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

Forrest G. Hall and Andrea Papagno, Editors

Volume 132

BOREAS TE-2 Root Respiration Data

M.G. Ryan and M. Lavigne

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

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BOREAS TE-2 Root Respiration Data

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BOREAS TE-2 Root Respiration Data

Michael G. Ryan, Michael Lavigne

Summary

The BOREAS TE-2 team collected several data sets in support of its efforts to characterize and interpret information on the respiration of the foliage, roots, and wood of boreal vegetation. This data set includes means of tree root respiration measurements on roots having diameters ranging from 0 to 2 mm conducted in the NSA during the growing season of 1994. The data are stored in tabular ASCII files.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS TE-02 Root Respiration Data

1.2 Data Set Introduction

Field studies of tree root respiration were conducted at the BOReal Ecosystem-Atmosphere Study (BOREAS) Northern Study Area (NSA) during the growing season of 1994.

1.3 Objectives/Purpose

The purposes of the work were to:

- Characterize respiration of roots 0-2 mm (fresh diameter) at the primary forested BOREAS sites in the northern and southern study areas (Old Jack Pine (OJP), Old Black Spruce (OBS), and Old Aspen (OA)) with respect to biomass and nutrient content, and determine whether respiration rates, corrected to a common temperature, differed among species and sites or varied seasonally.
- Determine if there was any relationship between fine root respiration and root nitrogen content

or root carbohydrate content.

- Use our estimates of root respiration, Gower and Steele's estimates of root biomass (Steele et al., 1997), and soil temperature to throughout the year to estimate the annual carbon cost for fine root respiration.

1.4 Summary of Parameters

Each data record includes the mean, standard deviation, and the number of cases included in the measurement of each of the following: root respiration, soil temperature, CO_2 concentration in the chamber, nitrogen content, phosphorus content, carbon content, sugars as a percent of dry weight, starch as a percent of dry weight and total nonstructural carbohydrates.

1.5 Discussion

In the NSA, we measured fine root respiration rates for OA (Populus tremuloides), OBS (Picea mariana), and OJP (Pinus banksiana) in 1994 during June, July, and August, corresponding with the BOREAS Intensive Field Campaigns (IFCs).

1.6 Related Data Sets

BOREAS TE-02 Wood Respiration Data
BOREAS TE-02 Foliage Respiration Data
BOREAS TE-02 Stem Growth and Sapwood Data
BOREAS TE-02 Continuous Wood Respiration Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. Michael G. Ryan
Dr. Michael Lavigne

2.2 Title of Investigation

Autotrophic Respiration in Boreal Ecosystems

2.3 Contact Information

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3. Theory of Measurements

Respiration oxidizes sugars, producing energy, water, and CO_2 and absorbing oxygen. In most plant cells, the ratio between the oxygen absorbed and CO_2 produced in respiration is close to one. Therefore, because small changes in CO_2 concentration in the air are easier to measure than small changes in the oxygen content of the air, respiration is typically measured as CO_2 evolution from plant tissues. CO_2 evolution is typically measured with an infrared gas analyzer (IRGA), operating in one of three modes: open, closed, or differential. The system that we used was a closed system, which estimates molar flux of CO_2 from plant tissue respiration as the rate of increase in CO_2 concentration in the chamber times the molar volume of the air inside the chamber enclosing the sample [Field et al., 1991]. Respiration rates are typically expressed as moles CO_2 per kg of dry weight per second.

4. Equipment

4.1 Instrument Description

4.1.1 Collection Environment

Respiration measurements were made on intact roots in the field. All other measurements took place under laboratory conditions.

4.1.2 Source/Platform

Measurements were taken from the ground in the field and nutrient measurements were taken in the laboratory.

4.1.3 Source/Platform Mission Objectives

The objective of the platforms was to support the equipment and samples.

4.1.4 Key Variables

Root respiration, soil temperature, CO_2 concentration in the chamber, nitrogen content, phosphorus content, carbon content, sugars as a percent of dry weight, starch as a percent of dry weight, and total nonstructural carbohydrates.

