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NASA/TM—2000–209891, Vol. 201

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

Forrest G. Hall and Karl Huemmrich, Editors

Volume 201

BOREAS TF-6 SSA-YA Surface Energy Flux and Meteorological Data

Pierre Bessemoulin and Dominique Puech
Meteo-France, CNRM/Groupe De Meteorologie Experimentale et Instrumentale (GMEI)
Toulouse

National Aeronautics and Space Administration

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Greenbelt, Maryland 20771

October 2000

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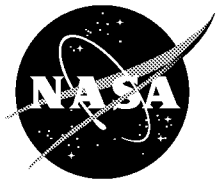
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BOREAS TF-6 SSA-YA Surface Energy Flux and Meteorological Data

Pierre Bessemoulin, Dominique Puech

Summary

The BOREAS TF-6 team collected surface energy flux and meteorology data at the SSA-YA site. The data characterize the energy flux and meteorological conditions at the site from 18-Jul to 20-Sep-1994. The data set does not contain any trace gas exchange measurements. The data are available in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS TF-06 SSA-YA Surface Energy Flux and Meteorological Data

1.2 Data Set Introduction

Meteorological and flux measurements were collected in 1994 by Centre National de Recherches Mètèorologiques (CNRM) personnel during Intensive Field Campaigns (IFCs) 2 and 3 of the BOReal Ecosystem-Atmosphere Study (BOREAS) at the Southern Study Area (SSA) Young Aspen (YA) site. Energy fluxes were reported as 30-minute averages, and the meteorology data were reported at 10-minute intervals. Carbon dioxide flux data were not collected.

1.3 Objective/Purpose

The common aim of the BOREAS surface flux group was to use a network of tower- based observing systems to measure fluxes of heat, momentum, evaporation, and some trace gases over different vegetation types (aspen, jack pine, black spruce, and fen), vegetation age (old and young), and surface wetness. CNRM personnel on the BOREAS Tower Flux (TF) team TF-06 conducted such a study at the SSA-YA site. The YA site is of importance because it is representative of a regenerating forest that occurs widely in the boreal forest region.

1.4 Summary of Parameters

Net radiation, total and solar upward and downward radiation, sensible heat flux, latent heat flux, Bowen ratio, soil heat flux, wind speed and direction, air pressure, rainfall, air temperature and humidity above and in canopy, soil temperature at two depths.

1.5 Discussion

Flux data were acquired using fast response sensors. The data were collected and stored by a COMPAQ portable PC powered by batteries and solar panels. Meteorological measurements were acquired using a CEIS ESPACE Automated Weather Station (AWS). The sampling rate for all parameters is on the order of a few seconds. Reported variables are arithmetic means, with the exception of mean wind speed and direction, which are estimated using a vector mean and rainfall, which is the cumulative amount of water collected during 10-minute intervals. Flux data were reported every 30 minutes. Meteorological data were reported as 10-minute averages. The instruments operated continuously from 18-Jul to 20-Sep-1994.

1.6 Related Data Sets

BOREAS TF-01 SSA-OA Tower Flux and Meteorological Data
BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data
BOREAS TF-04 SSA-YJP Tower Flux, Meteorological, and Canopy Condition Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. Pierre Bessemoulin
METEO-FRANCE/CNRM
Toulouse

2.2 Title of Investigation

Study of the Boreal Forest Effects on Surface/Atmosphere Fluxes (TF-06)

2.3 Contact Information

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3. Theory of Measurements

Eddy correlation is a well-known technique that has the advantage of being a direct method of measuring surface energy fluxes (compared to indirect methods such as the Bowen ratio method, or profile methods). The principle of eddy correlation is to measure fluctuations of the three wind components (u,v,w) with a 3-D sonic anemometer, along with air temperature and moisture. The air temperature may be determined from the sonic temperature (Ts). The sonic temperature is derived from a measure of the sound velocity (C). The air temperature may also be measured directly with a thermocouple. Covariances of the above parameters were computed in real time in the field. Fluxes were derived from covariances by applying different corrections:

- Coordinate rotations to remove possible misalignment of the sonic anemometer structure with respect to the local mean wind streamlines.
- w'T's corrected from the influence of latent and momentum fluxes to derive the sensible heat flux.
- Webb and frequency response corrections (including the effect of limited response of the sensors, time constants, path length averaging, and sensor separation).
- Contamination of humidity measurements when using a Krypton hygrometer by sensible heat flux.

