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

Forrest G. Hall and Andrea Papagno, Editors

Volume 185
BOREAS TE-21 Daily Surface Meteorological Data

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

October 2000
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John Kimball, University of Montana, Missoula

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Summary

The BOREAS TE-21 team collected data sets in support of its efforts to characterize and interpret information on the meteorology of boreal forest areas. Daily meteorological data were derived from half-hourly BOREAS TF and AMS mesonet measurements collected in the SSA and NSA for the period of 01-Jan-1994 until 31-Dec-1994. The data were stored in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification
BOREAS TE-21 Daily Surface Meteorological Data

1.2 Data Set Introduction
Daily meteorological data were assembled from 1994 half-hourly BOREal Ecosystem-Atmosphere Study (BOREAS) Tower Flux (TF) and Automatic Meteorological Station (AMS) mesonet measurements collected in the Southern Study Area (SSA) and Northern Study Area (NSA).

1.3 Objective/Purpose
The purpose of this data set is to provide a full-year meteorological data base for stand hydrologic and biogeochemical model simulations at the BOREAS TF sites.
1.4 Summary of Parameters

Each data set contains the date, total incoming photosynthetically active radiation (PAR), total incoming solar radiation (direct + diffuse), total incoming longwave radiation, maximum daily air temperature, minimum daily air temperature, average daily air temperature, average daily windspeed, average daily relative humidity, daily precipitation derived from tipping bucket and Belfort gauges, and an identification flag for precipitation.

1.5 Discussion

Half-hourly meteorological data were derived from 1994 TF and AMS mesonet measurements. These data often contained temperature, wind, and humidity data at one or more heights. When data at more than one height were available, data were taken from the upper height that corresponded most closely with the top of the canopy or the upper level at which water and CO2 fluxes were measured. No attempt was made to adjust the data to account for differences in measurement heights.

Full-year half-hourly data files for each tower site were created by placing several adjacent tower site data files together in series. Missing values were then selected from adjacent data files with complete data for the same time period. Preceding data were always favored first in the selection process. The following series were used to create complete data files for each tower site:

- NSA-FEN site: NSA-FEN, NSA-OBS, NSA-OJP-SRC, NSA, INT
- NSA-OJP site: NSA-OJP-SRC, NSA-OBS, NSA-YJP, NSA-FEN, INT
- NSA-YJP site: NSA-YJP, NSA-OJP-SRC, NSA-FEN, NSA-OBS, INT
- SSA-FEN site: SSA-FEN, SSA-YA, SSA-OA-SRC, SSA-OA, INT
- SSA-OA site: SSA-OA-SRC, SSA-OA, SSA-YA, SSA-OBS, INT
- SSA-OBS site: SSA-OBS, SSA-OJP-SRC, SSA-OA, SSA-YA, INT
- SSA-OJP site: SSA-OJP-SRC, SSA-OBS, SSA-OA, SSA-OJP, INT
- SSA-YA site: SSA-YA, SSA-OA-SRC, SSA-OA, SSA-OBS, INT

where:

- NSA-FEN - NSA-FEN TF Site
- NSA-OJP-SRC - Airborne Fluxes and Meteorology (AFM)-07 Saskatchewan Research Council (SRC) Met Tower at NSA-Old Jack Pine (OJP) site
- NSA-OBS - NSA-Old Black Spruce (OBS) TF site
- NSA-YJP - NSA-YJP TF site
- SSA-OJP-SRC - AFM-07 SRC Met Tower at SSA-OJP
- NSA-YJP - NSA-Young Jack Pine (YJP) TF site
- NSA-9BS-YTH - AFM-07 SRC Met Tower at Thompson
- SSA-OA-SRC - AFM-07 SRC Met Tower at SSA-Old Aspen (OA)
- SSA-FEN - SSA-FEN TF site
- SSA-OA - SSA-OA TF site
- SSA-OBS - SSA-OBS TF site
- SSA-OJP - SSA-OJP TF site
- SSA-YA - SSA-Young Aspen (YA) TF site
- SSA - Combination of SSA-OA-SRC, SSA-OJP-SRC, NSA-OJP-SRC, NSA-9BS-YTH, and SSA-OA
- NSA - Combination of NSA-OJP-SRC, NSA-9BS-YTH, SSA-OA-SRC, SSA-OJP-SRC, and NSA-OBS
- INT - NSA and SSA with temporally interpolated missing values

