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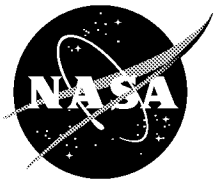

Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Jeffrey A. Newcomer, Editors

Volume 121

BOREAS Derived Surface Meteorological Data

Tracy Twine, University of Wisconsin
Donald Rinker, Research and Data Systems
David Knapp, Raytheon ITSS

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

September 2000

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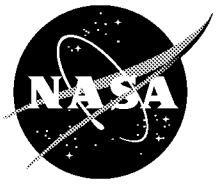

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BOREAS Derived Surface Meteorological Data

Tracy Twine, Donald Rinker, David Knapp

Summary

In 1995, the BOREAS science teams identified the need for a continuous surface meteorological and radiation data set to support flux and surface process modeling efforts. This data set contains actual, substituted, and interpolated 15-minute meteorological and radiation data compiled from several surface measurements sites over the BOREAS SSA and NSA. Temporally, the data cover 01-Jan-1994 to 31-Dec-1996. The data are stored in tabular ASCII files, and are classified as AFM-Staff data.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS Derived Surface Meteorological Data

1.2 Data Set Introduction

The 1994-96 surface meteorological modeling data set contains actual and 'derived' 15-minute meteorological and radiation data from four BOReal Ecosystem-Atmosphere Study (BOREAS) sites. These surface meteorological data were compiled to create a continuous set of surface meteorological and radiation parameters (i.e., no data gaps) for use by BOREAS modeling groups. The data were compiled from various meteorological measurement sites in the BOREAS Northern Study Area (NSA) and Southern Study Area (SSA). Data gaps were filled by interpolation or substitution depending on the length of time that data were missing. If the gap was 2 hours or less, the data were interpolated. For data gaps greater than 2 hours, the data were filled with data from other instruments from the same study area.

1.3 Objective/Purpose

This data set was compiled in order to provide a continuous surface meteorological data set for use in modeling activities.

1.4 Summary of Parameters

Parameters include:

- Date
- Time
- Air Temperatures
- Pressure
- Humidity
- Wind Components
- Precipitation
- Snow Depth
- Radiation Fields
- Soil Temperatures

1.5 Discussion

The BOREAS Staff Science effort covered those activities that were BOREAS community-level activities or required uniform data collection procedures across sites and time. These activities included the compilation of integrated data sets for various purposes. These meteorological data were compiled to create a continuous set of surface meteorological and radiation parameters (i.e., no data gaps) for use in various modeling efforts.

1.6 Related Data Sets

The data sets used in creating this data set are:
BOREAS AFM-07 SRC Surface Meteorological Data
BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data
BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data
BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data
Atmospheric Environment Service (AES) Thompson Airport Snow and Precipitation Reports

Related data sets include:
BOREAS AES Campbell Scientific Surface Meteorological Data
BOREAS AES READAC Surface Meteorological Data
BOREAS AES MARS II Surface Meteorological Data
BOREAS AFM-05 Level-1 Upper Air Network Data
BOREAS AFM-05 Level-2 Upper Air Network Standard Pressure Level Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

BOREAS Staff Science

2.2 Title of Investigation

BOREAS Staff Science Meteorological Data Acquisition Program

2.3 Contact Information

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3. Theory of Measurements

This data set was compiled in order to provide a continuous and standard surface meteorological data set for modeling efforts. The majority of the measurements were made from BOREAS Saskatchewan Research Council (SRC) towers, which were generally colocated with BOREAS flux towers. Other SRC tower sites were spread across the BOREAS region. The SRC network provided meteorological data representative of the BOREAS region to be used in conjunction with other BOREAS data sets to better understand the climate of the boreal region.

4. Equipment

4.1 Sensor/Instrument Description

The following provides a list of the instruments used to measure various parameters in the data set. More detailed instrument information is provided in the original data set documents found in the references of Section 17.

SRC Equipment

- Single Channel Sensor: This instrument measures photosynthetically active radiation (PAR).
- Q-6 Net Radiometer: This instrument measures net radiation.
- Eppley Model PSP Precision Spectral Pyranometers: These instruments measure total incoming shortwave radiation and reflected shortwave radiation.
- Model HMP35CF Temperature Relative Humidity Probe: This instrument measures above canopy air temperature and relative humidity.
- Model 107F Temperature Probe: This instrument measures within canopy air temperature.
- Model 107BAM Temperature Probes: These instruments measure soil temperature.
- 4000AL Everest Interscience Infrared Thermometer: This instrument measures infrared (canopy radiative) temperature.
- Setra SBP270 Barometric Pressure Sensor: This instrument measures station pressure.

- R.M. Young Wind Monitor (Model 05103-10): This instrument measures horizontal wind speed and direction.
- Belfort Rainfall Transmitter: This instrument measures cumulative precipitation.
- UDG01 Ultrasonic Depth Gauge: This instrument measures snow depth.
- Model TE525 Tipping Bucket Rain Gauge: This instrument measures the intensity of rainfall.
- Eppley Precision Infrared Radiometer (Pyrgeometer) (Model PIR): This instrument measures incoming longwave radiation.
- Eppley Precision Pyranometer (Model PSP) and Eppley Shadow Band Stand: These instruments measure diffuse shortwave radiation.

Tower Flux (TF)-02 Equipment

- R.M. Young Model 05103: This instrument measures horizontal wind speed and direction.
- Eppley Model PSP Precision Spectral Pyranometer: This instrument measures total incoming shortwave radiation.
- LI-COR Model LI-190SB: This instrument measures PAR.
- Net Radiometer Swissteco Model S-1: This instrument measures net radiation.
- Weathertronics 5124: This instrument measures above canopy air temperature and relative humidity.
- Setra SBP270 Barometric Pressure Sensor: This instrument measures station pressure.
- 4000A Everest Interscience Infrared Thermometer: This instrument measures infrared (canopy radiative) temperature.
- Texas Electronics Tipping Bucket Rain Gauge: This instrument measures the intensity of rainfall.

TF-05 Equipment

- LI-COR Model LI-190S: This instrument measures PAR.
- Net Radiometer (Swissteco Model S-1 or Rebs Model 6): These instruments measure net radiation.
- Campbell Model 207: This instrument measures air temperature.
- Vaisala, Model HMP-35A: This instrument measures relative humidity.
- R.M. Young Model 05701: This instrument measures horizontal wind speed and direction.
- Everest Radiation Thermometer (Model 112C): This instrument measures infrared (canopy radiative) temperature.

4.1.1 Collection Environment

Data were collected continuously in all kinds of weather from 01-Jan-1994 through 31-Dec-1996. Missing data in the NSA resulted in the data set beginning 18-Jan-1994 and ending 01-Dec-1996 for the NSA-Old Jack Pine (OJP) site and Thompson airport (NSA-YTH). Sites are located in forested areas of aspen and jack pine. Please refer to Airborne Fluxes and Meteorology (AFM)-07 SRC Meteorological and Radiation Data Set documentation, TF-02 documentation, TF-05 documentation, and TF-01 documentation for more detailed information on data collection.

4.1.2 Source/Platform

Data were collected from towers extending from the ground to above canopy height. Instruments were placed on these towers along with the necessary data logging and communication equipment to remotely transfer the data to SRC in Saskatoon. Data were checked every 6 hours for errors. Instrument failure was corrected within several days of detection. Please refer to AFM-07 SRC Meteorological and Radiation Data Set documentation, TF-02 documentation, TF-05 documentation, and TF-01 documentation for more detailed information on data collection.

4.1.3 Source/Platform Mission Objectives

Please refer to the BOREAS AFM-07 SRC Surface Meteorological Data, BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data, BOREAS TF-02 SSA-Old Aspen (OA) Tower Flux and Meteorological Data, and BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data documents for more detailed information on data collection.

4.1.4 Key Variables

YEAR
JULIAN DAY
DATE
TIME
ABOVE CANOPY AIR TEMPERATURE
WITHIN CANOPY AIR TEMPERATURE
STATION PRESSURE
RELATIVE HUMIDITY
MIXING RATIO
U COMPONENT OF WIND
V COMPONENT OF WIND
PRECIPITATION
SNOW DEPTH
TOTAL INCOMING SHORTWAVE RADIATION
INCOMING PAR
REFLECTED SHORTWAVE RADIATION
NET RADIATION
INFRARED (CANOPY RADIATIVE) TEMPERATURE
SOIL TEMPERATURE AT 10CM DEPTH
SOIL TEMPERATURE AT 20CM DEPTH
SOIL TEMPERATURE AT 50CM DEPTH
DIFFUSE INCOMING SHORTWAVE RADIATION
INCOMING LONGWAVE RADIATION
PARAMETER FLAGS

4.1.5 Principles of Operation

Please refer to the BOREAS AFM-07 SRC Surface Meteorological Data, BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data, BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data, and BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data documents for more detailed information on data collection.

4.1.6 Sensor/Instrument Measurement Geometry

Please refer to the BOREAS AFM-07 SRC Surface Meteorological Data, BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data, BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data, and BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data documents for more detailed information on data collection.

4.1.7 Manufacturer of Sensor/Instrument

Please refer to the BOREAS AFM-07 SRC Surface Meteorological Data, BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data, BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data, and BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data documents for more detailed information on data collection.

