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BOREAS HYD-9 Belfort Rain Gauge Data

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BOREAS HYD-9 Belfort Rain Gauge Data

Nicholas Kouwen, Ric Soulis, Wayne Jenkinson, Allyson Graham, Todd Neff

Summary

The BOREAS HYD-9 team collected several data sets containing precipitation and streamflow measurements over the BOREAS study areas. This data set contains the measurements from the Belfort rain gauges at the BOREAS NSA and SSA. These measurements were submitted in 15-minute and 1-hour intervals. Only the 15-minute interval data set was loaded into the data base tables. Data were collected from the Belfort gauges from mid-April until mid-October in 1994, 1995, and 1996. The data are available as tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS HYD-09 Belfort Rain Gauge Data

1.2 Data Set Introduction

This data set contains the measurements from the Belfort rain gauges at the BOReal Ecosystem-Atmosphere Study (BOREAS) Northern Study Area (NSA) and Southern Study Area (SSA). These measurements were submitted in 15-minute and 1-hour intervals. Only the 15-minute interval data set was loaded into the data base tables.

1.3 Objective/Purpose

The purpose of this investigation is to identify, through field measurements and computer modeling, the space-time distribution of meltwater supply to the soil during the spring melt period and the evolution of soil moisture, evaporation, and runoff from the end of the snowmelt period through freeze up. The snow modeling activity will consist of two components. The first phase will use

existing "off- the-shelf" models to forecast the onset and spatial extent of snowmelt and meltwater supply to the soil column prior to the 1994 Intensive Field Campaigns (IFCs). The second phase will extend, implement, and verify a physically based energy balance snowmelt model of the two sites and will evaluate approaches to aggregating detailed snowmelt predictions and measurements based on the model to larger scales, up to the size of a rectangle of several hundred km containing the northern and southern sites. The soil moisture modeling is based on a grouped response unit method that will allow characterization of soil moisture, evaporation, and runoff for the entire northern and southern sites.

1.4 Summary of Parameters

The following phenomena and their parameters are being reported: precipitation amount in a 15-minute period.

1.5 Discussion

The locations for 12 tipping bucket measuring devices, 10 Belfort gauges, and 5 stream sites were selected within the two BOREAS study sites (NSA and SSA). These instruments were installed during the 1994 Focused Field Campaign-Thaw (FFC-T) in the last week of April. They were in operation until October 1994, when they were removed from service. The tipping buckets and Belfort gauges provided an approximate measure of the precipitation in the study areas, and the discharge rates of the streams provided a measurement of water leaving the study area. When used together, these two sets of data provide a balance of the water cycle. Similar measurements were collected in 1995 and 1996 from approximately April to October of those years.

1.6 Related Data Sets

BOREAS HYD-09 Tipping Bucket Rain Gauge Data
BOREAS HYD-09 Stream Flow Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Prof. Ric Soulis
University of Waterloo
Department of Civil Engineering

2.2 Title of Investigation

From Micro-Scale to Meso-Scale Snowmelt, Soil Moisture and Evapotranspiration from Distributed Hydrologic Models

2.3 Contact Information

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3. Theory of Measurements

The Belfort gauges, used to measure precipitation, were 4 feet tall, had an orifice of 8 inches in diameter on top, and were supported in a stable, upright position on a wooden base at all of the sites. They are designed to find the vertical depth of water that would accumulate on a level surface if the precipitation remained where it fell. Precipitation falls through the 8-inch opening at the top of the apparatus and is funneled into a bucket near its center. This bucket is mounted on a gravimetric measuring device. Different weights are transmitted to the data logger as different voltages and recorded for later use. When the data are retrieved, the voltages must be converted to the corresponding volumes and precipitation using calibration coefficients.

4. Equipment

4.1 Sensor/Instrument Description

Belfort Gauge:
A Belfort gauge is a device used to measure the amount of precipitation in a given area. When rain falls, it is collected in a bucket and weighed. When the weight of the water is calculated and compared to the calibration coefficient, the amount of rainfall can be calculated. The data logger stores this information at regular intervals until it can be retrieved. The Belfort gauges used were originally equipped with chart recorders. They were converted to electronic recorders before they were installed using the linear potentiometer so that data could be recorded at 15-minute intervals.

Linear Potentiometer:
The LP-XXFP linear potentiometer is a device designed to measure differences in resistance. The resistance is varied by a movable shaft. When the shaft is moved by the different weights of the collecting bucket, the resistance is changed, resulting in different voltages. The volume of water can then be calculated.

