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

Forrest G. Hall and David E. Knapp, Editors

Volume 5

BOREAS AFM-3 NCAR Electra 1994 Aircraft Sounding Data

D.H. Lenschow and S.P Oncley

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

June 2000

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BOREAS AFM-3 NCAR Electra 1994 Aircraft Sounding Data

Donald H. Lenschow, Steven P. Oncley

Summary

The BOREAS AFM-3 team used the NCAR Electra aircraft to make sounding measurements to study the planetary boundary layer using in situ and remote-sensing measurements. Measurements were made of wind speed and direction, air pressure and temperature, potential temperature, dewpoint, mixing ratio of H_2O, CO_2 concentration, and ozone concentration. Twenty-five research missions were flown over the NSA, SSA, and the transect during BOREAS IFCs 1, 2, and 3 during 1994. All missions had from 4 to 10 soundings through the top of the planetary boundary layer. This sounding data set contains all of the in situ vertical profiles through the boundary layer top that were made (with the exception of "porpoise" maneuvers). Data were recorded in 1-second time intervals. These data are stored in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS AFM-03 NCAR Electra 1994 Aircraft Sounding Data

1.2 Data Set Introduction

The BOReal Ecosystem-Atmosphere Study (BOREAS) Airborne Fluxes and Meteorology (AFM)-03 team used the National Center for Atmospheric Research (NCAR) Electra aircraft to make sounding measurements to study the planetary boundary layer using in situ and remote-sensing measurements. Measurements were made of wind speed and direction, air pressure and temperature, potential temperature, dewpoint, mixing ratio of H_2O, CO_2 concentration, and ozone concentration. Twenty-five research missions were flown over the Northern Study Area (NSA), Southern Study Area (SSA), and the transect during BOREAS Intensive Field Campaigns (IFCs) 1, 2, and 3 during 1994.

All missions had from 4 to 10 soundings through the top of the planetary boundary layer. This sounding data set contains all of the in situ vertical profiles through the boundary layer top that were made (with the exception of "porpoise" maneuvers). Data were recorded in 1-second time intervals. These data are stored in tabular American Standard Code for Information Interchange (ASCII) files.

1.3 Objective/Purpose

The Electra aircraft was used both to measure surface fluxes and to study the planetary boundary layer using in situ and remote-sensing measurements. This sounding data set contains all of the in situ vertical profiles through the boundary layer top that were made (with the exception of "porpoise" maneuvers).

1.4 Summary of Parameters

The AFM-03 soundings data include time, date, location, wind speed and direction, air pressure and temperature, potential temperature, dewpoint, mixing ratio of H_2O, CO_2 concentration, and ozone concentration.

1.5 Discussion

A total of 25 research missions were flown, distributed fairly evenly throughout IFCs 1, 2, and 3. Flights were always along the regional transect, following the waypoints between Saskatoon and Churchill, except for some deviations north of the NSA. See Section 7.1 for location of the waypoints. Some missions concentrated exclusively on the SSA (waypoints A-H). Other missions (at least one each IFC) went to/from Churchill, Manitoba (YYQ). All missions had from 4 to 10 soundings through the top of the planetary boundary layer. Takeoff and landing vertical profiles (at Saskatoon (YXE) or Churchill (YYQ)) are included when they penetrated the top of the boundary layer. Most soundings were transitions between legs flown at 100 meters above ground level (AGL) to measure fluxes close to the surface and legs flown above the boundary layer (sometimes as high as 3,150 meters AGL) to measure continuous water vapor profiles remotely using a downward-looking water vapor DIAL instrument. These soundings were flown as circles near the waypoint so that both the low and high legs would begin/end at the same location. There are several flights, such as R05, where a very long (in this case 1,000 km) flight at 100 meters was broken up by an "up-and-down" sounding. All flights had other changes of altitude within the boundary layer that have not been included in this data set.

