

NASA/TM—2000–209891, Vol. 192



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

*Forrest G. Hall and Andrea Papagno, Editors*

### **Volume 192**

## **BOREAS TF-1 SSA-OA Soil Characteristics Data**

*T. Andrew Black, Z. Chen, and Zoran Nesic  
University of British Columbia, Vancouver*

National Aeronautics and  
Space Administration

**Goddard Space Flight Center**  
Greenbelt, Maryland 20771

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October 2000

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# **BOREAS TF-1 SSA-OA Soil Characteristics Data**

T. Andrew Black, Z. Chen, Zoran Nesic

## **Summary**

The BOREAS TF-1 team collected several data sets in support of its efforts to characterize and interpret soil information at the SSA-OA tower site in 1994 as part of BOREAS. Data sets collected include soil respiration, temperature, moisture, and gravimetric data. The data are stored in tabular ASCII format.

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## **1. Data Set Overview**

### **1.1 Data Set Identification**

BOREAS TF-01 SSA-OA Soil Characteristics Data

### **1.2 Data Set Introduction**

Tower Flux (TF)-01 collected measurements of soil respiration, temperature, moisture, and gravimetric data in an effort to characterize the soil at the Southern Study Area (SSA) Old Aspen (OA) tower site in 1994 as part of the BOREal Ecosystem-Atmosphere Study (BOREAS).

### **1.3 Objective/Purpose**

The objectives of this research were to:

- Determine the efflux of CO<sub>2</sub> from the soil using the closed-chamber method and to investigate the flow of C and N through the litter/soil system (Paul Voroney and Craig Russell, University of Guelph).
- Determine the course of soil moisture content during the year using gravimetric (University of British Columbia) and Time Domain Reflectometry (TDR) (University of Guelph and University of British Columbia).

## **1.4 Summary of Parameters**

The soil respiration flux data contain measurements of mean daytime soil CO<sub>2</sub> flux, mean daytime soil temperature, mean daytime chamber air temperature, and mean daytime chamber relative humidity.

The CO<sub>2</sub> concentration data include measurements of the CO<sub>2</sub> concentration in the humus soil layer at 62 mm below the surface of the soil and in the surface mineral soil layer at 15 cm below the soil surface.

The soil temperature data contain measurements of the mean daily soil temperature at depths of 50 mm, 100 mm, 200 mm, 500 mm, and 1 m.

The soil gravimetric data contain measurements of mean gravimetric and mean volumetric soil moisture and mean bulk density taken at the following soil depths: Litter-Fibric-Humus (LFH) organic soil horizons, 0-3 cm, 3-6 cm and 6-10 cm, and 0-15 cm and 15-30 cm.

The soil moisture data contain measurements of soil moisture in the mid-humus, mineral soil, and submineral soil layers taken at locations A, B, C, and D at the SSA-OA site using surface probes. Soil moisture was also measured at depths ranging from 0 cm to 120 cm in increments of 15 cm using depth probes read by Tektronix Cable Tester and Moisture Point (Gabel Corp.) instruments.

The soil moisture summary data contain means, variation coefficients, and the number of observations of the soil moisture data as discussed above.

## **1.5 Discussion**

TF-01 collected measurements of soil respiration, temperature, moisture, and gravimetric data in an effort to characterize the soil at the SSA-OA tower site in 1994 as part of BOREAS. The closed chamber was the primary method of measuring soil CO<sub>2</sub> efflux. The data from this method were used to obtain the seasonal pattern of soil CO<sub>2</sub> efflux. The open chamber method was used over a 3-week period late in the growing season to determine the diurnal patterns of soil CO<sub>2</sub> efflux. A soil temperature profile was taken at depths of 2, 5, 10, 20, 50, and 100 cm using CSI direct-burial copper-constantan thermocouples. Gravimetric measurements of soil water content of the surface layers (0-3, 3-6, and 6-10 cm) were made every 2-3 days. In addition, the TDR technique (Hook and Livingston, 1996) was also used. Two probes consisting of three stainless steel rods (3 mm in diameter, 30 cm long, and 2 cm apart) were positioned horizontally at 8-cm (organic layer) and 15-cm (mineral layer) depths. Five 120-cm segmented rods (two thin stainless steel strips 1.2 cm wide and 1.5 cm apart bonded by an epoxy resin layer) were installed to measure average water content in 15-cm (0- to 30-cm depth) and 30-cm layers (30- to 120-cm depth). The TDR rods near hut B (University of British Columbia) were mainly read using the Tektronix Cable Tester in hut B with signal cables (about 30 m long) extending out to the TDR rods. A small manually weighed lysimeter (15 cm diameter x 15 cm deep) was operated for 15 days in July and August of 1994 to determine the magnitude of evaporation from the soil.

## **1.6 Related Data Sets**

BOREAS HYD-06 Moss/Humus Moisture Data

BOREAS TE-01 Soils Data Over the SSA Tower Sites in Raster Format

BOREAS TF-01 SSA-OA Tower Flux, Meteorological, and Soil Temperature Data

BOREAS TF-01 SSA-OA Understory Flux, Meteorological, and Soil Temperature Data

BOREAS TF-02 SSA-OA Tower Flux, Meteorological, and Precipitation Data

BOREAS TGB-01 Soil CH<sub>4</sub> And CO<sub>2</sub> Profile Data From NSA Tower Sites

BOREAS TGB-12 Soil Carbon Data

## **2. Investigator(s)**

### **2.1 Investigator(s) Name and Title**

Dr. T. Andy Black, Professor

### **2.2 Title of Investigation**

Boreal Forest Atmosphere Interactions: Exchanges of Energy, Water Vapor and Trace Gases (SSA-OA)

