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

Forrest G. Hall and Jeffrey A. Newcomer, Editors

Volume 16

BOREAS AFM-08 ECMWF Hourly Surface and Upper Air Data for the SSA and NSA

P. Viterbo and A. Betts

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

June 2000

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BOREAS AFM-08 ECMWF Hourly Surface and Upper Air Data for the SSA and NSA

Pedro Viterbo, European Center for Medium-Range Weather Forecasts
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BOREAS AFM-8 ECMWF Hourly Surface and Upper Air Data for the SSA and NSA

Pedro Viterbo, Alan Betts

Summary

The BOREAS AFM-8 team focused on modeling efforts to improve the understanding of the diurnal evolution of the convective boundary layer over the boreal forest. This data set contains hourly data from the ECMWF operational model from below the surface to the top of the atmosphere, including the model fluxes at the surface. Spatially, the data cover a pair of the points that enclose the rawinsonde sites at Candle Lake, Saskatchewan, in the SSA and Thompson, Manitoba, in the NSA. Temporally, the data include the two time periods of 13-May-1994 to 30-Sept-1994 and 01-Mar-1996 to 31-Mar-1997. The data are stored in tabular ASCII files. The number of records in the upper air data files may exceed 20,000, causing a problem for some software packages.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS AFM-08 ECMWF Hourly Surface and Upper Air Data for the SSA and NSA

1.2 Data Set Introduction

These data were produced by Pedro Viterbo at the European Center for Medium-Range Weather Forecasts (ECMWF) from the operational model at the time, by Pedro Viterbo (ECMWF). They were reviewed by Alan Betts.

1.3 Objective/Purpose

This is an hourly data set for a single column of air from the ECMWF operational model from below the surface to the top of the atmosphere, including the model fluxes at the surface. It is intended to be used primarily for the comparison of the model with surface observations.

1.4 Summary of Parameters

There are two components in this data set:

- A surface component with subsurface variables:
  - Temperature and soil moisture for the first model layer (0-7 cm); and an average for the next three soil layers, 7-289 cm.
  - Surface fluxes of energy, radiation, and water. c) Atmospheric variables of wind, temperature, mixing ratio, and pressure at model 31, which is about 30 m above the surface.
- An atmospheric component with atmospheric meteorological variables of wind, temperature, mixing ratio, and pressure at 31 levels, starting at approximately 30 m above the surface. The first level is duplicated on the surface data set for convenience. In 1996-97, the atmospheric part contains an additional field for vertical p-velocity (of unknown quality).

These data are values from the ECMWF model and are subject to the errors of the ECMWF model at that time and to the operational model changes.

1.5 Discussion

These are ECMWF model data, which should be useful for comparison with surface flux measurements and as drivers for offline vegetation models, needing continuous atmospheric time-series.

1.6 Related Data Sets

BOREAS ECMWF 6-Hour Analysis and Forecast Data
BOREAS AFM-05 Level-1 Upper Air Network Data
BOREAS AFM-05 Level-2 Upper Air Network Standard Pressure Level Data
BOREAS AES Campbell Scientific Surface Meteorological Data
BOREAS AFM-07 SRC Surface Meteorological Data
BOREAS AES MARSII Surface Meteorological Data
BOREAS AES READAC Surface Meteorological Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Alan Betts
Atmospheric Research

Pedro Viterbo
ECMWF

2.2 Title of Investigation

Boundary Layer Research for BOREAS

2.3 Contact Information

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3. Theory of Measurements

These data are from the ECMWF operational model. The user is encouraged to see the ECMWF manuals for the model physics.

4. Equipment

4.1 Sensor/Instrument Description

The ECMWF uses surface and upper air data from numerous sources and locations around Earth to create its 6-hour forecast product. The output data are created using multivariate optimal interpolation analysis, followed by nonlinear normal model initialization, before 29-Jan-1996 and 3D-VAR from 30-Jan-1996, and a high-resolution spectral model that produces a first-guess forecast for the subsequent analysis. Data were assimilated every 6 hours.

4.1.1 Collection Environment

The input data used in the ECMWF models are collected from a wide range of global stations that are operated in ambient atmospheric conditions.

4.1.2 Source/Platform

The platforms from which the input data were collected include human observers, fixed towers of various sorts, and tethered and free-flying balloons.