Longwave incoming radiation (lw) measurement data from the NSA-OJP AMS mesonet tower site (NSA-OJP-SRC) and the SSA-OJP AMS mesonet tower site (SSA-OJP-SRC) were used to represent longwave radiation characteristics for tower sites in the BOREAS NSA and SSA, respectively. Missing values were estimated using a multiple linear regression fit between measured longwave radiation, estimated clear-sky longwave radiation, and relative humidity:
lw.est = 80.3855 + 0.7521 * lw.clr + 0.4525 * RH \hspace{1cm} (1)

where:
- lw.est = estimated lw irradiance (W/m²)
- lw.clr = estimated clear-sky lw irradiance (W/m²)
- RH = measured relative humidity (%) 

lw.clr was estimated from air temperature and relative humidity measurements using an approach described by Marks and Dozier (1979).

Incoming solar radiation and PAR files were created by combining NSA-OJP-SRC, NSA-9BS-YTH, SSA-OA-SRC, SSA-OJP-SRC, and NSA-OBS files. Missing solar radiation that was not available was estimated as (PAR * 2.0) and missing PAR radiation as 50% of the solar radiation value. Daily data were derived from the complete half-hourly data files created for each tower site. Daily tipping bucket and Belfort precipitation data were combined at each site. Precipitation data from adjacent tower sites were then used to fill in missing values. Each daily precipitation value is flagged with the identification flag of the tower site file where it came from.

The 1994 full-year half-hourly data used to create the daily data files are available upon request from Terrestrial Ecology (TE)-21.

1.6 Related Data Sets
- BOREAS AFM-07 SRC Surface Meteorological Data
- BOREAS TE-05 Surface Meteorological and Radiation Data
- BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data
- BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data
- BOREAS TF-03 NSA-OBS Tower Flux, Meteorological, and Soil Temperature Data
- BOREAS TF-04 SSA-OJP Flux and Meteorology Data
- BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data
- BOREAS TF-06 SSA-YA Surface Energy Flux and Meteorological Data
- BOREAS TF-09 SSA-OBS Tower Flux, Meteorological, and Soil Temperature Data
- BOREAS TF-10 NSA-Fen Tower Flux and Meteorological Data
- BOREAS TF-11 SSA-Fen Tower Flux and Meteorological Data

2. Investigator(s)

2.1 Investigator(s) Name and Title
- Dr. Steve Running
- Dr. John Kimball

2.2 Title of Investigation
- Simulation of Boreal Ecosystem Carbon and Water Budgets: Scaling from Local to Regional Extents

2.3 Contact Information

Contact 1:
- John Kimball
- University of Montana
- Missoula, MT 59812
- (406) 243-5616
- (406) 243-4510 (fax)
- johnk@ntsg.umt.edu
3. Theory of Measurements

None given.

4. Equipment

4.1 Sensor/Instrument Description

4.1.1 Collection Environment
Data were derived from 1994 TF and AMS mesonet measurements. Refer to the documentation for the data sets listed in Section 1.6 for further information.

4.1.2 Source/Platform
None given.

4.1.3 Source/Platform Mission Objectives
None given.

4.1.4 Key Variables
Each data set contains the date, total incoming PAR, total incoming solar radiation (direct + diffuse), total incoming longwave radiation, maximum daily air temperature, minimum daily air temperature, average daily air temperature, average daily windspeed, average daily relative humidity, daily precipitation derived from tipping bucket and Belfort gauges, and an identification flag for precipitation.