4.2 Calibration

4.2.1 Specifications

4.2.1.1 Tolerance

Please refer to the BOREAS AFM-07 SRC Surface Meteorological Data, BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data, BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data, and BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data documents for more detailed information on data collection.

4.2.2 Frequency of Calibration

Please refer to the BOREAS AFM-07 SRC Surface Meteorological Data, BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data, BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data, and BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data documents for more detailed information on data collection.

4.2.3 Other Calibration Information

Please refer to the BOREAS AFM-07 SRC Surface Meteorological Data, BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data, BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data, and BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data documents for more detailed information on data collection.

5. Data Acquisition Methods

To begin the compilation of this data set, the required parameters were extracted from the SRC tables in the BOREAS Information System (BORIS) data base into files containing each year of 15-minute data for each of the four sites. Flux tower data from TF-02 and TF-05 were also acquired so that available parameters could be used as substitute data when the SRC data were missing. Snow and precipitation data were also acquired for several days from the AES station at Thompson Airport, Thompson, Manitoba when SRC and TF snow and precipitation data were missing.

6. Observations

6.1 Data Notes

There were many gaps in the initially extracted SRC data. When these data gaps lasted less than 2 hours, the missing data were linearly interpolated from bounding values. If data were missing for more than 2 hours, data from that time period were substituted from the other SRC site within that study area if data were available. When data were missing from both sites, data were also linearly interpolated from bounding values since none of the time periods lasted more than several hours. Because precipitation cannot be readily interpolated, all efforts were made to determine precipitation amounts during a period of missing data by using known information. If precipitation was missing for a block of time but the Belfort gauge showed the same amount of precipitation when the site came back online as it showed just before the site went down, it was assumed that no precipitation fell during that period of time (i.e., precipitation values are shown as zero). If Belfort information was not known, precipitation was substituted from the other SRC site within the same study area. Because snow depth varies more from site to site than from day to day, snow may be interpolated while other data have been substituted. This is done to give a more accurate estimation of actual snow depth.

The following list shows the data gaps that remained after both interpolation and substitution were performed (all times in Greenwich Mean Time (GMT)):

```
SSA-OA:
            INFRARED TEMPERATURE    01-JAN-94:0000 to 15-FEB-94:2345
            DIFFUSE SHORTWAVE       01-JAN-94:0000 to 18-FEB-94:2015
            INCOMING LONGWAVE       01-JAN-94:0000 to 20-JAN-94:2145
            ALL PARAMETERS EXCEPT
              DIFFUSE SHORTWAVE AND
              INCOMING LONGWAVE     15-JUL-94:1815 to 16-JUL-94:0300
                                    16-JUL-94:1815 to 20-JUL-94:2030

SSA-OJP:
            INFRARED TEMPERATURE    01-JAN-94:0000 to 15-FEB-94:2345
            DIFFUSE SHORTWAVE       01-JAN-94:0000 to 18-FEB-94:2015
            INCOMING LONGWAVE       01-JAN-94:0000 to 20-JAN-94:2145
            ALL PARAMETERS EXCEPT
              DIFFUSE SHORTWAVE AND
              INCOMING LONGWAVE     15-JUL-94:1815 to 16-JUL-94:0300
                                    16-JUL-94:1815 to 20-JUL-94:2030

NSA-OJP:
            INFRARED TEMPERATURE    18-JAN-94:0000 to 18-FEB-94:2300
            PRECIPITATION           19-NOV-94:1000 to 20-NOV-94:1845
            SNOW DEPTH              22-NOV-94:2200 to 23-NOV-94:0145
            DIFFUSE SHORTWAVE       18-JAN-94:0000 to 27-JAN-94:2345
                                    08-AUG-94:2215 to 22-AUG-94:2200
            INCOMING LONGWAVE       08-AUG-94:2215 to 22-AUG-94:2200

NSA-YTH:
            INFRARED TEMPERATURE    18-JAN-94:0000 to 18-FEB-94:2300
            PRECIPITATION           19-NOV-94:1000 to 20-NOV-94:1845
            SNOW DEPTH              22-NOV-94:2200 to 23-NOV-94:0145
```

Due to turnover in staff and loss of information in the creation of this data set, tabulation of the remaining time gaps are not available for 1995 and 1996.

6.2 Field Notes

Please refer to Section 6.2 in the AFM-07 SRC Meteorological and Radiation Data Set documentation, TF-02 documentation, TF-05 documentation, and TF-01 documentation.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The data in this data set are intended to represent two sites in the NSA and two sites in the SSA.

The North American Datum of 1983 (NAD83) corner coordinates of the SSA are:

	Latitude	Longitude
Northwest	56.249 N	98.825 W
Northeast	56.083 N	97.234 W
Southwest	55.542 N	99.045 W
Southeast	55.379 N	97.489 W

The NAD83 coordinates of the BOREAS SRC tower sites were:

	Latitude	Longitude
SRC SSA-OA	53.628 N	106.196 W
SRC SSA-OJP	53.916 N	104.689 W
SRC NSA-OJP	55.928 N	98.622 W
SRC NSA-YTH	55.804 N	97.874 W

Data were substituted from flux tower sites with the following NAD83 coordinates:

	Latitude	Longitude
SSA-OA	53.62890 N	106.19779 W
SSA-OJP	53.91634 N	104.69203 W
NSA-OJP	55.92842 N	98.62396 W

7.1.2 Spatial Coverage Map

None.

7.1.3 Spatial Resolution

The data from the original sites are point values at a given location. The intent of creating a merged data set was for the data to be representative of the SSA or NSA, although the gradients can be observed between the SSA sites and the NSA sites.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

The data cover the time period of 01-Jan-1994 to 01-Dec-1996.

7.2.2 Temporal Coverage Map

Not available.

7.2.3 Temporal Resolution

```
SRC   15-minute averages for all parameters except Belfort precipitation
      and snow depth.
      Hourly:
            BELFORT GAUGE PRECIPITATION (winter only)
            SNOW DEPTH
            Although Belfort Precipitation and Snow Depth are measured
            every hour on the hour, each hour's value is given every 15
            minutes.
TF-02 30 minute values
TF-05 30 minute values
```

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
CALC_TEMP_ABV_CNPY_10M
CALC_TEMP_WITHIN_CNPY_2M
CALC_SURF_PRESS_15MIN
CALC_REL_HUM_15MIN_10M
CALC_MIXING_RATIO_10M
CALC_U_COMPNT_WIND_VELOC
CALC_V_COMPNT_WIND_VELOC
CALC_ACCUM_PRECIP
CALC_SNOW_DEPTH
CALC_TOT_DOWN_SHORTWAVE_15MIN
CALC_DIFF_DOWN_SHORTWAVE_15MIN
CALC_DOWN_LONGWAVE_15MIN
CALC_DOWN_PAR_15MIN
CALC_REFLECTED_SHORTWAVE_15MIN
CALC_NET_RAD_15MIN
CALC_IR_TEMP_15MIN
CALC_SOIL_TEMP_10CM_15MIN
CALC_SOIL_TEMP_20CM_15MIN
CALC_SOIL_TEMP_50CM_15MIN
PARM_VALUE_FLAGS
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-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.
DATE_OBS	The date on which the data were collected.
TIME_OBS	The Greenwich Mean Time (GMT) when the data were collected.
CALC_TEMP_ABV_CNPY_10M	The calculated fifteen-minute air temperature at ten meters above the canopy starting at the given time.
CALC_TEMP_WITHIN_CNPY_2M	The calculated fifteen-minute air temperature at two meters above ground starting at the given time.
CALC_SURF_PRESS_15MIN	The calculated fifteen-minute atmospheric pressure at station level starting at the given time.
CALC_REL_HUM_15MIN_10M	The calculated fifteen-minute relative humidity of the air at ten meters above the canopy starting at the given time.
CALC_MIXING_RATIO_10M	The calculated mixing ratio of the air at ten meters above the canopy using the above canopy temperature, surface pressure, and relative humidity.
CALC_U_COMPNT_WIND_VELOC	The calculated westerly (from the west) vector component of the wind speed and wind direction.
CALC_V_COMPNT_WIND_VELOC	The calculated southerly (from the south) vector component of the wind speed and wind direction.
CALC_ACCUM_PRECIP	The calculated total amount of precipitation that has fallen since a relative date.
CALC_SNOW_DEPTH	The calculated depth of snow on the ground.
CALC_TOT_DOWN_SHORTWAVE_15MIN	The calculated fifteen-minute direct and diffuse downward shortwave solar radiation starting at the given time. Measured wavelengths range from 0.285 to 2.800 micrometers.
CALC_DIFF_DOWN_SHORTWAVE_15MIN	The calculated fifteen-minute diffuse downward shortwave solar radiation starting at the given time. Measured wavelengths range from 0.285 to 2.800 micrometers.
CALC_DOWN_LONGWAVE_15MIN	The calculated fifteen-minute direct and diffuse downward longwave radiation starting at the

	given time. Measured wavelengths range from 4 to 50 micrometers.
CALC_DOWN_PAR_15MIN	The calculated fifteen-minute direct and diffuse downward photosynthetically active radiation starting at the given time. Measured wavelengths range from 0.4 to 0.7 micrometers.
CALC_REFLECTED_SHORTWAVE_15MIN	The calculated fifteen-minute upward shortwave solar radiation reflected from the ground starting at the given time. Measured wavelengths are 0.285 to 2.800 micrometers.
CALC_NET_RAD_15MIN	The calculated fifteen-minute incoming and outgoing radiation starting at the given time.
CALC_IR_TEMP_15MIN	The calculated fifteen-minute infrared temperature looking down from ten meters above the canopy starting at the given time.
CALC_SOIL_TEMP_10CM_15MIN	The calculated fifteen-minute temperature of the soil at ten centimeters below the surface starting at the given time.
CALC_SOIL_TEMP_20CM_15MIN	The calculated fifteen-minute temperature of the soil at twenty centimeters below the surface starting at the given time.
CALC_SOIL_TEMP_50CM_15MIN	The calculated fifteen-minute temperature of the soil at fifty centimeters below the surface starting at the given time.
PARM_VALUE_FLAGS	Contains values or codes that indicate special conditions for the data parameters. See the end of this section for descriptions of these codes as well as a more in depth discussion of their meaning.
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.