1.6 Related Data Sets

BOREAS AFM-01 NOAA/ATDD Long-EZ 1994 Aircraft Flux Data over the SSA
BOREAS AFM-02 Wyoming King Air 1994 Aircraft Flux and Moving Window Data
BOREAS AFM-03 NCAR Electra 1994 Aircraft Flux Data
BOREAS AFM-03 NCAR Electra 1994 Aircraft Moving Window Data
BOREAS AFM-04 NRC Twin Otter Aircraft Flux Data
BOREAS AFM-04 NRC Twin Otter Aircraft Sounding Data
BOREAS AFM-05 Level-1 Upper Air Network Data
BOREAS AFM-05 Level-2 Upper Air Network Standard Pressure Level Data
BOREAS AFM-11 Aircraft Flux Analysis and Comparison PDF Documents

2. Investigator(s)

2.1 Investigator(s) Name and Title

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2.2 Title of Investigation

Airborne Investigation of Biosphere - Atmosphere Interactions Over the Boreal Forest

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3. Theory of Measurements

This section summarizes the capabilities of the Electra as used in BOREAS. For a complete description, see the Project Summary Documentation for BOREAS distributed by the Research Aviation Facility (RAF) and associated RAF Bulletins. Winds were determined by combining measurements of the air motion relative to the aircraft by pressure sensors connected to five holes on the radome of the Electra, with aircraft motion measured by a Honeywell laser inertial reference system (IRS). Corrections to the IRS data were made using measurements by a Global Positioning System (GPS) satellite receiver. See NCAR RAF Bulletin No. 23 for a complete description of this system and the data processing used. In situ measurements of temperature, humidity, atmospheric pressure, aerosol and cloud droplet size distributions were made by sensors mounted to the wing and fuselage of the aircraft (RAF Bulletin Nos. 22 and 24). In situ measurements of chemical constituents were made by drawing outside air into closed-path sensors within the aircraft cabin. These sensors included a LI-COR LI-6262 for water vapor and carbon dioxide and two NCAR gas-phase chemiluminescent sensors for ozone.

4. Equipment

4.1 Sensor/Instrument Description

None given.

4.1.1 Collection Environment

Most data were acquired by an onboard computer that handled serial digital data, analog data (after anti-alias filtering), and event counters. (The DIAL system and disjunct sampler each had independent data systems.) Data were written to 8-mm digital tape in flight and were later processed using the Nimbus program to calibrate, digitally filter (when necessary), and synchronize the final time series. The time series data sets are available in NetCDF format at two data rates: 1) all channels output at 1 sample/second, and 2) all turbulence channels output at 25 samples/second.

4.1.2 Source/Platform

All instruments were mounted on a Lockheed Electra, which is a pressurized, low-wing, turbo-propeller airplane, designed as a medium-range airliner. It is powered by four Allison 501-D13 constant-speed, axial-flow, turbine engines that drive four-bladed, full-feathering, reversible-pitch, turbo-propellers. Flight is approved in known icing conditions; however, external instrumentation installations may restrict operations in icing conditions.

4.1.3 Source/Platform Mission Objectives

See Section 1.3.

4.1.4 Key Variables

See Sections 1.4 and 7.3.

4.1.5 Principles of Operation

See Section 4 and associated documents.

4.1.6 Sensor/Instrument Measurement Geometry

Most turbulence sensors are mounted on or near the aircraft radome on the fuselage. The air-chemistry instruments had sampling inlets protruding from window locations along the fuselage. Particle size sensors were mounted from pylons on the wings.

4.1.7 Manufacturer of Sensor/Instrument

None given.

4.2 Calibration

Most of the sensors were calibrated following normal NCAR/RAF procedures. See the Project Documentation Summary for BOREAS (in particular, the Data Quality Report), available from Paul Spyers-Duran, for a complete description of the data used for these calibrations and a list of unique problems. Some general conclusions:

- Wind finding was good once a 10- to 15-degree bias in wind direction was removed.
- Aircraft position and velocity measured by the IRS were adjusted to match positions from the GPS receiver.
- The Lyman-alpha hygrometer failed during flights 3, 9, and 12, and during periods of flights 17 and 20. For these flights, the LI-COR measurement of humidity was used.
- The bottom dewpoint hygrometer performed worse than a "top" one, so the top sensor was used for all flights.
- The LI-COR carbon dioxide channel was calibrated using a series of measurements with calibration gases during preflight testing and in-flight. An empirical fit using pressure and temperature was used, since the manufacturer calibration equation performed poorly.