### **2.3 Contact Information**

#### **Contact 1:**

Mr. Zoran Nesic  
University of British Columbia  
Department of Soil Science  
2357 Main Mall Rm. 139  
Vancouver, BC V6T 1Z4  
CANADA  
(604) 822-3479  
(604) 822-5654 (Lab)  
(604) 822-8639 (fax)  
NESIC@PPC.UBC.CA

#### **Contact 2:**

Prof. T. Andy Black  
University of British Columbia  
Department of Soil Science  
2357 Main Mall Rm. 139  
Vancouver, BC V6T 1Z4  
CANADA  
(604) 822-2730  
(604) 822-8639 (fax)  
ablack@unixg.ubc.ca

#### **Contact 3:**

Andrea Papagno  
Raytheon ITSS  
NASA GSFC  
Code 923.4  
Greenbelt, MD 20771  
(301) 286-3134  
(301) 286-0239 (fax)  
Andrea.Papagno@gsfc.nasa.gov

## **3. Theory of Measurements**

Three methods were employed to estimate soil CO<sub>2</sub> efflux. The first method used Fick's law, which required estimates of soil gas (CO<sub>2</sub>) diffusivity and measured CO<sub>2</sub> concentration gradients. See Section 18 for a definition of Fick's law. The second method used the accumulation of gas within a chamber placed over the soil surface (static closed chamber). The third method is the steady-state or dynamic open chamber. In this method, flow rate through the chamber and the difference in gas concentration between the inlet and outlet of the chamber are measured. The CO<sub>2</sub> efflux is given by the

product of the concentration difference and flow rate. These estimates were compared with nighttime eddy covariance CO<sub>2</sub> fluxes (Russell et al., 1998).

TDR relies on the different dielectric constants for water and air to detect the reflection of a high-frequency electromagnetic pulse sent down a transmission line or wave guide, with volume water content related to the apparent dielectric constant by a model described by Hook and Livingston (1996).

## **4. Equipment**

### **4.1 Sensor/Instrument Description**

#### **4.1.1 Collection Environment**

Soil respiration, soil CO<sub>2</sub> concentrations, gravimetric, and soil moisture data were collected by TF-01 from the ground or from the soil respiration boardwalk at the SSA-OA site. Soil respiration was measured with a LI-COR 6200 portable photosynthesis unit from the 6000-09 soil respiration chamber. Data are daytime averages of daily observations recorded between 10 a.m. and 4 p.m. local time. Soil CO<sub>2</sub> concentrations were collected in evacuated containers from sampling lines in the surface soil. Data are daily averages of half-hour observations. Data for 0.05, 0.1, and 0.2 m below the soil surface are averages of three probes (one close to tower, i.e., University of British Columbia probes, and two along soil respiration boardwalk, i.e., University of Guelph probes). Data for 0.5 and 1.0 m were recorded from one set of probes close to the SSA-OA flux tower. Gravimetric data were derived from the weight loss of wet soil after 72 hours in an oven at 60 °C for organic soil samples and at 105 °C for mineral soil samples.

Soil moisture was determined from the time delay along probe transmission lines, i.e., TDR. Time delays were converted to volumetric moisture contents using the Hook and Livingston (1996) equation where the ratio of the time delay in dry soil to that in air was 1.2 for organic soil and 1.55 for mineral soil. Two types of TDR probes were used. Surface probes consisted of three parallel 0.3-m lengths of stainless steel welding rod 2 cm apart. These were inserted into surface soil layers, i.e., 0 to 0.3 m in a horizontal orientation, and connected to a Tektronix cable tester via lengths of coaxial cable. Depth probes were purchased from Environmental Sensors, Inc., along with a MoisturePoint TDR analysis instrument. The depth probes could be read by both Tektronix and MoisturePoint instruments. The depth probes were 4 feet in length and could estimate soil moisture content along five segments (6", 6", 1', 1', 1'). These probes were inserted vertically into the forest floor.

#### **4.1.2 Source/Platform**

Soil respiration, soil CO<sub>2</sub> concentrations, gravimetric, and soil moisture data were collected by TF-01 from the ground or from the soil respiration boardwalk at the SSA-OA site.

#### **4.1.3 Source/Platform Mission Objectives**

The general objective was to study carbon dioxide and water vapor exchange between the forest and atmosphere at SSA-OA. Specific objectives were to:

- Measure the fluxes of sensible heat, H<sub>2</sub>O, and CO<sub>2</sub> above the aspen stand throughout the year.
- Obtain from the CO<sub>2</sub> flux data estimates of gross photosynthesis and respiration.
- Determine the contribution of the hazelnut understory to net ecosystem productivity (NEP).
- Determine the effects of environmental factors on stand evapotranspiration (E) and NEP.
- Take part in the development of procedures for scaling up component fluxes to the stand level.
- Study the processes controlling turbulent transfer of H<sub>2</sub>O and CO<sub>2</sub> within the stand.
- Take part in the evaluation of methods of estimating nocturnal CO<sub>2</sub> in and above the stand.



#### **4.1.4 Key Variables**

Mean soil CO<sub>2</sub> flux, soil CO<sub>2</sub> concentration, mean volumetric soil moisture, mean soil temperature, mean soil bulk density, mean gravimetric soil moisture, mean TDR soil moisture, and TDR soil moisture.

#### **4.1.5 Principles of Operation**

The principles of operation of most of the instruments can be found in Percy et al., 1991, and Fritschen and Gay, 1979. (See Sections 3 and 4.1.1 also.)

#### **4.1.6 Sensor/Instrument Measurement Geometry**

Closed chamber: Inner diameter 9.55 cm and height 14.60 cm. Open chamber: Collar inner diameter 20 cm and collar height 10 cm (Russell et al., 1998). TDR: 120-cm segmented (two 15-cm segments and three 30-cm segments) rods (two stainless steel strips 2 cm apart separated by epoxy) with shorting diodes (Hook et al., 1992).