PARM_VALUE FLAGS Description

The third to last column in the data set shows the parameter flags. There is one flag for each parameter plus three extra as explained below. This data set is based upon the 1994 to 1996 SRC Meteorological Data. In order to make a continuous data set with no missing data gaps, it was necessary to substitute data from other data sets when the SRC data was missing. The parameter flags show the source of each parameter. For example, consider the data set from SSA-OA. All available data from the SRC tower at SSA-OA is first put into the data set. This is considered original data and each parameter will show an original data source flag (O). (See below for specific flag definitions). If data is missing from a site for longer than what is allowed for linear interpolation (two hours), it was substituted from another site. The first step is to substitute data from the other SRC site within the same study area. In the case of the SSA, this would be SRC SSA-OJP. The parameters will then have a substituted flag (S). If data is missing from SRC SSA-OJP, the next step is to substitute data from the flux tower at SSA-OA. The parameter will then have the TF SSA-OA substitution flag (A). If data is not available from TF SSA-OA, the next step is to substitute data from the flux tower at SSA-OJP. The parameter will then have the TF SSA-OJP substitution flag (J). If data is not available from TF SSA-OJP, the final step is to use a method of estimating the data as explained in Section 9.3.

PARAMETER FLAGS FOR SSA-OA, SSA-OJP, NSA-OJP

There are a total of twenty-two one-letter flags in the flag column. The first nineteen of these flags correspond to the nineteen parameters and show the source of each corresponding parameter. The last three flags give additional information about certain parameters (see Section 9.1.1). The first of these last three is the PRECIPITATION GAUGE FLAG. The second is the PRECIPITATION ZEROED FLAG. The last is the SNOW DEPTH ZEROED FLAG.

PARAMETER FLAGS FOR NSA-YTH

There are seventeen parameter columns for the NSA-YTH data set since this site did not measure DIFFUSE INCOMING SHORTWAVE RADIATION and INCOMING LONGWAVE RADIATION. There are a total of twenty one-letter flags in the flag column. The first seventeen of these flags correspond to the seventeen parameters and show the source of each corresponding parameter. The last three flags give additional information about certain parameters (see Section 9.1.1). The first of these last three is the PRECIPITATION GAUGE FLAG. The second is the PRECIPITATION ZEROED FLAG. The last is the SNOW DEPTH ZEROED FLAG.

PARAMETER FLAG DESCRIPTION:

A This flag denotes the substitution of SSA-OA flux tower data that were linearly interpolated to 15 minutes from the existing 30 minute data. The SSA-OA flux tower data are used for the SSA-OA site when SRC data are not available from SRC SSA-OA or SRC SSA-OJP. The SSA-OA flux tower data are also used for the SSA-OJP site when data are not available from SRC SSA-OJP or SRC SSA-OA or SSA-OJP flux tower. Although the actual flux tower measurements were made at 0 and 30 minutes past the hour, the 'A' designation is used for data from the flux tower at 15 and 45 minutes past the hour which were linearly interpolated from the existing 30 minute data.

C This flag denotes the substitution of linearly interpolated SSA-OA flux tower data when a gap of less than 2 hours existed in the SSA-OA flux tower data.

D This flag denotes the estimation of DIFFUSE INCOMING SHORTWAVE RADIATION that was estimated using the techniques described in section 9.3.1.

E This flag denotes the substitution of derived DIFFUSE INCOMING SHORTWAVE RADIATION from the other site within the same study area when the TOTAL INCOMING SHORTWAVE RADIATION value was substituted from the other site. This was done so that both total and diffuse shortwave values come from the same site for a more accurate relationship.

H This flag denotes the substitution of precipitation and snow depth data from Thompson airport when data from both the NSA-OJP and NSA-YTH sites were missing.

J This flag denotes the substitution of SSA-OJP flux tower data that were linearly interpolated to 15 minutes from the existing 30 minute data. The SSA-OJP flux tower data is used for the SSA-OJP site when SRC data is not available from SRC SSA-OJP or SRC SSA-OA. The SSA-OJP flux tower data is also used for the SSA-OA site when data is not available from SRC SSA-OA or SRC SSA-OJP or SSA-OA flux tower. Although the actual flux tower measurements were made at 0 and 30 minutes past the hour, the 'J' designation is used for data from the flux tower at 15 and 45 minutes past the hour which were linearly interpolated from the existing 30 minute data.

K This flag denotes the substitution of linearly interpolated SSA-OJP flux tower data when a gap of less than 2 hours existed in the SSA-OJP flux tower data.

L This flag denotes data that were linearly interpolated from original SRC data when data were missing for less than two hours.

M This flag is used in the soil temperature flag columns when the time-step method of linear interpolation is used (see Section 9.3.1.). Data were missing for more than two hours from both SRC sites but could not be substituted from a flux tower as these data were not measured at flux towers. Therefore, data from a specific time of day on the last day of known values were used with data from the same time on the first day of known values after the missing block to interpolate values at that time on all the missing days.

O This flag denotes original SRC data.

R This flag denotes the estimation of REFLECTED SHORTWAVE RADIATION using the techniques described in section 9.3.1.

S This flag denotes the substitution of this parameter from the other SRC tower within the same study area. This was done when data were missing for more than two hours (otherwise it would be linearly interpolated). When data were missing from SRC SSA-OA tower, data from SRC SSA-OJP tower were used and vice versa. When data were missing from SRC NSA-OJP tower, data from SRC NSA-YTH tower were used and vice versa.

W This flag denotes the estimation of INCOMING LONGWAVE RADIATION using the techniques described in section 9.3.1.

? This flag denotes pressure data that is incorrect and should only be used to obtain pressure trends. (see Sections 10.1 and 11.2.)

PRECIPITATION GAUGE FLAGS:

B This flag denotes the use of a Belfort weighing precipitation gauge (winter only) for the water-equivalent precipitation data.

T This flag denotes the use of a tipping bucket rain gauge (not available in winter) for the liquid-only precipitation data.

PRECIPITATION ZEROED FLAGS:

O This flag denotes the use of original precipitation data.

Z This flag is used when, because of sensor error, the measured value was negative and has been set to zero. If this data has been substituted from another site, this flag is left as O but the parameter flag shows the substitution flag. (see Section 9.3.1.)

SNOW DEPTH ZEROED FLAGS:

O This flag denotes the use of original snow depth data.

Z This flag is used when, because of sensor error, the measured value was negative and has been set to zero. If this data has been substituted from another site, this flag is left as O but the parameter flag shows the substitution flag. (see Section 9.3.1.)

7.3.3 Unit of Measurement

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

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
CALC_TEMP_ABV_CNPY_10M	[degrees Celsius]
CALC_TEMP_WITHIN_CNPY_2M	[degrees Celsius]
CALC_SURF_PRESS_15MIN	[kiloPascals]
CALC_REL_HUM_15MIN_10M	[percent]
CALC_MIXING_RATIO_10M	[grams of water vapor][kilogram dry air^-1]
CALC_U_COMPNT_WIND_VELOC	[meters][second^-1]
CALC_V_COMPNT_WIND_VELOC	[meters][second^-1]
CALC_ACCUM_PRECIP	[millimeters]
CALC_SNOW_DEPTH	[millimeters]
CALC_TOT_DOWN_SHORTWAVE_15MIN	[Watts][meter^-2]
CALC_DIFF_DOWN_SHORTWAVE_15MIN	[Watts][meter^-2]
CALC_DOWN_LONGWAVE_15MIN	[Watts][meter^-2]
CALC_DOWN_PAR_15MIN	[Watts][meter^-2]
CALC_REFLECTED_SHORTWAVE_15MIN	[Watts][meter^-2]
CALC_NET_RAD_15MIN	[Watts][meter^-2]
CALC_IR_TEMP_15MIN	[degrees Celsius]
CALC_SOIL_TEMP_10CM_15MIN	[degrees Celsius]
CALC_SOIL_TEMP_20CM_15MIN	[degrees Celsius]
CALC_SOIL_TEMP_50CM_15MIN	[degrees Celsius]
PARM_VALUE_FLAGS	[none]
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	[Assigned by BORIS]
SUB_SITE	[Assigned by BORIS]
DATE_OBS	[Supplied by Investigator]
TIME_OBS	[Supplied by Investigator]
CALC_TEMP_ABV_CNPY_10M	[Supplied by Investigator]
CALC_TEMP_WITHIN_CNPY_2M	[Supplied by Investigator]
CALC_SURF_PRESS_15MIN	[Supplied by Investigator]
CALC_REL_HUM_15MIN_10M	[Supplied by Investigator]
CALC_MIXING_RATIO_10M	[Supplied by Investigator]
CALC_U_COMPNT_WIND_VELOC	[Supplied by Investigator]
CALC_V_COMPNT_WIND_VELOC	[Supplied by Investigator]
CALC_ACCUM_PRECIP	[Supplied by Investigator]
CALC_SNOW_DEPTH	[Supplied by Investigator]
CALC_TOT_DOWN_SHORTWAVE_15MIN	[Supplied by Investigator]
CALC_DIFF_DOWN_SHORTWAVE_15MIN	[Supplied by Investigator]
CALC_DOWN_LONGWAVE_15MIN	[Supplied by Investigator]
CALC_DOWN_PAR_15MIN	[Supplied by Investigator]

```
CALC_REFLECTED_SHORTWAVE_15MIN [Supplied by Investigator]
CALC_NET_RAD_15MIN             [Supplied by Investigator]
CALC_IR_TEMP_15MIN             [Supplied by Investigator]
CALC_SOIL_TEMP_10CM_15MIN      [Supplied by Investigator]
CALC_SOIL_TEMP_20CM_15MIN      [Supplied by Investigator]
CALC_SOIL_TEMP_50CM_15MIN      [Supplied by Investigator]
PARM_VALUE_FLAGS               [Assigned by BORIS]
CRTFCN_CODE                    [Assigned by BORIS]
REVISION_DATE                  [Assigned by BORIS]
```

