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

Forrest G. Hall and David E. Knapp, Editors

Volume 215
BOREAS TF-11 SSA-Fen
Leaf Gas Exchange Data

Timothy J. Arkebauer
University of Nebraska-Lincoln

November 2000
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Timothy J. Arkebauer
University of Nebraska-Lincoln

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

November 2000
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Timothy J. Arkebauer

Summary

The BOREAS TF-11 team gathered a variety of data to complement its tower flux measurements collected at the SSA-Fen site. This data set contains single-leaf gas exchange data from the SSA-Fen site during 1994 and 1995. These leaf gas exchange properties were measured for the dominant vascular plants using portable gas exchange systems. The data are stored in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS TF-11 SSA-Fen Leaf Gas Exchange Data

1.2 Data Set Introduction

The BOREal Ecosystem-Atmosphere Study (BOREAS) Tower Flux (TF)-11 team collected single-leaf gas exchange data at the Southern Study Area (SSA)-Fen site in 1994 and 1995. These leaf gas exchange properties were measured for the dominant vascular plants using portable gas exchange systems. The variables that were measured include leaf species, leaf area, boundary layer conductance, leaf temperature, net CO₂ assimilation rate, stomatal conductance, internal CO₂ concentration, photosynthetic photon flux density (PPFD), air temperature, CO₂ concentration, relative humidity, and air vapor pressure.

1.3 Objectives/Purpose

The objectives of this study were to quantify the response of leaf gas exchange properties (e.g., net CO₂ assimilation rate, stomatal conductance) to environmental conditions in the field and to determine diurnal and seasonal changes in leaf gas exchange properties.
1.4 Summary of Parameters
Each data record includes the date and time of measurements, leaf properties (species, leaf area, boundary layer conductance, leaf temperature, net CO₂ assimilation rate, stomatal conductance, internal CO₂ concentration), and environmental conditions (PPFD, air temperature, CO₂ concentration, relative humidity, air vapor pressure).

1.5 Discussion
Our overall project goal was to investigate the surface-atmosphere exchange of carbon dioxide and methane, and the associated energy fluxes, at the SSA-Fen site. Leaf-level gas exchange measurements were made in the field on the dominant vascular plant species growing at the SSA-Fen site. Our primary focus was on Betula pumila (bog birch) and Menyanthes trifoliata (buckbean) based on the relative abundance (as reflected in, e.g., leaf area index (LAI)) of these species in the fen. A limited set of measurements was also made on Carex (sedge) species, mostly Carex diandra.

1.6 Related Data Sets
- BOREAS TF-11 SSA-Fen Tower Flux and Meteorological Data
- BOREAS TF-11 SSA-Fen 1996 Water Surface Film Capping Data
- BOREAS TF-11 SSA-Fen Soil Surface CO₂ Flux Data
- BOREAS TF-11 SSA-Fen 1995 Leaf Area Index Data

2. Investigator(s)

2.1 Investigator(s) Name and Title
Dr. Timothy J. Arkebauer, Associate Professor
Department of Agronomy
University of Nebraska-Lincoln

Dr. Shashi B. Verma, Professor
Department of Agricultural Meteorology
University of Nebraska-Lincoln

2.2 Title of Investigation
Field Micrometeorological Measurements, Process-Level Studies and Modeling of Methane and Carbon Dioxide Fluxes in a Boreal Wetland Ecosystem

2.3 Contact Information

Contact 1
Dr. Timothy J. Arkebauer
Department of Agronomy
106 KCR Building
University of Nebraska
Lincoln, NE 68583-0817 USA
(402) 472-2847
(402) 472-3654 (fax)
tja@unlinfo.unl.edu
3. Theory of Measurements

Most gas exchange measurements were made by using an LI-6200 system in the closed-circuit mode. The net CO₂ assimilation rate is calculated via the change in CO₂ concentration in the sample chamber with time. Stomatal conductance is calculated from the rate of change of water vapor concentration with time, the fraction of the total system flow through the desiccant, and the (previously determined) boundary layer conductance of the leaf. Further details can be found in the LI-6200 Technical Reference Manual (LI-COR, Inc., 1990).