#### **4.1.7 Manufacturer of Sensor/Instrument**

Cable Length Tester (model 1502B & C)

Tektronix, Inc  
26600 SW Parkway  
Wilsonville, OR 97070 USA  
800-TEK-WIDE

Data logging system 21x, CR10

Campbell Scientific  
P.O. Box 551  
Logan, UT 84321 USA  
(801) 753-2342  
(801) 752-3268 (fax)

Field (110 VAC) drying oven

LI-COR 6200 portable photosynthesis unit and 6000-09 soil respiration chamber

LI-COR, Inc.  
P.O. Box 4425/4421  
Superior Street  
Lincoln, NE 68504  
(303) 499-1701  
(303) 499-1767 (fax)

Soil temperature (burial) Campbell Thermocouple

Copper-constantan thermocouple  
Campbell Scientific  
P.O. Box 551  
Logan, UT 84321 USA  
(801) 753-2342  
(801) 752-3268 (fax)

Thermal conductivity gas chromatography instrumentation (University of Guelph)

Datalogger model 21X  
Campbell Scientific, Inc. (CSI)  
P.O. Box 551  
Logan, UT 84321 USA  
(801) 753-234  
(801) 752-3268 (fax)

## TDR

TDR depth (segmented) probes and Moisture Point Depth Probe Reader  
G.S. Gabel & Associates Ltd.  
100 - 4243 Glanford Avenue  
Victoria, British Columbia, Canada V8Z 4B9  
(250) 479-6588 (general)  
(800) 799-6324 (within North America only)  
(250) 479-1412 (fax)  
info@esica.com <http://www.esica.com/>

TDR surface probes  
(three stainless steel rods and two diodes)  
(homemade)

## 4.2 Calibration

### 4.2.1 Specifications

The TDR calibration was done in the field using gravimetric sampling and a bulk density profile. Chamber calibration was done by using calibration gases used to calibrate the eddy correlation/CO<sub>2</sub> profile analyzers. Analysis was performed at the Atmospheric Environment Service (AES) Headquarters, Downsview, Ontario, Canada, using a standard traceable to a Scripps analysis in 1993.

#### 4.2.1.1 Tolerance

None given.

### 4.2.2 Frequency of Calibration

- Soil chamber Infrared Gas Analyzer (IRGA): 3 times during 1994 growing season
- TDR: Organic surface layer: calibrated using gravimetric samples taken every 2-3 days in 1994 (Blanken et al. 1997).
- TDR: Mineral layers: calibrated using gravimetric profiles (2) in 1994

### 4.2.3 Other Calibration Information

Not applicable.

## 5. Data Acquisition Methods

Soil respiration (CO<sub>2</sub> efflux) was measured with a LI-COR 6200 portable photosynthesis unit from the 6000-09 soil respiration chamber. This unit also facilitates measurements of chamber temperature, relative humidity, and soil temperature adjacent to the chamber. Data are daytime averages of daily observations recorded between 10 a.m. and 4 p.m. SSA local time. Soil CO<sub>2</sub> concentrations were collected in evacuated containers from sampling lines in the surface soil. These samples were analyzed for CO<sub>2</sub> concentration by thermal conductivity gas chromatography. Soil temperatures were measured with thermocouples attached to a Campbell 21X datalogger. Data are daily averages of half-hour observations. Data for 0.05, 0.1, and 0.2 m are averages of three probes (one close to tower, i.e., University of British Columbia probes, and two along soil respiration boardwalk, i.e., University of Guelph probes). Data for 0.5 and 1.0 m were recorded from one set of probes close to the tower. Gravimetric data were derived from the weight loss of wet soil after 72 hours in an oven at 60 °C for organic soil samples and at 105 °C for mineral soil samples. Soil moisture was determined from the time delay along probe transmission lines, i.e., TDR. Time delays were converted to volumetric moisture contents using the Hook and Livingston (1992) equation where the ratio of the time delay in dry soil to that in air was 1.2 for organic soil and 1.55 for mineral soil. Two types of TDR probes were used, surface and depth. Surface probes consisted of three parallel 0.3-m lengths of stainless

steel welding rod 2 cm apart. These were inserted into surface soil layers, i.e., 0 to 0.3 m in a horizontal orientation, and connected to a Tektronix cable tester via lengths of coaxial cable. TDR depth probes and Moisture Point electronics were purchased from Gabel Corp. The depth probes could also be read by the Tektronix cable tester. The depth probes were 4 feet in length and could estimate soil moisture content along five segments (6 inches, 6 inches, 1 foot, 1 foot, 1 foot). These probes were inserted vertically into the forest floor. Extensive details of methods and equipment is outlined in the publications (i.e., Russell and Voroney, 1998; Russell et al., 1998; Black et al., 1996; Chen et al., 1999).

For the main flux system, all raw data were recorded using PC computer systems with backup tape drives. Half-hour fluxes were calculated online. For other measurements, all those data were recorded by data loggers (model 21X, Campbell Scientific, Inc., Logan, UT), which were networked together (using the model MD-9 network interface ) along with the main system. Every 3 hours, this network automatically transferred (using pc ANYWHERE, Symantec Corp.) all data from the loggers to a network computer. This computer was accessed from our laboratory at University of British Columbia through a communication system, which comprised a modem, cellular phone, and Yagi antenna at the site, and a phone and modem in the laboratory. The Yagi antenna was mounted above the trees and the cellular phone was housed in a thermostatically controlled box near the antenna. At midnight the site computer compressed the previous 24 hours of half-hour flux data, called the laboratory, and in 3 minutes transferred (using Kermit) the compressed data to the laboratory computer.

## **6. Observations**

### **6.1 Data Notes**

None given.

### **6.2 Field Notes**

None given.

## **7. Data Description**

### **7.1 Spatial Characteristics**

#### **7.1.1 Spatial Coverage**

The SSA measurement site and associated North American Datum of 1983 (NAD83) coordinates are:

- SSA-OA, site id C3B7T, Lat/Long: 53.62889° N, 106.19779° W, UTM Zone 13, N: 5942899.9, E: 420790.5.

#### **7.1.2 Spatial Coverage Map**

Not available.

#### **7.1.3 Spatial Resolution**

The data are point measurements at the given location.

#### **7.1.4 Projection**

Not applicable.

#### **7.1.5 Grid Description**

Not applicable.

## 7.2 Temporal Characteristics

### 7.2.1 Temporal Coverage

Measurement occurred between 10 a.m. and 4 p.m. SSA local time.

### 7.2.2 Temporal Coverage Map

None given.

### 7.2.3 Temporal Resolution

None given.

## 7.3 Data Characteristics

### 7.3.1 Parameter/Variable

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

#### **TF01\_SOIL\_CO2\_CONC**

Column Name

-----  
SITE\_NAME  
SUB\_SITE  
DATE\_OBS  
START\_TIME  
END\_TIME  
SOIL\_DEPTH  
SOIL\_LAYER  
MEAN\_CO2\_CONC  
COEFF\_VAR\_SOIL\_CO2\_CONC  
CRTFCN\_CODE  
REVISION\_DATE

#### **TF01\_SOIL\_MOIST\_GRAV**

Column Name

-----  
SITE\_NAME  
SUB\_SITE  
DATE\_OBS  
SOIL\_DEPTH\_DESCR  
MEAN\_GRAV\_SOIL\_MOIST  
MEAN\_BULK\_DENSITY  
MEAN\_VOL\_SOIL\_MOIST  
CRTFCN\_CODE  
REVISION\_DATE

#### **TF01\_SOIL\_MOIST\_SUMMARY**

Column Name

-----  
SITE\_NAME  
SUB\_SITE  
DATE\_OBS  
SOIL\_DEPTH\_DESCR  
SENSOR\_TYPE  
NUM\_OBS  
MEAN\_VOL\_SOIL\_MOIST

COEFF\_VAR\_VOL\_SOIL\_MOIST  
CRTFCN\_CODE  
REVISION\_DATE

**TF01\_SOIL\_MOIST\_VOL**

Column Name

-----  
SITE\_NAME  
SUB\_SITE  
DATE\_OBS  
SOIL\_DEPTH\_DESCR  
LOCATION\_ID  
SENSOR\_TYPE  
SENSOR\_ID  
VOL\_SOIL\_MOIST  
CRTFCN\_CODE  
REVISION\_DATE

**TF01\_SOIL\_RESP\_FLUX**

Column Name

-----  
SITE\_NAME  
SUB\_SITE  
DATE\_OBS  
START\_TIME  
END\_TIME  
NUM\_OBS  
NUM\_SITES  
MEAN\_SOIL\_CO2\_FLUX  
COEFF\_VAR\_SOIL\_CO2\_FLUX  
MEAN\_SOIL\_TEMP\_0\_10CM  
MEAN\_AIR\_TEMP\_CHAMBER  
MEAN\_REL\_HUM\_CHAMBER  
CRTFCN\_CODE  
REVISION\_DATE

**TF01\_SOIL\_TEMP**

Column Name

-----  
SITE\_NAME  
SUB\_SITE  
DATE\_OBS  
SOIL\_DEPTH  
MEAN\_SOIL\_TEMP  
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:

#### TF01\_SOIL\_CO2\_CONC

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
START_TIME	The starting Greenwich Mean Time (GMT) for the data collected.
END_TIME	The ending Greenwich Mean Time (GMT) for the data collected.
SOIL_DEPTH	The depth below the soil surface at which the measurement was taken.
SOIL_LAYER	The soil layer in which the measurement was taken.
MEAN_CO2_CONC	The mean carbon dioxide concentration.
COEFF_VAR_SOIL_CO2_CONC	The coefficient of variation for the soil CO2 concentration 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.

#### TF01\_SOIL\_MOIST\_GRAV

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.

DATE_OBS	The date on which the data were collected.
SOIL_DEPTH_DESCR	The soil depth range or the name of the soil surface horizon where the measurements were taken. See documentation for a description of the soil horizons.
MEAN_GRAV_SOIL_MOIST	The mean percentage of gravimetric moisture present in the soil at this depth range or horizon area.
MEAN_BULK_DENSITY	The mean bulk density of the soil at this depth range or horizon area.
MEAN_VOL_SOIL_MOIST	The mean percentage of volumetric moisture present in the soil at this depth range or horizon area.
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.

#### **TF01\_SOIL\_MOIST\_SUMMARY**

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-III III, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and III III is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
SOIL_DEPTH_DESCR	The soil depth range or the name of the soil surface horizon where the measurements were taken. See documentation for a description of the soil horizons.
SENSOR_TYPE	The type of sensor used to make the measurements.
NUM_OBS	Number of observations of the given sample used to calculate given values.
MEAN_VOL_SOIL_MOIST	The mean percentage of volumetric moisture present in the soil at this depth range or horizon area.
COEFF_VAR_VOL_SOIL_MOIST	The coefficient of variation for the volumetric (TDR) soil moisture 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.

**TF01\_SOIL\_MOIST\_VOL**

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
SOIL_DEPTH_DESCR	The soil depth range or the name of the soil surface horizon where the measurements were taken. See documentation for a description of the soil horizons.
LOCATION_ID	The location within the site where the measurement was taken.
SENSOR_TYPE	The type of sensor used to make the measurements.
SENSOR_ID	The identifier given to the sensor/instrument that collected the data.
VOL_SOIL_MOIST	Contains the percent volumetric soil moisture value.
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.