4.2.1 Specifications

Specifications for standard Electra sensors are given in RAF Bulletin No. 4.

4.2.1.1 Tolerance

None given.

4.2.2 Frequency of Calibration

See the Project Documentation Summary for BOREAS (in particular, the Data Quality Report), available from Paul Spyers-Duran. Many sensors are checked before every flight.

4.2.3 Other Calibration Information

None given.

5. Data Acquisition Methods

Most data were acquired by an onboard computer that handled serial digital data, analog data (after anti-alias filtering), and event counters. (The DIAL system and disjunct sampler each had independent data systems.) Data were written to 8-mm digital tape in flight and were later processed using the Nimbus program to calibrate, digitally filter (when necessary), and synchronize the final time series. The time series data sets are available in NetCDF format at two data rates: 1) all channels output at 1 sample/second, and 2) all turbulence channels output at 25 samples/second.

6. Observations

6.1 Data Notes

None given.

6.2 Field Notes

Each investigator on the aircraft kept his/her own set of (usually handwritten) notes. These have not yet been assembled into a complete document.

7. Data Description

7.1 Spatial Characteristics

These data were taken at 1-second intervals during aircraft vertical spiral maneuvers and during takeoff and landings. At a nominal airspeed of 100 m/s and climb rate of 10 m/s, this corresponds to measurements every 100 m horizontally and 10 m vertically. A total of 25 research missions were flown, distributed fairly evenly throughout IFCs 1, 2, and 3.

Flights were always along the regional transect, following the waypoints between Saskatoon and Churchill, except for some deviations north of the NSA. This track was approximately a line from Saskatoon, Saskatchewan (52° N, 107° W) to a point north of Churchill (61° N, 95° W).

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

Waypoint	Latitude	Longitude
A	53° 32' N	106° 34' W
H	54° 7' N	104° 13.5' W
K	54° 41.7' N	103° 47.5' W
L	54° 57.3' N	101° 58' W
M	55° 54.8' N	99° 7.5' W
O	55° 53.2' N	98° 00' W
P	60° 30' N	98° 00' W
Q	60° 30' N	95° 30' W
R	59° 00' N	95° 30' W
CH	58° 44.5' N	94° 04' W

Some missions concentrated exclusively on the SSA (waypoints A-H). Waypoints between A and H:

Waypoint	Latitude	Longitude
a	53° 34.7' N	106° 23.8' W
b	53° 42.8' N	105° 52' W
c	53° 55' N	105° 04' W
d	53° 59' N	104° 47.2' W

Other missions (at least one each IFC) went to/from Churchill, Manitoba (YYQ). All missions had from 4 to 10 soundings through the top of the planetary boundary layer. Takeoff and landing vertical profiles (at Saskatoon (YXE) or Churchill (YYQ)) are included when they penetrated the top of the boundary layer.

7.1.1 Spatial Coverage

All soundings are nominally taken at one point horizontally, though these usually are in the form of tight (6-km diameter) circles flown near one of the waypoints listed above. In a few cases (such as takeoffs and landings), the sounding was taken as an "enroute" climb or descent. The altitude range typically is 100 meters AGL to about 300 m above the inversion height for these soundings. Obviously, the takeoff and landing soundings go to 0 meters AGL. In some cases, the bottom of the soundings are higher.

7.1.2 Spatial Coverage Map

None given.

7.1.3 Spatial Resolution

Individual position measurements should be accurate to 100 m horizontally, and 1 m vertically.

7.1.4 Projection

None given.

7.1.5 Grid Description

None given.

7.2 Temporal Characteristics

The Electra flew 25 missions during the 1994 IFCs (25-May-1994 to 16-Sep-1994): 8 in IFC-1, 8 in IFC-2, and 9 in IFC-3.

7.2.1 Temporal Coverage

Each flight was about 7 hours in duration and was usually between 11:00 a.m. and 4:00 p.m. local time (all daylight hours).

