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

Forrest G. Hall and David E. Knapp, Editors

Volume 214

BOREAS TF-11 SSA-Fen 1995
Leaf Area Index Data

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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Summary

The BOREAS TF-11 team gathered a variety of data to complement its tower flux measurements collected at the SSA-Fen site. These data are LAI measurements made by the TF-11 team throughout the 1995 growing season. The data include the LAI of plants that fall into six categories: total, Carex spp., Betula pumila, Menyanthes trifoliata, Salix spp., and other vascular plants. 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 1995 Leaf Area Index Data

1.2 Data Set Introduction
These data are Leaf Area Index (LAI) measurements made by the Tower Flux (TF)-11 team at the BOREal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA)-Fen site throughout the 1995 growing season. These data include the LAI of plants that fall into six categories: total, Carex spp., Betula pumila, Menyanthes trifoliata, Salix spp., and other vascular plants.

1.3 Objective/Purpose
The objective of this study was to quantify the distribution of green LAI during the growing season for the various plant species in the SSA-Fen.
1.4 Summary of Parameters
Each data record includes the date and the LAI in each of six categories: total, Carex spp., Betula pumila, Menyanthes trifoliata, Salix spp., and other vascular plants.

1.5 Discussion
The 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. The LAI data were collected in support of the various components of the overall project.

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 Leaf Gas Exchange Data
BOREAS TF-11 SSA-Fen Soil Surface CO2 Flux 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 (SSA-Fen)

2.3 Contact Information

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

Contact 2:
David Knapp
Raytheon ITSS
NASA GSFC
Code 923
Greenbelt, MD 20771
(301) 286-1424
(301) 286-0239 (fax)
David.Knapp@gsfc.nasa.gov
3. Theory of Measurements

LAI is the total leaf area per unit ground area. For broadleaf species, the leaf area is taken as one half the total surface area of the leaf, i.e., the area projected normal to the plane of the leaf.

4. Equipment

4.1 Instrument Description

A LI-COR LI-3100 leaf area meter was used to determine the leaf area of the samples.

4.1.1 Collection Environment

Samples were collected at the SSA-Fen site in ambient conditions from May to September 1995.

4.1.2 Source/Platform

None given.

4.1.3 Source/Platform Mission Objectives

None given.

4.1.4 Key Variables

Date, LAI for the following categories: total vascular plants, Carex spp., Betula pumila, Menyanthes trifoliata, Salix spp., and other vascular plants.

4.1.5 Principles of Operation

None given.

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

None given.

4.2.1 Specifications

The LI-3100 was operated and maintained in accordance with the manufacturer's instructions.

4.2.1.1 Tolerance

None given.

4.2.2 Frequency of Calibration

None given.

4.2.3 Other Calibration Information

None.
5. Data Acquisition Methods

A sampling area was chosen that had vegetation characteristics similar to the eddy correlation instrumentation "footprint." This area was located several hundred meters south of the main eddy correlation boardwalk.

A transect approximately 200 m long was laid out in an east-west direction. The transect was divided into four 50-m-long subtransects, giving a total of 20 samples. On each sampling date, five locations were chosen at random along each of the four subtransects giving a total of 20 samples. All the vegetation above the surface of a 0.25 m² area at each location was harvested. Samples were placed in plastic ziplock bags and transported to the leaf area meter.

For each sample, green leaves were separated from stems and dead material. Leaf area of each of the following categories was determined: Carex spp., Betula pumila, Menyanthes trifoliata, Salix spp., and other vascular plants.

6. Observations

6.1 Data Notes
None.

6.2 Field Notes
A limited set of field notes and observations is available by request from T.J. Arkebauer (see Section 2.3).

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage
All of the data were collected in the vicinity of the SSA-Fen flux tower site. This tower is located at the following North American Datum of 1983 (NAD83) coordinates:

<table>
<thead>
<tr>
<th>Latitude</th>
<th>Longitude</th>
<th>BOREAS_X</th>
<th>BOREAS_Y</th>
<th>UTM Northing</th>
<th>UTM Easting</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.80206°N</td>
<td>104.61798°W</td>
<td>419.527</td>
<td>330.991</td>
<td>5961566.6</td>
<td>525159.8</td>
</tr>
</tbody>
</table>

7.1.2 Spatial Coverage Map
None given.

7.1.3 Spatial Resolution
Each sample was from a 0.25 m² area. There were 20 samples for each day on which measurements were taken. See Section 5 for details.