Measurements were also made with an LI-6400 system operated in the open mode. Here, the net CO₂ assimilation rate is calculated via the difference between the CO₂ concentration entering and exiting the sample chamber. Similarly, the stomatal conductance is a function of the water vapor concentrations entering and exiting the sample chamber, in conjunction with the boundary layer conductance of the leaf. Further details can be found in the LI-6400 Technical Reference Manual (LI-COR, Inc., 1995).

In all cases, the internal CO₂ concentrations of the leaves were calculated based on the measured net CO₂ assimilation rates and leaf conductances. Additional information on the theory related to leaf gas exchange measurements can be found in Ball (1987).

4. Equipment

4.1 Instrument Description

Most of the measurements were made with an LI-6200 Portable Photosynthesis System. Several measurements were made with a prototype LI-6400 Portable Photosynthesis System.

4.1.1 Collection Environment

All measurements were made on intact plants in the field at the SSA-Fen site under ambient environmental conditions.

4.1.2 Source/Platform

Measurements were made from platforms or boardwalks raised approximately 0.2 m above the fen surface.

4.1.3 Source/Platform Mission Objectives

None given.

4.1.4 Key Variables

Leaf properties: net CO₂ assimilation rate, stomatal conductance, internal CO₂ concentration, leaf temperature. Environmental conditions: air temperature, air vapor pressure, incident PPFD, air CO₂ concentration.
4.1.5 Principles of Operation

The LI-6200 was operated in the closed mode. Net CO₂ assimilation rate was determined from the time rate of change of CO₂ concentration in the sample chamber. Stomatal conductance was determined from the time rate of change of water vapor concentration in the chamber, in conjunction with the fraction of the system flow diverted through the desiccant and the (previously determined) leaf boundary layer conductance. CO₂ concentrations were measured with an infrared gas analyzer (IRGA). A pump circulated the air from the sample chamber, through the analyzer, and back into the sample chamber. Water vapor concentrations in the sample chamber were determined by a Vaisala humidity chip and a thermistor sensing the air temperature. Leaf temperatures were determined by a thermocouple pair that measured the temperature difference between the air thermistor and a thermocouple appressed to the leaf.

The LI-6400 was operated in the open mode. Net CO₂ assimilation rate was determined from the difference between the CO₂ concentration entering and exiting the sample chamber. Stomatal conductance was determined by the difference between the water vapor concentrations entering and exiting the chamber. Both CO₂ and water vapor concentrations were measured with a pair of IRGAs.

Additional information can be found in the LI-COR LI-6200 and LI-6400 Technical Reference manuals.

4.1.6 Sensor/Instrument Measurement Geometry

None given.

4.1.7 Manufacturer of Instrument

LI-COR, Inc.
P.O. Box 4425
4421 Superior Street
Lincoln, NE 68504 USA
(402) 467-3576
(402) 467-2819 (fax)

4.2 Calibration

4.2.1 Specifications

The IRGAs, the humidity chips, the flow meters, and the quantum sensors were calibrated by the manufacturer prior to each field season. The zero and span of the LI-6200 CO₂ analyzer and the zeros and spans of the LI-6400 CO₂ and water vapor analyzers were calibrated against known standard gases in the field.

4.2.1.1 Tolerance

None given.

4.2.2 Frequency of Calibration

Annual calibration of the IRGAs, the humidity chips, the flow meters, and the quantum sensors was done by the manufacturer. Daily calibration of the zero and span of the IRGAs in the field. The CO₂ zero and the flow meter zero were checked and adjusted several times daily.

4.2.3 Other Calibration Information

Calibration gases for the IRGAs were obtained from Acklands, 1042 Quebec Ave., Saskatoon, Saskatchewan CANADA, S7K 1V5 (Primary supplier: Linde gas, Alberta, CANADA). These gases were calibrated against gases of known concentration traceable to the National Oceanic and Atmospheric Administration (NOAA), Boulder, CO.