7.2.2 Temporal Coverage Map

Measurements were made from 25-May-1994 to 16-Sep-1994.

7.2.3 Temporal Resolution

Measurements were made at intervals of 1 second. Missions were flown five to seven times per month.

7.3 Data Characteristics

7.3.1 Parameter/Variable

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

```
         Column Name
----------------------------
SPATIAL_COVERAGE
DATE_OBS
TIME
FLUX_MISSION_DESIGNATOR
LATITUDE
LONGITUDE
BOREAS_X
BOREAS_Y
PRESS_ALT
RADAR_ALT
HEADING
WIND_DIR
WIND_SPEED
U_COMPNT_WIND_VELOC
V_COMPNT_WIND_VELOC
ATMOSPHERIC_PRESS
DRY_BULB_TEMP
POTENT_TEMP
DEWPOINT_TEMP
MIXING_RATIO_AFM
CO2_CONC
O3_CONC
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
SPATIAL_COVERAGE	The general term used to denote the spatial area over which the data were collected.
DATE_OBS	The date on which the data were collected.
TIME	The Greenwich Mean Time (GMT) when the data were collected.
FLUX_MISSION_DESIGNATOR	The two-letter mission identifier used to identify the type of mission being flown, where GS or GN=grids and stacks, CS=Candle Lake runs, TS or TN=site-specific runs, RT=transects, LS or LN=mini- or meso-transects, PS or PN=Budget Box pattern, HS or HN=stacks and tees, FS or FN=flights of two for intercomparison, ZS=low-level routes, and XX=not standard.
LATITUDE	The NAD83-based latitude coordinate at the site.
LONGITUDE	The NAD83-based longitude coordinate at the site.
BOREAS_X	The x component of the BOREAS grid coordinate at the site.
BOREAS_Y	The y component of the BOREAS grid coordinate at the site.
PRESS_ALT	The measured pressure altitude.
RADAR_ALT	The measured radar altitude.
HEADING	The aircraft heading.
WIND_DIR	The direction from which the wind was traveling, increasing in a clockwise direction from north.
WIND_SPEED	The wind speed.
U_COMPNT_WIND_VELOC	The westerly (from the west) vector component of the wind speed and wind direction.
V_COMPNT_WIND_VELOC	The southerly (from the south) vector component of the wind speed and wind direction.
ATMOSPHERIC_PRESS	The atmospheric pressure.
DRY_BULB_TEMP	The temperature measured from the dry-bulb thermometer.
POTENT_TEMP	The computed potential temperature.
DEWPOINT_TEMP	The measured dewpoint temperature.
MIXING_RATIO_AFM	The calculated mixing ratio.
CO2_CONC	CO2 concentration.
O3_CONC	The measured ozone concentration.
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:

Column Name	Units
SPATIAL_COVERAGE	[none]
DATE_OBS	[DD-MON-YY]
TIME	[HHMMSS GMT]
FLUX_MISSION_DESIGNATOR	[none]
LATITUDE	[degrees]
LONGITUDE	[degrees]
BOREAS_X	[kilometers]
BOREAS_Y	[kilometers]
PRESS_ALT	[meters]
RADAR_ALT	[meters]
HEADING	[degrees]
WIND_DIR	[degrees]
WIND_SPEED	[meters][second^-1]
U_COMPNT_WIND_VELOC	[meters][second^-1]
V_COMPNT_WIND_VELOC	[meters][second^-1]
ATMOSPHERIC_PRESS	[kiloPascals]
DRY_BULB_TEMP	[degrees Celsius]
POTENT_TEMP	[degrees Kelvin]
DEWPOINT_TEMP	[degrees Celsius]
MIXING_RATIO_AFM	[grams of water vapor][kilogram dry air^-1]
CO2_CONC	[parts per million]
O3_CONC	[parts per billion]
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
SPATIAL_COVERAGE	[Assigned by BORIS.]
DATE_OBS	[Supplied by NCAR.]
TIME	[Supplied by NCAR.]
FLUX_MISSION_DESIGNATOR	[Supplied by NCAR.]
LATITUDE	[Supplied by NCAR.]
LONGITUDE	[Supplied by NCAR.]
BOREAS_X	[Supplied by NCAR.]
BOREAS_Y	[Supplied by NCAR.]
PRESS_ALT	[Supplied by NCAR.]
RADAR_ALT	[Supplied by NCAR.]
HEADING	[Supplied by NCAR.]
WIND_DIR	[Supplied by NCAR.]
WIND_SPEED	[Supplied by NCAR.]
U_COMPNT_WIND_VELOC	[Supplied by NCAR.]
V_COMPNT_WIND_VELOC	[Supplied by NCAR.]
ATMOSPHERIC_PRESS	[Supplied by NCAR.]
DRY_BULB_TEMP	[Supplied by NCAR.]
POTENT_TEMP	[Supplied by NCAR.]
DEWPOINT_TEMP	[Supplied by NCAR.]