The primary data source was the AFM-07 SRC BOREAS data submitted to BORIS. These were augmented with:

Selected parameters and time periods from the TF-02 BOREAS OA flux tower site's meteorological variable data submitted to BORIS

```
Parameters:
INCOMING PHOTOSYNTHETICALLY ACTIVE RADIATION (PAR)
TOTAL INCOMING SHORTWAVE RADIATION
NET RADIATION
ABOVE CANOPY AIR TEMPERATURE
RELATIVE HUMIDITY
STATION PRESSURE
WIND SPEED
WIND DIRECTION
INFRARED (CANOPY RADIATIVE) TEMPERATURE
PRECIPITATION (TIPPING BUCKET)

Time periods:
15-JUL-94:1815Z to 16-JUL-94:0300Z
16-JUL-94:1815Z to 20-JUL-94:2030Z
```

Selected parameters and time periods from the TF-05 BOREAS OJP flux tower site's meteorological variable data submitted to BORIS

```
Parameters:
INCOMING PHOTOSYNTHETICALLY ACTIVE RADIATION (PAR)
NET RADIATION
ABOVE CANOPY AIR TEMPERATURE
ABSOLUTE HUMIDITY
WIND SPEED
WIND DIRECTION

Time periods:
15-JUL-94:1815Z to 16-JUL-94:0300Z
16-JUL-94:1815Z to 20-JUL-94:2030Z
```

Precipitation and snow depth data from Atmospheric Environment Service (AES) at Thompson airport.

```
PRECIPITATION

Time periods:
19-NOV-94:1000Z to 20-NOV-94:1845Z
```

```
     SNOWFALL INTENSITY

     Time periods:
     22-NOV-94:2200Z to 23-NOV-94:0145Z
```

The following indicates the instrument measured values used as the precipitation values during the indicated periods of time for the specified sites and other data used to fill in needed gaps:

```
1994

SRC   SSA-OA        01-JAN-94 to 31-DEC-94
            Belfort Gauge:          01-JAN-94 to 30-APR-94 and
                                    01-NOV-94 to 31-DEC-94
            Tipping Bucket Gauge:   01-MAY-94 to 31-OCT-94

SRC   SSA-OJP       01-JAN-94 to 31-DEC-94
            Belfort Gauge:          01-JAN-94 to 30-APR-94 and
                                    01-NOV-94 to 31-DEC-94
            Tipping Bucket Gauge:   01-MAY-94 to 31-OCT-94

SRC   NSA-OJP       18-JAN-94 to 18-JAN-95
            Belfort Gauge:          18-JAN-94 to 15-MAY-94 and
                                    01-NOV-94 to 18-JAN-95
            Tipping Bucket Gauge:   16-MAY-94 to 31-OCT-94

SRC   NSA-YTH       18-JAN-94 to 18-JAN-95
            Belfort Gauge:          18-JAN-94 to 25-MAY-94 and
                                    01-NOV-94 to 18-JAN-95
            Tipping Bucket Gauge:   26-MAY-94 to 31-OCT-94

TF-02  SSA-OA       22-OCT-93 to 18-SEP-94: U COMPONENT OF WIND,
                                            V COMPONENT OF WIND,
                                            INCOMING TOTAL SHORTWAVE,
                                            INCOMING TOTAL PAR,
                                            ABOVE CANOPY AIR TEMPERATURE,
                                            RELATIVE HUMIDITY,
                                            STATION PRESSURE
                    23-OCT-93 to 13-NOV-93 and
                    05-FEB-94 to 18-SEP-94: NET RADIATION
                    19-FEB-94 to 18-SEP-94: INFRARED TEMPERATURE
                    17-MAY-94 to 18-SEP-94: PRECIPITATION

TF-05  SSA-OJP       23-MAY-94 to 16-SEP-94: ALL PARAMETERS

1995

SRC   SSA-OA        01-JAN-95 to 31-DEC-95
            Belfort Gauge:          01-JAN-95 to 30-APR-95 and
                                    01-NOV-95 to 31-DEC-95
            Tipping Bucket Gauge:   01-MAY-95 to 31-OCT-95

SRC   SSA-OJP       01-JAN-95 to 31-DEC-95
            Belfort Gauge:          01-JAN-95 to 07-MAY-95 and
                                    01-NOV-95 to 31-DEC-95
            Tipping Bucket Gauge:   08-MAY-95 to 31-OCT-95
```

```
SRC   NSA-OJP       01-JAN-95 to 31-DEC-95
            Belfort Gauge:           01-JAN-95 to 15-JUN-95 and
                                     01-NOV-95 to 31-DEC-95
            Tipping Bucket Gauge:    16-JUN-95 to 31-OCT-95

SRC   NSA-YTH       01-JAN-95 to 31-DEC-95
            Belfort Gauge:           01-JAN-95 to 08-MAY-95:1145Z and
                                     01-NOV-95 to 31-DEC-95
            Tipping Bucket Gauge:    08-MAY-95:1200Z to 31-DEC-95
```

Due to turnover in staff and loss of information in the creation of this data set, a summary of the coverage information is not available for the 1996 data.

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-YTHSA	SSA-OJP-FLXTR	None	None	None	None
SUB_SITE	STAFF-MOD01	STAFF-MOD01	None	None	None	None
DATE_OBS	01-JAN-94	18-JAN-95	None	None	None	None
TIME_OBS	0	2345	None	None	None	None
CALC_TEMP_ABV_CNPY_10M	-75.2	30	None	None	None	None
CALC_TEMP_WITHIN_CNPY_2M	-44.6	32.1	-999	None	None	None
CALC_SURF_PRESS_15MIN	91.5	101.09	None	None	None	None
CALC_REL_HUM_15MIN_10M	5.4	105.5	None	None	None	None
CALC_MIXING_RATIO_10M	0	14.529	None	None	None	None
CALC_U_COMPNT_WIND_VELOC	-6.9823	8.869	None	None	None	None
CALC_V_COMPNT_WIND_VELOC	-10.955	7.0474	None	None	None	None
CALC_ACCUM_PRECIP	0	15.3	None	None	None	None
CALC_SNOW_DEPTH	0	832	None	None	None	None
CALC_TOT_DOWN_SHORTWAVE_15MIN	-9.345	1109.244	None	None	None	None
CALC_DIFF_DOWN_SHORTWAVE_15MIN	-6.089	795.944	-999	None	None	None
CALC_DOWN_LONGWAVE_15MIN	-21.98	421.178	-999	None	None	None
CALC_DOWN_PAR_15MIN	-.098	452.6	None	None	None	None
CALC_REFLECTED_SHORTWAVE_15MIN	-322.444	612.101	None	None	None	None
CALC_NET_RAD_15MIN	-254.789	835.7	None	None	None	None
CALC_IR_TEMP_15MIN	-41.5	36.3	-999	None	None	None
CALC_SOIL_TEMP_10CM_15MIN	-15.83	20.36	None	None	None	None
CALC_SOIL_TEMP_20CM_	-14.82	18.47	None	None	None	None

15MIN						
CALC_SOIL_TEMP_50CM_ 15MIN	-12.8	15.83	None	None	None	None
PARM_VALUE_FLAGS	N/A	N/A	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	06-SEP-96	09-SEP-96	None	None	None	None