**TF01\_SOIL\_RESP\_FLUX**

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
START_TIME	The starting Greenwich Mean Time (GMT) for the data collected.



END_TIME	The ending Greenwich Mean Time (GMT) for the data collected.
NUM_OBS	Number of observations of the given sample used to calculate given values.
NUM_SITES	The number of sites measured.
MEAN_SOIL_CO2_FLUX	The mean of the soil CO2 flux.
COEFF_VAR_SOIL_CO2_FLUX	The coefficient of variation for the soil CO2 flux data.
MEAN_SOIL_TEMP_0_10CM	The mean soil temperature for 0 to 10 centimeter depth collected adjacent to the soil CO2 flux chamber.
MEAN_AIR_TEMP_CHAMBER	The mean air temperature in the chamber.
MEAN_REL_HUM_CHAMBER	The mean relative humidity inside the measurement chamber.
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.

#### **TF01\_SOIL\_TEMP**

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
SOIL_DEPTH	The depth below the soil surface at which the measurement was taken.
MEAN_SOIL_TEMP	The mean soil temperature.
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:

#### TF01\_SOIL\_CO2\_CONC

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
START_TIME	[HHMM GMT]
END_TIME	[HHMM GMT]
SOIL_DEPTH	[millimeters]
SOIL_LAYER	[none]
MEAN_CO2_CONC	[micromoles CO2] [mole air <sup>-1</sup> ]
COEFF_VAR_SOIL_CO2_CONC	[percent]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

#### TF01\_SOIL\_MOIST\_GRAV

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
SOIL_DEPTH_DESCR	[none]
MEAN_GRAV_SOIL_MOIST	[percent]
MEAN_BULK_DENSITY	[kilograms] [meter <sup>-3</sup> ]
MEAN_VOL_SOIL_MOIST	[percent]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

#### TF01\_SOIL\_MOIST\_SUMMARY

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
SOIL_DEPTH_DESCR	[none]
SENSOR_TYPE	[none]
NUM_OBS	[counts]
MEAN_VOL_SOIL_MOIST	[percent]
COEFF_VAR_VOL_SOIL_MOIST	[percent]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

#### TF01\_SOIL\_MOIST\_VOL

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
SOIL_DEPTH_DESCR	[none]
LOCATION_ID	[none]
SENSOR_TYPE	[none]

SENSOR_ID	[none]
VOL_SOIL_MOIST	[percent]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

#### TF01\_SOIL\_RESP\_FLUX

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
START_TIME	[HHMM GMT]
END_TIME	[HHMM GMT]
NUM_OBS	[counts]
NUM_SITES	[count]
MEAN_SOIL_CO2_FLUX	[micromoles CO2] [meters <sup>-2</sup> ] [second <sup>-1</sup> ]
COEFF_VAR_SOIL_CO2_FLUX	[percent]
MEAN_SOIL_TEMP_0_10CM	[degrees Celsius]
MEAN_AIR_TEMP_CHAMBER	[degrees Celsius]
MEAN_REL_HUM_CHAMBER	[percent]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

#### TF01\_SOIL\_TEMP

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
SOIL_DEPTH	[millimeters]
MEAN_SOIL_TEMP	[degrees Celsius]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

### 7.3.4 Data Source

The source of the parameter values contained in the data files on the CD-ROM are:

#### TF01\_SOIL\_CO2\_CONC

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
START_TIME	[Human Observer]
END_TIME	[Human Observer]
SOIL_DEPTH	[Human Observer]
SOIL_LAYER	[Human Observer]
MEAN_CO2_CONC	[Laboratory Equipment]
COEFF_VAR_SOIL_CO2_CONC	[Laboratory Equipment]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

**TF01\_SOIL\_MOIST\_GRAV**

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
SOIL_DEPTH_DESCR	[Human Observer]
MEAN_GRAV_SOIL_MOIST	[Laboratory Equipment]
MEAN_BULK_DENSITY	[Laboratory Equipment]
MEAN_VOL_SOIL_MOIST	[Laboratory Equipment]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

**TF01\_SOIL\_MOIST\_SUMMARY**

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
SOIL_DEPTH_DESCR	[Human Observer]
SENSOR_TYPE	[Human Observer]
NUM_OBS	[Human Observer]
MEAN_VOL_SOIL_MOIST	[Laboratory Equipment]
COEFF_VAR_VOL_SOIL_MOIST	[Laboratory Equipment]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

**TF01\_SOIL\_MOIST\_VOL**

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
SOIL_DEPTH_DESCR	[Human Observer]
LOCATION_ID	[Human Observer]
SENSOR_TYPE	[Human Observer]
SENSOR_ID	[Human Observer]
VOL_SOIL_MOIST	[Laboratory Equipment]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

**TF01\_SOIL\_RESP\_FLUX**

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
START_TIME	[Human Observer]
END_TIME	[Human Observer]
NUM_OBS	[Human Observer]
NUM_SITES	[Human Observer]
MEAN_SOIL_CO2_FLUX	[Laboratory Equipment]
COEFF_VAR_SOIL_CO2_FLUX	[Laboratory Equipment]
MEAN_SOIL_TEMP_0_10CM	[Laboratory Equipment]

MEAN_AIR_TEMP_CHAMBER	[Laboratory Equipment]
MEAN_REL_HUM_CHAMBER	[Laboratory Equipment]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

#### TF01\_SOIL\_TEMP

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
SOIL_DEPTH	[Human Observer]
MEAN_SOIL_TEMP	[Thermometer]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

### 7.3.5 Data Range

The following table gives information about the parameter values found in the data files on the CD-ROM.