4.1.3 Source/Platform Mission Objectives
Not applicable.

4.1.4 Key Variables
This data set contains meteorological parameters that were produced from an ECMWF model.

4.1.5 Principles of Operation
Not applicable.

4.1.6 Sensor/Instrument Measurement Geometry
Not applicable.

4.1.7 Manufacturer of Sensor/Instrument
The ECMWF in Reading, England.

4.2 Calibration

4.2.1 Specifications
Not applicable.

4.2.1.1 Tolerance
Not applicable.

4.2.2 Frequency of Calibration
Not applicable.

4.2.3 Other Calibration Information
The land-surface scheme is discussed in Viterbo and Beljaars (1995).

5. Data Acquisition Methods

The ECMWF uses surface and upper air data from numerous sources and locations around Earth to create its 6-hour forecast product. The 6-hour data are created using multivariate optimal interpolation analysis, followed by nonlinear normal model initialization, before 29-Jan-1996 and 3D-VAR from 30-Jan-1996, and a high-resolution spectral model that produces a first-guess forecast for the subsequent analysis. Data are assimilated every 6 hours.

6. Observations

6.1 Data Notes
None given.

6.2 Field Notes
Not applicable.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The Candle Lake data are a 2-grid point average of grid points between 53.4° N and 54.5° N latitude and 104.4° W and 105.4° W longitude. Each grid point is approximately 50 x 50 km. The Thompson data are a single grid point at 55.88° N latitude, 98° W longitude in 1994 and 55.88° N, 98.44° W in 1996. The difference in grid cell location over Thompson between the years is due to a change in the ECMWF grid. These points are marked on Figure 3.2.2 of the BOReal Ecosystem-Atmosphere Study (BOREAS) May 1994 Experiment Plan (Sellers and Hall, 1994). Although their location may shift a little during the experiment, they are to be considered as representative of the Southern Study Area (SSA) and Northern Study Area (NSA).

The approximate boundaries of the areas described above are listed below in BOREAS grid coordinates based on the North American Datum of 1983 (NAD83).

SSA

Corner	BOREAS_X	BOREAS_Y
Northwest	361.990	404.083
Northeast	426.452	409.746
Southeast	438.053	287.745
Southwest	371.837	281.928

NSA 1994

Corner	BOREAS_X	BOREAS_Y
Northwest	782.800	643.991
Northeast	832.800	643.991
Southeast	832.800	593.991
Southwest	782.800	593.991

NSA 1996

Corner	BOREAS_X	BOREAS_Y
Northwest	755.762	638.971
Northeast	805.762	638.971
Southeast	805.762	588.971
Southwest	755.762	588.971

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

Each original grid cell was approximately 50 x 50 km. Since the data for the SSA were derived from averaging two adjacent (east-west) grid cells together, the SSA data represent a 100 km (east-west) by 50 km (north-south) area.

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 periods of 13-May-1994 to 30-Sept-1994 and 01-Mar-1996 to 31-Mar-1997. We have included a full 13-month year for 1996-97 because there was a significant model change in August 1996, which corrected the subsurface temperatures and in December 1997, which corrected the snow albedo error. Comparing the 1996 and 1997 data will draw attention to this issue.

7.2.2 Temporal Coverage Map

Not available.

7.2.3 Temporal Resolution

Each 24-hr day of hourly model data is the 12- to 35-hr forecast (the 11-35 hr forecast for the fluxes) extracted from a daily 72-hr global forecast from the preceding 1200 Universal Time Code (UTC) analysis. Occasional forecasts are missing, and that day's data then come from the 36- to 59-hr forecast (36- to 59-hr for fluxes) from the preceding day's 1200 UTC analysis. The data are given in hourly time steps.

Note that all the flux values are averages for the preceding hour. All other variables are instantaneous values at that time. Consequently, flux data labeled for UTC = 00 are actually from the preceding day at 2300-2400.