Fluxes were estimated every 30 minutes, using a sampling rate of 21 Hz. Fluctuations were computed by referencing the actual signals to running means (recursive filter where the time constant was 200 seconds).

4. Equipment

4.1 Sensor/Instrument Description

4.1.1 Collection Environment

Measurements were taken continuously from 18-Jul to 20-Sep-1994. The tower extended above the canopy and was exposed to direct sunlight and weather. Because the site operated only through late summer, the temperature conditions were mild.

4.1.2 Source/Platform

Two portable pole-type towers, stabilized with guy wires, were used. One tower supported the meteorological instruments; the other supported the sonic anemometer. A third structure at the site, in the form of an "A"-shaped folding ladder, supported the solar cells that powered the instruments.

4.1.3 Source/Platform Mission Objectives

The purpose of the tower was to provide a stable platform extending above the canopy from which surface flux observations could be collected.

4.1.4 Key Variables

Net radiation, total and solar upward and downward radiation, sensible heat flux, latent heat flux, Bowen ratio, soil heat flux, wind speed and direction, air pressure, rainfall, air temperature and humidity above and in canopy, soil temperature at two depths.

4.1.5 Principles of Operation

Eddy correlation using a 3-D sonic anemometer.

4.1.6 Sensor/Instrument Measurement Geometry

Instruments were attached to the tower at the following heights (negative values are underground):

- Sonic anemometer at 6.0 m (agl)
- Moisture sensor, Krypton hygrometer, at 6.0 m (agl)

Response times (path length) were the following:

- Sonic anemometer: 0.05 s (14.9 cm)
- Hygrometer: 0.01 s (1.3 cm)
- The separation between the two sensors was 18 cm.
- Wind speed and direction at 10 m (agl)
- Temperature at 9.2 m (agl)
- Humidity at 9.2 m (agl)
- Upward/downward total radiation at 9.2 m (agl)
- Upward/downward solar radiation at 9.2 m (agl)
- Temperature at 2.0 m (agl)
- Humidity at 2.0 m (agl)
- Rainfall measured at 6 m (above canopy)
- Soil temperature at -1 cm
- Soil temperature at -5 cm
- Soil heat flux plate at -3 cm

4.1.7 Manufacturer of Sensor/Instrument

Sonic anemometer - Gill Solent3D sonic anemometer

Moisture sensor - Campbell Scientific KH20 Krypton hygrometer
Campbell Scientific, Inc.
815 W. 1800 N.
Logan, UT 84321-1784
(801) 753-2342

Wind speed and direction - R.M. Young wind monitor AQ type
Manufacturer: R.M. Young Company
Distributor: Campbell Scientific, Inc.
815 W. 1800 N.
Logan, UT 84321-1784
(801) 753-2342

Humidity sensors - Vaisala HMP35A
Manufacturer: Vaisala, Inc., Woburn, MA
Distributor: Campbell Scientific, Inc.
815 W. 1800 N.
Logan, UT 84321-1784
(801) 753-2342

Upward/downward total radiation - Schenk 8111 pyranometer

Upward/downward solar radiation - Schenk 8101 pyranometer

Rainfall - Weathermeasure tipping bucket

Surface pressure - AIR DB2A

Soil heat flux plate - Thornthwaite plate

4.2 Calibration

4.2.1 Specifications

The Campbell Scientific KH20 hygrometer was connected to one analog input of the sonic anemometer. Data available on the serial port of the sonic anemometer, which was set to MODE 1 (calibrated UVW), were used. In this mode, the three vector speeds were corrected to allow for the effects of the framework and transducers. Accordingly, calibrations of the manufacturer were used for the sonic anemometer. Regular checks were made in the field (comparison with wind speed measured by the nearby AWS did not reveal any discrepancy). For the KH20 hygrometer, calibration information provided by Campbell Scientific was used. Only mean moisture values could be checked, compared to humidity measurements conducted at the AWS.