#### TF01\_SOIL\_CO2\_CONC

	Minimum	Maximum	Missng	Unrel	Below	Data
Column Name	Data	Data	Data	Data	Detect	Not
	Value	Value	Value	Value	Limit	Cllctd
SITE_NAME	SSA-90A-FLXTR	SSA-90A-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	25-MAY-94	18-SEP-94	None	None	None	None
START_TIME	1600	1600	None	None	None	None
END_TIME	2200	2200	None	None	None	None
SOIL_DEPTH	62	150	None	None	None	None
SOIL_LAYER	N/A	N/A	None	None	None	None
MEAN_CO2_CONC	813.53	7674.1	None	None	None	None
COEFF_VAR_SOIL_CO2_CONC	12.06818	56.84175	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	14-SEP-99	14-SEP-99	None	None	None	None

#### TF01\_SOIL\_\_MOIST\_GRAV

	Minimum	Maximum	Missng	Unrel	Below	Data
Column Name	Data	Data	Data	Data	Detect	Not
	Value	Value	Value	Value	Limit	Cllctd
SITE_NAME	SSA-90A-FLXTR	SSA-90A-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	13-MAY-94	19-SEP-94	None	None	None	None
SOIL_DEPTH_DESCR	N/A	N/A	None	None	None	None
MEAN_GRAV_SOIL_MOIST	4.827254	248.61	None	None	None	None
MEAN_BULK_DENSITY	108	1500	None	None	None	None
MEAN_VOL_SOIL_MOIST	5.985795	41.2	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	18-AUG-99	18-AUG-99	None	None	None	None

**TF01\_SOIL\_MOIST\_SUMMARY**

	Minimum	Maximum	Missng	Unrel	Below	Data
	Data	Data	Data	Data	Detect	Not
Column Name	Value	Value	Value	Value	Limit	Cllctd
SITE_NAME	SSA-90A-FLXTR	SSA-90A-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	02-FEB-94	26-NOV-94	None	None	None	None
SOIL_DEPTH_DESCR	N/A	N/A	None	None	None	None
SENSOR_TYPE	N/A	N/A	None	None	None	None
NUM_OBS	1	6	-999	None	None	None
MEAN_VOL_SOIL_MOIST	1	67	-999	None	None	None
COEFF_VAR_VOL_SOIL_MOIST	0	135.4253	-999	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	03-SEP-99	03-SEP-99	None	None	None	None

**TF01\_SOIL\_MOIST\_VOL**

	Minimum	Maximum	Missng	Unrel	Below	Data
	Data	Data	Data	Data	Detect	Not
Column Name	Value	Value	Value	Value	Limit	Cllctd
SITE_NAME	SSA-90A-FLXTR	SSA-90A-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	02-FEB-94	26-NOV-94	None	None	None	None
SOIL_DEPTH_DESCR	N/A	N/A	None	None	None	None
LOCATION_ID	A	D	None	None	None	Blank
SENSOR_TYPE	N/A	N/A	None	None	None	None
SENSOR_ID	N/A	N/A	None	None	None	Blank
VOL_SOIL_MOIST	-4	67	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	02-SEP-99	02-SEP-99	None	None	None	None

**TF01\_SOIL\_RESP\_FLUX**

	Minimum	Maximum	Missng	Unrel	Below	Data
	Data	Data	Data	Data	Detect	Not
Column Name	Value	Value	Value	Value	Limit	Cllctd
SITE_NAME	SSA-90A-FLXTR	SSA-90A-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	16-APR-94	24-SEP-94	None	None	None	None
START_TIME	1600	1600	None	None	None	None
END_TIME	2200	2200	None	None	None	None
NUM_OBS	5	36	None	None	None	None
NUM_SITES	3	24	None	None	None	None
MEAN_SOIL_CO2_FLUX	.000618	.0093454	None	None	None	None
COEFF_VAR_SOIL_CO2_FLUX	5.429534	73.7449	None	None	None	None
MEAN_SOIL_TEMP_0_10CM	.489444	16.73333	None	None	None	None
MEAN_AIR_TEMP_CHAMBER	8.9	30.6	None	None	None	None

MEAN_REL_HUM_CHAMBER	8.26	98.4	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	02-SEP-99	02-SEP-99	None	None	None	None

---

#### TF01\_SOIL\_TEMP

	Minimum	Maximum	Missng	Unrel	Below	Data
	Data	Data	Data	Data	Detect	Not
Column Name	Value	Value	Value	Value	Limit	Cllctd

---

SITE_NAME	SSA-90A-FLXTR	SSA-90A-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	01-APR-94	18-SEP-94	None	None	None	None
SOIL_DEPTH	50	1000	None	None	None	None
MEAN_SOIL_TEMP	-.2546	15.615	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	07-SEP-99	07-SEP-99	None	None	None	None

---

Minimum Data Value -- The minimum value found in the column.

Maximum Data Value -- The maximum value found in the column.

Missng Data Value -- The value that indicates missing data. This is used to indicate that an attempt was made to determine the parameter value, but the attempt was unsuccessful.

Unrel Data Value -- The value that indicates unreliable data. This is used to indicate an attempt was made to determine the parameter value, but the value was deemed to be unreliable by the analysis personnel.

Below Detect Limit -- The value that indicates parameter values below the instruments detection limits. This is used to indicate that an attempt was made to determine the parameter value, but the analysis personnel determined that the parameter value was below the detection limit of the instrumentation.

Data Not Cllctd -- This value indicates that no attempt was made to determine the parameter value. This usually indicates that BORIS combined several similar but not identical data sets into the same data base table but this particular science team did not measure that parameter.

Blank -- Indicates that blank spaces are used to denote that type of value.

N/A -- Indicates that the value is not applicable to the respective column.

None -- Indicates that no values of that sort were found in the column.