4.1.5 Principles of Operation
None given.

4.1.6 Sensor/Instrument Measurement Geometry
None given.

4.1.7 Manufacturer of Sensor/Instrument
None given.

4.2 Calibration
None given.

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 Information
Not applicable.

5. Data Acquisition Methods

See Section 1.5.

6. Observations

6.1 Data Notes
The 1994 full-year half-hourly data used to create the daily data files are available upon request from TE-21.

1994 full-year 15-minute data for the TF sites have also been created by BOREAS Information System (BORIS) staff.

6.2 Field Notes
None given.

7. Data Description

7.1 Spatial Characteristics
None given.

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

- NSA-FEN flux tower, site id T7S1T, Lat/Long: 55.91481° N, 98.42072° W, Universal Transverse Mercator (UTM) Zone 14, N: 6,196,749.6, E: 536,207.9.
- NSA-OBS flux tower, site id T3R8T, Lat/Long: 55.88007° N, 98.48139° W, UTM Zone 14, N: 6,192,853.4, E: 532,444.5.
- NSA-OJP-SRC and NSA-OJP flux tower, site id T7QST, Lat/Long: 55.92842° N, 98.62396° W, UTM Zone 14, N: 6,198,176.3, E: 523,496.2.
- NSA-YJP flux tower, site id T8S9T, Lat/Long: 55.89575° N, 98.28706° W, UTM Zone 14, N: 6,194,706.9, E: 544,583.9.
- SSA-FEN flux tower, site id F0L9T, Lat/Long: 53.80206° N, 104.61798° W, UTM Zone 13, N: 5,961,566.6, E: 525,159.8.
- SSA-OA-SRC and SSA-OA flux tower, site id G3B7T, Lat/Long: 53.62889° N, 106.19779° W, UTM Zone 13, N: 5942899.9, E: 420790.5.
- SSA-OBS flux tower, site id G814T, Lat/Long: 53.98717° N, 105.11779° W, UTM Zone 13, N: 5,982,100.5, E: 492,276.5.
- NSA-9BS-YTH mesonet tower, Station identifier number 5062922, Lat/Long: 55.8° N, 97.87° W, UTM Zone 14, N: 6,184,839, E: 570,580.
7.1.2 Spatial Coverage Map
Not available.

7.1.3 Spatial Resolution
The data are intended to represent the surface meteorological conditions at the given sites. Due to the substitution and interpolation performed to compile complete data records for each site, users should use their best judgment in interpreting the spatial nature of the data.

7.1.4 Projection
Not applicable.

7.1.5 Grid Description
Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage
Daily data were collected from 01-Jan-1994 until 31-Dec-1994.