```
MIXING_RATIO_AFM                [Supplied by NCAR.]
CO2_CONC                        [Supplied by NCAR.]
O3_CONC                         [Supplied by NCAR.]
CRTFCN_CODE                     [Assigned by BORIS.]
REVISION_DATE                   [Assigned by BORIS.]
```

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
SPATIAL_COVERAGE	N/A	N/A	None	None	None	None
DATE_OBS	25-MAY-94	16-SEP-94	None	None	None	None
TIME	143130	224900	None	None	None	None
FLUX_MISSION_ DESIGNATOR	SN	SN	None	None	None	None
LATITUDE	52.1391	60.6291	None	None	None	None
LONGITUDE	-106.986	-93.8965	None	None	None	None
BOREAS_X	271.171	985.684	None	None	None	None
BOREAS_Y	135.874	1160.606	None	None	None	None
PRESS_ALT	-59.2	3843.6	None	None	None	None
RADAR_ALT	-31.5	3488.6	None	None	None	None
HEADING	0	360	None	None	None	None
WIND_DIR	0	360	None	None	None	None
WIND_SPEED	0	295	None	None	None	None
U_COMPNT_WIND_VELOC	-130.71	220.73	None	None	None	None
V_COMPNT_WIND_VELOC	-82.57	264.46	None	None	None	None
ATMOSPHERIC_PRESS	62.89	102.04	None	None	None	None
DRY_BULB_TEMP	-28.21	29.26	None	None	None	None
POTENT_TEMP	243.68	313.95	None	None	None	None
DEWPOINT_TEMP	-39.4	22	None	None	None	None
MIXING_RATIO_AFM	-4.27	17.82	None	None	None	None
CO2_CONC	-35.6	1261.1	None	None	None	None
O3_CONC	-1.87	100.57	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	26-MAR-97	02-MAR-99	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 a data record from a sample data file on the CD-ROM.

```
SPATIAL_COVERAGE,DATE_OBS,TIME,FLUX_MISSION_DESIGNATOR,LATITUDE,LONGITUDE,
BOREAS_X,BOREAS_Y,PRESS_ALT,RADAR_ALT,HEADING,WIND_DIR,WIND_SPEED,
U_COMPNT_WIND_VELOC,V_COMPNT_WIND_VELOC,ATMOSPHERIC_PRESS,DRY_BULB_TEMP,
POTENT_TEMP,DEWPOINT_TEMP,MIXING_RATIO_AFM,CO2_CONC,O3_CONC,CRTFCN_CODE,
REVISION_DATE
'NSA',25-MAY-94,193430,'SN',55.8891,-97.996,807.858,620.035,301.8,110.9,89.0,18,
6.9,-2.11,-6.6,97.75,12.7,287.73,-2.4,3.56,358.2,39.3,'CPI',02-MAR-99
'NSA',25-MAY-94,193431,'SN',55.889,-97.9945,807.952,620.041,305.5,114.6,89.3,23,
7.6,-2.96,-6.98,97.71,12.62,287.68,-1.6,3.57,358.2,39.52,'CPI',02-MAR-99
'NSA',25-MAY-94,193432,'SN',55.889,-97.993,808.044,620.059,307.9,118.3,89.6,31,
7.9,-4.07,-6.75,97.68,12.76,287.85,-.8,3.61,358.2,39.33,'CPI',02-MAR-99
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data is the set of observations taken at 1-second intervals for a given day.