1995 Data

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	NSA-9BS-YTHSA	SSA-OJP-FLXTR	None	None	None	None
SUB_SITE	STAFF-MOD01	STAFF-MOD01	None	None	None	None
DATE_OBS	01-JAN-95	31-DEC-95	None	None	None	None
TIME_OBS	0	2345	None	None	None	None
CALC_TEMP_ABV_CNPY_ 10M	-41.1	37	None	None	None	None
CALC_TEMP_WITHIN_ CNPY_2M	-43.2	38.3	None	None	None	None
CALC_SURF_PRESS_ 15MIN	91.19	101.59	None	None	None	None
CALC_REL_HUM_15MIN_ 10M	10.9	106	None	None	None	None
CALC_MIXING_RATIO_ 10M	.072	16.834	None	None	None	None
CALC_U_COMPNT_WIND_ VELOC	-6.2573	7.2428	None	None	None	None
CALC_V_COMPNT_WIND_ VELOC	-6.7945	8.9861	None	None	None	None
CALC_ACCUM_PRECIP	0	10.6	None	None	None	None
CALC_SNOW_DEPTH	0	615	None	None	None	None
CALC_TOT_DOWN_ SHORTWAVE_15MIN	-8.668	1122.111	None	None	None	None
CALC_DIFF_DOWN_ SHORTWAVE_15MIN	-6.202	804.778	-999	None	None	None
CALC_DOWN_LONGWAVE_ 15MIN	11.873	462.378	-999	None	None	None
CALC_DOWN_PAR_15MIN	-.099	430.089	None	None	None	None
CALC_REFLECTED_ SHORTWAVE_15MIN	-33.793	192.467	None	None	None	None
CALC_NET_RAD_15MIN	-131.789	808.111	None	None	None	None
CALC_IR_TEMP_15MIN	-111.4	40.1	None	None	None	None
CALC_SOIL_TEMP_10CM_ 15MIN	-14.53	19.05	None	None	None	None
CALC_SOIL_TEMP_20CM_ 15MIN	-12.3	17.05	None	None	None	None
CALC_SOIL_TEMP_50CM_ 15MIN	-9.77	14.44	None	None	None	None
PARM_VALUE_FLAGS	N/A	N/A	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	09-SEP-96	10-SEP-96	None	None	None	None

1996 Data

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	NSA-9BS-YTHSA	SSA-OJP-FLXTR	None	None	None	None
SUB_SITE	STAFF-MOD01	STAFF-MOD01	None	None	None	None
DATE_OBS	01-JAN-96	01-DEC-96	None	None	None	None
TIME_OBS	0	2345	None	None	None	None
CALC_TEMP_ABV_CNPY_10M	-46.2	33.2	None	None	None	None
CALC_TEMP_WITHIN_CNPY_2M	-47.1	33.9	None	None	None	None
CALC_SURF_PRESS_15MIN	91.23	101.61	None	None	None	None
CALC_REL_HUM_15MIN_10M	8.1	103.2	None	None	None	None
CALC_MIXING_RATIO_10M	.03	15.383	None	None	None	None
CALC_U_COMPNT_WIND_VELOC	-6.0446	6.9578	None	None	None	None
CALC_V_COMPNT_WIND_VELOC	-6.2381	7.4699	None	None	None	None
CALC_ACCUM_PRECIP	0	1115.2	None	None	None	None
CALC_SNOW_DEPTH	0	928	-999	None	None	None
CALC_TOT_DOWN_SHORTWAVE_15MIN	-10.929	1114.222	None	None	None	None
CALC_DIFF_DOWN_SHORTWAVE_15MIN	0	857.167	-999	None	None	None
CALC_DOWN_LONGWAVE_15MIN	90.328	435.856	-999	None	None	None
CALC_DOWN_PAR_15MIN	-.1	428.022	None	None	None	None
CALC_REFLECTED_SHORTWAVE_15MIN	-5.319	196.178	None	None	None	None
CALC_NET_RAD_15MIN	-212.711	785.833	None	None	None	None
CALC_IR_TEMP_15MIN	-45.5	39.1	None	None	None	None
CALC_SOIL_TEMP_10CM_15MIN	-12.79	18.93	None	None	None	None
CALC_SOIL_TEMP_20CM_15MIN	-10.86	18.26	None	None	None	None
CALC_SOIL_TEMP_50CM_15MIN	-8.36	14.73	None	None	None	None
PARM_VALUE_FLAGS	N/A	N/A	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	31-JAN-97	03-FEB-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 are wrapped versions of data records from a sample data file on the CD-ROM.

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,CALC_TEMP_ABV_CNPY_10M,
CALC_TEMP_WITHIN_CNPY_2M,CALC_SURF_PRESS_15MIN,CALC_REL_HUM_15MIN_10M,
CALC_MIXING_RATIO_10M,CALC_U_COMPNT_WIND_VELOC,CALC_V_COMPNT_WIND_VELOC,
CALC_ACCUM_PRECIP,CALC_SNOW_DEPTH,CALC_TOT_DOWN_SHORTWAVE_15MIN,
CALC_DIFF_DOWN_SHORTWAVE_15MIN,CALC_DOWN_LONGWAVE_15MIN,
CALC_DOWN_PAR_15MIN,CALC_REFLECTED_SHORTWAVE_15MIN,CALC_NET_RAD_15MIN,
CALC_IR_TEMP_15MIN,CALC_SOIL_TEMP_10CM_15MIN,CALC_SOIL_TEMP_20CM_15MIN,
CALC_SOIL_TEMP_50CM_15MIN,PARM_VALUE_FLAGS,CRTFCN_CODE,REVISION_DATE
'NSA-9BS-YTHSA','STAFF-MOD01',01-SEP-95,0,20.0,19.9,97.33,36.3,5.469,2.6547,.041
7,0.0,0.0,163.822,-999.0,-999.0,62.492,49.146,52.58,19.2,13.56,12.17,11.87,
'SSSS SSSSOOOOOSSSSTOO','CPI',10-SEP-96 'NSA-9BS-YTHSA','STAFF-MOD01',01-SEP-95,
15,19.9,19.6,97.33,36.9,5.526,2.1518,.02 63,0.0,0.0,130.422,-999.0,-999.0,49.84,
50.24,22.392,19.0,13.58,12.2,11.87,'SSSSS SSSOOOOOSSSSTOO','CPI',10-SEP-96
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data that can be ordered from this data set is the data for a given site in a given month.

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

The following formulae were required in processing this data set:

For RELATIVE HUMIDITY:

$$RH = e / es(T)$$

where RH is relative humidity (percent)
e is vapor pressure
es(T) is saturation vapor pressure.

$$e = X * (R / Mw) * T$$

where e is vapor pressure (Pa)
X is absolute humidity, or vapor density (g/m^3)
R is the gas constant = 8.314 J/mol/K
Mw is the molecular weight of water = 18 g/mol
T is air temperature (K)

$$es(T) = 6.112 * \exp[(17.67 * T) / (T + 243.5)]$$

where es(T) is saturation vapor pressure (mb)
T is air temperature (degrees Celsius)

For MIXING RATIO:

$$q = (622 * e) / (P - e)$$

where q is mixing ratio (grams/kilogram)
e is vapor pressure (mb)
P is station pressure (mb)

$$e = RH * es(T)$$

where e is vapor pressure
RH is relative humidity (percent)
es(T) is saturation vapor pressure

$$es(T) = 6.112 * \exp[(17.67 * T) / (T + 243.5)]$$

where es(T) is saturation vapor pressure (mb)
T is air temperature (degrees Celsius)

For DIFFUSE INCOMING SHORTWAVE RADIATION:

Diffuse Incoming Shortwave / Incoming Shortwave =
slope * [Incoming Shortwave / cosine(zenith angle)] + intercept

For INCOMING LONGWAVE RADIATION:

Incoming Longwave = Net Radiation + Reflected Shortwave
+ Outgoing Longwave - Total Incoming Shortwave

where Outgoing Longwave is approximated by 5.67E-08 * (Infrared Temperature)^4
which is based on the Stefan-Boltzmann radiation law, assuming an emissivity of 1.

9.1.1 Derivation Techniques and Algorithms

As the FORTRAN program linearly interpolated and substituted data (see Section 9.2.1), it flagged the source of each parameter and is included in each file record. The last column in each file shows a string of characters that are the flags. Beginning with the flag for ABOVE CANOPY AIR TEMPERATURE, since this is the first measured parameter, each flag in the string corresponds to a parameter column. There will be the same number of parameter flags as there are parameters -- 19 for SSA-OA, SSA-OJP, and NSA-OJP, and 17 for NSA-YTH.

Following the parameter flags are three precipitation-related flags. The first of these is the PRECIPITATION GAUGE FLAG. A 'T' is shown if precipitation data were measured from the tipping bucket rain gauge. A 'B' is shown if precipitation data were measured from the Belfort weighing precipitation gauge. The tipping bucket gauge cannot measure frozen precipitation, so it is used only in the summer.

The next flag is the PRECIPITATION ZEROED FLAG. This place will show either an 'O' for original precipitation data, or a 'Z' if the data have been zeroed. Sometimes when the Belfort gauge is used, a negative precipitation value is obtained. Before processing, the Belfort raw value is cumulative. At each time, the previous cumulative value is subtracted from the current value to obtain the amount of precipitation that has fallen within the last 15 minutes. When this value is negative (because of sensor error), it has been zeroed and flagged with a Z in this flag place to alert the user that actual data are not shown.

The last flag is the SNOW DEPTH ZEROED FLAG. Like the Belfort gauge, the snow depth sensor sometimes gives negative values when there is little snow on the ground. This value has been zeroed and will be flagged with a 'Z' in this flag place. At all other times the flag is 'O'.