7.2.2 Temporal Coverage Map
None given.

7.2.3 Temporal Resolution
The data represent daily surface meteorological conditions.

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>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
<td>Site name</td>
</tr>
<tr>
<td>SUB_SITE</td>
<td>Subsite</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>Observation date</td>
</tr>
<tr>
<td>DAILY_DOWN_FAS</td>
<td>Daily down FAS</td>
</tr>
<tr>
<td>DAILY_DOWN_SUN_FAS</td>
<td>Daily down SUN FAS</td>
</tr>
<tr>
<td>DAILY_DOWN_WIND_FAS</td>
<td>Daily down WIND FAS</td>
</tr>
<tr>
<td>DAILY_MAX_FAS</td>
<td>Daily max FAS</td>
</tr>
<tr>
<td>DAILY_MIN_FAS</td>
<td>Daily min FAS</td>
</tr>
<tr>
<td>DAILY_MEAN_FAS</td>
<td>Daily mean FAS</td>
</tr>
<tr>
<td>DAILY_MEAN_WIND</td>
<td>Daily mean WIND</td>
</tr>
<tr>
<td>DAILY_MEAN_PRECIP</td>
<td>Daily mean PRECIP</td>
</tr>
<tr>
<td>DAILY_PRECIP</td>
<td>Daily precipitation</td>
</tr>
<tr>
<td>PRECIP_LOCATION</td>
<td>Precipitation location</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
<td>CRTFCN code</td>
</tr>
<tr>
<td>REVISION_DATE</td>
<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>DAILY_DOWN_PAR</td>
<td>The daily downwelling photosynthetically active radiation.</td>
</tr>
<tr>
<td>DAILY_DOWN_SOLAR_RAD</td>
<td>The daily downwelling solar radiation.</td>
</tr>
<tr>
<td>DAILY_DOWN_LONGWAVE_RAD</td>
<td>The daily downwelling longwave radiation.</td>
</tr>
<tr>
<td>DAILY_MAX_AIR_TEMP</td>
<td>The daily maximum air temperature.</td>
</tr>
<tr>
<td>DAILY_MIN_AIR_TEMP</td>
<td>The daily minimum air temperature.</td>
</tr>
<tr>
<td>DAILY_MEAN_AIR_TEMP</td>
<td>The mean daily air temperature.</td>
</tr>
<tr>
<td>DAILY_MEAN_WIND_SPEED</td>
<td>The mean daily wind speed.</td>
</tr>
<tr>
<td>DAILY_MEAN_REL_HUM</td>
<td>The mean daily relative humidity.</td>
</tr>
<tr>
<td>DAILY_PRECIP</td>
<td>The daily precipitation.</td>
</tr>
<tr>
<td>PRECIP_LOCATION</td>
<td>The identification of the tower site file where the precipitation data came from.</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
<td>The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-?? (CPI but questionable).</td>
</tr>
<tr>
<td>REVISION_DATE</td>
<td>The most recent date when the information in the referenced data base table record was revised.</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>
<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>DAILY_DOWN_PAR</td>
<td>[MegaJoules][meters^-2][day^-1]</td>
</tr>
<tr>
<td>DAILY_DOWN_SOLAR_RAD</td>
<td>[MegaJoules][meters^-2][day^-1]</td>
</tr>
<tr>
<td>DAILY_DOWN_LONGWAVE_RAD</td>
<td>[MegaJoules][meters^-2][day^-1]</td>
</tr>
<tr>
<td>DAILY_MAX_AIR_TEMP</td>
<td>[degrees Celsius]</td>
</tr>
<tr>
<td>DAILY_MIN_AIR_TEMP</td>
<td>[degrees Celsius]</td>
</tr>
<tr>
<td>DAILY_MEAN_AIR_TEMP</td>
<td>[degrees Celsius]</td>
</tr>
<tr>
<td>DAILY_MEAN_WIND_SPEED</td>
<td>[meters][second^-1]</td>
</tr>
<tr>
<td>DAILY_MEAN_REL_HUM</td>
<td>[percent]</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>[BORIS Designation]</td>
</tr>
<tr>
<td>SUB_SITE</td>
<td>[BORIS Designation]</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>[Human Observer]</td>
</tr>
<tr>
<td>DAILY_DOWN_PAR</td>
<td>[Laboratory Equipment]</td>
</tr>
<tr>
<td>DAILY_DOWN_SOLAR_RAD</td>
<td>[Laboratory Equipment]</td>
</tr>
<tr>
<td>DAILY_DOWN_LONGWAVE_RAD</td>
<td>[Laboratory Equipment]</td>
</tr>
<tr>
<td>DAILY_MAX_AIR_TEMP</td>
<td>[Thermometer]</td>
</tr>
<tr>
<td>DAILY_MIN_AIR_TEMP</td>
<td>[Thermometer]</td>
</tr>
<tr>
<td>DAILY_MEAN_AIR_TEMP</td>
<td>[Laboratory Equipment]</td>
</tr>
<tr>
<td>DAILY_MEAN_WIND_SPEED</td>
<td>[Laboratory Equipment]</td>
</tr>
<tr>
<td>DAILY_MEAN_REL_HUM</td>
<td>[Laboratory Equipment]</td>
</tr>
<tr>
<td>DAILY_PRECIP</td>
<td>[Laboratory Equipment]</td>
</tr>
<tr>
<td>PRECIP_LOCATION</td>
<td>[Human Observer]</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
<td>[BORIS Designation]</td>
</tr>
<tr>
<td>REVISION_DATE</td>
<td>[BORIS Designation]</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>Missng Data Value</th>
<th>Unrel Data Value</th>
<th>Detect Limit Value</th>
<th>Collectd Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
<td>NSA-FEN-FLXTR</td>
<td>SSA-OJP-FLXTR</td>
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<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>SUB_SITE</td>
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<td>9TE21-MET01</td>
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<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>01-JAN-94</td>
<td>31-DEC-94</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>DAILY_DOWN_PAR</td>
<td>0.12217</td>
<td>12.9</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>DAILY_DOWN_SOLAR_RAD</td>
<td>0.26677</td>
<td>32.4</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>DAILY_DOWN_LONGWAVE_RAD</td>
<td>10.82358</td>
<td>32.5</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>DAILY_MAX_AIR_TEMP</td>
<td>-35.76</td>
<td>31.01</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>DAILY_MIN_AIR_TEMP</td>
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<td>19.2</td>
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<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>DAILY_MEAN_AIR_TEMP</td>
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<td>23.607</td>
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</tr>
<tr>
<td>DAILY_MEAN_WIND_SPEED</td>
<td>0.0111565</td>
<td>7.13842</td>
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<td>None</td>
<td>None</td>
<td>None</td>
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<tr>
<td>DAILY_MEAN_REL_HUM</td>
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<td>99.074</td>
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<tr>
<td>DAILY_PRECIP</td>
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<tr>
<td>PRECIP_LOCATION</td>
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<td>None</td>
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<td>None</td>
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<tr>
<td>REVISION_DATE</td>
<td>14-JAN-99</td>
<td>14-JAN-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.
Missng Data Value -- The value that indicates missing data. This is used to
Unrel Data Value -- The value that indicates unreliable data. This is used to indicate an attempt was made to determine the parameter value, but the value was deemed to be unreliable by the analysis personnel.