8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain 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

Values are reported at one sample per second. Since all channels on the aircraft are sampled faster than this rate, these values are "boxcar" averages over all of the samples acquired during each second.

9.1.1 Derivation Techniques and Algorithms

None.

9.2 Data Processing Sequence

9.2.1 Processing Steps

- AFM-03 processed data and sent them to the BOREAS Information System (BORIS).
- BORIS staff received the data, made necessary conversions to standard units, and loaded the data into the data base.
- BORIS staff documented the data set and compiled basic statistics about the data.

9.2.2 Processing Changes

None.

9.3 Calculations

None.

9.3.1 Special Corrections/Adjustments

Most values reported here are copied directly from the standard RAF low-rate data file. The only exception is radar altitude, which was derived from two independent sensors. A single radar altitude was synthesized from the low-range altimeter (HGM) for altitudes less than 780 m, and from the high-range altimeter (HGME) above 780 m. This synthesized altitude had occasional spikes. These spikes were detected by testing if the difference between the pressure altitude and sum of radar altitude plus height of the ground was greater than 50 m. The ground height was set to the difference between pressure altitude and radar altitude at the first point in the sounding. Spikes were replaced by pressure altitude minus the ground height.

9.3.2 Calculated Variables

Most values reported here are copied directly from the standard RAF low-rate data file. The only exception is radar altitude, which was derived from two independent sensors. A single radar altitude was synthesized from the low-range altimeter (HGM) for altitudes less than 780 m, and from the high-range altimeter (HGME) above 780 m. See Section 9.3.1 for information about corrections to this parameter.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

There were several instrument malfunctions during this program. See the Data Quality section of the Project Documentation Summary.

- Calibration gas was connected to the LI-COR CO_2/H_2O sensor during some flight legs. Most of these periods were near the beginning or end of a flight leg and have been removed by selection of leg start and stop times, but a few cases have been included.
- The LI-COR CO_2 calibration is still somewhat uncertain, though it is the best we can do at this time.
- The Lyman-alpha hygrometer has spikes caused by rain that have not yet been removed from the data.
- The radar altimeter has spikes from an unknown source. These have not been removed, but should not contaminate the mean altitude much. (They should be detectable by comparing the altitude standard deviation from the radar altimeter and pressure altitude.)
- The dewpoint hygrometer sometimes cannot keep up with large changes in temperature (as occur during ascents and descents), so humidity profiles (not included in the leg-average data) should be used with caution.

10.2 Quality Assessment

Spot checks of data quality were done in the field, in calibration by NCAR/RAF, and in postprocessing. These checks mostly relied on the experience of the person checking to determine if values were suspicious. Time series, profiles, and spectra have been used. According to the AFM-03 team, this process is ongoing and the quality of these products is still unknown.

10.2.1 Data Validation by Source

None given.

10.2.2 Confidence Level/Accuracy Judgment

None given.

10.2.3 Measurement Error for Parameters

None given.

10.2.4 Additional Quality Assessments

None given.

10.2.5 Data Verification by Data Center

BOREAS personnel verified that the delivered data agreed with the information provided by the AFM-03 team.

11. Notes

11.1 Limitations of the Data

None given.

11.2 Known Problems with the Data

See the Data Quality Report (Appendix A.4) for a complete list of data quality issues. In particular, pay attention to the sections describing the following sensors:

The Electra carried two dewpoint hygrometers, a Lyman-alpha hygrometer, and a LI-COR closed-path infrared absorption hygrometer. The dewpoint reported here came from the dewpoint hygrometer, which was determined to behave the best (by inspection). Even so, there are periods where this signal has large oscillations due to the inability of the hygrometer to cycle fast enough to follow the large changes in humidity often found in soundings. This behavior can be checked qualitatively by looking at the mean water vapor density, which was derived from either the Lyman-alpha or LI-COR sensor. However, both of these sensors have their own problems: the Lyman-alpha can read high after cloud penetration or rain, and the LI-COR had a pressure dependence that obviously changed with height. Also, calibrations of the LI-COR often were performed during soundings.