4.1.5 Principles of Operation

Fine root (<2 mm diameter) respiration rates were measured once during each IFC on 10-20 samples per site. Measurements were made on intact fine roots 1-5 cm below the surface of the litter. Fine roots (0.1-0.3 g) were carefully separated from the surrounding litter and soil with small brushes and water. Because CO_2 concentration alters the CO_2 efflux rate of fine roots [Qi et al., 1994], CO_2 concentration in the cuvette was approximately that of the soil air surrounding the roots before sampling. CO_2 efflux was measured using a closed system [Field et al., 1991] CID C-301 (CID, Inc., Vancouver, WA). Fine root temperature was assumed to be that of the surrounding soil, measured with a thermocouple. Temperature response was determined by measuring fine root respiration rates at

5, 15, and 25 °C with a temperature-controlled cuvette [Hubbard et al., 1995] on five samples in July at the NSA sites. Temperature response did not differ among species ($p < 0.05$) and the average increase of respiration with a 10 °C increase in temperature was 1.9. After the respiration measurements were taken, the sample was harvested, dried at 65 °C for 48 hours, weighed, and stored for analysis of nutrients (nitrogen and phosphorus) and nonstructural carbohydrates. Nitrogen and phosphorus were generally measured with a micro-Kjeldahl procedure [Lachat Instruments, 1992a, b]; some samples were done with a carbon-hydrogen-nitrogen analyzer (LECO CHN-1000, LECO, Inc., St. Joseph, MN). Soluble sugar and starch were extracted from plant material as described by Tissue and Wright [1995]. Starch and sugar concentration was determined colorimetrically using the phenol-sulfuric acid method of Dubois et al. [1956]. Total nonstructural carbohydrate was calculated as the sum of the soluble sugar and starch. For each sample period and site, each measurement was adjusted to a reference temperature (10 °C) using the average increase of respiration with a 10 °C increase in temperature. These temperature-corrected respiration rates were then averaged to give an estimate of respiration rate for a given site and time.

4.1.6 Sensor/Instrument Measurement Geometry

Not applicable.

4.1.7 Manufacturer of Instrument

LECO CHN-1000
LECO, Inc.
3000 Lakeview AV
St. Joseph, MN 49085
(616) 983-5531

Closed System IRGA
CID C-301
CID Inc.
4018 NE 112th Ave Suite D-8
Vancouver, WA 98682
(360) 254-7874
(360) 254-7923 (fax)

4.2 Calibration

4.2.1 Specifications

We calibrated the IRGA to a concentration standard supplied by BOREAS prior to a measurement period and every 48 hours during measurements. Typically, the analyzer drifted less than 1% between calibrations.

4.2.1.1 Tolerance

None.

4.2.2 Frequency of Calibration

We calibrated the IRGA to a concentration standard supplied by BOREAS prior to a measurement period and every 48 hours during measurements.

4.2.3 Other Calibration Information

Measurement of molar volume (moles of ideal gas in the gas circuit) depends on air pressure and circuit volume. We used standard meteorological pressure, corrected for elevation for this calculation.

5. Data Acquisition Methods

Data were taken from the IRGA, recorded in a notebook, and copied to computer files.

6. Observations

6.1 Data Notes

None.

6.2 Field Notes

None.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The NSA measurement sites and associated North American Datum of 1983 (NAD83) coordinates are:

- OA canopy access, site id T2Q6A, Lat/Long: 55.88691°N, 98.67479°W, Universal Transverse Mercator (UTM) Zone 14, N: 6,193,540.7, E: 520,342
- OBS canopy access tower, site id T3R8T, Lat/Long: 55.88007°N, 98.48139°W, UTM Zone 14, N: 6,192,853.4, E: 532,444.5
- OJP, site id T7Q8T, Lat/Long: 55.92842Q°N, 98.62396°W, UTM Zone 14, N: 6,198,176.3, E: 523,496.2

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

These data are point source measurements at the given locations.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

We measured root respiration rates on intact roots 1 to 5 cm below the surface of the litter in 1994 during June, July, and August, corresponding with the BOREAS IFCs at NSA-OBS, NSA-OJP, and NSA-OA.

7.2.2 Temporal Coverage Map

None given.

7.2.3 Temporal Resolution

Measurements were made on intact fine roots located 1 to 5 cm below the surface of the litter and having a diameter range of 0 to 2 mm. The root respiration measurements took place once during each IFC on 10-20 samples per site.

