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

Forrest G. Hall and Andrea Papagno, Editors

Volume 129
BOREAS TE-2 Wood Respiration Data

M.G. Ryan and M. Lavigne

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

October 2000
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Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

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Volume 129
BOREAS TE-2 Wood
Respiration Data

Michael G. Ryan, USDA Forest Service, Fort Collins, Colorado
Michael Lavigne, Forestry Canada, Maritimes Region, Fredericton, New Brunswick, Canada

National Aeronautics and Space Administration
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October 2000
BOREAS TE-2 Wood 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 contains measurements of wood respiration conducted in the NSA during the growing season of 1994. The data are stored in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification
BOREAS TE-02 Wood Respiration Data

1.2 Data Set Introduction
Field studies of wood respiration were conducted on tree stems at the BOReal Ecosystem-Atmosphere Study (BOREAS) Northern Study Area (NSA) in 1994. This data set includes the measurements of wood respiration measured from May 1994 to late September 1994 at the Old Black Spruce (OBS), Old Jack Pine (OJP), Young Jack Pine (YJP), and Old Aspen (OA) study sites in the NSA. Characteristics of the stem (growth, sapwood volume, etc.) for samples measured for wood respiration on tree stems were sampled after the end of the 1994 growth season at the end of September 1994 and given in another file. TIME_OBS times of -999 in the data were times not reported by the Terrestrial Ecology (TE)-02 team.
1.3 Objectives/Purpose
The objectives of the work were to: Determine whether respiratory parameters vary among three boreal tree species (black spruce, jack pine, and trembling aspen). Compare respiration parameters from the cold northern sites with those from the warmer, southern sites. Provide estimates of respiratory parameters for ecosystem process models. Use our estimates of wood respiration, estimates of wood biomass, and wood temperature throughout the year to estimate the annual carbon cost for wood respiration.

1.4 Summary of Parameters
Each data record includes the air temperature, sapwood temperature, concentration of CO₂ in chamber during measurement, area of chamber, area of the segment, respiration for the chamber at the sapwood temperature, respiration for the chamber at 15 °C, and respiration for the segment at 15 °C.

1.5 Discussion
In the NSA, we measured wood 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), and in September, after IFC-3.

1.6 Related Data Sets
BOREAS TE-02 Foliage Respiration Data
BOREAS TE-02 Root Respiration Data
BOREAS TE-02 Stem Growth 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

Contact 1:
Dr. Michael G. Ryan
USDA Forest Service
Rocky Mountain Research Station
240 West Prospect Rd.
Fort Collins, CO 80526-2098
(970) 498-1012
mryan@lamar.colostate.edu

Contact 2:
Dr. Michael Lavigne
Forestry Canada, Maritimes Region
P.O. Box 4000
Fredericton, New Brunswick E3B 5P7
Canada
3. Theory of Measurements

Respiration requires oxygen and oxidizes sugars, producing energy, water, and CO₂. In most plant cells, the ratio between the oxygen absorbed and CO₂ produced in respiration is close to one. Therefore, because small changes in CO₂ concentration in the air are easier to measure than small changes in the oxygen content of the air, respiration is typically measured as CO₂ evolution from plant tissues. CO₂ 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 to measure stem wood respiration was an open system, which estimates molar flux of CO₂ from plant tissue respiration as the difference between the CO₂ concentration entering and exiting the chamber times the molar flow rate of air through the chamber (Field et al., 1991). Respiration of woody tissues is estimated as the CO₂ efflux at the boundary of the bark-air interface. Respiration rates are typically expressed as moles CO₂ per m² bark area per second. Respiration of woody tissues will vary with temperature and sapwood volume, and perhaps with sapwood nitrogen, phosphorus, or carbohydrate content. Sampling for nitrogen, phosphorus, or carbohydrate content or determining sapwood cross-sectional area of a stem involves destructive measurements. Therefore, samples are generally taken after the respiration measurements have been completed. These characteristics are stored in TE-02 Stem Growth Sapwood.

4. Equipment

4.1 Instrument Description

4.1.1 Collection Environment
Respiration measurements were made in the field. All other measurements took place under laboratory conditions.