4.2.1.1 Tolerance

Not given.

4.2.2 Frequency of Calibration

Not given.

4.2.3 Other Calibration Information

Not given.

5. Data Acquisition Methods

Flux data were acquired using fast response sensors. Data were collected and stored by a COMPAQ portable PC powered by batteries and solar panels. Meteorological measurements were acquired using a CEIS ESPACE AWS. The sampling rate for all parameters is on the order of a few seconds. Parameters appearing in the message delivered by the station are arithmetic means, except for mean wind speed and direction, which are estimated using a vector and rainfall, which is the cumulative amount of water fallen during 10-minute intervals. Flux data were reported every 30-minutes. Meteorological data were 10-minute averages (see above).

6. Observations

6.1 Data Notes

Fetch conditions were excellent for the flux measurements.

6.2 Field Notes

Four days of data were lost (23-Aug - 26-Aug, out of IFC-3) because some big game destroyed the cable powering the AWS.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

All data were collected at the SSA-YA site. The North American Datum of 1983 (NAD83) coordinates of the site were approximately 53° 39' N; 105° 20'W. The altitude was 550 m. The tower was located in a clearing 2 km long, 1 km wide, covered by dense young aspen (mean height: 2.5 to 3 m), surrounded by large trees (mixed aspen and jack pines, up to 20 m). Near the tower, the tree density was 10 trunks per square meter, with a mean trunk diameter of 3 cm. The biomass was estimated at 20 kg per square meter.

7.1.2 Spatial Coverage Map

Not applicable.

7.1.3 Spatial Resolution

The data represent point source measurements taken at the given location. The towers were placed in a clearing 2 km long, 1 km wide, covered by dense young aspen (mean height: 2.5 to 3 m). The area was surrounded by large trees (mixed aspen and jack pines, up to 20 m). Fetch conditions were excellent for the flux measurements.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

Measurements are available from 18-Jul to 20-Sep-1994. Four days of data were lost (23-Aug - 26-Aug, out of IFC-3) because some big game destroyed the cable powering the AWS.

7.2.2 Temporal Coverage Map

All data were collected at the SSA-YA site.

7.2.3 Temporal Resolution

The Gill Solent3D sonic anemometer has a sampling rate of 21 Hz; these data are averaged to 30-minute values. Flux data were reported every 30 minutes. Meteorological data are 10-minute averages.

7.3 Data Characteristics

The data from TF-06 are stored in two files, one for the tower flux and one for the meteorology data. Both files are described in the following sections.

7.3.1 Parameter/Variable

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

TF06_TOWER_FLUX

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
TIME_OBS
SENSIBLE_HEAT_FLUX_ABV_CNPY
LATENT_HEAT_FLUX_ABV_CNPY
BOWEN_RATIO_ABV_CNPY
NET_RAD_ABV_CNPY
SOIL_HEAT_FLUX
CRTFCN_CODE
REVISION_DATE

TF06_METEOROLOGICAL

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
TIME_OBS
SURF_PRESS
AIR_TEMP_ABV_CNPY
AIR_TEMP_2M
SOIL_TEMP_1CM
SOIL_TEMP_5CM
REL_HUM_ABV_CNPY
REL_HUM_2M
WIND_DIR_ABV_CNPY
WIND_VELOC_ABV_CNPY
RAINFALL
DOWN_TOTAL_RAD_ABV_CNPY
UP_TOTAL_RAD_ABV_CNPY
DOWN_SOLAR_RAD_ABV_CNPY
UP_SOLAR_RAD_ABV_CNPY
NET_RAD_ABV_CNPY
SOIL_HEAT_FLUX
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:

TF06_TOWER_FLUX

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) of the start of the data collection.
SENSIBLE_HEAT_FLUX_ABV_CNPY	The sensible heat flux measured above the canopy.
LATENT_HEAT_FLUX_ABV_CNPY	The latent heat flux measured above the canopy.
BOWEN_RATIO_ABV_CNPY	The Bowen Ratio, defined as the sensible heat flux divided by the latent heat flux.
NET_RAD_ABV_CNPY	The net radiation measured above the canopy.
SOIL_HEAT_FLUX	The surface soil heat flux.
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.