The LI-6400 water vapor analyzer span was calibrated using an LI-610 Dew Point Generator (LI-COR, Inc., Lincoln, NE 68504).
5. Data Acquisition Methods

A positive net CO₂ assimilation rate (e.g., photosynthesis) means that the net flux of CO₂ is into the leaf. A negative net CO₂ assimilation rate (e.g., respiration) indicates the net flux of CO₂ is out of the leaf.

Measurements of Betula and Menyanthes were made on single leaves (or portions of single leaves). For Carex measurements, several (typically 10 to 12) leaves were taped together, and the resulting rectangular area was placed in the sample chamber.

The LI-6200 measurements were made with a 0.25-liter sample chamber. Most measurements were made on plants growing adjacent to either the main (eddy correlation) boardwalk or raised platforms located approximately 200 m north and south of the main boardwalk. Most measurements were made under natural illumination (sunlight); however, a limited number of measurements were made with a red light emitting diode (LED) light source in conjunction with a LI-6400 gas exchange system. Leaves to be measured were placed in the sample chamber without altering their original orientation. The sample chamber was held with a tripod standing on the fen surface. Light response curves were usually made by attenuating natural illumination with neutral density filters. Respiration rates were determined after enclosing leaves in an opaque film-changing bag. Assimilation rates versus internal CO₂ concentration responses were determined using a transient technique with an LI-6200 gas exchange system. The net CO₂ assimilation rate and the internal CO₂ concentrations for these studies were corrected for chamber leaks, and an external fan was used to moderate chamber temperatures (for details see McDermitt et al., 1989). Leaf areas for irregularly shaped leaves (e.g., most of the Betula samples) were determined by tracing the leaf outline on ruled graph paper.

6. Observations

6.1 Data Notes
None given.

6.2 Field Notes
A limited set of field notes and observations is available by request from T.J. Arkebauer.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage
Most measurements were made on plants growing adjacent to either the main (eddy correlation) boardwalk or raised platforms located approximately 200 m from the eddy correlation instrumentation, north and south of the main boardwalk. The North American Datum of 1983 (NAD83) corner coordinates of the SSA-Fen site are:

<table>
<thead>
<tr>
<th>Site</th>
<th>Longitude</th>
<th>Latitude</th>
<th>BOREAS X</th>
<th>BOREAS Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSA-Fen</td>
<td>104.61798° W</td>
<td>53.80206° N</td>
<td>419.527</td>
<td>330.991</td>
</tr>
</tbody>
</table>

7.1.2 Spatial Coverage Map
Not available.

7.1.3 Spatial Resolution
Not applicable.
7.1.4 Projection
These data were collected at point locations.

7.1.5 Grid Description
None.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage
Measurements were made from 08-Jun through 07-Sep-1994 and 30-Jun through 06-Aug-1995.

7.2.2 Temporal Coverage Map
None.

7.2.3 Temporal Resolution
None given.

7.3 Data Characteristics

7.3.1 Parameter/Variable
The parameters contained in the data files on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
</tr>
<tr>
<td>SUB_SITE</td>
</tr>
<tr>
<td>DATE_OBS</td>
</tr>
<tr>
<td>TIME_OBS</td>
</tr>
<tr>
<td>INSTRUMENT_NUM</td>
</tr>
<tr>
<td>GENUS</td>
</tr>
<tr>
<td>LEAF_ID</td>
</tr>
<tr>
<td>LEAF_AREA</td>
</tr>
<tr>
<td>STUDY_TYPE</td>
</tr>
<tr>
<td>OBS_NUM</td>
</tr>
<tr>
<td>ELAPSED_TIME_INIT</td>
</tr>
<tr>
<td>DOWN_PPDF_CHAMBER</td>
</tr>
<tr>
<td>LEAF_TEMP</td>
</tr>
<tr>
<td>AIR_TEMP_CHAMBER</td>
</tr>
<tr>
<td>CO2_CONC_CHAMBER</td>
</tr>
<tr>
<td>AIR_FLOW_CHAMBER</td>
</tr>
<tr>
<td>REL_HUM_CHAMBER</td>
</tr>
<tr>
<td>VAPOR_PRESS_CHAMBER</td>
</tr>
<tr>
<td>CO2_ASSIMILATION</td>
</tr>
<tr>
<td>STOMATAL_MOLAR_CONDUCT_H2O</td>
</tr>
<tr>
<td>INTERCELL_CO2_CONC</td>
</tr>
<tr>
<td>BOUND_LAYER_MOLAR_CONDUCT_H2O</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
</tr>
<tr>
<td>REVISION_DATE</td>
</tr>
</tbody>
</table>
7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
<td>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.</td>
</tr>
<tr>
<td>SUB_SITE</td>
<td>The identifier assigned to the sub-site by BOREAS, in the format GGGGG-III, 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.</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>The date on which the data were collected.</td>
</tr>
<tr>
<td>TIME_OBS</td>
<td>The Greenwich Mean Time (GMT) when the data were collected.</td>
</tr>
<tr>
<td>INSTRUMENT_NUM</td>
<td>The instrument number used for the measurement. If = 6400, the LI-COR 6400 was used. Otherwise, the LI-COR 6200 was used and the number indicates the LI-COR 6200 file number.</td>
</tr>
<tr>
<td>GENUS</td>
<td>The genus of the plant sample, where Betula=Betula pumila, Menyanthes=Menyanthes trifoliata, and Carex=Carex sp. (primarily Carex diandra).</td>
</tr>
<tr>
<td>LEAF_ID</td>
<td>The unique leaf identifier, within a day.</td>
</tr>
<tr>
<td>LEAF_AREA</td>
<td>The area of the leaf (or needles) enclosed in the chamber, this value is always half the total surface area of the sample.</td>
</tr>
<tr>
<td>STUDY_TYPE</td>
<td>An indicator of the type of study being conducted. Pn=net photosynthesis, Lr=light response curve, Rd=dark respiration, Aci=net CO2 assimilation versus internal CO2 concentration curve, Vr=vapor pressure deficit response. Note: these are not mutually exclusive designations.</td>
</tr>
<tr>
<td>OBS_NUM</td>
<td>The observation number.</td>
</tr>
<tr>
<td>ELAPSED_TIME_INIT</td>
<td>The elapsed time since the initiation of the measurement indicated by the observation time.</td>
</tr>
<tr>
<td>DOWN_PPFD_CHAMBER</td>
<td>The incoming photosynthetic photon flux density measured in the chamber.</td>
</tr>
<tr>
<td>LEAF_TEMP</td>
<td>The leaf or shoot temperature</td>
</tr>
<tr>
<td>AIR_TEMP_CHAMBER</td>
<td>The temperature of the air in the chamber.</td>
</tr>
<tr>
<td>CO2_CONC_CHAMBER</td>
<td>The CO2 concentration of the air in the chamber.</td>
</tr>
<tr>
<td>AIR_FLOW_CHAMBER</td>
<td>The total air flow rate through the system.</td>
</tr>
<tr>
<td>REL_HUM_CHAMBER</td>
<td>The relative humidity of the air in the chamber.</td>
</tr>
<tr>
<td>VAPOR_PRESS_CHAMBER</td>
<td>Vapor pressure of the air in the chamber.</td>
</tr>
<tr>
<td>CO2_ASSIMILATION</td>
<td>CO2 assimilation on leaf area basis</td>
</tr>
<tr>
<td>STOMATAL_MOLAR_CONDUCT_H2O</td>
<td>Stomatal conductance of water vapor.</td>
</tr>
<tr>
<td>INTERCELL_CO2_CONC</td>
<td>Intercellular CO2 concentration.</td>
</tr>
<tr>
<td>BOUND_LAYER_MOLAR_CONDUCT_H2O</td>
<td>The boundary layer conductance for water vapor of the sample.</td>
</tr>
</tbody>
</table>
7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