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
START_DATE
END_DATE
SPECIES
IFC
MEAN_RESP_PER_DRY_WT_10C
SDEV_RESP_PER_DRY_WT_10C
NUM_OBS_RESP_PER_DRY_WT_10C
MEAN_SOIL_TEMP
SDEV_SOIL_TEMP
NUM_OBS_SOIL_TEMP
MEAN_CO2_CONC_CHAMBER
SDEV_CO2_CONC_CHAMBER
NUM_OBS_CO2_CONC_CHAMBER
MEAN_NITROGEN_CONTENT
SDEV_NITROGEN_CONTENT
NUM_OBS_NITROGEN_CONTENT
MEAN_PHOSPHOROUS_CONTENT
SDEV_PHOSPHOROUS_CONTENT
NUM_OBS_PHOSPHOROUS_CONTENT
MEAN_CARBON_CONTENT
SDEV_CARBON_CONTENT
NUM_OBS_CARBON_CONTENT
MEAN_SUGAR_CONTENT
SDEV_SUGAR_CONTENT
NUM_OBS_SUGAR_CONTENT
MEAN_STARCH_CONTENT
SDEV_STARCH_CONTENT
NUM_OBS_STARCH_CONTENT
MEAN_NONSTRUC_CARBOHYD_CONTENT
SDEV_NONSTRUC_CARBOHYD_CONTENT
NUM_OBS_NSTRUC_CARBOH_CONTENT
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 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.
START_DATE	The date on which the collection of data commenced
END_DATE	The date on which the collection of the data was terminated.
SPECIES	Botanical (Latin) name of the species (Genus species).
IFC	BOREAS Intensive Field campaign sampling period
MEAN_RESP_PER_DRY_WT_10C	Mean respiration of CO2 from the sample under dark conditions and at 10 degrees Celsius per unit of dried sample weight.
SDEV_RESP_PER_DRY_WT_10C	Standard deviation of respiration of CO2 from the sample under dark conditions and at 10 degrees Celsius per unit of dried sample weight.
NUM_OBS_RESP_PER_DRY_WT_10C	The number of measurements used to calculate the mean respiration of CO2 under dark conditions and at 10 degrees Celsius per unit of dried sample weight.
MEAN_SOIL_TEMP	The mean soil temperature.
SDEV_SOIL_TEMP	The standard deviation of the soil temperature.
NUM_OBS_SOIL_TEMP	The number of measurements used to calculate the mean soil temperature.
MEAN_CO2_CONC_CHAMBER	The mean CO2 concentration in the chamber.
SDEV_CO2_CONC_CHAMBER	The standard deviation of the CO2 concentration in the chamber.
NUM_OBS_CO2_CONC_CHAMBER	The number of measurements used to calculate the mean of the CO2 concentration in the chamber.
MEAN_NITROGEN_CONTENT	The mean nitrogen content of the sample based on dried sample weight.
SDEV_NITROGEN_CONTENT	The standard deviation of the nitrogen content.
NUM_OBS_NITROGEN_CONTENT	The number of measurements used to calculate the mean of the nitrogen content.
MEAN_PHOSPHOROUS_CONTENT	The mean phosphorous content based on dried sample weight.
SDEV_PHOSPHOROUS_CONTENT	The standard deviation of the phosphorous content.
NUM_OBS_PHOSPHOROUS_CONTENT	The number of measurements used to calculate the mean of the phosphorous content.
MEAN_CARBON_CONTENT	The mean carbon content based on dried sample

	weight.
SDEV_CARBON_CONTENT	The standard deviation of the carbon content.
NUM_OBS_CARBON_CONTENT	The number of measurements used to calculate the mean carbon content.
MEAN_SUGAR_CONTENT	The mean sugar content based on dried sample weight.
SDEV_SUGAR_CONTENT	The standard deviation of the sugar content.
NUM_OBS_SUGAR_CONTENT	The number of measurements used to calculate the mean sugar content.
MEAN_STARCH_CONTENT	The mean starch content based on dried sample weight.
SDEV_STARCH_CONTENT	The standard deviation of the starch content.
NUM_OBS_STARCH_CONTENT	The number of measurements used to calculate the mean starch content.
MEAN_NONSTRUC_CARBOHYD_CONTENT	The mean total non-structural carbohydrates content based on dried sample weight.
SDEV_NONSTRUC_CARBOHYD_CONTENT	The standard deviation of the total non-structural carbohydrates content.
NUM_OBS_NSTRUC_CARBOH_CONTENT	The number of cases included in the mean total non-structural carbohydrates content.
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]
START_DATE	[DD-MON-YY]
END_DATE	[DD-MON-YY]
SPECIES	[none]
IFC	[none]
MEAN_RESP_PER_DRY_WT_10C	[nanomoles][gram^-1][second^-1]
SDEV_RESP_PER_DRY_WT_10C	[nanomoles][gram^-1][second^-1]
NUM_OBS_RESP_PER_DRY_WT_10C	[count]
MEAN_SOIL_TEMP	[degrees Celsius]
SDEV_SOIL_TEMP	[degrees Celsius]
NUM_OBS_SOIL_TEMP	[count]
MEAN_CO2_CONC_CHAMBER	[parts per million]
SDEV_CO2_CONC_CHAMBER	[parts per million]
NUM_OBS_CO2_CONC_CHAMBER	[count]
MEAN_NITROGEN_CONTENT	[percent]
SDEV_NITROGEN_CONTENT	[percent]
NUM_OBS_NITROGEN_CONTENT	[count]
MEAN_PHOSPHOROUS_CONTENT	[percent]
SDEV_PHOSPHOROUS_CONTENT	[percent]
NUM_OBS_PHOSPHOROUS_CONTENT	[count]
MEAN_CARBON_CONTENT	[percent]