TF06_METEOROLOGICAL

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) of the start of the

	data collection.
SURF_PRESS	The atmospheric pressure measured at station level.
AIR_TEMP_ABV_CNPY	This column contains the air temperature measured above the canopy.
AIR_TEMP_2M	The air temperature at 2 meters above the ground.
SOIL_TEMP_1CM	Soil temperature at 1 cm depth.
SOIL_TEMP_5CM	Soil temperature at 5 cm depth.
REL_HUM_ABV_CNPY	The relative humidity measured above the canopy.
REL_HUM_2M	The relative humidity at 2 meters above ground.
WIND_DIR_ABV_CNPY	The wind direction measured above the canopy.
WIND_VELOC_ABV_CNPY	The wind velocity measured above the canopy.
RAINFALL	The amount of rainfall in this 30 minutes measured above the canopy.
DOWN_TOTAL_RAD_ABV_CNPY	The total downward (incoming) radiation measured above the canopy.
UP_TOTAL_RAD_ABV_CNPY	The total upward (outgoing) radiation measured above the canopy.
DOWN_SOLAR_RAD_ABV_CNPY	The downward (incoming) solar radiation measured above the canopy.
UP_SOLAR_RAD_ABV_CNPY	The reflected (outgoing) solar radiation measured above the canopy.
NET_RAD_ABV_CNPY	The net radiation measured above the canopy.
SOIL_HEAT_FLUX	The surface soil heat flux.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

7.3.3 Unit of Measurement

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

TF06_TOWER_FLUX

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
SENSIBLE_HEAT_FLUX_ABV_CNPY	[Watts][meter^-2]
LATENT_HEAT_FLUX_ABV_CNPY	[Watts][meter^-2]
BOWEN_RATIO_ABV_CNPY	[unitless]
NET_RAD_ABV_CNPY	[Watts][meter^-2]
SOIL_HEAT_FLUX	[Watts][meter^-2]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

TF06_METEOROLOGICAL

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
SURF_PRESS	[unitless]
AIR_TEMP_ABV_CNPY	[degrees Celsius]
AIR_TEMP_2M	[degrees Celsius]
SOIL_TEMP_1CM	[degrees Celsius]
SOIL_TEMP_5CM	[degrees Celsius]
REL_HUM_ABV_CNPY	[percent]
REL_HUM_2M	[percent]
WIND_DIR_ABV_CNPY	[degrees from North]
WIND_VELOC_ABV_CNPY	[meters][second^-1]
RAINFALL	[millimeters]
DOWN_TOTAL_RAD_ABV_CNPY	[Watts][meter^-2]
UP_TOTAL_RAD_ABV_CNPY	[Watts][meter^-2]
DOWN_SOLAR_RAD_ABV_CNPY	[Watts][meter^-2]
UP_SOLAR_RAD_ABV_CNPY	[Watts][meter^-2]
NET_RAD_ABV_CNPY	[Watts][meter^-2]
SOIL_HEAT_FLUX	[Watts][meter^-2]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