<table>
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<th>Units</th>
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<td>SUB_SITE</td>
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<tr>
<td>DATE_OBS</td>
<td>[DD-MON-YY]</td>
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<tr>
<td>TIME_OBS</td>
<td>[HHMM GMT]</td>
</tr>
<tr>
<td>INSTRUMENT_NUM</td>
<td>[unitless]</td>
</tr>
<tr>
<td>GENUS</td>
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<tr>
<td>LEAF_ID</td>
<td>[unitless]</td>
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<tr>
<td>LEAF_AREA</td>
<td>[millimeter^2]</td>
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<tr>
<td>STUDY_TYPE</td>
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</tr>
<tr>
<td>OBS_NUM</td>
<td>[unitless]</td>
</tr>
<tr>
<td>ELAPSED_TIME_INIT</td>
<td>[seconds]</td>
</tr>
<tr>
<td>DOWN_PPFD_CHAMBER</td>
<td>[micromoles][meters^-2][second^-1]</td>
</tr>
<tr>
<td>LEAF_TEMP</td>
<td>[degrees Celsius]</td>
</tr>
<tr>
<td>AIR_TEMP_CHAMBER</td>
<td>[degrees Celsius]</td>
</tr>
<tr>
<td>CO2_CONC_CHAMBER</td>
<td>[parts per million]</td>
</tr>
<tr>
<td>AIRFLOW_CHAMBER</td>
<td>[micromoles][second^-1]</td>
</tr>
<tr>
<td>REL_HUM_CHAMBER</td>
<td>[percent]</td>
</tr>
<tr>
<td>VAPOR_PRESS_CHAMBER</td>
<td>[millibars]</td>
</tr>
<tr>
<td>CO2_ASSIMILATION</td>
<td>[micromoles CO2][meter^-2][second^-1]</td>
</tr>
<tr>
<td>STOMATAL_MOLAR_CONDUCT_H2O</td>
<td>[millimoles H2O][meter^-2][second^-1]</td>
</tr>
<tr>
<td>INTERCELL_CO2_CONC</td>
<td>[parts per million]</td>
</tr>
<tr>
<td>BOUND_LAYER_MOLAR_CONDUCT_H2O</td>
<td>[moles H2O][meter^-2][second^-1]</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
<td>[none]</td>
</tr>
<tr>
<td>REVISION_DATE</td>
<td>[DD-MON-YY]</td>
</tr>
</tbody>
</table>

7.3.4 Data Source

The sources of the parameter values contained in the data files on the CD-ROM are:

<table>
<thead>
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<th>Column Name</th>
<th>Data Source</th>
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<td>SUB_SITE</td>
<td>[Assigned by BORIS.]</td>
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<tr>
<td>DATE_OBS</td>
<td>[Supplied by Investigator.]</td>
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<tr>
<td>LEAF_AREA</td>
<td>[Supplied by Investigator.]</td>
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<td>STUDY_TYPE</td>
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<tr>
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<td>[Supplied by Investigator.]</td>
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<td>ELAPSED_TIME_INIT</td>
<td>[Supplied by Investigator.]</td>
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<tr>
<td>DOWN_PPFD_CHAMBER</td>
<td>[Supplied by Investigator.]</td>
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</table>
### 7.3.5 Data Range

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

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<th>Column Name</th>
<th>Minimum Data Value</th>
<th>Maximum Data Value</th>
<th>Missng Data Value</th>
<th>Unrel Data Value</th>
<th>Below Data Limit</th>
<th>Not Collectd</th>
</tr>
</thead>
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<td>SITE NAME</td>
<td>SSA-FEN-FLXTR</td>
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<td>LEAF_AREA</td>
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<td>None</td>
<td>None</td>
<td>None</td>
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</table>

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

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

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

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

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

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

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

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

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

---

### 7.4 Sample Data Record

The following are wrapped versions of data records from a sample data file on the CD-ROM. The data is arranged as comma-separated variables with the following information in each record.

```
```

---

### 8. Data Organization

#### 8.1 Data Granularity

The smallest unit of data that can be ordered from this data set is the entire set of data.

