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

Forrest G. Hall, Editor

Volume 108
BOREAS Regional DEM in Raster Format and AEAC Projection

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Goddard Space Flight Center
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BOREAS Regional DEM in Raster Format and AEAC Projection

David Knapp, Kristine Verdin

Summary

This data set is based on the GTOPO30 DEM produced by the USGS EDC. The BOREAS region (1,000 km x 1000 km) was extracted from the GTOPO30 data and reprojected by BOREAS staff into the AEAC projection. The pixel size of these data is 1 km. The data are stored in binary, image format files.

Note that the binary files of this data set on the BOREAS CD-ROMs have been compressed using the Gzip program. See Section 8.2 for details.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS Regional DEM in Raster Format and AEAC Projection

1.2 Data Set Introduction

This data set is based on the GTOPO30 global Digital Elevation Model (DEM) produced by theUnited States Geological Survey (USGS) Earth Resources Observation System (EROS) Data Center (EDC). The area covering the BOReal Ecosystem-Atmosphere Study (BOREAS) region (1,000 km x 1,000 km) was extracted from the GTOPO30 data and reprojected by BOREAS Information System (BORIS) staff into the BOREAS grid projection. The pixel size of these data is 1 km. The GTOPO30 data set produced by EDC is in latitude/longitude and has a pixel size of 30 arcseconds. The GTOPO30 data set is available from the EDC Distributed Active Archive Center (DAAC).

1.3 Objective/Purpose

These data are provided as part of the BOREAS Staff Science Geographic Information System (GIS) Data Collection Program, which included the collection of pertinent map data in both hardcopy and digital form. The purpose of this data set is to provide users with a data product that characterizes the topography of the BOREAS region. This data set is to be used for modeling purposes at a regional scale.

1.4 Summary of Parameters

Elevation above mean sea level.

1.5 Discussion

None.

1.6 Related Data Sets

BOREAS HYD-08 DEM Data over the NSA-MSA and SSA-MSA in the UTM Projection
BOREAS DEM Data over the NSA-MSA and SSA-MSA in the AEAC Projection

GTOPO30 Global 30 Arc Second Elevation Data Set:
(available at http://edcwww.cr.usgs.gov/landdaac/gtopO30/gtopO30.html)
(tiles W100N90 and W140N90 of GTOPO30 cover the BOREAS region)

2. Investigator(s)

2.1 Investigator(s) Name and Title

BOREAS Staff Science

2.2 Title of Investigation

BOREAS Staff Science GIS Activities

2.3 Contact Information

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Raytheon ITSS
NASA GSFC
Code 923
Greenbelt, MD 20771
(301) 286-1424
(301) 286-0239 (fax)
David.Knapp@gsfc.nasa.gov

3. Theory of Measurements

This data product was reprojected from a DEM product by EDC. It is intended to represent the terrain at a regional scale.

4. Equipment

4.1 Sensor/Instrument Description

Users of this data set are referred to the EDC DAAC to obtain background information on how these data were compiled.

4.1.1 Collection Environment

Unknown.

4.1.2 Source/Platform

Unknown.

4.1.3 Source/Platform Mission Objectives

Unknown.

4.1.4 Key Variables

Elevation above mean sea level

4.1.5 Principles of Operation

Unknown.

4.1.6 Sensor/Instrument Measurement Geometry

Unknown.

4.1.7 Manufacturer of Sensor/Instrument

Unknown.

4.2 Calibration

Unknown.

4.2.1 Specifications

Unknown.

4.2.1.1 Tolerance

Unknown.

4.2.2 Frequency of Calibration

Unknown.

4.2.3 Other Calibration Information

Unknown.

5. Data Acquisition Methods

The original data were acquired from personnel at the USGS EDC. EDC personnel used Digital Terrain Elevation Data (DTED) from Canada and resampled them to 30 arcseconds using a nearest neighbor resampling method. Any areas that were not covered by DTED were filled in with gridded contour data from the Digital Chart of the World (DCW). These data were gridded by EDC using the TOPOG software package. The stream network from the DCW was used for drainage enforcement. The data covering the BOREAS region were extracted from the EDC DEM by BORIS staff and reprojected into the BOREAS grid projection.

6. Observations

6.1 Data Notes

Unknown.