7.3.4 Data Source

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

TF06_TOWER_FLUX

Column Name	Data Source
SITE_NAME	[Assigned by BORIS]
SUB_SITE	[Assigned by BORIS]
DATE_OBS	[Investigator]
TIME_OBS	[Investigator]
SENSIBLE_HEAT_FLUX_ABV_CNPY	[Sonic Anemometer]
LATENT_HEAT_FLUX_ABV_CNPY	[Krypton Hygrometer]
BOWEN_RATIO_ABV_CNPY	[Sonic Anemometer, Krypton Hygrometer]
NET_RAD_ABV_CNPY	[Net Radiometer]
SOIL_HEAT_FLUX	[Soil heat flux plate]
CRTFCN_CODE	[Assigned by BORIS]
REVISION_DATE	[Assigned by BORIS]

TF06_METEOROLOGICAL

Column Name	Data Source
SITE_NAME	[Assigned by BORIS]
SUB_SITE	[Assigned by BORIS]
DATE_OBS	[Investigator]
TIME_OBS	[Investigator]
SURF_PRESS	[barometer]
AIR_TEMP_ABV_CNPY	[VAISALA HMP35A]
AIR_TEMP_2M	[VAISALA HMP35A]

SOIL_TEMP_1CM	[thermocouple]
SOIL_TEMP_5CM	[thermocouple]
REL_HUM_ABV_CNPY	[VAISALA HMP35A]
REL_HUM_2M	[VAISALA HMP35A]
WIND_DIR_ABV_CNPY	[RM YOUNG Wind Monitor AQ type]
WIND_VELOC_ABV_CNPY	[RM YOUNG Wind Monitor AQ type]
RAINFALL	[Tipping bucket rain gauge]
DOWN_TOTAL_RAD_ABV_CNPY	[SCHENK 8111 pyranometer]
UP_TOTAL_RAD_ABV_CNPY	[SCHENK 8111 pyranometer]
DOWN_SOLAR_RAD_ABV_CNPY	[SCHENK 8101 pyranometer]
UP_SOLAR_RAD_ABV_CNPY	[SCHENK 8101 pyranometer]
NET_RAD_ABV_CNPY	[Net Radiometer]
SOIL_HEAT_FLUX	[Soil heat flux plate]
CRTFCN_CODE	[Assigned by BORIS]
REVISION_DATE	[Assigned by BORIS]

7.3.5 Data Range

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

TF06_TOWER_FLUX

Column Name	Minimum Data Value	Maximum Data Value	Missing Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9YA-FLXTR	SSA-9YA-FLXTR	None	None	None	None
SUB_SITE	9TF06-FLX01	9TF06-FLX01	None	None	None	None
DATE_OBS	19-JUL-94	19-SEP-94	None	None	None	None
TIME_OBS	0	2330	None	None	None	None
SENSIBLE_HEAT_FLUX_ABV_CNPY	-123	332	-999	None	None	None
LATENT_HEAT_FLUX_ABV_CNPY	-53	472	-999	None	None	None
BOWEN_RATIO_ABV_CNPY	-36	58	-999	None	None	None
NET_RAD_ABV_CNPY	-75	675	-999	None	None	None
SOIL_HEAT_FLUX	-27	56	-999	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	05-DEC-97	05-DEC-97	None	None	None	None

TF06_METEOROLOGICAL

Column Name	Minimum Data Value	Maximum Data Value	Missing Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9YA-FLXTR	SSA-9YA-FLXTR	None	None	None	None
SUB_SITE	9TF06-MET01	9TF06-MET01	None	None	None	None
DATE_OBS	19-JUL-94	19-SEP-94	None	None	None	None
TIME_OBS	0	2350	None	None	None	None
SURF_PRESS	936.1	963.1	-999	None	None	None
AIR_TEMP_ABV_CNPY	1.4	28.6	-999	None	None	None
AIR_TEMP_2M	-4.6	29.5	-999	None	None	None
SOIL_TEMP_1CM	3.3	20.9	-999	None	None	None
SOIL_TEMP_5CM	6.8	15.1	-999	None	None	None