Mean carbon dioxide (from the LI-COR) and ozone values should not be trusted due to instrument and calibration problems.

Wind calculations on the Electra depend on accurate measurements of aircraft acceleration, which is large during the turns typical of these soundings. Therefore, the wind speed and direction reported here could be in error, though it is difficult assign a magnitude for this error.

11.3 Usage Guidance

The Lyman-alpha hygrometer can read high after cloud penetration or rain, and the LI-COR closed-path infrared absorption hygrometer had a pressure dependence that changed with height.

11.4 Other Relevant Information

None given.

12. Application of the Data Set

These data could be used to verify the quality of the AFM-03 flux and moving window data.

13. Future Modifications and Plans

None given.

14. Software

14.1 Software Description

None given.

14.2 Software Access

None given.

15. Data Access

The NCAR Electra 1994 aircraft sounding 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/ [Internet Link].

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

All time series as recorded by the investigators are saved on the NCAR Mass-Store System in NetCDF format and are available from the investigators upon request. Contact Steven Oncley or Don Lenschow.

16.2 Film Products

Videotapes with imagery from forward-, side (left)-, and downward-looking cameras are also available from the investigators. The forward-looking is black and white, and the others are color. The quality is medium, since the tapes were recorded in "extended play" mode to create one tape for each (6-7 hour) flight. All videotapes have a time stamp in the image. Contact Steven Oncley for details.

16.3 Other Products

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

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Oncley, S.P., D.H. Lenschow, K.J. Davis, T. Campos, and J. Mann. 1996. Regional-scale surface flux observations across the boreal forest during BOREAS. 22nd Conference on Agricultural and Forest Meteorology, Atlanta, GA, Jan. 28-Feb. 2, American Meteorological Society.

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17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

AFM	- Airborne Fluxes and Meteorology
AGL	- Above Ground Level
ASCII	- American Standard Code for Information Interchange
ATD	- Atmospheric Technology Division of NCAR
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
CD-ROM	- Compact Disk-Read-Only Memory
DAAC	- Distributed Active Archive Center
EOS	- Earth Observing System
EOSDIS	- EOS Data and Information System
GIS	- Geographic Information System
GMT	- Greenwich Mean Time
GPS	- Global Positioning System
GSFC	- Goddard Space Flight Center
HTML	- HyperText Markup Language
IFC	- Intensive Field Campaign
INS	- Inertial Navigation System
IRS	- Inertial Reference System
MMM	- Mesoscale and Microscale Research Division, NCAR
NAD83	- North American Datum of 1983
NASA	- National Aeronautics and Space Administration
NCAR	- National Center for Atmospheric Research
NDVI	- Normalized Difference Vegetation Index
NRC	- National Research Council, Canada
NSA	- Northern Study Area
OA	- Old Aspen
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert National Park
PPFD	- Photosynthetic Photon Flux Density
RAF	- Research Aviation Facility, NCAR
SSA	- Southern Study Area
SSSF	- Sounding and Surface System Facility, NCAR
TF	- Tower Flux
URL	- Uniform Resource Locator
UTC	- Universal Time Code

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13. ABSTRACT *(Maximum 200 words)*

The BOREAS AFM-3 team used the NCAR Electra aircraft to make sounding measurements to study the planetary boundary layer using in situ and remote-sensing measurements. Measurements were made of wind speed and direction, air pressure and temperature, potential temperature, dewpoint, mixing ratio of H_2O, CO_2 concentration, and ozone concentration. Twenty-five research missions were flown over the NSA, SSA, and the transect during BOREAS IFCs 1, 2, and 3 during 1994. All missions had from 4 to 10 soundings through the top of the planetary boundary layer. This sounding data set contains all of the in situ vertical profiles through the boundary layer top that were made (with the exception of "porpoise" maneuvers). Data were recorded in 1-second time intervals. These data are stored in tabular ASCII files.

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