SDEV_CARBON_CONTENT	[percent]
NUM_OBS_CARBON_CONTENT	[count]
MEAN_SUGAR_CONTENT	[percent]
SDEV_SUGAR_CONTENT	[percent]
NUM_OBS_SUGAR_CONTENT	[count]
MEAN_STARCH_CONTENT	[percent]
SDEV_STARCH_CONTENT	[percent]
NUM_OBS_STARCH_CONTENT	[count]
MEAN_NONSTRUC_CARBOHYD_CONTENT	[percent]
SDEV_NONSTRUC_CARBOHYD_CONTENT	[percent]
NUM_OBS_NSTRUC_CARBOH_CONTENT	[count]
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	[BORIS Designation]
SUB_SITE	[BORIS Designation]
START_DATE	[Human Observer]
END_DATE	[Human Observer]
SPECIES	[Human Observer]
IFC	[Human Observer]
MEAN_RESP_PER_DRY_WT_10C	[Laboratory Equipment]
SDEV_RESP_PER_DRY_WT_10C	[Laboratory Equipment]
NUM_OBS_RESP_PER_DRY_WT_10C	[Human Observer]
MEAN_SOIL_TEMP	[Thermometer]
SDEV_SOIL_TEMP	[Thermometer]
NUM_OBS_SOIL_TEMP	[Human Observer]
MEAN_CO2_CONC_CHAMBER	[Laboratory Equipment]
SDEV_CO2_CONC_CHAMBER	[Laboratory Equipment]
NUM_OBS_CO2_CONC_CHAMBER	[Human Observer]
MEAN_NITROGEN_CONTENT	[Laboratory Equipment]
SDEV_NITROGEN_CONTENT	[Laboratory Equipment]
NUM_OBS_NITROGEN_CONTENT	[Human Observer]
MEAN_PHOSPHOROUS_CONTENT	[Laboratory Equipment]
SDEV_PHOSPHOROUS_CONTENT	[Laboratory Equipment]
NUM_OBS_PHOSPHOROUS_CONTENT	[Human Observer]
MEAN_CARBON_CONTENT	[Laboratory Equipment]
SDEV_CARBON_CONTENT	[Laboratory Equipment]
NUM_OBS_CARBON_CONTENT	[Human Observer]
MEAN_SUGAR_CONTENT	[Laboratory Equipment]
SDEV_SUGAR_CONTENT	[Laboratory Equipment]
NUM_OBS_SUGAR_CONTENT	[Human Observer]
MEAN_STARCH_CONTENT	[Laboratory Equipment]
SDEV_STARCH_CONTENT	[Laboratory Equipment]
NUM_OBS_STARCH_CONTENT	[Human Observer]
MEAN_NONSTRUC_CARBOHYD_CONTENT	[Laboratory Equipment]
SDEV_NONSTRUC_CARBOHYD_CONTENT	[Laboratory Equipment]
NUM_OBS_NSTRUC_CARBOH_CONTENT	[Human Observer]
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.