REL_HUM_ABV_CNPY	28	97	-999	None	None	None
REL_HUM_2M	19	100	-999	None	None	None
WIND_DIR_ABV_CNPY	0	360	-999	None	None	None
WIND_VELOC_ABV_CNPY	0	8.4	-999	None	None	None
RAINFALL	0	5	-999	None	None	None
DOWN_TOTAL_RAD_ABV_CNPY	244	1352	-999	None	None	None
UP_TOTAL_RAD_ABV_CNPY	294	602	-999	None	None	None
DOWN_SOLAR_RAD_ABV_CNPY	0	950	-999	None	None	None
UP_SOLAR_RAD_ABV_CNPY	0	173	-999	None	None	None
NET_RAD_ABV_CNPY	-76	763	-999	None	None	None
SOIL_HEAT_FLUX	-28	77	-999	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	05-DEC-97	05-DEC-97	None	None	None	None

Minimum Data Value -- The minimum value found in the column.
Maximum Data Value -- The minimum value found in the column.
Missing Data Value -- The value that indicates missing data. This is used to indicate that an attempt was made to determine the parameter value, but the attempt was unsuccessful.
Unrel Data Value -- The value that indicates unreliable data. This is used to indicate an attempt was made to determine the parameter value, but the value was deemed to be unreliable by the analysis personnel.
Below Detect Limit -- The value that indicates parameter values below the instruments detection limits. This is used to indicate that an attempt was made to determine the parameter value, but the analysis personnel determined that the parameter value was below the detection limit of the instrumentation.
Data Not Cllctd -- This value indicates that no attempt was made to determine the parameter value. This usually indicates that BORIS combined several similar but not identical data sets into the same data base table but this particular science team did not measure that parameter.