7.1.4 Projection
None given.

7.1.5 Grid Description
None given.

7.2 Temporal Characteristics
7.2.1 Temporal Coverage
Measurements were made on 20-May, 02-Jun, 22-Jun, 28-Jul, 17-Aug, 08-Sep, and 29-Sep-1995.

7.2.2 Temporal Coverage Map
None.

7.2.3 Temporal Resolution
These data were collected on particular days. See Section 7.2.1.

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>MEAN_TOTAL_LAI</td>
</tr>
<tr>
<td>STD_ERR_TOTAL_LAI</td>
</tr>
<tr>
<td>SEDGE_LAI</td>
</tr>
<tr>
<td>BOGBIRCH_LAI</td>
</tr>
<tr>
<td>MENYANTHES_LAI</td>
</tr>
<tr>
<td>SALIX_LAI</td>
</tr>
<tr>
<td>OTHER_LAI</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-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.</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>The date on which the data were collected.</td>
</tr>
<tr>
<td>MEAN_TOTAL_LAI</td>
<td>The total vascular plant mean green Leaf Area Index (mean of 20 samples).</td>
</tr>
<tr>
<td>STD_ERR_TOTAL_LAI</td>
<td>The standard error of the total vascular plant mean green Leaf Area Index.</td>
</tr>
<tr>
<td>SEDGE_LAI</td>
<td>The Leaf Area Index for all Carex species.</td>
</tr>
</tbody>
</table>
BOGBIRCH_LAI  The Leaf Area Index of Betula Pumila.
MENYANTHES_LAI  The Leaf Area Index for Menyanthes trifoliata.
SALIX_LAI  The Leaf Area Index for Salix species.
OTHER_LAI  The Leaf Area Index for all other vascular plant species.

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:

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
<td>[none]</td>
</tr>
<tr>
<td>SUB_SITE</td>
<td>[none]</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>[DD-MON-YY]</td>
</tr>
<tr>
<td>MEAN_TOTAL_LAI</td>
<td>[unitless]</td>
</tr>
<tr>
<td>STD_ERR_TOTAL_LAI</td>
<td>[unitless]</td>
</tr>
<tr>
<td>SEDGE_LAI</td>
<td>[unitless]</td>
</tr>
<tr>
<td>BOGBIRCH_LAI</td>
<td>[unitless]</td>
</tr>
<tr>
<td>MENYANTHES_LAI</td>
<td>[unitless]</td>
</tr>
<tr>
<td>SALIX_LAI</td>
<td>[unitless]</td>
</tr>
<tr>
<td>OTHER_LAI</td>
<td>[unitless]</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>
<tr>
<th>Column Name</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
<td>[Assigned by BORIS.]</td>
</tr>
<tr>
<td>SUB_SITE</td>
<td>[Assigned by BORIS.]</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>[Supplied by Investigator.]</td>
</tr>
<tr>
<td>MEAN_TOTAL_LAI</td>
<td>[Supplied by Investigator.]</td>
</tr>
<tr>
<td>STD_ERR_TOTAL_LAI</td>
<td>[Supplied by Investigator.]</td>
</tr>
<tr>
<td>SEDGE_LAI</td>
<td>[Supplied by Investigator.]</td>
</tr>
<tr>
<td>BOGBIRCH_LAI</td>
<td>[Supplied by Investigator.]</td>
</tr>
<tr>
<td>MENYANTHES_LAI</td>
<td>[Supplied by Investigator.]</td>
</tr>
<tr>
<td>SALIX_LAI</td>
<td>[Supplied by Investigator.]</td>
</tr>
<tr>
<td>OTHER_LAI</td>
<td>[Supplied by Investigator.]</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
<td>[Assigned by BORIS.]</td>
</tr>
<tr>
<td>REVISION_DATE</td>
<td>[Assigned by BORIS.]</td>
</tr>
</tbody>
</table>
### 7.3.5 Data Range