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

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

Blank -- Indicates that blank spaces are used to denote that type of value.
N/A -- Indicates that the value is not applicable to the respective column.
None -- Indicates that no values of that sort were found in the column.

7.4 Sample Data Record
The following are wrapped versions of data record from a sample data file on the CD-ROM.

| SITE_NAME, SUB_SITE, DATE_OBS, DAILY_DOWN_PAR, DAILY_DOWN_SOLAR_RAD, DAILY_DOWN_LONGWAVE_RAD, DAILY_MAX_AIR_TEMP, DAILY_MIN_AIR_TEMP, DAILY_MEAN_AIR_TEMP, DAILY_MEAN_WIND_SPEED, DAILY_MEAN_REL_HUM, DAILY_PRECIP, PRECIP_LOCATION, CRTFCN_CODE, REVISION_DATE |
| 'NSA-FEN-FLXTR', '9TE21-MET01', 01-JAN-94, .654753, 1.12, 22.0, -32.1, -37.8, -35.071, 2.16078, 65.3041, 0.0, 'NOJP AMS mesonet tower site', 'CPI', 14-JAN-99 |
| 'NSA-FEN-FLXTR', '9TE21-MET01', 02-JAN-94, .397476, .52705, 22.2, -29.39, -36.7, -34.083, 1.78435, 66.7298, 0.0, 'NOJP AMS mesonet tower site', 'CPI', 14-JAN-99 |

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
See Section 9.3.