---

## 7.4 Sample Data Record

The following are wrapped versions of data record from a sample data file on the CD-ROM.

### TF01\_SOIL\_CO2\_CONC

```
SITE_NAME,SUB_SITE,DATE_OBS,START_TIME,END_TIME,SOIL_DEPTH,SOIL_LAYER,
MEAN_CO2_CONC,COEFF_VAR_SOIL_CO2_CONC,CRTFCN_CODE,REVISION_DATE
'SSA-90A-FLXTR','9TF01-SOI01',25-MAY-94,1600,2200,62.0,'MID HUMUS',934.11,
30.1483,'CPI',14-SEP-99
'SSA-90A-FLXTR','9TF01-SOI01',25-MAY-94,1600,2200,150.0,'SURFACE MINERAL SOIL',
1684.26,31.01604,'CPI',14-SEP-99
```

### TF01\_SOIL\_MOIST\_GRAV

```
SITE_NAME,SUB_SITE,DATE_OBS,SOIL_DEPTH_DESCR,MEAN_GRAV_SOIL_MOIST,
MEAN_BULK_DENSITYMEAN_VOL_SOIL_MOIST,CRTFCN_CODE,REVISION_DATE
'SSA-90A-FLXTR','9TF01-SOI01',13-MAY-94,'0_3',217.19,108,23.6,'CPI',18-AUG-99
'SSA-90A-FLXTR','9TF01-SOI01',13-MAY-94,'3_6',140.98,182,25.6,'CPI',18-AUG-99
```

### TF01\_SOIL\_MOIST\_SUMMARY

```
SITE_NAME,SUB_SITE,DATE_OBS,SOIL_DEPTH_DESCR,SENSOR_TYPE,NUM_OBS,
MEAN_VOL_SOIL_MOIST,COEFF_VAR_VOL_SOIL_MOIST,CRTFCN_CODE,REVISION_DATE
'SSA-90A-FLXTR','9TF01-SOI01',02-FEB-94,'MID HUMUS','SURFACE PROBE',1,8.0,0.0,
'CPI',03-SEP-99
'SSA-90A-FLXTR','9TF01-SOI01',02-FEB-94,'15 CM','SURFACE PROBE',1,15.0,0.0,
'CPI',03-SEP-99
```

### TF01\_SOIL\_MOIST\_VOL

```
SITE_NAME,SUB_SITE,DATE_OBS,SOIL_DEPTH_DESCR,LOCATION_ID,SENSOR_TYPE,SENSOR_ID,
VOL_SOIL_MOIST,CRTFCN_CODE,REVISION_DATE
'SSA-90A-FLXTR','9TF01-SOI01',02-FEB-94,'8 CM','D','SURFACE PROBE','',8.0,'CPI',
02-SEP-99
'SSA-90A-FLXTR','9TF01-SOI01',02-FEB-94,'SURFACE MINERAL SOIL (15 CM)','D',
'SURFACE PROBE','',15.0,'CPI',02-SEP-99
```

### TF01\_SOIL\_RESP\_FLUX

```
SITE_NAME,SUB_SITE,DATE_OBS,START_TIME,END_TIME,NUM_OBS,NUM_SITES,
MEAN_SOIL_CO2_FLUX,COEFF_VAR_SOIL_CO2_FLUX,MEAN_SOIL_TEMP_0_10CM,
MEAN_AIR_TEMP_CHAMBER,MEAN_REL_HUM_CHAMBER,CRTFCN_CODE,REVISION_DATE
'SSA-90A-FLXTR','9TF01-SOI01',16-APR-94,1600,2200,5,5,.0007793,35.3695,.5,12.0,
48.0,'CPI',02-SEP-99
'SSA-90A-FLXTR','9TF01-SOI01',22-APR-94,1600,2200,24,24,.0013687,36.60205,
.66875,21.3,46.33333,'CPI',02-SEP-99
```

### TF01\_SOIL\_TEMP

```
SITE_NAME,SUB_SITE,DATE_OBS,SOIL_DEPTH,MEAN_SOIL_TEMP,CRTFCN_CODE,REVISION_DATE
'SSA-90A-FLXTR','9TF01-SOI01',01-APR-94,50.0,-.0469,'CPI',07-SEP-99
'SSA-90A-FLXTR','9TF01-SOI01',01-APR-94,100.0,-.0923,'CPI',07-SEP-99
```



## **8. Data Organization**

### **8.1 Data Granularity**

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

### **8.2 Data Format(s)**

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

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

## **9. Data Manipulations**

### **9.1 Formulae**

#### **9.1.1 Derivation Techniques and Algorithms**

None given.

### **9.2 Data Processing Sequence**

None given.

#### **9.2.1 Processing Steps**

None given.

#### **9.2.2 Processing Changes**

None given.

### **9.3 Calculations**

#### **9.3.1 Special Corrections/Adjustments**

None given.

#### **9.3.2 Calculated Variables**

None given.

### **9.4 Graphs and Plots**

None given.

## **10. Errors**

### **10.1 Sources of Error**

None given.

### **10.2 Quality Assessment**

None given.

**10.2.1 Data Validation by Source**

Data have been reviewed by TF-01 personnel.

**10.2.2 Confidence Level/Accuracy Judgment**

None given.

**10.2.3 Measurement Error for Parameters**

None given.

**10.2.4 Additional Quality Assessments**

None given.

**10.2.5 Data Verification by Data Center**

The data were examined for general consistency and clarity.

**11. Notes****11.1 Limitations of the Data**

None given.

**11.2 Known Problems with the Data**

None given.

**11.3 Usage Guidance**

None given.

**11.4 Other Relevant Information**

None given.

**12. Application of the Data Set**

This data set can be used to study the soil properties of an aspen boreal forest.

**13. Future Modifications and Plans**

None given.