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

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Minimum Data Value</th>
<th>Maximum Data Value</th>
<th>Missing Data Value</th>
<th>Unrel Data Value</th>
<th>Below Detect Limit</th>
<th>Data Not Cllctd</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE NAME</td>
<td>SSA-FEN-FLXTR</td>
<td>SSA-FEN-FLXTR</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>SUB_SITE</td>
<td>9TF11-LAI01</td>
<td>9TF11-LAI01</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>20-MAY-95</td>
<td>29-SEP-95</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>MEAN TOTAL LAI</td>
<td>.088</td>
<td>1.281</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>STD_ERR TOTAL LAI</td>
<td>.016</td>
<td>.083</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>SEDGE LAI</td>
<td>.041</td>
<td>.286</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>BOGBIRCH LAI</td>
<td>0</td>
<td>.346</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>MENYANTHES LAI</td>
<td>0</td>
<td>.409</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>SALIX LAI</td>
<td>.001</td>
<td>.153</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>OTHER LAI</td>
<td>.017</td>
<td>.152</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
<td>CPI</td>
<td>CPI</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>REVISION_DATE</td>
<td>29-MAR-99</td>
<td>29-MAR-99</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

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

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

Missing 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.

```
SITE_NAME, SUB_SITE, DATE_OBS, MEAN_TOTAL_LAI, STD_ERR_TOTAL_LAI, SEDGE_LAI, BOGBIRCH_LAI, MENYANTHES_LAI, SALIX_LAI, OTHER_LAI, CRTFCN_CODE, REVISION_DATE
'SSA-FEN-FLXTR', '9TF11-LAI01', 20-MAY-95, .088, .016, .041, .001, 0.0, .011, .036, 'CPI', 29-MAR-99
'SSA-FEN-FLXTR', '9TF11-LAI01', 02-JUN-95, .471, .051, .114, .208, .054, .077, .017, 'CPI', 29-MAR-99
```
8. Data Organization

8.1 Data Granularity
The smallest amount 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
None given.

9.1.1 Derivation Techniques and Algorithms
None.

9.2 Data Processing Sequence
None given.

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

9.2.2 Processing Changes
None.

9.3 Calculations
None.

9.3.1 Special Corrections/Adjustments
None.

9.3.2 Calculated Variables
None.

9.4 Graphs and Plots
None.
10. Errors

10.1 Sources of Error
None given.

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 Assessment
None given.

10.2.5 Data Validation by Data Center
BORIS staff loaded the data into the data base and checked for any inconsistencies during loading.

11. Notes

11.1 Limitations of the Data
None given.

11.2 Known Problems with the Data
No problems are known to exist. However, it should noted that there are significant numbers of nonvascular plants (e.g., green and brown mosses, lichens) present in the fen that were not measured.

11.3 Usage Guidance
The normal caveat of 'use at your own risk' applies. Correspondence with T.J. Arkebauer is encouraged when questions arise or if additional data set details are required.

11.4 Other Relevant Information
Dr. Evan C. Jolitz was responsible for most of the day-to-day coordination of the field measurements, and Ms. Marlene McCloud aided in the LAI measurements. Their assistance is greatly appreciated.

In 1994 an indirect technique (LI-COR LAI-2000 Plant Canopy Analyzer) was used to estimate the total LAI at the fen site. However, for a number of reasons, these values are regarded as unreliable. Those interested in the details are urged to correspond with T.J. Arkebauer (see Section 2.3).

12. Application of the Data Set
These data can be used as estimates of LAI 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 1995 LAI 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
None.

17.2 Journal Articles and Study Reports


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
20. Document Information

20.1 Document Revision Date of This Document
Written: 30-Jun-1997
Last Revised: 12-Sep-1999

20.2 Document Review Date(s)
BORIS Review: 19-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
**Title and Subtitle**
Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)
BOREAS TF-11 SSA-Fen 1995 Leaf Area Index Data

**Authors**
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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. These data are LAI measurements made by the TF-11 team throughout the 1995 growing season. The data include the LAI of plants that fall into six categories: total, Carex spp., Betula pumila, Menyanthes trifoliata, Salix spp., and other vascular plants. The data are stored in tabular ASCII files.

**Subject Terms**
BOREAS, tower flux, leaf area index data.