9.2 Data Processing Sequence

9.2.1 Processing Steps

BORIS staff compiled surface meteorological data by:

- Extracting a year-long file of 15-minute continuous data for each of four chosen BOREAS SRC Meteorological Towers from the BORIS data base.
- Inputting these files into a FORTRAN program that would linearly interpolate missing parameters when these parameters were missing for less than 2 hours.
- Inputting the files from step 2 into a FORTRAN program that would compare the files from the two towers within one study area and substitute missing parameters from one file to the other when parameters were missing for more than 2 hours.
- Using the TF data sets from TF-02 (SSA-OA) and TF-05 (SSA-OJP) to substitute available missing parameters when both sites within the SSA were missing the same parameters.
- Using Thompson airport precipitation data when SRC data were missing during winter when no flux tower data were available.
- Using the methods described in Section 9.3.1 to calculate remaining missing parameters to obtain a complete continuous 15-minute data set for an entire year at the four chosen BOREAS SRC sites.

9.2.2 Processing Changes

None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

RELATIVE HUMIDITY:

The flux tower at SSA-OJP measures absolute humidity. When relative humidity is missing from SRC and is replaced by the value measured at SSA-OJP, the absolute humidity has been converted to relative humidity. The relative humidity value was calculated using the equation

$$RH = e / es(T) \quad (1)$$

where e is vapor pressure and es(T) is saturation vapor pressure.
By substituting the following for e in equation (1)

$$e = X * (R / Mw) * T \quad (2)$$

the result is:

$$RH(fraction) = X * T /(2.165 * es(T))$$

where e is vapor pressure (Pa), X is absolute humidity, or vapor density (g/m^3), R is the gas constant = 8.314 J/(mol K), Mw is the molecular weight of water = 18 g/mol, and T is air temperature (K), can be substituted, as shown in equation 3.

But to put vapor pressure in standard units of kiloPascals (kPa), it is necessary to divide (2) by 1000, resulting in

$$RH(fraction) = X * T / (2165 * es(T)) \quad (3)$$

(Monteith and Unsworth, 1990).

Using the measured air temperature, the saturation vapor pressure is obtained by using the equation

$$es(T) = 6.112 * \exp[(17.67 * T) / (T + 243.5)] \quad (4)$$

where here T is air temperature (degrees Celsius) and es(T) is saturation vapor pressure (mb). To put es(T) in standard units of kPa in order to be used with vapor pressure in kPa, divide the equation by 10 to obtain:

$$es(T) = (6.112 * \exp[(17.67 * T) / (T + 243.5)]) / 10 \quad (5)$$

Now terms for e and es(T) are used to obtain RH(fraction) so that relative humidity is now in terms of air temperature and absolute humidity (both are measured parameters.) Multiply by 100 to obtain percentage.

MIXING RATIO:

This parameter is not measured but is derived from the measured relative humidity, pressure, and above-canopy air temperature. The following equation is used to determine mixing ratio:

$$q = (622 * e) / (P - e) \quad (6)$$

where q is mixing ratio (grams kilogram-1), e is vapor pressure (mb), and P is station pressure in (mb). Substituting

$$e = RH * es(T) \quad (7)$$

into (6) gives

$$q = (622 * RH * es(T)) / (P - (RH * es(T))) \quad (8)$$

where RH is relative humidity (fraction) and es(T) is saturation vapor pressure.

Using (4)

we can substitute into (8) to form

$$q = 622 * a / (P - a) \quad (9)$$

where $a = RH * 6.112 * \exp[(17.67 * T) / (T + 243.5)]$

Using the property that (Constant * a) / (b - a) =
[(Constant * a) / (b - a)] * [1/a] / [1/a] = Constant / (b / a - 1)

where Constant = 622 and b = P,

we obtain

$$q = 622 / (P / (RH * 6.112 * \exp [(17.67 * T) / (T + 243.5)]) - 1) \quad (10)$$

which can be rearranged to form

$$q = 622 / ((.16361 / RH) * P * \exp [(-17.67 * T) / (T + 243.5)] - 1)$$

(Bolton, 1980).

Since three parameters are required to derive mixing ratio, its data source flag is marked according to the source from which at least two of the three parameters came.

U COMPONENT OF WIND
V COMPONENT OF WIND:

Wind speed and wind direction were measured at the SSA-OA and SSA-OJP flux towers. Therefore, it was necessary to convert these parameters to components for the data set using the equations

U COMPONENT OF WIND =
-(wind speed)*[sine(wind direction from which wind travels)]

V COMPONENT OF WIND =
-(wind speed)*[cosine(wind direction from which wind travels)]

PRECIPITATION:

Two precipitation gauges are used. In 1994, a tipping bucket rain gauge was used to measure 15-minute rainfall from 01-MAY-94:0000Z through 31-OCT-94:2345Z at SSA-OA and SSA-OJP, from 16-MAY-94:0000Z through 31-OCT-94:2345Z at NSA-OJP, and from 26-MAY-94:0000Z through 31-OCT-94:2345Z at NSA-YTH. In 1995, a tipping bucket rain gauge was used to measure 15-minute rainfall from 01-MAY-95:0000Z through 31-OCT-95:2345Z at SSA-OA, from 08-MAY-95:0000Z through 31-OCT-95:2345Z at SSA-OJP, from 16-JUN-95:0000Z through 31-OCT-95:2345Z at NSA-OJP, and from 08-MAY-95:1200Z through 31-OCT-95:2345Z at NSA-YTH. At all other times of the year, a Belfort gauge was used to measure cumulative rainfall and cumulative water equivalence of frozen precipitation. There is some error in the Belfort sensor such

that the value may oscillate about a point. To get 15-minute precipitation data from the cumulative value, the previous record's value is subtracted from the current value. When the calculated value was negative due to sensor error, the value was zeroed. This is flagged with a Z in the second to last (PRECIPITATION ZEROED) flag column. The usual flags for data source (original (O), interpolated, or substituted) appear in the actual precipitation parameter flag column. SSA data sets were missing precipitation in the summer when this value could be substituted from flux towers. NSA data sets were missing precipitation only in winter when flux towers were not running. For missing precipitation in the NSA sites, precipitation data from the Thompson airport are used. Thompson airport measures water equivalence and ranges of snowfall intensity such as light, moderate, heavy, etc.; therefore, snow depth has been estimated for this time period.

For SSA-OA:

Data were missing from 17-JUN-95:0615Z through 17-JUN-95:1200Z. All parameters except precipitation were interpolated. The Belfort gauge showed zero at 17-JUN-95:0600Z and 5.4 mm at 17-JUN-95:1215Z, so it was assumed that 5.4 mm of rain fell within that time period. Data from SRC SSA-OJP were also missing. By checking the SRC sites at La Ronge, Meadow Lake, and Saskatoon, an estimate of precipitation was determined. La Ronge and Meadow Lake showed no precipitation, but Saskatoon showed that 0.6 mm fell at 0815Z, 0.2 mm at 0830Z, 0.6 mm at 0845Z, and 2 mm at 0900Z. Assuming it rained at SSA-OA at the same time, the extra 2 mm that fell at SSA-OA was divided among the time periods so that precipitation was set to 1.1 mm at 0815Z, 0.7 mm at 0830Z, 1.1 mm at 0845Z, and 2.5 mm at 0900Z. Precipitation for this time period is flagged with 'P'.

Data were missing from 20-JUN-95:0015Z through 20-JUN-95:0600Z. All parameters except precipitation were interpolated. The Belfort gauge showed 27.1 mm at 20-JUN-95:0000Z and 37.7 mm at 20-JUN-95:0615Z. Data from SRC SSA-OJP were also missing. By checking the SRC sites at La Ronge, Meadow Lake, The Pas, and Saskatoon, an estimate of precipitation was determined. La Ronge was also missing. The Pas and Meadow Lake showed no precipitation, but Saskatoon showed 1.2 mm at 0230Z, 0.2 mm at 0315Z, 0.2 mm at 0330Z, 0.8 mm at 0345Z, and 0.2 mm at 0400Z.

Data were missing from 22-AUG-95:0615Z through 23-AUG-95:0645. All parameters except precipitation were substituted from SSA-OJP. The Belfort gauge showed 14.1 mm at 22-AUG-95:0600Z and 15.6 mm at 23-AUG-95:0700Z, so it was assumed that 1.5 mm of rain fell within that time period. One mm fell at SSA-OJP at 22-AUG-95:0830Z, and 0.3 mm fell at 0845Z. Since SSA-OA is located west of SSA-OJP, precipitation was set to 1 mm at 22-AUG-95:0730Z, 0.3 mm at 0745Z, and 0.2 mm at 0800Z and flagged with 'P'.

Data were missing from 11-JUL-95:0015Z through 12-JUL-95:0200Z. The Belfort gauge showed 59.6 mm at 11-JUL-95:0000Z and 79.1 mm at 12-JUL-95:0215Z. This amount appears to be too great since only 2 mm fell at SSA-OJP during this time period. It was decided to substitute all missing parameters including precipitation from SSA-OJP for this time period.

Data were missing from 29-DEC-95:0015Z through 29-DEC-95:0400Z. All parameters were interpolated since data were also missing from SSA-OA at these times. Precipitation values did not change while the site was down, so it was assumed that no precipitation fell at these times.

For NSA-OJP:

All parameters were missing from 02-FEB-95:1715Z through 22-FEB-95:2330Z. All parameters were substituted since precipitation events could not be determined.

All parameters were missing from 23-NOV-95:1900Z through 23-NOV-95:1945Z. All parameters were interpolated except precipitation. The Belfort gauge showed 101.38 mm at 1845Z and 105.78 mm at 2000Z. It was decided to divide this 4.4 mm evenly by recording 1.1 mm at 1900Z, 1915Z, 1930Z, and 1945Z.

Precipitation and snow depth were missing 28-NOV-95 at 0230Z and 0245Z. Both values were the same at 0215Z and 0300Z so it was determined that no precipitation occurred.

All data were missing 29-DEC-95:0015Z through 29-DEC-95:0345Z. All parameters were interpolated, but Belfort values were the same, so it was determined that no precipitation occurred.

For NSA-YTH:

All parameters were missing from 23-JUN-95:1215Z through 23-JUN-95:1700Z. All parameters were substituted except precipitation. The Belfort value did not change so it was assumed that precipitation did not occur.

All parameters except radiation were missing from 17-AUG-95:1930Z through13-OCT-95:1900Z. All parameters were substituted since it was not possible to determine precipitation events.

Precipitation was missing from 23-NOV-95:1730Z through 24-NOV-95:0000Z. The Belfort value did not change so it was determined that no precipitation occurred.

All parameters were missing from 29-DEC-95:0015 through 29-DEC-95:0345Z. The Belfort value did not change so it was determined that no precipitation occurred.

SNOW DEPTH:

Snow depth was not measured during the summer months and is shown as '0'. When there was very little snow on the ground, the sensor gave sporadic
negative values. For this data set, these values have been set to zero and
flagged with a Z in the last (SNOW DEPTH ZEROED) flag column. The usual flags for data source (original (O), interpolated, or substituted) appear in the
actual snow depth parameter flag column.

REFLECTED SHORTWAVE RADIATION:

This parameter was not measured at flux towers. When SRC data are missing, all other radiation components have been substituted from flux towers. This parameter is then calculated as a residual using

Reflected Shortwave = Total Incoming Shortwave + Incoming Longwave
- Outgoing Longwave - Net Radiation

where Outgoing Longwave is approximated by

$5.67E\text{-}08 * (\text{Infrared Temperature})^4$

which is based on the Stefan-Boltzmann radiation law, assuming an emissivity of 1.

SOIL TEMPERATURE AT 10-CM DEPTH
SOIL TEMPERATURE AT 20-CM DEPTH
SOIL TEMPERATURE AT 50-CM DEPTH:

Soil temperatures at these depths were not measured at the flux towers. These parameters are missing from 15-JUL-94:1815Z through 20-JUL-94:2030Z at SSA-OA and SSA-OJP. Values for each time step have been linearly interpolated such that values at 14-JUL-94:1815Z and 21-JUL-94:1815 are used to interpolate 15-JUL-94:1815, 16-JUL-94:1815, 17-JUL-94:1815, 18-JUL-94:1815, 19-JUL-94:1815, 20-JUL-94:1815, and so on through every 15-minute block of each missing day. These values are flagged with M to denote this time-step type of linear interpolation. Near the end of the missing data period at SSA-OJP, a straight linear interpolation is performed between 21-JUL-94:1815 and 21-JUL-94:2030 to smooth the data. This is flagged with the usual L.

DIFFUSE INCOMING SHORTWAVE RADIATION:

This parameter was not measured at the NSA-YTH site. Missing periods for SSA-OA, SSA-OJP, and NSA-OJP cannot be substituted from TF sites as this parameter was not measured at flux towers. In 1994, diffuse incoming shortwave was missing at NSA-OJP from 18-JAN-94:0000Z to 27-JAN-94:2345 and 08-AUG-94:2215Z to 22-AUG-94:2200Z, and at SSA-OA and SSA-OJP from 01-JAN-94:0000Z to 18-FEB-94:2015Z. In 1995, diffuse incoming shortwave was missing at NSA-OJP from 06-MAY-95:1815Z to 08-MAY-95:0330Z, from 27-MAY-95:1815Z to 29-MAY-95:0045Z, and from 23-NOV-95:1815Z to 11-DEC-95:0400Z.

For NSA-OJP:

Using Total Incoming Shortwave Radiation, Diffuse Incoming Shortwave Radiation, and zenith angle from the missing time periods, Total Incoming Shortwave / Diffuse Incoming Shortwave, or the diffuse fraction, was plotted versus Incoming Shortwave / [cosine (zenith angle)]. This has a near linear relationship when zenith angles between 40 and 90 degrees are used. Only values of Incoming Shortwave / [cosine(zenith angle)] between 200 and 1200 were used as this eliminated wide scatter. Regression was performed to obtain a linear equation from the plot. For these particular cases, the following equations were obtained:

for 28-JAN-94:0000Z to 06-FEB-94:0000Z:

Diffuse Incoming Shortwave / Incoming Shortwave =
-0.00042 * Incoming Shortwave / cosine(zenith angle) + 1.001453

for 29-JUL-94:0000Z to 08-AUG-94:2200Z:

Diffuse Incoming Shortwave / Incoming Shortwave =
-0.00077 * Incoming Shortwave / cosine(zenith angle) + 0.989878

for 23-NOV-95:1815Z to 11-DEC-95:0400Z:

Diffuse Incoming Shortwave / Incoming Shortwave =
-0.00079 * Incoming Shortwave / cosine(zenith angle) + 1.129367

These equations were used for the missing time periods to calculate DIFFUSE INCOMING SHORTWAVE RADIATION using known values of TOTAL INCOMING SHORTWAVE RADIATION. When a value of DIFFUSE INCOMING SHORTWAVE RADIATION greater than TOTAL INCOMING SHORTWAVE RADIATION was calculated, it was set equal to TOTAL INCOMING SHORTWAVE RADIATION.

For SSA-OA:

This site has substituted TOTAL INCOMING SHORTWAVE from SSA-OJP from 01-JAN-94:0000Z to 10-JAN-94:1400, from 11-JAN-94:0330Z to 20-JAN-94:2230Z, and from 18-FEB-94:2030Z to 22-FEB-94:0045Z. At these times, the derived DIFFUSE INCOMING SHORTWAVE RADIATION has also been substituted from SSA-OJP for consistency. Using Total Incoming Shortwave Radiation, Diffuse Incoming Shortwave Radiation, and zenith angle from 22-FEB-94:0100Z to 01-MAR-94:2345Z (since these time periods are available at this site), Total Incoming Shortwave / Diffuse Incoming Shortwave, or the diffuse fraction, was plotted versus Incoming Shortwave / [cosine(zenith angle)]. This has a near linear relationship when zenith angles between 40 and 90 degrees are used. Only values of Incoming Shortwave / [cosine(zenith angle)] between 200 and 1200 were used as this eliminated wide scatter. Regression was performed to obtain a linear equation from the plot. For this particular case, the equation

Diffuse Incoming Shortwave / Incoming Shortwave =
-0.00096 * Incoming Shortwave / cosine(zenith angle) + 1.323676

was obtained. This equation was used for the missing time periods to calculate DIFFUSE INCOMING SHORTWAVE RADIATION using known values of TOTAL INCOMING SHORTWAVE RADIATION. When a value of DIFFUSE INCOMING SHORTWAVE RADIATION greater than TOTAL INCOMING SHORTWAVE RADIATION was calculated, it was set equal to TOTAL INCOMING SHORTWAVE RADIATION.

For SSA-OJP:

Using Total Incoming Shortwave Radiation, Diffuse Incoming Shortwave Radiation, and zenith angle from 18-FEB-94:2030Z to 28-FEB-94:2030Z, Total Incoming Shortwave / Diffuse Incoming Shortwave, or the diffuse fraction, was plotted versus Incoming Shortwave / [cosine(zenith angle)]. This has a near linear relationship when zenith angles between 40 degrees and 90 degrees are used. Only values of Incoming Shortwave / [cosine(zenith angle)] between 200 and 1200 were used as this eliminated wide scatter. Regression was performed to obtain a linear equation from the plot. For this particular case, the equation

Diffuse Incoming Shortwave / Incoming Shortwave =
-0.00094 * Incoming Shortwave / cosine(zenith angle) + 1.328154

was obtained. This equation was used for the missing time periods to calculate DIFFUSE INCOMING SHORTWAVE RADIATION using known values of TOTAL INCOMING SHORTWAVE RADIATION. When a value of DIFFUSE INCOMING SHORTWAVE RADIATION greater than TOTAL INCOMING SHORTWAVE RADIATION was calculated, it was set equal to TOTAL INCOMING SHORTWAVE RADIATION.

INCOMING LONGWAVE RADIATION:

This parameter was not measured at the NSA-YTH site. Missing periods cannot be substituted from TF sites as this parameter was not measured at flux towers. Incoming Longwave was missing at NSA-OJP from 08-AUG-94:2215Z to 22-AUG-94:2200Z, and at SSA-OA and SSA-OJP from 01-JAN-94:0000Z to 20-JAN-94:2145Z. For these missing periods, Incoming Longwave was calculated as a residual using

Incoming Longwave = Net Radiation + Reflected Shortwave
+ Outgoing Longwave - Total Incoming Shortwave

where Outgoing Longwave is approximated by
$5.67E\text{-}08 * (\text{Infrared Temperature})^4$

INTERPOLATION OF TF DATA:

TF data at SSA-OA and SSA-OJP were measured only at half-hour intervals (on the hour and half past the hour). Therefore it was necessary to interpolate the values at 15 and 45 minutes past the hour so that these data sets could be merged with the SRC data sets when SRC data were missing. It should be understood that the values at 15 and 45 minutes past the hour are interpolated. They will be flagged with the usual 'A' or 'J' for substitution from SSA-OA flux tower or SSA-OJP flux tower, respectively. Only when a block of data is missing (for less than 2 hours) from a flux tower and is linearly interpolated will the 'C' or 'K' be used for interpolation of SSA-OA flux tower data or SSA-OJP flux tower data, respectively.