**14. Software****14.1 Software Description**

None given.

**14.2 Software Access**

None given.

## **15. Data Access**

The SSA-OA soil characteristics 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](mailto:ornldaac@ornl.gov) or [ornl@eos.nasa.gov](mailto:ornl@eos.nasa.gov)

### **15.2 Data Center Identification**

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics  
<http://www-eosdis.ornl.gov/>.

### **15.3 Procedures for Obtaining Data**

Users may obtain data directly through the ORNL DAAC online search and order system [<http://www-eosdis.ornl.gov/>] and the anonymous FTP site [<ftp://www-eosdis.ornl.gov/data/>] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

### **15.4 Data Center Status/Plans**

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

## **16. Output Products and Availability**

### **16.1 Tape Products**

None.

### **16.2 Film Products**

None.

### **16.3 Other Products**

These data are available on the BOREAS CD-ROM series.

## 17. References

### 17.1 Platform/Sensor/Instrument/Data Processing Documentation

None given.

### 17.2 Journal Articles and Study Reports

Black, T.A., G. den Hartog, H.H. Neumann, P.D. Blanken, P.C. Yang, C. Russell, Z. Nesic, X. Lee, S.G. Chen, R. Staebler, and M.D. Novak. 1996. Annual cycles of water vapour and carbon dioxide fluxes in and above a boreal aspen forest. *Global Change Biology* 2: 219-229.

Blanken, P.D., T.A. Black, P.C. Yang, H.H. Neumann, Z. Nesic, R. Staebler, G. den Hartog, M.D. Novak, and X. Lee. 1997. Energy balance and canopy conductance of a boreal aspen forest: Partitioning overstory and understory components. *Journal of Geophysical Research* 102(D24): 28,915-28,927.

Chen, W.J., T.A. Black, P.C. Yang, A.G. Barr, H.H. Neumann, Z. Nesic, P.D. Blanken, M.D. Novak, J. Eley, R.J. Ketler, and R. Cuenca. 1999. Effects of climatic variability on the annual carbon sequestration by a boreal aspen forest. *Global Change Biology* 5: 41-53.

Fritschen, L.J. and L.W. Gay. 1979. *Environmental Instrumentation*. Springer-Verlag, Berlin, New York and Heidelberg.

Hook, W.R. and N.J. Livingston. 1996. Errors in converting time domain reflectometry measurements of propagation velocity to estimates of soil water content. *Soil Science Society of America Journal*. 60: 35-41.

Hook, W.R., N.J. Livingston, Z.J. Sun, and P.B. Hook. 1992. Remote diode shorting improves measurement of soil water by time domain reflectometry. *Soil Science Society of America Journal* 56: 1384-1391.

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.

Pearcy, R.W., J. Ehleringer, H.A. Mooney, and P.W. Rundel. 1991. *Plant physiological ecology: Field methods and instrumentation*. Chapman and Hall, London and New York.

Russell, C.A. and R.P. Voroney. 1998. Carbon dioxide efflux from the floor of a boreal aspen forest. I. Relationship to environmental variables and estimates of C respired. *Can. J. Soil Sci.* 78:301-310.

Russell, C.A., R.P. Voroney, T.A. Black, P.D. Blanken, and P.C. Yang. 1998. Carbon dioxide efflux from the floor of a boreal aspen forest. II. Evaluation of methods - verification by infra-red analysis of a dynamic closed chamber. *Can. J. Soil Sci.* 78:311-316.

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.

Soil Classification Working Group (Eds.). 1998. The Canadian System of Soil Classification. 3rd Edition. Agriculture and Agri-Food Canada Publication 1646. National Resource Council of Canada Research Press. Ottawa, Ontario, Canada. 187 pp.

### **17.3 Archive/DBMS Usage Documentation**

None.

## **18. Glossary of Terms**

E - Evapotranspiration.

F - Fibric: this is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

Fick's Law - This law states that the rate of diffusion,  $M$ , of one material through another is proportional to the cross sectional area of diffusion,  $A$ , the concentration gradient,  $dC/dX$ , and the diffusion coefficient,  $D$ . Their relationship is  $M = -D \cdot A \cdot (dC/dX)$ .

H - Humus: this is an organic horizon characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon.

L - Litter: this is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

LFH - The major organic horizons are L, F, and H, which consist mainly of forest litter at various stages of decomposition. These organic horizons developed primarily from leaves, twigs, woody materials, and a minor component of mosses under imperfectly to well-drained forest conditions.

## 19. List of Acronyms

AES	- Atmospheric Environmental Service
ASCII	- American Standard Code for Information Interchange
Batoche	- The study site located in the Batoche National Historic Park
BFTCS	- Boreal Forest Transect Case Study
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
CD-ROM	- Compact Disk-Read-Only Memory
CFS	- Canadian Forest Service
DAAC	- Distributed Active Archive Center
DOY	- Julian Day of Year
EOS	- Earth Observing System
EOSDIS	- EOS Data and Information System
GIS	- Geographic Information System
GMT	- Greenwich Mean Time
GSFC	- Goddard Space Flight Center
HTML	- HyperText Markup Language
IFC	- Intensive Field Campaign
IRGA	- Infrared Gas Analyzer
NAD83	- North American Datum of 1983
NASA	- National Aeronautics and Space Administration
NEP	- Net Ecosystem Productivity
NOAA	- National Oceanic and Atmospheric Administration
NSA	- Northern Study Area
OA	- Old Aspen
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert National Park
RSS	- Remote Sensing Science
S	- Sap Flux Density
SSA	- Southern Study Area
TDR	- Time Domain Reflectometry
TE	- Terrestrial Ecology
TF	- Tower Flux
URL	- Uniform Resource Locator
UTM	- Universal Transverse Mercator

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