7.3 Data Characteristics

7.3.1 Parameter/Variable

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

AFM08_ECMWF_SURFACE

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
TIME_OBS
FORECAST_DATE
ATMOSPHERIC_PRESS_L31
U_COMPNT_WIND_VELOC_L31
V_COMPNT_WIND_VELOC_L31
AIR_TEMP_L31
MIX_RATIO_L31
SOIL_TEMP_0_7_CM
SOIL_WATER_0_7_CM
SOIL_TEMP_7_289_CM
SOIL_WATER_7_289_CM
SNOW_DEPTH
SURFACE_PRESS
NET_SHORTWAVE_RAD
NET_LONGWAVE_RAD
LATENT_HEAT_FLUX
LATENT_HEAT_FLUX_SNOW
SENSIBLE_HEAT_FLUX
HEAT_FLUX_SOIL_1_2

HEAT_FLUX_SNOW_MELT
WATER_SNOW_MELT
LARGE_SCALE_RAIN
CONVECTIVE_SCALE_RAIN
LARGE_SCALE_SNOW
CONVECTIVE_SCALE_SNOW
SOIL_WATER_1_2
RUNOFF_1
DEEP_RUNOFF
CRTFCN_CODE
REVISION_DATE

AFM08_ECMWF_UPPER_AIR

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
TIME_OBS
FORECAST_DATE
LEVEL_NUM
ATMOSPHERIC_PRESS
U_COMPNT_WIND_VELOC
V_COMPNT_WIND_VELOC
AIR_TEMP
ECMWF_MIX_RATIO
ATMOS_OMEGA_VELOC
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:

AFM08_ECMWF_SURFACE

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.
FORECAST_DATE	Initial date of forecast analysis.

ATMOSPHERIC_PRESS_L31	The atmospheric pressure at Level 31, which is approximately 30 m above the surface.
U_COMPNT_WIND_VELOC_L31	The U component wind velocity at Level 31, which is approximately 30 m above the surface.
V_COMPNT_WIND_VELOC_L31	The V component wind velocity at Level 31, which is approximately 30 m above the surface.
AIR_TEMP_L31	The air temperature at Level 31, which is approximately 30 m above the surface.
MIX_RATIO_L31	The atmospheric mixing ratio at level 31, which is approximately 30 m above the surface.
SOIL_TEMP_0_7_CM	The soil temperature at a depth of 0 to 7 cm.
SOIL_WATER_0_7_CM	The soil water content at a depth of 0 to 7 cm.
SOIL_TEMP_7_289_CM	The soil temperature at a depth of 7 to 289 cm.
SOIL_WATER_7_289_CM	The soil water content at a depth of 7 to 289 cm.
SNOW_DEPTH	The depth of snow on the ground.
SURFACE_PRESS	The surface pressure.
NET_SHORTWAVE_RAD	The net shortwave radiation.
NET_LONGWAVE_RAD	The net longwave radiation.
LATENT_HEAT_FLUX	The latent heat flux.
LATENT_HEAT_FLUX_SNOW	The latent heat flux (evaporation above snow).
SENSIBLE_HEAT_FLUX	The sensible heat flux.
HEAT_FLUX_SOIL_1_2	The heat flux from soil layer 1 (surface) to layer 2.
HEAT_FLUX_SNOW_MELT	The heat flux from snow melt.
WATER_SNOW_MELT	The water added to soil from snow melt.
LARGE_SCALE_RAIN	The large-scale rain.
CONVECTIVE_SCALE_RAIN	The convective scale rain.
LARGE_SCALE_SNOW	Large scale snow.
CONVECTIVE_SCALE_SNOW	Convective scale snow.
SOIL_WATER_1_2	The flux of water from soil layer 1 to layer 2.
RUNOFF_1	Runoff from layer 1.
DEEP_RUNOFF	The deep runoff.
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.

AFM08_ECMWF_UPPER_AIR

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.
FORECAST_DATE	Initial date of forecast analysis.
LEVEL_NUM	The atmospheric level number.

To represent the vertical variation of the dependent variables (wind components, temperature, specific humidity, cloud cover, cloud liquid water contents, and cloud ice water contents, the atmosphere is divided into NLEV layers. These layers are defined by the pressures at the interfaces between them (the `half-levels'), and these pressures are given by

$$p(k+1/2)=A(k+1/2) + B(k+1/2)*ps$$

for $0 <= k <= NLEV$, and where ps is surface pressure. The $A(k+1/2)$ and $B(k+1/2)$ are constants whose values effectively define the vertical coordinate (see table below). Notice that model levels are labeled top to bottom, i.e., the half-levels $p(0+1/2)$ and $p(NLEV+1/2)$ are, respectively, top of the atmosphere and surface.

