

NASA/TM—2000–209891, Vol. 30



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

Forrest G. Hall and David E. Knapp, Editors

Volume 30

**BOREAS HYD-6 Moss/Humus
Moisture Data**

E.L. Peck and T. Carroll

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

July 2000

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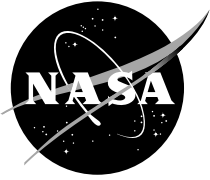
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BOREAS HYD-6 Moss/Humus Moisture Data

Eugene L. Peck, Thomas Carroll

Summary

The BOREAS HYD-6 team collected several data sets related to the moisture content of soil and overlying humus layers. This data set contains water content measurements of the moss/humus layer, where it existed. These data were collected along various flight lines in the SSA and NSA during 1994. The data are available in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS HYD-06 Moss/Humus Moisture Data

1.2 Data Set Introduction

This document describes the in situ water content measurements of the moss/humus layer along flight lines.

1.3 Objective/Purpose

The objectives of this research were: 1) to obtain improved estimates of the soil moisture conditions for the BOREal Ecosystem-Atmosphere Study (BOREAS) experimental areas; 2) to develop techniques for measuring the water content of the moss/humus layer; 3) to provide assistance to the Hydrology (HYD)-04 team in measuring the water equivalent of the snow cover; 4) to provide information for validating and calibrating other remote sensing methods; and 5) to provide information on the soil moisture of the mineral soil, the water content of the moss/humus layer, and the water equivalent of the snow cover to other investigators.

1.4 Summary of Parameters

Transect identifier, sample identifier, latitude and longitude of the in situ ground measurements of the water content of the moss/humus layer.

1.5 Discussion

As part of the BOREAS experiment, natural terrestrial gamma radiation data over a network of 48 flight lines were collected. For each of these flight lines, ground in situ soil moisture measurements of the mineral soil and water content of the moss/humus layer were collected and used, along with other available measurements, to establish one-time calibration of the natural terrestrial radioisotope signal over the flight line network.

1.6 Related Data Sets

BOREAS HYD-06 Aircraft Gamma Ray Soil Moisture Data
BOREAS HYD-06 Ground Gravimetric Soil Moisture Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. Eugene L. Peck
Hydex Corporation

Dr. Thomas Carroll
National Weather Service (NWS)

2.2 Title of Investigation

Remote Sensing of Hydrologic Variables in Boreal Areas

2.3 Contact Information

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3. Theory of Measurements

In situ ground samples of the water content of the moss/humus layer are obtained using the gravimetric method (percent by weight of dry soil). The moss/humus layer samples are placed in one or more plastic containers and are later dried out for 24 hours in a drying oven at 105 °C.

4. Equipment

4.1 Sensor/Instrument Description

An Eastern Snow Conference (ESC-30) snow tube with an orifice of 30 cm² is used to collect samples of the moss/humus layer. Depths of the moss/humus layer are measured with a ruler after digging down to the mineral soil.

4.1.1 Collection Environment

The airborne and ground measurements of the soil moisture and moss/humus layer were planned before each day's surveying. The airborne and ground measurements were taken as simultaneously as possible. Ground measurements for calibration purposes were obtained when the flight line areas were fairly dry and never during rain occurrences.

4.1.2 Source/Platform

Human.

4.1.3 Source/Platform Mission Objectives

The objective was to collect cores of moss/humus at various locations.

4.1.4 Key Variables

Moss/humus moisture content.

4.1.5 Principles of Operation

Unknown.

4.1.6 Sensor/Instrument Measurement Geometry

ESC-30 snow tube with an orifice of 30 cm².

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

Ground measurements were collected at over 1,100 locations along 42 of the 48 BOREAS airborne gamma radiation flight lines during the field experiments. Maps showing locations of most BOREAS established flight lines are shown on Figures 5.2.1.4a, 5.2.1.4b, and 5.2.1.4c of version 3.0 of the BOREAS Experimental Plan. Revised computerized maps of all of the 48 flight lines prepared by National Operational Hydrologic Remote Sensing Center (NOHRSC) (March 1995) are available in the BOREAS Information System (BORIS) (containing a few additional lines that were established during the field experiments).

The flight lines are numbered BP100 to BP123 and CR954 to CR960 in the Southern Study Area (SSA) and BP201 to BP213 in the Northern Study Area (NSA). Flight lines BP301 to BP305 are located along the transect between the SSA and NSA. The CR lines in the SSA are part of the operational snow measurement program of the Atmospheric Environment Service (AES) of Canada.