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

7.4 Sample Data Record

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

```
TF06_TOWER_FLUX
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,SENSIBLE_HEAT_FLUX_ABV_CNPY,
LATENT_HEAT_FLUX_ABV_CNPY,BOWEN_RATIO_ABV_CNPY,NET_RAD_ABV_CNPY, SOIL_HEAT_FLUX,
CRTFCN_CODE,REVISION_DATE
'SSA-9YA-FLXTR','9TF06-FLX01',01-AUG-94,0,-15,93,-.2,129,10,'CPI',05-DEC-97
'SSA-9YA-FLXTR','9TF06-FLX01',01-AUG-94,30,-3,5,-.6,31,2,'CPI',05-DEC-97

TF06_METEOROLOGICAL
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,SURF_PRESS,AIR_TEMP_ABV_CNPY, AIR_TEMP_2M,
SOIL_TEMP_1CM,SOIL_TEMP_5CM,REL_HUM_ABV_CNPY,REL_HUM_2M, WIND_DIR_ABV_CNPY,
WIND_VELOC_ABV_CNPY,RAINFALL,DOWN_TOTAL_RAD_ABV_CNPY, UP_TOTAL_RAD_ABV_CNPY,
DOWN_SHORTWAVE_RAD_ABV_CNPY, UP_SHORTWAVE_RAD_ABV_CNPY,NET_RAD_ABV_CNPY,
SOIL_HEAT_FLUX,CRTFCN_CODE, REVISION_DATE
'SSA-9YA-FLXTR','9TF06-MET01',01-AUG-94,0,950.3,25,25.9,19,14.8,58,63,190,2.1,
0,722,502,343,75,220,12,'CPI',05-DEC-97
'SSA-9YA-FLXTR','9TF06-MET01',01-AUG-94,10,950.2,25,25.9,19,14.8,58,62,191,1.8,
0,684,495,310,69,189,11,'CPI',05-DEC-97
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by the BOREAS Information System (BORIS) was data collected at a given site on a given date.

8.2 Data Format

The Compact Disk-Read-Only Memory (CD-ROM) files contain American Standard Code for Information Interchange (ASCII) numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

9. Data Manipulations

9.1 Formulae

9.1.1 Derivation Techniques and Algorithms

Formulas included statistical procedures for computing means, variances, and covariances of signals sampled. Coordinate rotations were simple geometric transformations.

9.2 Data Processing Sequence

9.2.1 Processing Steps

Means, variances, and covariances were computed in the field using fluctuations of the quantities computed as the difference between the actual measurement and a recursive mean value updated at each time step. The time constant used for the recursive filter was 200 seconds. Every 1 or 2 days, the memory of the acquisition computer was dumped in order to produce covariances corresponding to coordinates where the x axis is aligned with the mean wind speed (u=U; v=0), and the z axis is such that the mean vertical wind speed, w, is zero.

BORIS staff processed these data by:

- Reviewing the initial data files and loading them online for BOREAS team access.
- Designing relational data base tables to inventory and store the data.
- Loading the data into the relational data base tables.
- Working with the team to document the data set.
- Extracting the data into logical files.

9.2.2 Processing Changes

None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

Further processing included corrections to covariances necessary to obtain fluxes:

- Compensation for the spatial separation of sensors and limited frequency response of sensors.
- Webb correction for the effect of temperature-induced density fluctuations for the latent heat flux.
- Schotanus correction associated with the use of the sonic temperature: the sensible heat flux can be estimated from w'T's provided corrections involving the latent heat and momentum fluxes are applied.
- Contamination of the latent heat flux by the sensible heat flux when using the Krypton hygrometer.

9.3.2 Calculated Variables

The Bowen ratio is the ratio of the sensible heat flux to the latent heat flux.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

The main source of trouble comes from the Campbell hygrometer, which does not work correctly when the windows are wet.

10.2 Quality Assessment

10.2.1 Data Validation by Source

Intercomparison of the flux computation algorithms were conducted. The physical constants used in the derivation of the fluxes are widely accepted ones. The algorithms used to calculate fluxes at this site produced exactly the same results as the algorithm agreed upon for the intercomparison analysis. A roving net radiometer was used at all BOREAS TF sites in order to evaluate the intercomparability of net radiation measurements conducted at the tower sites.

10.2.2 Confidence Level/Accuracy Judgment

None given.

10.2.3 Measurement Error for Parameters
None given.

10.2.4 Additional Quality Assessments
None given.

10.2.5 Data Verification by Data Center
Data were examined to check for spikes, values that are four standard deviations from the mean, long periods of constant values, and missing data.

11. Notes

11.1 Limitations of the Data
The data set does not contain any trace gas exchange measurements. The measurement period covers only mid to late summer.

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

These data are useful for the study of water and energy exchange in a regenerating aspen stand.

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description
None given.

14.2 Software Access
None given.

15. Data Access

The TF-06 SSA-YA surface energy flux and 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: ornldaac@ornl.gov or ornl@eos.nasa.gov

15.2 Data Center Identification

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

15.3 Procedures for Obtaining Data

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

15.4 Data Center Status/Plans

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

16. Output Products and Availability

16.1 Tape Products

None.

16.2 Film Products

None.

16.3 Other Products

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

17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation

None.

17.2 Journal Articles and Study Reports

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. 2000. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM.

Sellers, P. and F. Hall. 1994. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1994-3.0, NASA BOREAS Report (EXPLAN 94).

Sellers, P. and F. Hall. 1996. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1996-2.0, NASA BOREAS Report (EXPLAN 96).

Sellers, P., F. Hall, and K.F. Huemmrich. 1996. Boreal Ecosystem-Atmosphere Study: 1994 Operations. NASA BOREAS Report (OPS DOC 94).

Sellers, P., F. Hall, and K.F. Huemmrich. 1997. Boreal Ecosystem-Atmosphere Study: 1996 Operations. NASA BOREAS Report (OPS DOC 96).

Sellers, P., F. Hall, H. Margolis, B. Kelly, D. Baldocchi, G. den Hartog, J. Cihlar, M.G. Ryan, B. Goodison, P. Crill, K.J. Ranson, D. Lettenmaier, and D.E. Wickland. 1995. The boreal ecosystem-atmosphere study (BOREAS): an overview and early results from the 1994 field year. Bulletin of the American Meteorological Society. 76(9):1549-1577.

Sellers, P.J., F.G. Hall, R.D. Kelly, A. Black, D. Baldocchi, J. Berry, M. Ryan, K.J. Ranson, P.M. Crill, D.P. Lettenmaier, H. Margolis, J. Cihlar, J. Newcomer, D. Fitzjarrald, P.G. Jarvis, S.T. Gower, D. Halliwell, D. Williams, B. Goodison, D.E. Wickland, and F.E. Guertin. 1997. BOREAS in 1997: Experiment Overview, Scientific Results and Future Directions. Journal of Geophysical Research 102(D24): 28,731-28,770.

17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