9.3.2 Calculated Variables

Variables calculated for entire data set:
MIXING RATIO

Variables calculated for portions of the data set:
RELATIVE HUMIDITY
REFLECTED SHORTWAVE RADIATION
DIFFUSE INCOMING SHORTWAVE RADIATION
INCOMING LONGWAVE RADIATION
U COMPONENT OF WIND
V COMPONENT OF WIND

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

STATION PRESSURE: This parameter has been flagged with a '?' from 01-JAN-94:0000Z to 19-FEB-94:0130Z at SSA-OA, 01-JAN-94:0000Z to 19-FEB-94:0230Z at SSA-OJP, 18-JAN-94:0000Z to 1994 19-FEB-94:0330Z at NSA-OJP, and 18-JAN-94:0000Z to 18-FEB-94:2245Z at NSA-YTH. Values at these times are incorrect and cannot be retroactively corrected. Please use these values only to evaluate pressure trends.

10.2 Quality Assessment

10.2.1 Data Validation by Source

Please refer to the BOREAS AFM-07 SRC Surface Meteorological Data, BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data, BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data, and the BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data documentation for more detailed information on data collection.

10.2.2 Confidence Level/Accuracy Judgment

Please refer to this section in the AFM-07 SRC Surface Meteorological Data, BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data, BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data, and BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data documents for original data confidence. Parameters were measured at various heights, which affects accuracy (see Section 11.2). It was felt that a linear interpolation of parameters missing for less than 2 hours was a good approximation of actual values. When substituting from one SRC tower to another, subtle differences in instrument height, elevation, terrain, canopy, current weather conditions, and other various factors cause the substituted data to be less accurate than actual data. The degree of accuracy depends on these numerous qualitative factors. Reflected Shortwave and Incoming Longwave are sometimes calculated as residuals assuming Net Radiation is the balance of Total Incoming Shortwave, Incoming Longwave, Reflected Shortwave, and Outgoing Longwave. Obviously this neglects other factors and sensor errors that either add to or subtract from this balance. Diffuse Incoming Shortwave is sometimes calculated from a regression equation relating Diffuse Incoming Shortwave, Total Incoming Shortwave, and zenith angle. It was very difficult to assess the accuracy of this method since no measurements of cloud cover were made by any of the data sources.

10.2.3 Measurement Error for Parameters

Please refer to the documentation for the following data sets for more detailed information:

BOREAS AFM-07 SRC Surface Meteorological Data
BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data
BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data
BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data

10.2.4 Additional Quality Assessments

Please refer to the documentation for the following data sets for more detailed information:

BOREAS AFM-07 SRC Surface Meteorological Data
BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data
BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data
BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data

10.2.5 Data Verification by Data Center

The data were spot checked for accuracy.

11. Notes

11.1 Limitations of the Data

These data were compiled to provide a consistent modeling data set over a long period of time (i.e., years) for a group of modelers in the BOREAS project. Since some of the data were interpolated or substituted from various sources, caution should be taken in using this data set, especially when trying to make inferences over short time periods.

11.2 Known Problems with the Data

Please note that substituted data will have been measured at a different height than the original data. The height difference depends on parameter and data source. This affects the accuracy of the data but is still a good approximation since height differences were not large. Please refer to the equipment sections (Section 4) of the following documents for sensor heights:

BOREAS AFM-07 SRC Surface Meteorological Data
BOREAS TF-05 SSA-OJP Tower Flux and Meteorological Data
BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data

WITHIN CANOPY AIR TEMPERATURE:

When this variable is missing from both SRC towers within a study area for more than 2 hours, it cannot be replaced by other means since it was not measured at a flux tower. A '-999' is given in place of a value. A good approximation of this value would be the Infrared (Canopy Radiative) Temperature.

INFRARED (CANOPY RADIATIVE) TEMPERATURE:

When this variable is missing from SRC for more than 2 hours during winter, it cannot be replaced by other means since flux towers were not collecting data in winter. A '-999' is given in place of a value. A good approximation of this value would be the within canopy air temperature.

STATION PRESSURE:

This parameter has been flagged with a '?' from 01-JAN-94:0000Z to 19-FEB-94:0130Z at SSA-OA, 01-JAN-94:0000Z to 19-FEB-94:0230Z at SSA-OJP, 18-JAN-94:0000Z to 1994 19-FEB-94:0330Z at NSA-OJP, and 18-JAN-94:0000Z to 18-FEB-94:2245Z at NSA-YTH. Values at these times are incorrect and cannot be retroactively corrected. Please use these values only to evaluate pressure trends.

PRECIPITATION:

When the Belfort gauge is used, as mentioned in Section 9.3.1, values sometimes oscillate about a point. The raw value is cumulative so that in order to obtain 15-minute values, the last period's value must be subtracted from the current value. If the current value is less than that of the last period, the value will be set to zero. If the current value is greater than that of the last period, the positive difference will be given. If this value is small, it may not be due to a precipitation event. The user must use his or her judgment to determine which values denote actual precipitation and which denote sensor noise. From analysis, it appears that values of 0.1 denote sensor noise.

11.3 Usage Guidance

This data set was compiled as a consistent standard data set for BOREAS modelers to use in climate and weather models. Because data were interpolated and substituted to fill data gaps, caution should be used when trying to draw inferences from this data set.

11.4 Other Relevant Information

None.

12. Application of the Data Set

This data set was compiled as a consistent standard data set for BOREAS modelers to use in process models. Because data were interpolated and substituted to fill data gaps, caution should be used when trying to draw inferences from this data set.

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description

BORIS staff developed a set of FORTRAN programs to process and merge the existing data into the form presented here. The software modules and their functions are:

LINTERP.FOR - Perform needed linear interpolation of data for gaps two hours or less in duration within a given file.

SUBST.FOR - Compares the contents of two input files and substitutes data from one to the other to fill in data gaps.

14.2 Software Access

The software is available from the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC). See Section 15 for details.

15. Data Access

The derived surface meteorological data are available from the Earth Observing System Data and Information System (EOSDIS) ORNL 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

Please refer to this section in the AFM-07 SRC Meteorological and Radiation Data Set documentation, TF-02 documentation, TF-05 documentation, and TF-01 documentation.

17.2 Journal Articles and Study Reports

Please refer to this section in the AFM-07 SRC Meteorological and Radiation Data Set documentation, TF-02 documentation, TF-05 documentation, and TF-01 documentation.

Bolton, D. 1980. The Computation of Equivalent Potential Temperature. Monthly Weather Review, 108:1046-1053.

Monteith, J.L. and M.H. Unsworth. 1990. Principles of Environmental Physics. Edward Arnold, New York.

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

```
e               - vapor pressure
es(T)           - saturation vapor pressure (function of T)
Mw              - molecular weight of water = 18 g/mol
P               - station pressure
q               - mixing ratio
R               - gas constant = 8.314 J/(mol K)
RH              - relative humidity
T               - air temperature at approximately 10 meters above the canopy
X               - absolute humidity or vapor density
-999            - given when parameter is missing

Units:
g               - grams
J               - Joules
K               - Kelvin
kPa             - kiloPascals
m               - meters
mb              - millibars
mol             - mole
Pa              - Pascals
```

19. List of Acronyms

AES	- Atmospheric Environment Service
AFM	- Aircraft Flux and Meteorology (BOREAS Science Group)
ARC	- Ames Research Center
ASCII	- American Standard Code for Information Interchange
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
CCRS	- Canada Centre for Remote Sensing
CCT	- Computer Compatible Tape
CD-ROM	- Compact Disk-Read-Only Memory
DAAC	- Distributed Active Archive Center
DAT	- Digital Archive Tape
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
MARSII	- Meteorological Automatic Reporting System II
NAD83	- North American Datum of 1983
NASA	- National Aeronautics and Space Administration
NSA	- Northern Study Area
OA	- Old Aspen
OJP	- Old Jack Pine
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert National Park
PAR	- Photosynthetically Active Radiation
READAC	- Remote Environmental Automatic Data Acquisition Concept
SRC	- Saskatchewan Research Council (AFM-07)
SSA	- Southern Study Area
TF	- Tower Flux (BOREAS Science Group)
URL	- Uniform Resource Locator
YTH	- Thompson Airport

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In 1995, the BOREAS science teams identified the need for a continuous surface meteorological and radiation data set to support flux and surface process modeling efforts. This data set contains actual, substituted, and interpolated 15-minute meteorological and radiation data compiled from several surface measurements sites over the BOREAS SSA and NSA. Temporally, the data cover 01-Jan-1994 to 31-Dec-1996. The data are stored in tabular ASCII files, and are classified as AFM-Staff data.

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