See Section 9.2.1 for details on how the ground samples were processed.

6. Observations

6.1 Data Notes

Unknown.

6.2 Field Notes

Field notes for the ground sampling of the water content of the moss/humus layer by members of HYD-04 and HYD-06 are contained in the comments of the actual data. Ground samples of the water equivalent of the snow cover and other measurements obtained during 1993 and the 1994 Intensive Field Campaigns (IFCs) are being placed in BORIS by HYD-04.

7. Data Description

7.1 Spatial Characteristics

These data were collected along various flight lines within the NSA and SSA. The data that provide the location of these flight lines are described in the HYD-06 Airborne Estimate of Soil Moisture Document.

7.1.1 Spatial Coverage

There is a reference table called HYD06_TRANSECT_REF that contains information about the location of the various flight lines. The ground samples of moss/humus water content were made at point locations throughout the NSA and SSA. The bounding coordinates of these areas are:

NSA Spatial Coverage (North American Datum of 1983 (NAD83))

	Longitude	Latitude
	-----	-----
Northwest	98.82 W	56.247 N
Northeast	97.24 W	56.081 N
Southeast	97.49 W	55.377 N
Southwest	99.05 W	55.54 N

SSA Spatial Coverage

	Longitude	Latitude
	-----	-----
Northwest	106.23 W	54.319 N
Northeast	104.24 W	54.223 N
Southeast	104.37 W	53.419 N
Southwest	106.32 W	53.513 N

7.1.2 Spatial Coverage Map

See Figures 5.2.1.4a, 5.2.1.4b, and 5.2.1.4c in version 3.0 of the BOREAS Experiment Plan.

7.1.3 Spatial Resolution

The ground samples of moss/humus water content were made at point locations throughout the NSA and SSA.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

The data were collected for as many flight lines as possible during the following periods:

08-Sep-1993 to 11-Sep-1993 in the SSA
07-Feb-1994 to 11-Feb-1994 in the SSA and NSA (in cooperation with HYD-04)
24-Jul-1994 to 05-Aug-1994 in the SSA and NSA
30-Aug-1994 to 10-Sep-1994 in the SSA

7.2.2 Temporal Coverage Map

Not available.

7.2.3 Temporal Resolution

Ground samples were collected on a daily basis. For those ground samples collected by members of HYD-06, the observational times the ground samples were obtained are included in the files Mastergd.DAT and Mastermh.DAT. Times of sampling were not noted for those collected by members of HYD-04.

7.3 Data Characteristics

7.3.1 Parameter/Variable

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

Column Name
HYD06_SITE_ID
DATE_OBS
TIME_OBS
FLIGHT_LINE
SAMPLE_NUM
SUBSAMPLE_NUM
LONGITUDE
LATITUDE
BOREAS_X
BOREAS_Y
TOTAL_WEIGHT
DRY_WEIGHT
WATER_WEIGHT
WATER_CONTENT_PARTIAL
WATER_CONTENT_MOSS_HUMUS
COMMENTS
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
HYD06_SITE_ID	The identifier assigned to the site by BOREAS, in the format AAA-FFF-GGGGG-SMAC01 where AAA is the study area, FFF is the flight line number, GGGGG is the science group, and SMAC01 stands for Soil Moisture Aircraft.
DATE_OBS	The date on which the data were collected.
TIME_OBS	The Greenwich Mean Time (GMT) when the data were collected.
FLIGHT_LINE	The designation for the line/transect over which the aircraft flew.
SAMPLE_NUM	The number of the sample.
SUBSAMPLE_NUM	The designation of the in situ sub sample.
LONGITUDE	The NAD83 based longitude coordinate at the site.
LATITUDE	The NAD83 based latitude 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.
TOTAL_WEIGHT	The total weight of the soil sample and the container with the lid.
DRY_WEIGHT	The dry weight of the soil sample and the container without the lid.
WATER_WEIGHT	The calculated weight of the water in the sample.