```
agl      - above ground level
ASCII    - American Standard Code for Information Interchange
AWS      - Automated Weather Station
BOREAS   - BOReal Ecosystem-Atmosphere Study
BORIS    - BOREAS Information System
CD-ROM   - Compact Disk-Read-Only Memory
CNRM     - Centre National de Recherches Mètèorologiques
DAAC     - Distributed Active Archive Center
EOS      - Earth Observing System
```

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EOSDIS  - EOS Data and Information System
GIS     - Geographic Information System
GMEI    - Groupe De Meteorologie Experimentale et Instrumentale
GMT     - Greenwich Mean Time
GSFC    - Goddard Space Flight Center
HTML    - HyperText Markup Language
IFC     - Intensive Field Campaign
NAD83   - North American Datum of 1983
NASA    - National Aeronautics and Space Administration
NSA     - Northern Study Area
ORNL    - Oak Ridge National Laboratory
PANP    - Prince Albert National Park
SSA     - Southern Study Area
TF      - Tower Flux
URL     - Uniform Resource Locator
YA      - Young Aspen
```

20. Document Information

20.1 Document Revision Dates

Written: 04-Mar-1998
Revised: 08-Jun-1999

20.2 Document Review Dates

BORIS Review: 09-Mar-1998
Science Review:

20.3 Document ID

20.4 Citation

When using these data, please include the following acknowledgment as well as citations of relevant papers in Section 17.2:

The observations were collected by P. Bessemoulin, D. Puech, G. Bouhours, G. Lachaud, E. Gizard, and J. Marcel.

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

Bessemoulin, P., "Study of the Boreal Forest Effects on Surface/Atmosphere Fluxes (TF-06)." In Collected Data of The Boreal Ecosystem-Atmosphere Study. Eds. J. Newcomer, D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers. CD-ROM. NASA, 2000.

Also, cite the BOREAS CD-ROM set as:

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM. NASA, 2000.

20.5 Document Curator

20.6 Document URL

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	October 2000	Technical Memorandum

4. TITLE AND SUBTITLE
Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)
BOREAS TF-6 SSA-YA Surface Energy Flux and Meteorological Data

5. FUNDING NUMBERS
923
RTOP: 923-462-33-01

6. AUTHOR(S)
Pierre Bessemoulin and Dominique Puech
Forrest G. Hall and Karl Huemmrich, Editors

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS (ES)
Goddard Space Flight Center
Greenbelt, Maryland 20771

8. PEFORMING ORGANIZATION REPORT NUMBER
2000-03136-0

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS (ES)
National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
TM—2000–209891
Vol. 201

11. SUPPLEMENTARY NOTES
P. Bessemoulin and D. Puech: Meteo-France, CNRM/Groupe De Meteorologie Experimentale et Instrumentale, Toulouse; K. Huemmrich: University of Maryland, NASA Goddard Space Flight Center, Greenbelt, Maryland

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Unclassified–Unlimited
Subject Category: 43
Report available from the NASA Center for AeroSpace Information,
7121 Standard Drive, Hanover, MD 21076-1320. (301) 621-0390.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The BOREAS TF-6 team collected surface energy flux and meteorology data at the SSA-YA site. The data characterize the energy flux and meteorological conditions at the site from 18-Jul to 20-Sep-1994. The data set does not contain any trace gas exchange measurements. The data are available in tabular ASCII files.

14. SUBJECT TERMS
BOREAS, tower flux, meteorological data.

15. NUMBER OF PAGES
18

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL