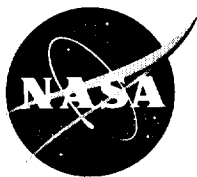


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Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Shelaine Curd, Editors

Volume 137

BOREAS TE-5 Diurnal CO₂ Canopy Profile Data

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BOREAS TE-5 Diurnal CO₂ Canopy Profile Data

Jim Ehleringer, J.Renee Brooks, Larry Flanagan

Summary

The BOREAS TE-5 team collected several data sets to investigate the vegetation-atmosphere CO₂ and H₂O exchange processes. These data were collected to provide detailed information within the canopy during times when TE-05 sampled canopy CO₂ for carbon and oxygen isotope analysis. These measurements were made in both the NSA and SSA at the OJP, OBS, UBS, and OA sites from 25-May-1994 to 08-Sep-1994. CO₂ profile data were not collected at SSA-OA during the first IFC. The data are available in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS TE-05 Diurnal CO₂ Canopy Profile Data

1.2 Data Set Introduction

The canopy CO₂ profile data were collected in both the Northern Study Area (NSA) and the Southern Study Area (SSA) during the 1994 Intensive Field Campaigns (IFCs).

1.3 Objective/Purpose

The data were collected to provide detailed information within the canopy during times when Terrestrial Ecology (TE)-05 sampled canopy CO₂ for carbon and oxygen isotope analysis.

1.4 Summary of Parameters

Time, CO₂ concentration at 9-m, 3-m, 1-m, 0.5-m, 0.25-m, and 0.05-m heights within the canopy at 10-min (NSA) or 30-min (SSA) intervals.

1.5 Discussion

These measurements were made at both the NSA and the SSA during each IFC at Old Jack Pine (OJP), Old Black Spruce (OBS), Upland Black Spruce (UBS), and Old Aspen (OA) sites. CO₂ profile data were not collected at SSA-OA during the first IFC.

1.6 Related Data Sets

BOREAS TE-05 Surface Meteorological and Radiation Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

J.R. Ehleringer
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Department of Biology

L. Flanagan
Carleton University
Department of Biological Sciences
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2.2 Title of Investigation

Vegetation-Atmosphere CO₂ and H₂O Exchange Processes: Stable Isotope Analyses

2.3 Contact Information

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NASA GSFC
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3. Theory of Measurements

CO₂ was measured with the LI-COR LI-6262 infrared gas analyzer (IRGA). For theoretical information on the LI-6262, please refer to LI-6262 CO₂/H₂O Analyzer Operating and Service Manual, Publication # 9003-59, 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.

The CO₂ profiles are a series of CO₂ concentrations measured on a vertical profile of air within the canopy. Tubing at various heights within the canopy was attached to a solenoid switching board (to switch height being monitored), through a pump, and into the IRGA (LI-6262). The IRGA was attached to a Campbell data logger so that CO₂ concentrations were recorded through time. The monitoring system ran continuously over a period of several days. More specific details are given below.

4. Equipment

4.1 Sensor/Instrument Description

CO₂ concentration was measured with the LI-COR LI-6262 IRGA. A Campbell CR-21x data logger was used to record the CO₂ data.

4.1.1 Collection Environment

The equipment operated under ambient environmental conditions during the measurement periods. Please see TE-05 Surface Meteorological and Radiation Data for specifics.

4.1.2 Source/Platform

CO₂ concentration was collected from a telescoping Rohn mast extending 9 m up into the canopy. Dekoron tubing was attached to the mast at six canopy heights.

4.1.3 Source/Platform Mission Objectives

This mission objective was to monitor diurnal changes in CO₂ concentration at six heights within the forest canopy.

4.1.4 Key Variables

Time, CO₂ concentration at 9 m, 3 m, 1 m, 0.5 m, 0.25 m, and 0.05 m.

4.1.5 Principles of Operation

An automated sampling system was set up at the site to monitor CO₂ when TE-05 was sampling canopy air for isotope analysis. Prior to setup in the field, the IRGA was calibrated in the lab, using the BOREAS standards. Every 10 min (NSA) or 30 min (SSA), CO₂ at each canopy height was monitored by the IRGA for 1.5 min before a 15-sec average reading was stored in the data logger. Air was pumped through 1/4-in. Dekoron tubing into the LI-6262 IRGA at the rate of 15 ml/sec. Every 3 hours, standard gases (0 ppm and 352 ppm) were measured to check IRGA calibration. The IRGA

temperature was also recorded so that temperature corrections for the zero could be made. All data were temperature corrected.

4.1.6 Sensor/Instrument Measurement Geometry

CO₂ data were collected from a Rohn mast extending 9 m up into the canopy. Dekoron tubing was attached to the mast at six canopy heights of 0.05, 0.25, 0.5, 1.0, 3.0, and 9.0 meters above the ground.

4.1.7 Manufacturer of Sensor/Instrument

LI-6262 IRGA:

LI-COR, Inc.

P.O. Box 4425

4421 Superior St.

Lincoln, NE 68504

1 (800) 447-3576 (USA and Canada)

(402) 467-2819

CR-21x Data logger:

Campbell Scientific, Inc.

P.O. Box 551

Logan, UT 84321

(801) 753-23425

4.2 Calibration

The LI-6262 IRGA was calibrated in the lab, using the BOREAS standards prior to setup at each field site, for each IFC. Once in the field, standard gases (0 ppm and 352 ppm) were measured to check IRGA calibration every 3 hours. IRGA temperature was also recorded so that temperature corrections for the zero could be made.

4.2.1 Specifications

None given.

4.2.1.1 Tolerance

None given.

4.2.2 Frequency of Calibration

Prior to setup in the field, the IRGA was calibrated in the lab, using the BOREAS standards. Every 10 min (NSA) or 30 min (SSA), CO₂ at each canopy height was monitored by the IRGA for 1.5 min before a 15-sec average reading was stored in the data logger. Air was pumped through 1/4-in. Dekoron tubing into the LI-6262 IRGA at the rate of 15 ml/sec. Every 3 hours, standard gases (0 ppm and 352 ppm) were measured to check IRGA calibration. IRGA temperature was also recorded so that temperature corrections for the zero could be made. All data were temperature corrected.

4.2.3 Other Calibration Information

None given.

5. Data Acquisition Methods

An automated sampling system was set up at the site to monitor CO₂ when TE-05 was sampling canopy air for isotope analysis. Prior to setup in the field, the IRGA was calibrated in the lab, using the BOREAS standards. Every 10 min (NSA) or 30 min (SSA), CO₂ at each canopy height was monitored by the IRGA for 1.5 min before a 15-sec average reading was stored in the data logger. Air was pumped through 1/4-in. Dekoron tubing into the LI-6262 IRGA at the rate of 15 ml/sec.

6. Observations

6.1 Data Notes

None given.

6.2 Field Notes

None given.

7. Data Description

7.1 Spatial Characteristics

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.
- NSA-OA canopy access tower site (auxiliary site number T2Q6A, BOREAS Experiment Plan, Version 3), Lat/Long = 55.88°N, 98.67°W.
- NSA-UBS canopy access tower site (auxiliary site number T6R5S, BOREAS Experiment Plan, Version 3), Lat/Long = 55.70°N, 98.51°W.
- SSA-OJP = Lat/Long: 53.91°N, 104.69°W.
- SSA-OBS = Lat/Long: 53.98°N, 105.12°W.
- SSA-OA = Lat/Long: 53.62°N, 106.19°W.

7.1.1 Spatial Coverage

- NSA-OJP flux tower site, Lat/Long: 55.927°N, 98.62°W, UTM Zone 14, N:6, 197,997 E:523,501.
- NSA-OA canopy access tower site (auxiliary site number T2Q6A, BOREAS Experiment Plan, Version 3), Lat/Long = 55.88°N, 98.67°W.
- NSA-UBS canopy access tower site (auxiliary site number T6R5S, BOREAS Experiment Plan, Version 3), Lat/Long = 55.70°N, 98.51°W.
- SSA-OJP = Lat/Long: 53.91°N, 104.69°W.
- SSA-OBS = Lat/Long: 53.98°N, 105.12°W.
- SSA-OA = Lat/Long: 53.62°N, 106.19°W.

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

These data are point source measurements.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

CO₂ profile data were measured at the sites from 02-Jun-1994 to 05-Sep-1994.

7.2.2 Temporal Coverage Map

CO₂ profile data were measured at the following sites during the following time periods.