WATER_CONTENT_PARTIAL	The water content of a portion of the whole sample. The portions are designated as A, B, etc.
WATER_CONTENT_MOSS_HUMUS	The water content of the moss/humus layer.
COMMENTS	Descriptive information to clarify or enhance the understanding of the other entered data.
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
HYD06_SITE_ID	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
FLIGHT_LINE	[none]
SAMPLE_NUM	[none]
SUBSAMPLE_NUM	[none]
LONGITUDE	[degrees]
LATITUDE	[degrees]
BOREAS_X	[kilometers]
BOREAS_Y	[kilometers]
TOTAL_WEIGHT	[grams]
DRY_WEIGHT	[grams]
WATER_WEIGHT	[grams]
WATER_CONTENT_PARTIAL	[millimeters]
WATER_CONTENT_MOSS_HUMUS	[millimeters]
COMMENTS	[none]
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
HYD06_SITE_ID	[Assigned by BORIS]
DATE_OBS	[Supplied by Investigator]
TIME_OBS	[Supplied by Investigator]
FLIGHT_LINE	[Supplied by Investigator]
SAMPLE_NUM	[Supplied by Investigator]
SUBSAMPLE_NUM	[Supplied by Investigator]
LONGITUDE	[Supplied by Investigator]
LATITUDE	[Supplied by Investigator]
BOREAS_X	[Calculated by BORIS from LATITUDE and LONGITUDE]
BOREAS_Y	[Calculated by BORIS from LATITUDE and LONGITUDE]
TOTAL_WEIGHT	[Supplied by Investigator]
DRY_WEIGHT	[Supplied by Investigator]
WATER_WEIGHT	[Supplied by Investigator]

WATER_CONTENT_PARTIAL	[Supplied by Investigator]
WATER_CONTENT_MOSS_HUMUS	[Supplied by Investigator]
COMMENTS	[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.

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
HYD06_SITE_ID	N/A	N/A	None	None	None	None
DATE_OBS	09-SEP-93	05-SEP-94	None	None	None	None
TIME_OBS	0	2304	None	None	None	None
FLIGHT_LINE	BP114	BP305	None	None	None	None
SAMPLE_NUM	1	97	None	None	None	None
SUBSAMPLE_NUM	A	F	None	None	None	None
LONGITUDE	-105.322	-98.23027	None	None	None	None
LATITUDE	53.64433	55.94011	None	None	None	None
BOREAS_X	374.691	802.6	None	None	None	None
BOREAS_Y	309.531	619.075	None	None	None	None
TOTAL_WEIGHT	16.6	1433.9	None	None	None	Blank
DRY_WEIGHT	14.52	592.7	None	None	None	Blank
WATER_WEIGHT	.81	109.45	None	None	None	Blank
WATER_CONTENT_PARTIAL	.3	127.8	None	None	None	Blank
WATER_CONTENT_MOSS_HUMUS	0	284	None	None	None	Blank
COMMENTS	N/A	N/A	None	None	None	Blank
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	12-JUL-95	12-JUL-95	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 a sample data file on the CD-ROM.

```
HYD06_SITE_ID,DATE_OBS,TIME_OBS,FLIGHT_LINE,SAMPLE_NUM,SUBSAMPLE_NUM,LONGITUDE,
LATITUDE,BOREAS_X,BOREAS_Y,TOTAL_WEIGHT,DRY_WEIGHT,WATER_WEIGHT,
WATER_CONTENT_PARTIAL,WATER_CONTENT_MOSS_HUMUS,COMMENTS,CRTFCN_CODE,REVISION_DATE
'SSA-115-HYD06-SMAC01',09-SEP-93,0,'BP115',11,'A',-105.12005,53.98835,384.854,
348.765,51.0,19.79,26.51,8.8,9.0,'using ESC30 tube moss and humus','CPI',
12-JUL-95
'SSA-115-HYD06-SMAC01',09-SEP-93,0,'BP115',12,'A',-105.12005,53.98835,384.854,
348.765,67.66,24.96,38.0,12.7,18.0,'using ESC30 tube humus only','CPI',12-JUL-95
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data that can be ordered from this data set is a day's worth of data.

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

See Section 9.3.

9.1.1 Derivation Techniques and Algorithms

See Section 9.3.

9.2 Data Processing Sequence

9.2.1 Processing Steps

The moss/humus layer samples in the sealed plastic containers obtained in the field are weighed (M-H total), the lids are removed, and the samples are dried in ovens and weighed again (dry). The weight of the water (water) in the moss/humus layer for each portion of the sample (A, B, etc.) is determined by subtracting the dry weight (dry) and the weight of an average plastic lid for that day from the total weight (M-H total) for the portion of the sample. The weights of the plastic lids and the

plastic containers vary from shipment to shipment, and the average weights of those being used each day are recorded on the laboratory form with the total and dry weights. The water content of the portion of the sample is obtained by dividing the water in the portion of the sample by 30 (the cross-sectional area (in square centimeters) of the ESC sampler). This is multiplied by 10 to yield water content in millimeters. The water content of each sample is computed by adding the water content of all of the portions (A, B, etc.) of the sample.

Samples processed by members of HYD-04 are sealed and taken to AES offices in Downsview, Ontario, for processing. The measurements obtained by members of HYD-04 do not have entries in column water or water content part. They compute the water content of a sample directly $((M-H \text{ total minus dry})/(30)) * 10$.

BORIS staff processed the data by:

- Reviewing the initial data files and loading them online for BOREAS team access.
- Designing relational data base tables to inventory and store the data.
- Loading the data into the relational data base tables.
- Performing the conversions on measurements into System International (SI) units.
- Working with the HYD-06 team to document the data set.
- Extracting the standardized data into logical files.

9.2.2 Processing Changes

Not applicable.

9.3 Calculations

The following equation yields water content in millimeters:

$$\text{Water Content} = (\text{Moss Humus total weight} - \text{dry weight of soil}) / 30 * 10$$

9.3.1 Special Corrections/Adjustments

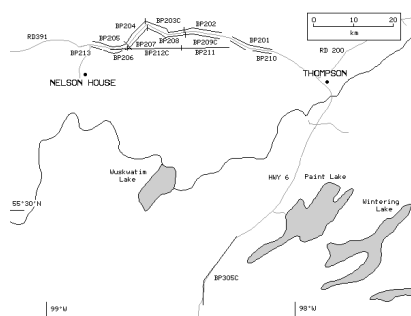
None.

9.3.2 Calculated Variables

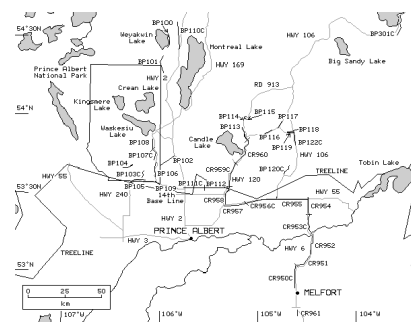
None.

9.4 Graphs and Plots

The following maps are provided courtesy of the HYD-04 BOREAS team, led by Dr. Barry Goodison.



Map of flight lines in the BOREAS Northern Study Area (NSA)



Map of flight lines in the BOREAS Southern Study Area (SSA)

10. Errors

10.1 Sources of Error

There are many possible sources of error measuring the water content of the moss/humus layer. Obtaining a sample in deep layers of moss/humus can be very difficult. In some cases, the depth is greater than the length of the ESC snow tube, and the moss/humus layer has to be dug down to the mineral soil and more than one core of the layer cut. In some cases, the root system in the moss/humus layer is so heavy that it is impossible to cut through the layer with the ESC tube. In other cases, there are air pockets in the moss/humus layer that may not be representative of the average layers in the area. Selecting a measurement site that represents the general conditions is also difficult. For this reason, four extra measurements of the depth of the moss/humus layer were made at 5-meter distances from the measuring site.

Even though there are difficulties in obtaining the measurements of the water content of the moss/humus layer, the data for most flight lines appear to be a reasonable indication of the average for the flight lines (and bins). In one case, measurements were made at different times over the same bin of the flight line with a heavy moss/humus layer. It was evident that two of the measurement sites had depths much greater than the average for the entire bin of the flight line (BP115, bin 3, 31-Aug-1994), and the computed average of the water content for the bin for that day was greater than expected.

10.2 Quality Assessment

10.2.1 Data Validation by Source

Confidence in the in situ measurement of the water content of the moss/humus layer depends on many factors regarding the accuracy of locating the sampling points along the flight line as well as the experience and training of the field personnel.

10.2.2 Confidence Level/Accuracy Judgment

The confidence level varies with the experience of the person selecting the flight line and marking the location of the ground measurement. In very flat areas, the exact location of a ground measurement is more difficult to identify on a map than for a location near a stream or in areas of variable terrain.

10.2.3 Measurement Error for Parameters

A precise estimate of the error of a water content measurement of the moss/humus layer cannot be determined. The selection of sites for in situ measurements of the water content of the moss/humus layer along a flight line is very critical in determining the calibration data for flight lines with considerable depth of moss/humus. Experience with the airborne gamma radiation system during the recent field experiments (FIFE) in Kansas (Carroll et al., 1988) illustrates the need to obtain ground measurements representative of the average of the area from which ground-based gamma are received by the airborne detectors.

During the BOREAS field experiments, careful attention has been given to obtaining as representative measurements of water content of the moss/humus layer as possible for flight lines having considerable depth of moss/humus. For the flight lines over the primary tower sites in the SSA, more than one set of ground measurements was obtained.

10.2.4 Additional Quality Assessments

None.

10.2.5 Data Verification by Data Center

BORIS personnel reviewed the data and documentation for clarity and consistency.

11. Notes

11.1 Limitations of the Data

None given.

11.2 Known Problems with the Data

None given.

11.3 Usage Guidance

The water content and depths of the moss/humus layer may be only representative for the soil and vegetative conditions of the particular flight line. Considerable change in moss/humus conditions may be found over very small distances (10s of meters). Careful review of the soil and vegetative conditions is necessary to transfer the moss/humus estimates to nearby areas. However, the use of the moss/humus measurements for similar conditions for flux analyses and other studies can add considerable information on the spatial and temporal variation in the moss/humus layer. For some flight lines, the number of depth measurements of the moss/humus layer probably has more reliability than fewer measurements of the water content of the moss/humus layer. There is merit in applying the average water content as a density to the average depth determined from the larger number of depth measurements. The average density (water content/average depth) for one flight line correlates well with average density for nearby lines.

11.4 Other Relevant Information

Ground measurements collected by members of HYD-06 were collected under slightly different methods than those collected by members of HYD-04. Those observed by members of HYD-04 have observation times of 0000 hours.

Members of HYD-04 followed sampling procedures established for the operational airborne gamma radiation snow surveys that have been collected in the BOREAS area for many years. Sampling points are selected on a set distance from the beginning of the flight line (at either 1-km or 2-km intervals depending on the length of the flight line). This approach has proven useful for the operational snow measuring program. Using this approach, the measurement sites are selected at nearly the same location along the flight line during snow and nonsnow periods. Members of HYD-06 collected only during nonsnow periods and selected measurements sites that tended to best represent the average conditions along the entire 305-m-wide foot path of the area measured by the airborne gamma radiation surveys.

12. Application of the Data Set

These data could be used to analyze the moisture holding capacity of the moss and humus layers in the areas sampled.

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description

None given.

14.2 Software Access

None given.

15. Data Access

The HYD-06 moss/humus moisture 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

None.

16.2 Film Products

Video tapes taken over each flight line during calibration showing the area directly under the aircraft are available (at NOHRSC). At the present time, no decision has been made on storing these tapes in BORIS.

16.3 Other Products

Maps showing the flight lines for which gamma data were obtained have been digitized by NOHRSC and submitted to BORIS. 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

Carroll, T.R., E.L. Peck, and D.M. Lipinski. 1988. Airborne time-series measurements of soil moisture using terrestrial gamma radiation. Proc. Ann. Conf. Am. Soc. Photogram. Remote Sens., St. Louis, MO

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).

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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

AES	- Atmospheric Environment Service of Canada
ASCII	- American Standard Code for Information Interchange
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
BPI	- Bytes Per Inch
CCT	- Computer Compatible Tape
CD-ROM	- Compact Disk - Read-Only Memory
DAAC	- Distributed Active Archive Center
EOS	- Earth Observing System
EOSDIS	- EOS Data and Information System
ESC	- Eastern Snow Conference
EXP	- Experiment
FIFE	- First ISLSCP Field Experiment
FIS	- FIFE Information System (NASA)
GIS	- Geographic Information System
GMT	- Greenwich Mean Time
GPS	- Global Positioning System
GSFC	- Goddard Space Flight Center
HTML	- Hyper-Text Markup Language
HYD	- Hydrology (BOREAS science team)
IFC	- Intensive Field Campaign
ISLSCP	- International Satellite Land Surface Climatology Project
MeV	- Million Electronic Volts
NAD27	- North American Datum of 1927
NAD83	- North American Datum of 1983
NASA	- National Aeronautics and Space Administration
NOAA	- National Oceanic and Atmospheric Administration
NOHRSC	- National Operational Hydrologic Remote Sensing Center
NSA	- Northern Study Area
NWS	- National Weather Service
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert National Park
SI	- System International
SM	- Soil moisture, percent by weight, of the mineral soil
SSA	- Southern Study Area
URL	- Uniform Resource Locator
USGS	- U.S. Geological Survey
WC	- Water content of the moss/humus layer
WE	- Water equivalent of the snow layer

20. Document Information

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

Eugene L. Peck, President, Hydrex Corporation Thomas Carroll, Chief, NOHRSC

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

Peck, E.L. and T. Carroll, "Remote Sensing of Hydrologic Variables in Boreal Areas." In Collected Data of The Boreal Ecosystem-Atmosphere Study. Eds. J. Newcomer, D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers. CD-ROM. NASA, 2000.

Also, cite the BOREAS CD-ROM set as:

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

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