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	NSA-9OA-9TETR	NSA-OJP-FLXTR	None	None	None	None
SUB_SITE	9TE02-RTR01	9TE02-RTR01	None	None	None	None
START_DATE	28-MAY-94	07-SEP-94	None	None	None	None
END_DATE	30-MAY-94	12-SEP-94	None	None	None	None
SPECIES	N/A	N/A	None	None	None	None
IFC	IFC1	IFC3	None	None	None	None
MEAN_RESP_PER_DRY_ WT_10C	2.18	7.79	None	None	None	None
SDEV_RESP_PER_DRY_ WT_10C	1.24	5.23	None	None	None	None
NUM_OBS_RESP_PER_ DRY_ WT_10C	17	22	None	None	None	None
MEAN_SOIL_TEMP	9.09	17.52	None	None	None	None
SDEV_SOIL_TEMP	.9	3.75	None	None	None	None
NUM_OBS_SOIL_TEMP	17	22	None	None	None	None
MEAN_CO2_CONC_ CHAMBER	700.63	752.49	None	None	None	None
SDEV_CO2_CONC_ CHAMBER	12.37	45.8	None	None	None	None
NUM_OBS_CO2_CONC_ CHAMBER	17	22	None	None	None	None
MEAN_NITROGEN_ CONTENT	.32	.83	None	None	None	None
SDEV_NITROGEN_ CONTENT	.1	.21	None	None	None	None
NUM_OBS_NITROGEN_ CONTENT	8	17	None	None	None	None
MEAN_PHOSPHOROUS_ CONTENT	.05	.1	None	None	None	None
SDEV_PHOSPHOROUS_ CONTENT	.01	.04	None	None	None	None
NUM_OBS_PHOSPHOROUS_ CONTENT	8	14	None	None	None	None
MEAN_CARBON_CONTENT	46.79	49.63	-999	None	None	None
SDEV_CARBON_CONTENT	.32	1.33	-999	None	None	None
NUM_OBS_CARBON_ CONTENT	0	4	None	None	None	None
MEAN_SUGAR_CONTENT	4	7.61	None	None	None	None
SDEV_SUGAR_CONTENT	.73	1.8	None	None	None	None
NUM_OBS_SUGAR_ CONTENT	9	17	None	None	None	None
MEAN_STARCH_CONTENT	4.11	9.05	None	None	None	None
SDEV_STARCH_CONTENT	.84	2.91	None	None	None	None
NUM_OBS_STARCH_ CONTENT	9	17	None	None	None	None
MEAN_NONSTRUC_ CARBOHYD_CONTENT	8.54	15.63	None	None	None	None

```
SDEV_NONSTRUC_       1.92           3.87           None    None   None    None
CARBOHYD_CONTENT
NUM_OBS_NSTRUC_      9              17             None    None   None    None
CARBOH_CONTENT
CRTFCN_CODE          CPI            CPI            None    None   None    None
REVISION_DATE        13-NOV-98      13-NOV-98      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.