IFC-1

NSA-OJP: 02-Jun-94, 7.32 Greenwich Mean Time (GMT) through 03-Jun-94, 16.32 (GMT)

NSA-OA: 10-Jun-94, 16.15 (GMT) through 11-Jun-94, 19.98 (GMT)

NSA-UBS: 03-Jun-94, 2.15 (GMT) through 04-Jun-94, 2.15 (GMT)

SSA-OA: 29-May-94, 1900 (GMT) through 30-May-94, 2150 (GMT)

SSA-OBS: 25-May-94, 1.50 (GMT) through 27-May-94, 20.00 (GMT)

SSA-OJP: 25-May-94, 2050 (GMT) through 27-May-94, 2.00 (GMT)

IFC-2:

NSA-OJP: 20-Jul-94, 21.48 (GMT) through 24-Jul-94, 22.32 (GMT)

NSA-OA: 31-Jul-94, 17.82 (GMT) through 05-Aug-94, 20.98 (GMT)

NSA-UBS: 25-Jul-94, 20.15 (GMT) through 29-Jul-94, 22.48 (GMT)

SSA-OA: 25-Jul-94, 1900 (GMT) through 27-JUL-94, 17.50 (GMT)

SSA-OBS: 20-Jul-94 20.50 (GMT) through 22-Jul-94, 15.50 (GMT)

SSA-OJP: 22-Jul-94, 2.50 (GMT) through 24-Jul-94, 18.00 (GMT)

IFC-3:

NSA-OJP: 30-Aug-94, 18.65 (GMT) through 01-Sep-94, 21.15 (GMT)

NSA-OA: 05-Sep-94, 19.32 (GMT) through 07-Sep-94, 18.65 (GMT)

NSA-UBS: 02-Sep-94, 18.48 (GMT) through 04-Sep-94, 16.15 (GMT)

SSA-OA: 03-Aug-94, 17.50 (GMT) through 05-Aug-94, 18.00 (GMT)

SSA-OBS: 31-Aug-94, 18.50 (GMT) through 02-Aug-94, 17.50 (GMT)

SSA-OJP: 06-Aug-94, 18.00 (GMT) through 08-Aug-94, 18.50 (GMT)

7.2.3 Temporal Resolution

A scan of each height was made every 10 minutes in the NSA and every 30 minutes in the SSA.

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
CO2_CONC
HT_AGL
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-III III, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and III III 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) when the data were collected.
CO2_CONC	CO2 concentration.
HT_AGL	The height above ground at which the measurements were taken.
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]
CO2_CONC	[parts per million]
HT_AGL	[meters]
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]
TIME_OBS	[Human Observer]

CO2_CONC	[Laboratory Equipment]
HT_AGL	[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-9BS-9TETR	SSA-OJP-FLXTR	None	None	None	None
SUB_SITE	9TE05-CO2P1	9TE05-CO2P1	None	None	None	None
DATE_OBS	25-MAY-94	08-SEP-94	None	None	None	None
TIME_OBS	4	2358	None	None	None	None
CO2_CONC	3.5	958	None	None	None	Blank
HT_AGL	.05	9	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	12-AUG-97	12-AUG-97	None	None	None	None

Minimum Data Value -- The minimum value found in the column.

Maximum Data Value -- The maximum value found in the column.

Missng Data Value -- The value that indicates missing data. This is used to indicate that an attempt was made to determine the parameter value, but the attempt was unsuccessful.

Unrel Data Value -- The value that indicates unreliable data. This is used to indicate an attempt was made to determine the parameter value, but the value was deemed to be unreliable by the analysis personnel.

Below Detect Limit -- The value that indicates parameter values below the instruments detection limits. This is used to indicate that an attempt was made to determine the parameter value, but the analysis personnel determined that the parameter value was below the detection limit of the instrumentation.

Data Not Cllctd -- This value indicates that no attempt was made to determine the parameter value. This usually indicates that BORIS combined several similar but not identical data sets into the same data base table but this particular science team did not measure that parameter.

Blank -- Indicates that blank spaces are used to denote that type of value.

N/A -- Indicates that the value is not applicable to the respective column.

None -- Indicates that no values of that sort were found in the column.

7.4 Sample Data Record

The following is a sample of the first few records from the data table on the CD-ROM:

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,CO2_CONC,HT_AGL,CRTFCN_CODE,REVISION_DATE
'NSA-9BS-9TETR','9TE05-CO2P1',03-JUN-94,209,363.0,9.0,'CPI',12-AUG-97
'NSA-9BS-9TETR','9TE05-CO2P1',03-JUN-94,209,362.2,3.0,'CPI',12-AUG-97
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by 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

Not applicable.

9.1.1 Derivation Techniques and Algorithms

IRGA zero value changes as a function of temperature. To correct the data for this drift, standard gases (0 ppm and 350 ppm) and IRGA temperature were measured every 3 hours. A linear relationship was derived between temperature and the zero value. Using IRGA temperature, all data were corrected based on the linear relationship. The number was added to the observed data, and the correction was usually quite small, under 5 ppm.

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

IRGA zero value changes as a function of temperature. To correct the data for this drift, standard gases (0 ppm and 350 ppm) and IRGA temperature were measured every 3 hours. A linear relationship was derived between temperature and the zero value. Using IRGA temperature, all data were corrected based on the linear relationship.

9.3.2 Calculated Variables

Not applicable.

9.4 Graphs and Plots

Not applicable.

10. Errors

10.1 Sources of Error

None given.

10.2 Quality Assessment

10.2.1 Data Validation by Source

CO₂ was independently measured at 9 m and 0.5 m when TE-05 sampled CO₂ for isotope analysis. The concentration values from the isotope measurements were compared with these automated data sets. In all cases, the values are comparable.

10.2.2 Confidence Level/Accuracy Judgment

All known errors have been removed from the data.

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

All known problems have been removed.

11.3 Usage Guidance

None given.

11.4 Other Relevant Information

None given.

12. Application of the Data Set

These data can be used for profile isotope analysis.

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 diurnal CO₂ canopy profile data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

15.1 Contact Information

For BOREAS data and documentation please contact:

ORNL DAAC User Services
Oak Ridge National Laboratory
P.O. Box 2008 MS-6407
Oak Ridge, TN 37831-6407
Phone: (423) 241-3952
Fax: (423) 574-4665
E-mail: ornldaac@ornl.gov or ornl@eos.nasa.gov

15.2 Data Center Identification

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics
<http://www-eosdis.ornl.gov>.

15.3 Procedures for Obtaining Data

Users may obtain data directly through the ORNL DAAC online search and order system [<http://www-eosdis.ornl.gov/>] and the anonymous FTP site [<ftp://www-eosdis.ornl.gov/data/>] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

15.4 Data Center Status/Plans

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

16. Output Products and Availability

16.1 Tape Products

None.

16.2 Film Products

None.

16.3 Other Products

These data are available on the BOREAS CD-ROM series.

17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation

None given.

17.2 Journal Articles and Study Reports

Brooks, J.R., L.B. Flanagan, G.T. Varney, and J.R. Ehleringer. 1995. Photosynthesis Profiles in Boreal Forest Canopies: Recycling of Soil-Respired CO₂. Ecological Society of America Annual Meetings, Snowbird, UT, 1995.

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 CO₂ within boreal forest canopies. *Tree Physiol.* 17: 1-12.

Brooks, J.R., L.B. Flanagan, N. Buchmann, and J.R. Ehleringer. 1997. Carbon isotope composition of boreal plants: functional grouping of life forms. *Oecologia*.

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.

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
GMT	- Greenwich Mean Time
GSFC	- Goddard Space Flight Center
HTML	- HyperText Markup Language
IFC	- Intensive Field Campaign
IRGA	- Infrared Gas Analyzer
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
UBS	- Upland Black Spruce
URL	- Uniform Resource Locator
UTM	- Universal Transverse Mercator

20. Document Information

20.1 Document Revision Date

Written: 03-May-1995

Last Updated: 02-Jun-1999

20.2 Document Review Date(s)

BORIS Review: 07-Sep-1997

Science Review: 19-Jan-1998

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 CO₂ and H₂O 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

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13. ABSTRACT (Maximum 200 words) The BOREAS TE-5 team collected several data sets to investigate the vegetation-atmosphere CO ₂ and H ₂ O exchange processes. These data were collected to provide detailed information within the canopy during times when TE-05 sampled canopy CO ₂ for carbon and oxygen isotope analysis. These measurements were made in both the NSA and SSA at the OJP, OBS, UBS, and OA sites from 25-May-1994 to 08-Sep-1994. CO ₂ profile data were not collected at SSA-OA during the first IFC. The data are available in tabular ASCII files.				
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