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

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Summary

The BOREAS AFM-08 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 soil 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 soil 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:

1) A surface component with subsurface variables:
a) Temperature and soil moisture for the first model layer (0-7 cm); and an average for the next three soil layers, 7-289 cm.
b) 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.

2) 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

Contact 1

Alan Betts
Atmospheric Research
Pittsford, VT
akbetts@aol.com
(802)483-2087
(802)483-6167 (fax)

Contact 2

Pedro Viterbo
ECMWF
Reading, England
pedro.viterbo@ecmwf.int
011-44-1189-499734
011-44-1189-869450 (fax)

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 non-linear 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.

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 was 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

Data characteristics are defined in the companion data definition file (ecmwf2.def).

7.4 Sample Data Record

Sample data format shown in the companion data definition file (ecmwf2.def).

8. Data Organization

8.1 Data Granularity

All of the AFM-08 ECMWF Hourly Surface and Upper Air Data for the SSA and NSA data are contained in one dataset.

8.2 Data Format(s)

The data files contain 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. Sample data records are shown in the companion data definition file (ecmwf2.def).

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).

10.2.5 Data Verification by Data Center

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

BOREAS Information System (BORIS) staff loaded the data received from Airborne Flux 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.

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

15.1 Contact for Data Center/Data Access Information

These BOREAS data are available from the Earth Observing System Data and Information System (EOS-DIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC). The BOREAS contact at ORNL is:

ORNL DAAC User Services
Oak Ridge National Laboratory
(865) 241-3952
ornldaac@ornl.gov
ornl@eos.nasa.gov

15.2 Procedures for Obtaining Data

BOREAS data may be obtained through the ORNL DAAC World Wide Web site at http://www-eosdis.ornl.gov/ or users may place requests for data by telephone, electronic mail, or fax.

15.3 Output Products and Availability

Requested data can be provided electronically on the ORNL DAAC's anonymous FTP site or on various media including, CD-ROMs, 8-MM tapes, or diskettes.

The complete set of BOREAS data CD-ROMs, entitled "Collected Data of the Boreal Ecosystem-Atmosphere Study", edited by Newcomer, J., et al., NASA, 1999, are also available.

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

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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 Flux 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
GSFC	- Goddard Space Flight Center

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

20. Document Information

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