#### 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
Formulae for calculating the net CO$_2$ assimilation rates, stomatal conductances, and internal CO$_2$ concentrations are given in the LI-6200 and LI-6400 Technical Reference Manuals.

9.1.1 Derivation Techniques/Algorithms
None given.

9.2 Data Processing Sequence

9.2.1 Processing Steps
- The BOREAS Information System (BORIS) received data from TF-11.
- BORIS standardized the units and loaded data into the database.
- BORIS extracted data from database into ASCII files.

9.2.2 Processing Changes
None.

9.3 Calculations

9.3.1 Special Correction/Adjustments
None.

9.3.2 Calculated Variables
None.

9.4 Graphs and Plots
None.

10. Errors

10.1 Sources of Error
Calibration drift: The flow meter zero and IRGA CO$_2$ zero exhibited occasional drifts. The zeros were set periodically throughout the day.
Dew/wetness: When leaves were wet, the stomatal conductance and internal CO$_2$ values may not be correct. Examples of spurious data include conductances less than zero and CO$_2$ concentrations in the thousands.

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
BORIS staff loaded the data into the data base and checked for any inconsistencies during loading. Certain data records were found to have unrealistic values in some of the columns. In cases where these large values prevented these records from being loaded (i.e., they did not fit in the data base column), the values were changed to -999. Only 36 records were found to have this kind of problem.

11. Notes

11.1 Limitations of the Data
None given.

11.2 Known Problems with the Data
Other than the few times measurements were made on moist leaves (as discussed above), there are no known problems with the data set.

11.3 Usage Guidance
The normal caveat of 'use at your own risk' applies. Correspondence with T.J. Arkebauer is encouraged when questions arise.
A positive net CO₂ assimilation rate (e.g., photosynthesis) means that the net flux of CO₂ is into the leaf. A negative net CO₂ assimilation rate (e.g., respiration) indicates the net flux of CO₂ is out of the leaf.

11.4 Other Relevant Information
Dr. Evan C. Jolitz was responsible for most of the day to day coordination of the field measurements. His assistance is greatly appreciated. We also thank LI-COR, Inc., for their generous contribution of the prototype LI-6400 gas exchange system.

12. Application of the Data Set
These data can be used to better understand the leaf carbon dioxide flux at a typical fen in the boreal forest.

13. Future Modifications and Plans
None.

14. Software

14.1 Software Description
None given.

14.2 Software Access
None given.
15. Data Access

The SSA-Fen 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

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

17.2 Journal Articles and Study Reports

17.3 Archive/DBMS Usage Documentation
None.

18. Glossary of Terms
None.
19. List of Acronyms

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<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
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<td>BOREAS</td>
<td>BOReal Ecosystem-Atmosphere Study</td>
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<td>BORIS</td>
<td>BOREAS Information System</td>
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<td>GMT</td>
<td>Greenwich Mean Time</td>
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<tr>
<td>GSFC</td>
<td>Goddard Space Flight Center</td>
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<tr>
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<td>Intensive Field Campaign</td>
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<td>Infrared Gas Analyzer</td>
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<td>Leaf Area Index</td>
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20. Document Information

20.1 Document Revision Date
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Last Revised: 12-Sep-1999

20.2 Document Review Date(s)
BORIS Review: 27-Apr-1999
Science Review:

20.3 Document ID

20.4 Citation
When using these data, please acknowledge T.J. Arkebauer and E.C. Jolitz and include citations of relevant papers in Section 17.2.

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


20.5 Document Curator

20.6 Document URL
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**Authors:** Timothy J. Arkebauer, Forrest G. Hall and David E. Knapp, Editors

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**Abstract:**  
The BOREAS TF-11 team gathered a variety of data to complement its tower flux measurements collected at the SSA-Fen site. This data set contains single-leaf gas exchange data from the SSA-Fen site during 1994 and 1995. These leaf gas exchange properties were measured for the dominant vascular plants using portable gas exchange systems. The data are stored in tabular ASCII files.

**Subject Terms:**  
BOREAS, tower flux, leaf gas exchange data.

**Number of Pages:** 16

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