9.1.1 Derivation Techniques and Algorithms
None given.

9.2 Data Processing Sequence

9.2.1 Processing Steps
Half-hourly meteorological data were derived from 1994 TF and AMS mesonet measurements. These data often contained temperature, wind, and humidity data at one or more heights. When data at more than one height were available, data were taken from the upper height that corresponded most closely with the top of the canopy or the upper level at which water and CO₂ fluxes were measured. No attempt was made to adjust the data to account for differences in measurement heights.

Full-year half-hourly data files for each tower site were created by placing several adjacent tower site data files together in series. Missing values were then selected from adjacent data files with complete data for the same time period. Preceding data were always favored first in the selection process. The following series were used to create complete data files for each tower site:

NSA-FEN site: NSA-FEN, NSA-OBS, NSA-OJP-SRC, NSA, INT
NSA-OBS site: NSA-OBS, NSA-OJP-SRC, NSA-YJP, NSA-FEN, INT
NSA-OJP site: NSA-OJP-SRC, NSA-OBS, NSA-YJP, NSA-FEN, INT
NSA-YJP site: NSA-YJP, NSA-OJP-SRC, NSA-FEN, NSA-OBS, INT
SSA-FEN site: SSA-FEN, SSA-YA, SSA-OA-SRC, SSA-OA, INT
SSA-OA site: SSA-OA-SRC, SSA-OA, SSA-YA, SSA-OBS, INT
SSA-OJP site: SSA-OJP-SRC, SSA-OBS, SSA-OA, SSA-OJP, INT
SSA-YJP site: SSA-YJP, NSA-OJP-SRC, NSA-FEN, NSA-OBS, INT

where:
NSA-FEN - NSA-FEN TF Site
NSA-OJP-SRC - AFM-07 SRC Met Tower at NSA-OJP
NSA-OBS - NSA-OBS TF site
NSA-OJP - NSA-OJP TF site
SSA-OJP-SRC - AFM-07 SRC Met Tower at SSA-OJP
NSA-YJP - NSA-YJP TF site
NSA-9BS-YTH - AFM-07 SRC Met Tower at Thompson
SSA-OA-SRC - AFM-07 SRC Met Tower at SSA-OA
SSA-FEN - SSA-FEN TF site
SSA-OA - SSA-OA TF site
SSA-OBS - SSA-OBS TF site
SSA-OJP - SSA-OJP TF site
SSA-YA - SSA-YA TF site
SSA - Combination of SSA-OA-SRC, SSA-OJP-SRC, NSA-OJP-SRC, NSA-9BS-YTH, and SSA-OA
NSA - Combination of NSA-OJP-SRC, NSA-9BS-YTH, SSA-OA-SRC, SSA-OJP-SRC, and NSA-OBS
INT - NSA and SSA with temporally interpolated missing values
9.2.2 Processing Changes
None given.

9.3 Calculations
LW measurement data from NSA-OJP-SRC and SSA-OJP-SRC were used to represent longwave radiation characteristics for tower sites in the BOREAS NSA and SSA, respectively. Missing values were estimated using a multiple linear regression fit between measured longwave radiation, estimated clear-sky longwave radiation, and relative humidity:

\[ lw\text{.est} = 80.3855 + 0.7521\times lw\text{.clr} + 0.4525\times RH \]  

where:
- \( lw\text{.est} \) = estimated LW irradiance (W/m²)
- \( lw\text{.clr} \) = estimated clear-sky LW irradiance (W/m²)
- \( RH \) = measured relative humidity (%)

\( lw\text{.clr} \) was estimated from air temperature and relative humidity measurements using an approach described by Marks and Dozier (1979).

9.3.1 Special Corrections/Adjustments
None.

9.3.2 Calculated Variables
See Section 9.3.

9.4 Graphs and Plots
None given.

10. Errors

10.1 Sources of Error
Only general error checking has been done to the data to eliminate unreasonably extreme data values. No attempt has been made to identify and correct for errors caused by location, terrain, or instrument elevation differences between TF sites. Analyses of meteorological data showed that daily temperature and humidity differences between TF sites were small within the NSA and SSA, indicating that terrain effects were generally minimal. Differences in daily data as a result of sensor height differences were also found to be small. The daily magnitudes of precipitation between sites, however, tended to be quite variable.