Data Logger:
The chart pac CP-X data logger was connected to the Belfort gauge so that it could record water levels every 15 minutes. The data logger stored the information in its memory until it was retrieved.

4.1.1 Collection Environment

The equipment was operated in variable ambient atmospheric conditions at the field sites in Saskatchewan and Manitoba during 1994.

4.1.2 Source/Platform

The Belfort gauge was mounted on a wide wooden base placed on the ground. The linear potentiometer was mounted inside the Belfort gauge housing. The data logger was mounted inside the Belfort gauge housing.

4.1.3 Source/Platform Mission Objectives

In order to make a detailed estimate of the total amount of precipitation, sufficient precipitation data must be collected to account for all peak periods of precipitation and any variations that occur over time. To achieve this, the data were recorded at regular intervals of 15 minutes. The data logger stored the information until it was retrieved. Tipping buckets and Belfort gauges were used to provide independent measures of precipitation in order to reduce errors.

4.1.4 Key Variables

Belfort Gauge - Precipitation amount in a 15-minute period
Linear Potentiometer - Voltage
Data Logger - Voltage

4.1.5 Principles of Operation

The Belfort gauge is a self-contained device designed to measure the amount of precipitation occurring in a given area over time. It is only an estimate of the total rainfall in an area. The amount of water is measured by weighing a bucket filled with rainwater and converting the weight to millimeters of rainfall using a calibration coefficient.

4.1.6 Sensor/Instrument Measurement Geometry

The Belfort gauge is mounted at ground level. It must be in a clearing large enough so that a 45-degree inverted cone originating from its highest point can reach the atmosphere unimpeded. If trees or other obstructions are surrounding the Belfort gauge, they will affect the data. The device should be mounted on a stable base (example: a wooden platform) and leveled so that the opening is completely vertical (i.e., axis of gauge is perpendicular to a water level).

4.1.7 Manufacturer of Sensor/Instrument

Belfort Gauge
Belfort Instrument Company
727 S. Wolfe Street
Baltimore, MD 21231 U.S.A.

Linear Potentiometer
MIDORI America Corporation
Corona, CA U.S.A.

Data Logger - Lakewood Systems
Edmonton, Alberta, Canada
(403) 462-9211

4.2 Calibration

A Belfort gauge is calibrated by pouring a known amount of water into the orifice at the top of the gauge or adding the calibration weights equivalent to known quantities of water and comparing this with the weight that the gauge registers. This will allow for the calculation of the millimeters of precipitation per milligram of weight. It is possible to find the volume of water associated with a certain mass by using the specific density of water at that temperature. The volume of water can then

be compared to the specification sheet and a calibration coefficient calculated.

4.2.1 Specifications

Belfort gauge - orifice opening: 8 inches
Bucket size: 12 quarts
Orifice height above ground: 4 feet

Linear Potentiometer - linearity: +/- 1%
Friction: 40- g maximum
Operating temperatures: -25 °C to 80 °C

4.2.1.1 Tolerance

A Belfort gauge can measure volumes of water from 0 to 12 quarts (the volume of the bucket). The gauge can measure precipitation in 0.01-inch increments.

4.2.2 Frequency of Calibration

The Belfort gauges were calibrated once at the beginning, the middle, and the end of the study period.

4.2.3 Other Calibration Information

Not applicable.

5. Data Acquisition Methods

A data logger recorded the precipitation data for the Belfort gauges. The data logger was connected to a notebook computer onsite, where the logger's stored information was transferred to the notebook.

6. Observations

6.1 Data Notes

Instrument	Year	Date	Event
Belfort 1	1994	10-Apr	Bell installed at Hwy 913 & 120 53° 51' 39"N 105° 56' 27"W approx.
		05-May	Bell moved to White Gull Drain
		11-May	Gauge reset at 11:00
		21-Jul	Gauge knocked over
		24-Jul	Lid knocked off
		16-Oct	Bell removed
	1995	26-Apr	Bell installed
		17-Jun - 06-Jul	Missing data - mechanical problems
		07-Nov	Bell removed
	1996	05-Jun	Bell installed
		06-Nov	Bell removed