```
SITE_NAME,SUB_SITE,START_DATE,END_DATE,SPECIES,IFC,MEAN_RESP_PER_DRY_WT_10C,
SDEV_RESP_PER_DRY_WT_10C,NUM_OBS_RESP_PER_DRY_WT_10C,MEAN_SOIL_TEMP,
SDEV_SOIL_TEMP,NUM_OBS_SOIL_TEMP,MEAN_CO2_CONC_CHAMBER,SDEV_CO2_CONC_CHAMBER,
NUM_OBS_CO2_CONC_CHAMBER,MEAN_NITROGEN_CONTENT,SDEV_NITROGEN_CONTENT,
NUM_OBS_NITROGEN_CONTENT,MEAN_PHOSPHOROUS_CONTENT,SDEV_PHOSPHOROUS_CONTENT,
NUM_OBS_PHOSPHOROUS_CONTENT,MEAN_CARBON_CONTENT,SDEV_CARBON_CONTENT,
NUM_OBS_CARBON_CONTENT,MEAN_SUGAR_CONTENT,SDEV_SUGAR_CONTENT,
NUM_OBS_SUGAR_CONTENT,MEAN_STARCH_CONTENT,SDEV_STARCH_CONTENT,
NUM_OBS_STARCH_CONTENT,MEAN_NONSTRUC_CARBOHYD_CONTENT,
SDEV_NONSTRUC_CARBOHYD_CONTENT,NUM_OBS_NSTRUC_CARBOH_CONTENT,CRTFCN_CODE,
REVISION_DATE
'NSA-OJP-FLXTR','9TE02-RTR01',28-MAY-94,30-MAY-94,'Pinus banksiana','IFC1',6.3,
5.23,20,9.09,1.16,20,733.01,41.27,20,.32,.11,14,.05,.02,14,-999.0,-999.0,0,4.0,
.73,12,4.53,1.63,12,8.54,2.0,12,'CPI',13-NOV-98
'NSA-OBS-FLXTR','9TE02-RTR01',07-JUN-94,27-JUN-94,'Picea mariana','IFC1',7.79,
4.74,20,9.64,3.75,20,700.63,45.8,20,.83,.19,12,.08,.04,12,-999.0,-999.0,0,6.25,
1.73,9,6.19,2.51,9,12.43,3.87,9,'CPI',13-NOV-98
```

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

None.

9.1.1 Derivation Techniques and Algorithms

None given.

9.2 Data Processing Sequence

9.2.1 Processing Steps

The gas analyzer gives a CO_2 concentration. We calculated flux (µmol/s) as:

CO_2 concentration change (µmol/s/mol) * volume (mol).

9.2.2 Processing Changes

None given.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

Not applicable.

9.3.2 Calculated Variables

Not applicable.

9.4 Graphs and Plots

Not applicable.

10. Errors

10.1 Sources of Error

Variability of the samples is estimated with the standard deviation of the mean. CO_2 concentration can have a large influence on the rate of respiration. However, it is difficult to determine the exact CO_2 concentration of the root in its natural environment. Therefore, one of the largest potential sources error is this unknown CO_2 concentration. We estimated the CO_2 concentration of the root in its natural environment by sampling the CO_2 in the soil pore space. Another potential source of error is the effect of disturbance (from removing the root from its natural environment) on respiration rate or apparent respiration rate. We detected no significant difference in respiration rate from roots in situ and roots that had been severed. However, the effect of removing the very fine roots and associated mycorrhizae on respiration rates of fine roots is unknown.

10.2 Quality Assessment

Flux rates of CO_2, nitrogen and phosphorus concentrations, starch and sugar content, and dry weight are likely estimated for the sample within +/-5 percent. The largest unknowns are the effect of soil CO_2 concentration and the impact of disturbance on apparent respiration rates.

10.2.1 Data Validation by Source

None given.

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

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

These data can be used to study the fine root respiration rates of boreal vegetation.

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 root respiration 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.

17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation

None.

17.2 Journal Articles and Study Reports

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Steele, S.J., S.T. Gower, J.G. Vogel, and J.M. Norman. 1997. Root mass, net primary production and turnover in aspen, jack pine and black spruce forests in Saskatchewan and Manitoba, Canada. Tree Phys. 17(8/9): 577-587.

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17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

ADC - Analytical Development Company
ASCII - American Standard Code for Information Interchange
BOREAS - BOReal Ecosystem-Atmosphere Study
BORIS - BOREAS Information System
CD-ROM - Compact Disk-Read-Only Memory
CO_2 - Carbon Dioxide
DAAC - Distributed Active Archive Center
EOS - Earth Observing System
EOSDIS - EOS Data and Information System
GIS - Geographic Information System
GSFC - Goddard Space Flight Center
HTML - Hypertext Markup Language
IFC - Intensive Field Campaign
IRGA - Infrared Gas Analyzer
MIX - Mixed
NAD83 - North American Datum of 1983
NIR - Near Infrared Radiation
NOAA - National Oceanic and Atmospheric Administration
NSA - Northern Study Area
OA - Old Aspen
OBS - Old Black Spruce
OJP - Old Jack Pine
ORNL - Oak Ridge National Laboratory
PANP - Prince Albert National Park

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PAR     - Photosynthetically Active Radiation
PPFD    - Photosynthetic Photon Flux Density
SSA     - Southern Study Area
TE      - Terrestrial Ecology
TF      - Tower Flux site
URL     - Uniform Resource Locator
UTM     - Universal Transverse Mercator
YA      - Young Aspen
YJP     - Young Jack Pine
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Dr. Michael G. Ryan, USDA Forest Service, Rocky Mountain Research Station, and Dr. Michael Lavigne, Forestry Canada, Maritimes Region

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The BOREAS TE-2 team collected several data sets in support of its efforts to characterize and interpret information on the respiration of the foliage, roots, and wood of boreal vegetation. This data set includes means of tree root respiration measurements on roots having diameters ranging from 0 to 2 mm conducted in the NSA during the growing season of 1994. The data are stored in tabular ASCII files.

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