The prognostic variables are represented by their values at `full-level' pressures p(k), $1 <= k <NLEV$. Values for p(k) are given by

$$p(k)=0.5*[p(k-1/2)+p(k+1/2)]$$

$$1 <= k <= NLEV$$

As can be seen in the table below, the model levels are pressure levels at the top (B=0) and sigma levels at the bottom (A=0). The name hybrid levels reflects that.

```
A(0+1/2)= 0.
A(1+1/2)= 2000.000000
A(2+1/2)= 4000.000000
A(3+1/2)= 6000.000000
A(4+1/2)= 8000.000000
A(5+1/2)= 9976.135361
A(6+1/2)= 11820.539617
A(7+1/2)= 13431.393926
A(8+1/2)= 14736.356909
A(9+1/2)= 15689.207458
A(10+1/2)= 16266.610500
A(11+1/2)= 16465.005734
A(12+1/2)= 16297.619332
A(13+1/2)= 15791.598604
A(14+1/2)= 14985.269630
A(15+1/2)= 13925.517858
A(16+1/2)= 12665.291662
A(17+1/2)= 11261.228878
A(18+1/2)= 9771.406290
A(19+1/2)= 8253.212096
A(20+1/2)= 6761.341326
A(21+1/2)= 5345.914240
A(22+1/2)= 4050.717678
A(23+1/2)= 2911.569385
A(24+1/2)= 1954.805296
A(25+1/2)= 1195.889791
```

```
A(26+1/2)= 638.148911
A(27+1/2)= 271.626545
A(28+1/2)= 72.063577
A(29+1/2)= 0.000000
A(30+1/2)= 0.000000
A(31+1/2)= 0.000000

B(0+1/2)= 0.0000000000
B(1+1/2)= 0.0000000000
B(2+1/2)= 0.0000000000
B(3+1/2)= 0.0000000000
B(4+1/2)= 0.0000000000
B(5+1/2)= 0.0003908582
B(6+1/2)= 0.0029197006
B(7+1/2)= 0.0091941320
B(8+1/2)= 0.0203191555
B(9+1/2)= 0.0369748598
B(10+1/2)= 0.0594876397
B(11+1/2)= 0.0878949492
B(12+1/2)= 0.1220035886
B(13+1/2)= 0.1614415235
B(14+1/2)= 0.2057032385
B(15+1/2)= 0.2541886223
B(16+1/2)= 0.3062353873
B(17+1/2)= 0.3611450218
B(18+1/2)= 0.4182022749
B(19+1/2)= 0.4766881754
B(20+1/2)= 0.5358865832
B(21+1/2)= 0.5950842740
B(22+1/2)= 0.6535645569
B(23+1/2)= 0.7105944258
B(24+1/2)= 0.7654052430
B(25+1/2)= 0.8171669567
B(26+1/2)= 0.8649558510
B(27+1/2)= 0.9077158297
B(28+1/2)= 0.9442132326
B(29+1/2)= 0.9729851852
B(30+1/2)= 0.9922814815
B(31+1/2)= 1.0000000000
```

ATMOSPHERIC_PRESS	The atmospheric pressure.
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.
AIR_TEMP	The air temperature.
ECMWF_MIX_RATIO	The atmospheric mixing ratio.
ATMOS_OMEGA_VELOC	The atmospheric omega velocity.

Note: ATMOS_OMEGA_VELOC is also described as the rate of change of pressure in the model hybrid levels.

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:

AFM08_ECMWF_SURFACE

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
FORECAST_DATE	[none]
ATMOSPHERIC_PRESS_L31	[kiloPascals]
U_COMPNT_WIND_VELOC_L31	[meters][second^-1]
V_COMPNT_WIND_VELOC_L31	[meters][second^-1]
AIR_TEMP_L31	[degrees Celsius]
MIX_RATIO_L31	[kilograms water vapor][kilogram dry air^-1]
SOIL_TEMP_0_7_CM	[degrees Celsius]
SOIL_WATER_0_7_CM	[fraction by volume]
SOIL_TEMP_7_289_CM	[degrees Celsius]
SOIL_WATER_7_289_CM	[fraction by volume]
SNOW_DEPTH	[millimeters]
SURFACE_PRESS	[kiloPascals]
NET_SHORTWAVE_RAD	[Watts][meter^-2]
NET_LONGWAVE_RAD	[Watts][meter^-2]
LATENT_HEAT_FLUX	[Watts][meter^-2]
LATENT_HEAT_FLUX_SNOW	[Watts][meter^-2]
SENSIBLE_HEAT_FLUX	[Watts][meter^-2]
HEAT_FLUX_SOIL_1_2	[Watts][meter^-2]
HEAT_FLUX_SNOW_MELT	[Watts][meter^-2]
WATER_SNOW_MELT	[kilograms][meter^-2][second^-1]
LARGE_SCALE_RAIN	[kilograms][meter^-2][second^-1]
CONVECTIVE_SCALE_RAIN	[kilograms][meter^-2][second^-1]
LARGE_SCALE_SNOW	[kilograms][meter^-2][second^-1]
CONVECTIVE_SCALE_SNOW	[kilograms][meter^-2][second^-1]
SOIL_WATER_1_2	[kilograms][meter^-2][second^-1]
RUNOFF_1	[kilograms][meter^-2][second^-1]
DEEP_RUNOFF	[kilograms][meter^-2][second^-1]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

AFM08_ECMWF_UPPER_AIR

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
FORECAST_DATE	[none]
LEVEL_NUM	[unitless or count]
ATMOSPHERIC_PRESS	[kiloPascals]
U_COMPNT_WIND_VELOC	[meters][second^-1]
V_COMPNT_WIND_VELOC	[meters][second^-1]
AIR_TEMP	[degrees Celsius]
ECMWF_MIX_RATIO	[kilograms water vapor][kilogram dry air^-1]
ATMOS_OMEGA_VELOC	[Pascals][second^-1]
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:

AFM08_ECMWF_SURFACE

Column Name	Data Source
SITE_NAME	[Assigned by BORIS]
SUB_SITE	[Assigned by BORIS]
DATE_OBS	[Supplied by Investigator]
TIME_OBS	[Supplied by Investigator]
FORECAST_DATE	[Supplied by Investigator]
ATMOSPHERIC_PRESS_L31	[Supplied by Investigator]
U_COMPNT_WIND_VELOC_L31	[Supplied by Investigator]
V_COMPNT_WIND_VELOC_L31	[Supplied by Investigator]
AIR_TEMP_L31	[Supplied by Investigator]
MIX_RATIO_L31	[Supplied by Investigator]
SOIL_TEMP_0_7_CM	[Supplied by Investigator]
SOIL_WATER_0_7_CM	[Supplied by Investigator]
SOIL_TEMP_7_289_CM	[Supplied by Investigator]
SOIL_WATER_7_289_CM	[Supplied by Investigator]
SNOW_DEPTH	[Supplied by Investigator]
SURFACE_PRESS	[Supplied by Investigator]
NET_SHORTWAVE_RAD	[Supplied by Investigator]
NET_LONGWAVE_RAD	[Supplied by Investigator]
LATENT_HEAT_FLUX	[Supplied by Investigator]
LATENT_HEAT_FLUX_SNOW	[Supplied by Investigator]
SENSIBLE_HEAT_FLUX	[Supplied by Investigator]
HEAT_FLUX_SOIL_1_2	[Supplied by Investigator]
HEAT_FLUX_SNOW_MELT	[Supplied by Investigator]
WATER_SNOW_MELT	[Supplied by Investigator]
LARGE_SCALE_RAIN	[Supplied by Investigator]
CONVECTIVE_SCALE_RAIN	[Supplied by Investigator]
LARGE_SCALE_SNOW	[Supplied by Investigator]
CONVECTIVE_SCALE_SNOW	[Supplied by Investigator]
SOIL_WATER_1_2	[Supplied by Investigator]

RUNOFF_1	[Supplied by Investigator]
DEEP_RUNOFF	[Supplied by Investigator]
CRTFCN_CODE	[Assigned by BORIS]
REVISION_DATE	[Assigned by BORIS]

AFM08_ECMWF_UPPER_AIR

Column Name	Data Source
SITE_NAME	[Assigned by BORIS]
SUB_SITE	[Assigned by BORIS]
DATE_OBS	[Supplied by Investigator]
TIME_OBS	[Supplied by Investigator]
FORECAST_DATE	[Supplied by Investigator]
LEVEL_NUM	[Supplied by Investigator]
ATMOSPHERIC_PRESS	[Supplied by Investigator]
U_COMPNT_WIND_VELOC	[Supplied by Investigator]
V_COMPNT_WIND_VELOC	[Supplied by Investigator]
AIR_TEMP	[Supplied by Investigator]
ECMWF_MIX_RATIO	[Supplied by Investigator]
ATMOS_OMEGA_VELOC	[Supplied by Investigator]
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.

AFM08_ECMWF_SURFACE

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	NSA	SSA	None	None	None	None
SUB_SITE			None	None	None	Blank
DATE_OBS	13-MAY-94	31-MAR-97	None	None	None	None
TIME_OBS	0	2300	None	None	None	None
FORECAST_DATE	12-MAY-94	30-MAR-97	None	None	None	None
ATMOSPHERIC_PRESS_L31	91.542	100.9	None	None	None	None
U_COMPNT_WIND_VELOC_L31	-8.2413	10.745	None	None	None	None
V_COMPNT_WIND_VELOC_L31	-9.2176	9.0575	None	None	None	None
AIR_TEMP_L31	-41.91	30.42	None	None	None	None
MIX_RATIO_L31	.0000639	.017445	None	None	None	None
SOIL_TEMP_0_7_CM	-72.06	25.61	None	None	None	None
SOIL_WATER_0_7_CM	.14278	.41416	None	None	None	None
SOIL_TEMP_7_289_CM	-37.9	11.89	None	None	None	None
SOIL_WATER_7_289_CM	.24239	.32438	None	None	None	None
SNOW_DEPTH	0	154	None	None	None	None
SURFACE_PRESS	91.897	101.29	None	None	None	None
NET_SHORTWAVE_RAD	-.001	812.36	None	None	None	None
NET_LONGWAVE_RAD	-171.61	47.069	None	None	None	None

LATENT_HEAT_FLUX	-535.01	33.834	None	None	None	None
LATENT_HEAT_FLUX_SNOW	-260.01	41.209	None	None	None	None
SENSIBLE_HEAT_FLUX	-533.31	216.31	None	None	None	None
HEAT_FLUX_SOIL_1_2	-107.74	104.86	None	None	None	None
HEAT_FLUX_SNOW_MELT	-116.18	6.576	None	None	None	None
WATER_SNOW_MELT	0	.0003	None	None	None	None
LARGE_SCALE_RAIN	0	.003	None	None	None	None
CONVECTIVE_SCALE_RAIN	0	.001	None	None	None	None
LARGE_SCALE_SNOW	0	.001	None	None	None	None
CONVECTIVE_SCALE_SNOW	0	0	None	None	None	None
SOIL_WATER_1_2	0	.002	None	None	None	None
RUNOFF_1	0	0	None	None	None	None
DEEP_RUNOFF	0	0	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	14-JAN-99	15-JAN-99	None	None	None	None

AFM08_ECMWF_UPPER_AIR

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	NSA	SSA	None	None	None	None
SUB_SITE			None	None	None	Blank
DATE_OBS	13-MAY-94	31-MAR-97	None	None	None	None
TIME_OBS	0	2300	None	None	None	None
FORECAST_DATE	12-MAY-94	30-MAR-97	None	None	None	None
LEVEL_NUM	1	31	None	None	None	None
ATMOSPHERIC_PRESS	1	100.9	None	None	None	None
U_COMPNT_WIND_VELOC	-43.189	94.796	None	None	None	None
V_COMPNT_WIND_VELOC	-71.347	67.214	None	None	None	None
AIR_TEMP	-80.03	30.42	None	None	None	None
ECMWF_MIX_RATIO	-.00014803	.017445	None	None	None	None
ATMOS_OMEGA_VELOC	-3.0755	.89795	None	None	None	Blank
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	17-JAN-99	19-JAN-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 data records from sample data files on the CD-ROM.

AFM08_ECMWF_SURFACE

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,FORECAST_DATE,ATMOSPHERIC_PRESS_L31,
U_COMPNT_WIND_VELOC_L31,V_COMPNT_WIND_VELOC_L31,AIR_TEMP_L31,MIX_RATIO_L31,
SOIL_TEMP_0_7_CM,SOIL_WATER_0_7_CM,SOIL_TEMP_7_289_CM,SOIL_WATER_7_289_CM,
SNOW_DEPTH,SURFACE_PRESS,NET_SHORTWAVE_RAD,NET_LONGWAVE_RAD,
LATENT_HEAT_FLUX,LATENT_HEAT_FLUX_SNOW,SENSIBLE_HEAT_FLUX,HEAT_FLUX_SOIL_1_2,
HEAT_FLUX_SNOW_MELT,WATER_SNOW_MELT,LARGE_SCALE_RAIN,CONVECTIVE_SCALE_RAIN,
LARGE_SCALE_SNOW,CONVECTIVE_SCALE_SNOW,SOIL_WATER_1_2,RUNOFF_1,DEEP_RUNOFF,
CRTFCN_CODE,REVISION_DATE
'NSA','',13-MAY-94,0,12-MAY-94,97.422,-2.5635,1.5938,9.95,.0035819,4.88,
.23921,-12.71,.26537,0.0,97.8,153.73,-39.502,-48.044,0.0,-21.509,41.824,0.0,
0.0,0.0,0.0, 0.0,0.0,0.0,0.0,0.0,'CPI',15-JAN-99
'NSA','',13-MAY-94,100,12-MAY-94,97.383,-3.0332,1.1714,9.0,.0036931,4.53,
.23925, -12.69,.26536,0.0,97.761,44.485,-31.159,-21.423,0.0,34.528,40.097,
0.0,0.0,0.0,0. 0,0.0,0.0,0.0,0.0,0.0,'CPI',15-JAN-99
```

AFM08_ECMWF_UPPER_AIR

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,FORECAST_DATE,LEVEL_NUM,ATMOSPHERIC_PRESS,
U_COMPNT_WIND_VELOC,V_COMPNT_WIND_VELOC,AIR_TEMP,ECMWF_MIX_RATIO,
ATMOS_OMEGA_VELOC,CRTFCN_CODE,REVISION_DATE
'NSA','',01-SEP-96,0,31-AUG-96,1,1.0,6.6485,-2.3998,-41.39,.0000024097,.0011975,
'CPI',19-JAN-99
'NSA','',01-SEP-96,0,31-AUG-96,2,3.0,1.7841,-3.5077,-53.09,.0000024083,.0015912,
'CPI',19-JAN-99
```

8. Data Organization

8.1 Data Granularity

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

8.2 Data Format(s)

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

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

9. Data Manipulations

9.1 Formulae

9.1.1 Derivation Techniques and Algorithms

For a detailed description of the ECMWF/WCRP Level III-A Global Atmospheric Data Archive, see ECMWF ECMWF/WCRP Level III-A Global Atmospheric Data Archive Technical Attachment.

9.2 Data Processing Sequence

9.2.1 Processing Steps

None given.

9.2.2 Processing Changes

None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

See Section 9.1.1.

9.3.2 Calculated Variables

See Section 9.1.1.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

These are ECMWF model data and are subject to the errors of the ECMWF model at that time. Note the following model changes:

- July 1 +/-, 1994: The root zone soil water reservoir was reflooded. There is a discontinuity on that date.
- November 1994: Soil water nudging was added.
- April 1995: Major model change; prognostic cloud scheme and new orographic drag scheme.
- September 1996: Changes to the stable BL scheme and the coupling to the ground; this affects ground temperatures.
- December 1996: Changes to the snow albedo scheme. Prior to this date there are large errors over the boreal forest in surface albedo, net radiation, and surface temperature, when there is snow on the ground in the model. The data in March and April 1996 have this error. Comparing March 1996 and 1997 will show differences

10.2 Quality Assessment

10.2.1 Data Validation by Source

Refer to papers listed in Section 17.2 on validation and structure of ECMWF model surface physics by Viterbo and Beljars (1995), Beljars et al. (1996), and Betts et al. (1996, 1997a, 1997b).

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

The data were reviewed for general content and consistency with descriptions provided by the science team.

BORIS staff loaded the data received from Airborne Fluxes and Meteorology (AFM)-08 and checked to make sure that no errors occurred during the loading process.

11. Notes

11.1 Limitations of the Data

These are ECMWF model data and are subject to the errors of the ECMWF model at that time. The reader is encouraged to review the provided references.

11.2 Known Problems with the Data

See Section 10.

11.3 Usage Guidance

These are ECMWF model data, subject to the errors of the ECMWF model at that time.

Note that all the flux values are averages for the preceding hour. All other variables are instantaneous values at that time. Consequently, flux data labeled for UTC = 00 are actually from the preceding day at 2300-2400.

The number of records in each of the upper air data files may exceed 20,000, causing a problem for some software packages.

11.4 Other Relevant Information

Other data points are available, but we believe that these two will be the most useful to BOREAS investigators, given the quality of the operational model at the time. We had hoped to get these data from the later ECMWF reanalysis, but at present this reanalysis stops at February 1994.

The upper air tendency and advection data are still questionable, so we have not included them. The upper air omega data may have some use, so we have included them in 1996, but they have not been validated in any way and could be in error. 0

12. Application of the Data Set

This is a single-column hourly data set from the ECMWF operational model from below the surface to the top of the atmosphere, including the model fluxes at the surface. It is intended to be used primarily for the comparison of model with surface observations.

13. Future Modifications and Plans

We recommend that users of these data contact the Principal Investigators (PIs) to be informed of any relevant results.

14. Software

14.1 Software Description

The software used were the ECMWF operational model and some postprocessing by the Research Department.

14.2 Software Access

Requests for ECMWF software should be sent directly to the Director, ECMWF. It is not generally available to nonmember countries, but specific physics subroutines might be released on request.

15. Data Access

The ECMWF hourly surface and upper air 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

Beljaars, A.C.M., P. Viterbo, M.J. Miller, and A.K. Betts. 1996. The anomalous rainfall over the United States during July 1993: sensitivity to land surface parameterization and soil moisture anomalies. Monthly Weather Review, 124:362-383.

Betts, A.K., J.H. Ball, A.C.M. Beljaars, M.J. Miller, and P. Viterbo. 1996. The land-surface-atmosphere interaction: a review based on observational and global modelling perspectives. Journal of Geophysical Research, 101:7209-7225.

Betts, A.K., P. Viterbo, and A.C.M. Beljaars. 1997a. Comparison of the ECMWF reanalysis with the 1987 FIFE data. Monthly Weather Review. (In press).

Betts, A.K., P. Viterbo, and E. Wood, 1997b. Surface Energy and water balance for the Arkansas-Red river basin from the ECMWF reanalysis. Available from author.

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.

Viterbo, P. and A.C.M. Beljaars. 1995. An improved land-surface parameterization in the ECMWF model and its validation. Journal of Climate 8:2716-2748.

17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

AFM	- Airborne Fluxes and Meteorology
ASCII	- American Standard Code for Information Interchange
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
CD-ROM	- Compact Disk-Read-Only Memory
DAAC	- Distributed Active Archive Center
ECMWF	- European Centre for Medium-Range Weather Forecasts
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
NASA	- National Aeronautics and Space Administration
NSA	- Northern Study Area
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert National Park
PI	- Principal Investigator
SSA	- Southern Study Area
URL	- Uniform Resource Locator
UTC	- Universal Time Code

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

This data set was produced by Pedro Viterbo at ECMWF, and Alan Betts of Atmospheric Research with support from NASA under Contract NAS5-32356.

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

Betts, A. and P. Viterbo, "Boundary Layer Research for BOREAS." 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:

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20.5 Document Curator

20.6 Document URL

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13. ABSTRACT *(Maximum 200 words)*

The BOREAS AFM-8 team focused on modeling efforts to improve the understanding of the diurnal evolution of the convective boundary layer over the boreal forest. This data set contains hourly data from the ECMWF operational model from below the surface to the top of the atmosphere, including the model fluxes at the surface. Spatially, the data cover a pair of the points that enclose the rawinsonde sites at Candle Lake, Saskatchewan, in the SSA and Thompson, Manitoba, in the NSA. Temporally, the data include the two time periods of 13-May-1994 to 30-Sept-1994 and 01-Mar-1996 to 31-Mar-1997. The data are stored in tabular ASCII files. The number of records in the upper air data files may exceed 20,000, causing a problem for some software packages.

14. SUBJECT TERMS
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