6.2 Field Notes

Unknown.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The area covered by this DEM is a 1,000-km x 1,000-km area that roughly straddles the Manitoba-Saskatchewan border in Canada. The North American Datum of 1983 (NAD83) corner coordinates of the BOREAS region are:

Corner	Latitude	Longitude	BOREAS X (km)	BOREAS Y (km)
Northwest	58.979 N	111.000 W	0.000	1000.000
Northeast	58.844 N	93.502 W	1000.000	1000.000
Southwest	51.000 N	111.000 W	0.000	0.000
Southeast	50.089 N	96.969 W	1000.000	0.000

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

These data were gridded to a cell size of 1,000 meters in both the X and Y directions.

7.1.4 Projection

The area mapped is projected in the BOREAS grid projection, which is based on the ellipsoidal version of the Albers Equal-Area Conic (AEAC) projection. The projection has the following parameters:

```
Datum:      NAD83
Ellipsoid:  GRS80   or WGS84
Origin:     111.000°W  51.000°N
Standard Parallels:    52°  30' 00"N
                       58°  30' 00"N
Units of Measure:  kilometers
```

7.1.5 Grid Description
Not available.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage
Not applicable

7.2.2 Temporal Coverage Map
Not available.

7.2.3 Temporal Resolution
The sources of data produced by EDC were from different dates. The temporal characteristics of these data are insignificant, considering the fact that these are elevation data at a very coarse scale (a pixel is 1,000 m x 1,000 m).

7.3 Data Characteristics

7.3.1 Parameter/Variable
Elevation above mean sea level

7.3.2 Variable Description/Definition
Elevation above mean sea level - The vertical distance between a plane at mean sea level and a parallel plane intersecting the given geographic point.

7.3.3 Unit of Measurement
Meters

7.3.4 Data Source
The original data were acquired from personnel at the USGS EDC.

7.3.5 Data Range
Not available.

7.4 Sample Data Record
Not applicable to binary raster images.

8. Data Organization

8.1 Data Granularity
The smallest amount of data that can be ordered from this data set is the entire data set covering the entire BOREAS region.

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.

8.2.1 Uncompressed Data Files

The data product contains two files:

- File 1: ASCII header file containing 8 records of 80 bytes.
- File 2: DEM data file consisting of 1,000 records containing 2,000 bytes each. Each 2,000-byte record is an image line and contains 1,000 2-byte (16-bit) integers stored as low-order byte first.

8.2.2 Compressed CD-ROM Files

On the BOREAS CD-ROMs, file 1 is stored as ASCII text; however, file 2 has been compressed with the Gzip compression program (file name *.gz). These data have been compressed using gzip version 1.2.4 and the high compression (-9) option (Copyright (C) 1992-1993 Jean-loup Gailly). Gzip (GNU zip) uses the Lempel-Ziv algorithm (Welch, 1994) used in the zip and PKZIP programs. The compressed files may be uncompressed using gzip (-d option) or gunzip. Gzip is available from many Web sites (for example, ftp site prep.ai.mit.edu/pub/gnu/gzip-*.*) for a variety of operating systems in both executable and source code form. Versions of the decompression software for various systems are included on the CD-ROMs.

9. Data Manipulations

9.1 Formulae

9.1.1 Derivation Techniques and Algorithms

As stated in Section 5, these data were reprojected from latitude/longitude coordinates to the BOREAS grid projection. The BOREAS grid is based on the ellipsoidal version of the AEAC projection as defined within NAD83. The parameters used for this projection are given in Section 7.1.4. A nearest neighbor resampling method was used in reprojecting the data.

9.2 Data Processing Sequence

9.2.1 Processing Steps

BORIS staff processed the data by:

- Extracting the DEM from EDC into ARC/INFO grid
- Creating a projection file to define input (latitude/longitude) and output (AEAC) projections
- Reprojecting the original DEM into the AEAC projection using the ARC/INFO PROJECT command
- Writing the reprojected data file to tape
- Copying the ASCII and compressing the binary files for release on CD-ROM

9.2.2 Processing Changes

None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

None.

9.3.2 Calculated Variables

None.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

The TOPOG program interpolates the values to grid cells from vector data (digitized contours). Errors occur where the original vector data are too sparse spatially, e.g., in flat lowland areas.

10.2 Quality Assessment

No quality assessment is available; therefore, caution is advised to those who use this product.

10.2.1 Data Validation by Source

Not available.

10.2.2 Confidence Level/Accuracy Judgment

Not available.

10.2.3 Measurement Error for Parameters

Not available.

10.2.4 Additional Quality Assessments

Not available.

10.2.5 Data Verification by Data Center

After extracting and reprojecting the data, BORIS staff displayed and visually reviewed the data. No anomalies or errors were detected in this review.

11. Notes

11.1 Limitations of the Data

Elevational variations can exist within the lakes, especially large lakes, due to the reason given in Section 10.1.

11.2 Known Problems with the Data

See Sections 10.1 and 11.1.

11.3 Usage Guidance

It is important to keep in mind that this data set is at a coarse scale and might not be useful at other scales.

Before uncompressing the Gzip files on CD-ROM, be sure that you have enough disk space to hold the uncompressed data files. Then use the appropriate decompression program provided on the CD-ROM for your specific system.

11.4 Other Relevant Information

The original EDC GTOPO30 Global 30 Arc Second Elevation Data Set is available at http://edcwww.cr.usgs.gov/landdaac/gtopO30/ (map tiles W100N90 and W140N90 of GTOPO30 cover the BOREAS region).

12. Application of the Data Set

These data could be used by anyone needing elevation data at coarse resolutions over large areas.

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description

The data manipulation capabilities in the ARC/INFO software package (Version 7.0) were used to reproject the data. ARC/INFO is a GIS package developed by the Environmental Systems Research Institute, Inc. (ESRI).

Gzip (GNU zip) uses the Lempel-Ziv algorithm (Welch, 1994) used in the zip and PKZIP commands.

14.2 Software Access

ARC/INFO is a proprietary software package produced by ESRI:

Environmental Systems Research Institute, Inc.
380 New York St.
Redlands, CA 92373-8100

Gzip is available from many Web sites across the Internet (for example, ftp site prep.ai.mit.edu/pub/gnu/gzip-*.*) for a variety of operating systems in both executable and source code form. Versions of the decompression software for various systems are included on the CD-ROMs.

15. Data Access

The BOREAS regional DEM data in raster format and AEAC projection 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

The DEM data can be made available on 8-mm, Digital Archive Tape (DAT), or 9-track tapes at 1600 or 6250 Bytes Per Inch (BPI).

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

Snyder, J.P. 1987. Map Projections - A Working Manual. USGS Professional Paper 1395.

TOPOG User Guide (Version 5.0). 1994. Division of Water Resources, CSIRO. Canberra, Australia.

Welch, T.A. 1984. A Technique for High Performance Data Compression. IEEE Computer, Vol. 17, No. 6, pp. 8-19.

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

```
AEAC    - Albers Equal-Area Conic
ASCII   - American Standard Code for Information Interchange
BOREAS  - BOReal Ecosystem-Atmosphere Study
BORIS   - BOREAS Information System
BPI     - Bytes Per Inch
CD-ROM  - Compact Disk-Read-Only Memory
DAAC    - Distributed Active Archive Center
DAT     - Digital Archive Tape
DCW     - Digital Chart of the World
DEM     - Digital Elevation Model
DTED    - Digital Terrain Elevation Data
EDC     - EROS Data Center
EOS     - Earth Observing System
EOSDIS  - EOS Data and Information System
EROS    - Earth Resources Observation System
ESRI    - Environmental Systems Research Institute, Inc.
GIS     - Geographic Information System
GSFC    - Goddard Space Flight Center
NAD27   - North American Datum of 1927
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
URL     - Uniform Resource Locator
USGS    - United States Geological Survey
UTM     - Universal Transverse Mercator
```

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

The efforts of the BORIS staff in making these data available are greatly appreciated.

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

David E. Knapp, "BOREAS Staff Science GIS Activities." 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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13. ABSTRACT *(Maximum 200 words)*

This data set is based on the GTOPO30 DEM produced by the USGS EDC. The BOREAS region (1,000 km x 1000 km) was extracted from the GTOPO30 data and reprojected by BOREAS staff into the AEAC projection. The pixel size of these data is 1 km. The data are stored in binary, image format files.

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