	192	-999	None	None	None
LEAF_BOUND_LAYER_ CONDUCT	2.4	3.2	-999	None	None	None
MEAN_DOWN_PPFD	551	1673	None	None	None	None
SDEV_DOWN_PPFD	213	819	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	06-FEB-98	06-FEB-98	None	None	None	None
COMMENTS	N/A	N/A	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,START_DATE,START_TIME,END_DATE,END_TIME,SPECIES,NUM_OBS,
LEAF_AREA,SHAPE_FACTOR,MEAN_CO2_FLUX,SDEV_CO2_FLUX,MEAN_STOMATAL_CONDUCT_CO2,
SDEV_STOMATAL_CONDUCT_CO2,MEAN_LEAF_TEMP,SDEV_LEAF_TEMP,CO2_CONC_CHAMBER,
SDEV_CO2_CONC_CHAMBER,MEAN_CO2_PRESS_CHAMBER,SDEV_CO2_PRESS_CHAMBER,
MEAN_ATMOSPHERIC_CO2_PRESS,MEAN_INTERCELL_CO2_CONC,SDEV_INTERCELL_CO2_CONC,
MEAN_INTERCELL_CO2_PRESS,SDEV_INTERCELL_CO2_PRESS,MEAN_AIR_TEMP_CHAMBER,
SDEV_AIR_TEMP_CHAMBER,MEAN_VAPOR_PRESS_CHAMBER,SDEV_VAPOR_PRESS_CHAMBER,
LEAF_BOUND_LAYER_CONDUCT,MEAN_DOWN_PPFD,SDEV_DOWN_PPFD,CRTFCN_CODE,
REVISION_DATE,COMMENTS
'NSA-OJP-FLXTR','9TE05-LGS01',06-JUN-94,1500,07-JUN-94,2200,
'Pinus banksiana',28,4170.0,4.1,.00000354,.00000181,.045,.0122,
22.41,1.98,341.99,7.29,36.245,.773,98000,209.18,53.7,22.17,5.696,22.2,1.59,
666.552,192.0,3.2,1400.0,658.2,'CPI',06-FEB-98,'Hemi-surface area'
'NSA-9BS-9TETR','9TE05-LGS01',08-JUN-94,1500,08-JUN-94,2200,
'Picea mariana',18,1380.0,4.0,.00000195,.00000088,.025,.0092,31.88,4.12,
345.57,2.86,37.84,.313,98500,203.9,42.1,22.33,4.611,30.5,3.43,626.172,62.9,
3.2,1134.0,646.1,'CPI',06-FEB-98,'Hemi-surface area'
```

8. Data Organization

8.1 Data Granularity

The smallest unit of orderable data is data collected on one day at one site.

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 given.

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 given.

9.4 Graphs and Plots
None given.

10. Errors

10.1 Sources of Error
All known errors have been removed from the data.

10.2 Quality Assessment
None given.

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 given.

11.4 Other Relevant Information
None given.

12. Application of the Data Set

These leaf gas exchange data cab be used to compare the photosynthetic capacity, stomatal conductance and leaf intercellular CO_2 concentrations among the major tree species at the BOREAS sites.

13. Future Modifications and Plans

None given.

14. Software

14.1 Software Description
None.

14.2 Software Access
None.

15. Data Access

The leaf gas exchange 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

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

Brooks, J.R., L.B. Flanagan, G.T. Varney, and J.R. Ehleringer. 1997. Vertical gradients in photosynthetic gas exchange characteristics and refixation of respired CO_2 within boreal forest canopies. Tree Physiology 17: 1-12.

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
EOS     - Earth Observing System
EOSDIS  - EOS Data and Information System
GIS     - Geographic Information System
GSFC    - Goddard Space Flight Center
HSA     - Hemi-surface area
HTML    - HyperText Markup Language
NASA    - National Aeronautics and Space Administration
NSA     - Northern Study Area
OA      - Old Aspen
OBS     - Old Black Spruce
OJP     - Old Jack Pine
ORNL    - Oak Ridge National Laboratory
PANP    - Prince Albert National Park
SSA     - Southern Study Area
TE      - Terrestrial Ecology
TLA     - Total Leaf Area
UBS     - Upland Black Spruce
URL     - Uniform Resource Locator
UTM     - Universal Transverse Mercator
```

20. Document Information

20.1 Document Revision Date

Written : 10-Jun-1997
Last Updated: 02-Jun-1999

20.2 Document Review Date(s)

BORIS Review: 02-Jun-1998
Science Review:

20.3 Document ID

20.4 Citation

When using these data, please contact the investigators listed in Section 2.3 as well as citations of relevant papers in Section 17.2.

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

Ehleringer, J.R. and L. Flanagan, "Vegetation-Atmosphere CO_2 and H_2O Exchange Processes: Stable Isotope Analyses." 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.

Also, cite the BOREAS CD-ROM set as:

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. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM. NASA, 2000.

20.5 Document Curator

20.6 Document URL

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
October 2000

3. REPORT TYPE AND DATES COVERED
Technical Memorandum

4. TITLE AND SUBTITLE
Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)
BOREAS TE-5 Leaf Gas Exchange Date

5. FUNDING NUMBERS
923
RTOP: 923-462-33-01

6. AUTHOR(S)
Jim Ehleriinger, J. Renee Brooks and Larry Flanagan
Forrest G. Hall and Shelaine Curd, Editors

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS (ES)
Goddard Space Flight Center
Greenbelt, Maryland 20771

8. PEFORMING ORGANIZATION REPORT NUMBER
2000-03136-0

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS (ES)
National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
TM—2000–209891
Vol. 138

11. SUPPLEMENTARY NOTES
J. Ehleriinger: University of Utah, Salt Lake City; J.R. Brooks: University of South Florida, Tampa; L. Flanagan: University of Lethbridge, Lethbridge, Alberta, Canada; C. Curd: Raytheon ITSS, NASA Goddard Space Flight Center, Greenbelt, Maryland

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Unclassified–Unlimited
Subject Category: 43
Report available from the NASA Center for AeroSpace Information,
7121 Standard Drive, Hanover, MD 21076-1320. (301) 621-0390.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The BOREAS TE-5 team collected measurements in the NSA and SSA on gas exchange, gas composition, and tree growth. The leaf photosynthetic gas exchange data were collected in the BOREAS NSA and the SSA from 06-Jun-1994 to 13-Sep-1994 using a LI-COR 6200 portable photosynthesis system. The data were collected to compare the photosynthetic capacity, stomatal conductance, and leaf intercellular CO_2 concentrations among the major tree species at the BOREAS sites. The data are average values from diurnal measurements on the upper canopy foliage (sun leaves). The data are available in tabular ASCII files.

14. SUBJECT TERMS
BOREAS, terrestrial ecology, leaf gas exchange.

15. NUMBER OF PAGES
16

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT
Unclassified

18. SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

19. SECURITY CLASSIFICATION OF ABSTRACT
Unclassified

20. LIMITATION OF ABSTRACT
UL