Instrument	Year	Date	Event
Belfort 2	1994	10-Apr	Bel2 installed
		01-Jun	Gauge knocked over
		13-Jun	Lid knocked off, affecting all subsequent readings; readings adjusted by using the ratio of the diameter of the gauge opening to the diameter of the bucket
		17-Oct	Bel2 removed
	1995	12-Apr	Bel2 installed
		12-Apr - 26-Apr	Precip recordings by TB5
		30-Aug	Water level lowered - Belfort gauge hit maximum water level
		08-Nov	Bel2 removed
	1996	15-Apr	Bel2 installed
		06-Nov	Bel2 removed
Belfort 3	1994	11-Apr	Bel3 installed
		28-Jun	Lid knocked off gauge
		21-Jul - 28-Jul	Missing data
		14-Oct	Gauge damaged by bear
		17-Oct	Bel3 removed
	1995	27-Apr	Bel3 installed
		07-Nov	Bel3 removed
	1996	05-Jun	Bel3 installed
		24-Jul - 11-Sep	Missing data
		05-Nov	Bel3 removed
Belfort 4, Tipping Bucket 9 Note: Was replaced with TB9 for 1995 and 1996	1994	21-Apr	Bel4 installed
		13-Jun	Lid knocked off
		17-Oct	Bel4 removed
	1995	-	Installed as TB9 - see Tipping Bucket information
	1996	-	Installed as TB9 - see Tipping Bucket information
Belfort 5	1994	12-Apr	Bel5 installed
		04-May - 09-May	Gauge knocked over during this period, data unreliable
		16-May	Gauge knocked over during windstorm
		17-May	Gauge reset
		16-Oct	Bel5 removed
	1995	11-Apr	Bel5 installed
		07-Nov	Bel5 removed
	1996	23-Aug	Bel5 installed
		06-Nov	Bel5 removed
Belfort 21, Tipping Bucket 26 Note: Was replaced with TB26 for 1995 and 1996	1994	11-May	Bel21 installed
		12-May	Logger changed to double precision
		11-Jul - 12-Jul	Gauge knocked over, repaired and reset; missing data
		04-Oct	Bel21 removed
	1995	-	Installed as TB26 - see Tipping Bucket information
	1996	-	Installed as TB26 - see Tipping Bucket information

Instrument	Year	Date	Event
Belfort 22, Tipping Bucket 28 Note: Was replaced with TB28 for 1995 and 1996	1994	29-Apr	Bel22 installed
		09-Jul	Changed logger number to 30 from 28
		13-Oct	Bel22 removed
	1995	-	Installed as TB28 - see Tipping Bucket information
	1996	-	Installed as TB28 - see Tipping Bucket information
Belfort 23, Tipping Bucket 27 Note: Was replaced with TB27 for 1995 and 1996	1994	28-Apr	Bel23 installed
		30-Jul	Gauge knocked over
		02-Aug	Gauge repaired
		13-Oct	Bel23 removed
	1995	-	Installed as TB27 - see Tipping Bucket information
	1996	-	Installed as TB27 - see Tipping Bucket information
Belfort 24, Tipping Bucket 21 Note: Was TB21 in 1994 replaced with Bel24 in 1995 and 1996	1994	-	Installed as TB21 - see Tipping Bucket information
	1995	23-Apr	Bel24 installed
		10-Nov	Bel24 removed
	1996	13-Apr	Bel24 installed
		04-Jul - 02-aug	Missing data
		06-Nov	Bel24 removed
Belfort 25, Tipping Bucket 24 Note: Was TB24 in 1994 replaced with Bel25 in 1995 and 1996	1994	-	Installed as TB24 - see Tipping Bucket information
	1995	23-Apr	Bel25 installed
		10-Nov	Bel25 removed
	1996	13-Apr	Bel25 installed
		06-Nov	Bel25 removed
Belfort at NW2	1994	25-Apr	Bel NW2 installed
		14-Oct	Bel NW2 removed
	1995	22-Apr	Bel NW2 installed
		03-Nov	Missing data
		09-Nov	Bel NW2 removed
	1996	13-Apr	Bel NW2 installed
		23-Oct	Bel NW2 removed
Belfort at NW3	1994	25-Apr	Bel NW3 installed
		14-Oct	Bel NW3 removed
	1995	23-Apr	Bel NW3 installed
		09-Nov	Bel NW3 removed
	1996	13-Apr	Bel NW3 installed
		09-Jun	Bel NW3 moved downstream and renamed NW3A
		24-Oct	Bel NW3A removed

6.2 Field Notes

None given.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

Ten Belfort gauges were set up in and around the boundaries of the water basins that were being studied. They gave an estimation of the precipitation within these boundaries. Each Belfort gauge was a point measurement of the precipitation. From these point measurements, the average precipitation for the study basins could be estimated.

Each Belfort gauge is a point measurement of the precipitation, making their total area of coverage very small. Together they represent the total rainfall in the area. The size of both northern water basins being studied is 27 km^2, while the size of the southern water basin is 574 km^2.

The following table lists the Belfort gauges used and their locations. These coordinates are in the North American Datum of 1983 (NAD83). In some cases, gauges were moved during the measurement campaigns. If the change in location was significant, the new location was given a new site identifier. Information regarding changes in location and servicing of the sites is listed in Section 11.2.

SITE_ID	LONGITUDE	LATITUDE	
NSA-B21-HYD09-BLRG21	98.41114W	55.88857N	
NSA-B22-HYD09-BLRG22	98.49892W	55.77653N	
NSA-B23-HYD09-BLRG23	98.55822W	55.89147N	
NSA-B24-HYD09-BLRG24	98.34275W	55.91236N	
NSA-B25-HYD09-BLRG25	98.566W	55.92661N	
NSA-BN2-HYD09-BLRGN2	98.52806W	55.91528N	
NSA-BN3-HYD09-BLRGN3	98.37603W	55.91686N	
SSA-BL1-HYD09-BLRG01	105.01149W	53.89156N	(moved slightly 05-May-1994)
SSA-BL2-HYD09-BLRG02	105.03775W	54.08506N	
SSA-BL3-HYD09-BLRG03	104.76263W	54.08551N	
SSA-BL4-HYD09-BLRG04	104.89617W	54.0047N	
SSA-BL5-HYD09-BLRG05	104.82002W	53.92625N	

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

The resolution of the resultant data is low because the data were gathered as point measurements. They are meant only to give the average precipitation rates at 15-minute intervals for the study basins.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

Data were collected from the Belfort gauges from mid-April until mid-October in 1994, 1995, and 1996.

7.2.2 Temporal Coverage Map

Not available.

7.2.3 Temporal Resolution

Measurements were recorded by the Belfort gauges at 15-minute intervals.

7.3 Data Characteristics

7.3.1 Parameter/Variable

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

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
TIME_OBS
PRECIPITATION
PARM_VALUE_FLAGS
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
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 is means will vary with site types.
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.
PRECIPITATION	The amount of precipitation measured by the rain gauge for the 15 minute period preceding the given time.
PARM_VALUE_FLAGS	This contains values or codes that indicate special conditions for the data parameters. See data set documentation for descriptions of these codes.
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
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
PRECIPITATION	[millimeters]
PARM_VALUE_FLAGS	[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
SITE_NAME	[Assigned by BORIS]
SUB_SITE	[Assigned by BORIS]
DATE_OBS	[Supplied by Investigator]
TIME_OBS	[Supplied by Investigator]
PRECIPITATION	[Supplied by Investigator]
PARM_VALUE_FLAGS	[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
SITE_NAME	NSA-999-99NW2	SSA-999-BRG05	None	None	None	None
SUB_SITE	HYD09-BRG01	HYD09-BRGN3	None	None	None	None
DATE_OBS	10-APR-94	07-NOV-96	None	None	None	None
TIME_OBS	0	2345	None	None	None	None
PRECIPITATION	0	60	-999	None	None	None
PARM_VALUE_FLAGS	N/A	N/A	None	None	None	Blank
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	19-MAR-96	03-JUN-97	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.

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,PRECIPITATION,PARM_VALUE_FLAGS,CRTFCN_CODE,
REVISION_DATE
'SSA-999-BRG01','HYD09-BRG01',01-SEP-94,0,0.0,'','CPI',19-MAR-96
'SSA-999-BRG01','HYD09-BRG01',01-SEP-94,15,0.0,'','CPI',19-MAR-96
'SSA-999-BRG01','HYD09-BRG01',01-SEP-94,30,0.0,'','CPI',19-MAR-96
```

8. Data Organization

8.1 Data Granularity

The smallest amount of data that can be ordered from this data set is a day's worth of data for a given site.

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

After a Belfort gauge was calibrated, the amount of precipitation per measuring period was found by using:

Total precipitation = weight of accumulated water * equivalent precipitation per milligram of weight

i.e., 4.5 mm = 45 milligrams * 0.1 mm of rain per milligram

9.1.1 Derivation Techniques and Algorithms

At regular intervals during the monitoring period, the accumulated weight of water in the bucket was recorded on a data logger. The weight was converted first to a volume of water and then to precipitation using the calibration coefficient. If the Belfort gauge was reset (bucket was emptied and data logger started to record from zero again), then the data were adjusted accordingly. Temperature fluctuations caused some variation in the collected data. An algorithm was run on the data to correct for this error.

9.2 Data Processing Sequence

9.2.1 Processing Steps

The following steps were performed to collect the data:

- Set up necessary equipment.
- Measure the accumulated weight of water over time.
- Calculate the cumulative precipitation amounts using the coefficient.
- Convert cumulative amounts to incremental amounts and write ASCII files with the appropriate identifying information noted beside each row (location, year, day, month).
- Add the necessary column headings.
- Transfer the information to the data base.

BOREAS Information System (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.
- Working with the Hydrology (HYD)-09 team to document the data set.
- Extracting the standardized data into logical files.

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

See associated report file "hyd09_report.pdf" (an Adobe Acobat file).

10. Errors

10.1 Sources of Error

Most of the errors occur during the actual measuring of the precipitation. Some of the smaller sources of error occur from water splashing out of the funnel, evaporating water that cannot be measured, water used to initially wet the gauge's funnel and inside surfaces, and gauges that are not perfectly level. A larger source of error is the wind, which can cause turbulent air flow around the gauge, creating updrafts and downdrafts that interfere with the normal path of precipitation. A high wind speed will create compressed lines of flow, reducing the amount of precipitation that enters the gauge. The higher the wind speed, the greater the effect on the measured precipitation. In addition, if the collecting rim (opening to the outside) is damaged in any way, the amount of precipitation being measured will be changed because less water can enter the gauge than it was calibrated for.

10.2 Quality Assessment

10.2.1 Data Validation by Source

The effects of the wind were reduced considerably by placing the gauges in clearings surrounded by forest, which shielded the gauge from oncoming winds. Evaporation was reduced through the use of a thin film of oil placed in the bucket. After the information was collected, it was run through an algorithm to detect any data that were abnormal when compared to the rest of the data. Computer programs were also used to adjust the gauges for periods when they had missing lids. There may be anomalies in the data that could not be resolved at the time these data were published. Please consult the data notes (Section 6.1) for information that might give some indication about the source of any anomalies.

10.2.2 Confidence Level/Accuracy Judgment

The confidence level in the data varies with the particular Belfort gauge at the time of measurement.

10.2.3 Measurement Error for Parameters

The collected data will eventually be compared to radar data and the calibration measurements, but at this time no steps have been taken to carry this out.

10.2.4 Additional Quality Assessments

None.

10.2.5 Data Verification by Data Center

Data that were loaded into the data tables were spot checked against the original ASCII data that were submitted to check for data loading errors.

11. Notes

11.1 Limitations of the Data

None given.

11.2 Known Problems with the Data

See Section 6.1.

11.3 Usage Guidance

Because of the problems that occurred, some periods of precipitation are not accurate. During the study period, the temperature was changing, which affected the observations of the measuring equipment. Although this was corrected with an algorithm, the data were not as accurate those obtained from a float tube at a constant temperature.

11.4 Other Relevant Information

HYD-09 wrote a report stored on this CD-ROM called "hyd09_report.pdf" (an Adobe Acobat file). It can be referenced as:.

Kouwen, N., R. Soulis, W. Jenkinson, A. Graham, and T. Neff. 1997. BOREAS: Boreal Forest Hydrological Research Study. Hydrology 9 Group: From Micro-scale to meso-scale snowmelt, soil moisture and evapotranspiration from distributed hydrological models, University of Waterloo, Dept. of Civil Engineering, August 1997.

12. Application of the Data Set

These data can be used for precipitation distribution, soil moisture, and other hydrological studies.

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description

Several computer programs are required to convert the data logger information into precipitation and to check it for quality.

14.2 Software Access

None given.

15. Data Access

The HYD-09 Belfort rain gauge 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.

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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
BEL	- Belfort Gauge
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
CD-ROM	- Compact Disk (optical), Read-Only Memory
DAAC	- Distributed Active Archive Center
EOS	- Earth Observing System
EOSDIS	- EOS Data and Information System
FFC-T	- Focused Field Campaign - Thaw
GIS	- Geographic Information System
GMT	- Greenwich Mean Time
GSFC	- Goddard Space Flight Center
HYD	- Hydrology
IFC	- Intense Field Campaign
ml	- milliliters
mm	- millimeters
NAD83	- North American Datum 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
TB	- Tipping Bucket
URL	- Uniform Resource Locator

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The BOREAS HYD-9 team collected several data sets containing precipitation and streamflow measurements over the BOREAS study areas. This data set contains the measurements from the Belfort rain gauges at the BOREAS NSA and SSA. These measurements were submitted in 15-minute and 1-hour intervals. Only the 15-minute interval data set was loaded into the data base tables. Data were collected from the Belfort gauges from mid-April until mid-October in 1994, 1995, and 1996. The data are available as tabular ASCII files.

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