Greater than 80% of the temperature, precipitation, and humidity data for SSA-OJP, SSA-OA, and NSA-OJP sites were measured at those locations. At the other sites, between 20% and 40% of air temperature and humidity measurements and from 40% to 60% of precipitation measurements were actually obtained from those respective locations for 1994. Most of these data were collected during the growing season. The majority of the data during the winter months were obtained from the AMS mesonet sites, which ran over the entire year.

10.2 Quality Assessment

10.2.1 Data Validation by Source
General error checking has been done to the data to eliminate unreasonably extreme data values.
10.2.2 Confidence Level/Accuracy Judgment
See Section 10.

10.2.3 Measurement Error for Parameters
None given.

10.2.4 Additional Quality Assessments
None given.

10.2.5 Data Verification by Data Center
Data were examined for general consistency and clarity.

11. Notes

11.1 Limitations of the Data
None given.

11.2 Known Problems with the Data
None given.

11.3 Usage Guidance
None given.

11.4 Other Relevant Information
None given.

12. Application of the Data Set
This data set can be used to study the meteorological conditions of the boreal forest.

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 daily surface meteorological 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: orndaac@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 given.

17.2 Journal Articles and Study Reports


17.3 Archive/DBMS Usage Documentation
None.

18. Glossary of Terms

None given.
19. List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>AFM</td>
<td>Airborne Fluxes and Meteorology</td>
</tr>
<tr>
<td>AMS</td>
<td>Automatic Meteorological Station</td>
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<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
</tr>
<tr>
<td>BOREAS</td>
<td>BOReal Ecosystem-Atmosphere Study</td>
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<tr>
<td>BORIS</td>
<td>BOREAS Information System</td>
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<tr>
<td>CD-ROM</td>
<td>Compact Disk-Read-Only memory</td>
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<td>EOS</td>
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<td>EOSDIS</td>
<td>EOS Data and Information System</td>
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<tr>
<td>FEN</td>
<td>Fen TF Site</td>
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<td>GMT</td>
<td>Greenwich Mean Time</td>
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<td>GSFC</td>
<td>Goddard Space Flight Center</td>
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<tr>
<td>HTML</td>
<td>HyperText Markup Language</td>
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<tr>
<td>IFC</td>
<td>Intensive Field Campaign</td>
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<td>INT</td>
<td>NSA and SSA with temporally interpolated missing values</td>
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<tr>
<td>LW</td>
<td>Long-wave Incoming Radiation</td>
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<tr>
<td>MIX</td>
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<td>NAD83</td>
<td>North American Datum of 1983</td>
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<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
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<tr>
<td>ORNL</td>
<td>Oak Ridge National Laboratory</td>
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<tr>
<td>PANP</td>
<td>Prince Albert National Park</td>
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<tr>
<td>PAR</td>
<td>Photosynthetically Active Radiation</td>
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<td>Universal Transverse Mercator</td>
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20. Document Information

20.1 Document Revision Date
Written: 08-May-1996
Last Updated: 30-Aug-1999

20.2 Document Review Date(s)
Science Review:

20.3 Document ID
None.

20.4 Citation
When using these data, please include the following acknowledgment as well as citations of relevant papers in Section 17.2:
John Kimball of the University of Montana.

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
The BOREAS TE-21 team collected data sets in support of its efforts to characterize and interpret information on the meteorology of boreal forest areas. Daily meteorological data were derived from half-hourly BOREAS TF and AMS mesonet measurements collected in the SSA and NSA for the period of 01-Jan-1994 until 31-Dec-1994. The data were stored in tabular ASCII files.