4.1.2 Source/Platform
The measured trees and ground supported the needed equipment.

4.1.3 Source/Platform Mission Objectives
Not applicable.

4.1.4 Key Variables
Air temperature, sapwood temperature, CO₂ in chamber during measurement, area of chamber, area of segment, respiration for chamber at sap temperature, respiration for chamber at 15 °C, and respiration for segment at 15 °C. To further explain these two terms, area of chamber is the surface area (m²) of bark physically covered by the chamber. Area of segment is the surface area (m²) of a cylinder of stem with height equal to chamber height centered on the chamber.
4.1.5 Principles of Operation
The system that we used to measure stem wood respiration was an open system, which estimates molar flux of CO₂ from plant tissue respiration as the difference between the CO₂ concentration entering and exiting the chamber times the molar flow rate of air through the chamber (Field et al., 1991).

4.1.6 Sensor/Instrument Measurement Geometry
None.

4.1.7 Manufacturer of Instrument
CR-21X Datalogger
Campbell Scientific, Inc.
815 West 1800 North
Logan, UT 84321-1784
(435) 753-2342
(435) 750-9540 (fax)
support@campbellsci.com

IRGA
LCA3 or LCA4
Analytical Development Company (ADC)
Hoddeston, Herts., UK
Distributed by:
Dynamax, Inc.
10808 Fallstone
Suite 350
Houston, TX 77099 USA
(281) 564-5100

4.2 Calibration

4.2.1 Specifications
None given.

4.2.1.1 Tolerance
None given.

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. Typically, the analyzer drifted less than 1% between calibrations.

4.2.3 Other Calibration Information
We calibrated the molar flow of ideal gas roughly every month with a bubble column. We used standard meteorological pressure (reported at Thompson), corrected for elevation, and temperature from a copper-constantan thermocouple to calculate molar flow from the volume flow for this calculation.
5. Data Acquisition Methods

Stem respiration was measured on 20 trees in the NSA at the OJP, OBS, and OA sites, and 10 trees at YJP; tree diameters spanned the range of the stand. At the OJP, OBS, and OA sites, aluminum chamber plates with an external neoprene gasket were attached to the north side of the tree with putty; loose bark was removed before attaching the chamber plate. Chambers were at 1.2 to 1.4 m height; on four trees per stand, additional chambers were placed at 6 m. For CO2 efflux measurements, a Plexiglas chamber was sealed to the chamber plate with an elastic cord. Chamber area for OA, OBS, and OJP was 110 cm². That is counting 1/2 of the plate area (assuming 1/2 of the flux under the plate goes into the chamber and 1/2 does not). The area inside the chamber is 80.5 cm². For measurements at YJP, split Plexiglas chambers (23 cm) enclosed the entire stem, with neoprene gaskets creating a seal. A small fan mixed the air in each chamber, and chambers were removed between measurements. Temperatures were measured only on trees 1 to 4 at OA, OJP, and OBS and on all trees at YJP. At OA, OJP, and OBS, we averaged the temperatures from the position 1 chambers from trees 1-4 for chambers on trees 4-20. Coefficient of variation (CV) for sapwood temperatures on trees 1-4 were 1-5%. Measurements were taken in late afternoon, when temperature had been relatively stable for a few hours, to help overcome the problem of flux lagging sapwood temperature.

Two types of measurements were made in 1994. (1) Each IFC at the OJP, OBS, and OA sites, CO2 efflux was measured once per hour for 3-6 days on eight chambers (four trees at 1.3 and 6 m) to determine temperature response; at YJP, continuous measurements were made for six trees only during the midsummer IFC. These data are in file: wood_respiration_continuous_nsa.csv. (2) Point measurements of CO2 flux were made every 2-3 weeks at all sites for all chambers (this file). The continuous measurements were made using a manifold and an open system (Field et al., 1991), controlled with a CR-21X datalogger (Campbell Scientific, Logan, UT, USA). The manifold system had two separate gas circuits: when CO2 efflux was being measured, inlet air was drawn through a 20-L mixing chamber (to provide a stable reference CO2 concentration), passed through the chamber at 270 pmol/s, and returned to the CO2 analyzer (ADC LCA2, ADC, Hoddeston, UK). Otherwise, inlet air was pushed through the chambers at 3.5 mmol/s, to keep CO2 concentration in the chamber at < 5 µmol/mol above ambient. The point measurements were made with an open system (Field et al., 1991) and an ADC LCA3 or LCA4 gas analyzer with an air flow of 270 µmol/s. Methods are similar to those described in Ryan et al. (1995) and are more fully described in Lavigne and Ryan (1997).

6. Observations

6.1 Data Notes
TIME_OBS times of -999 in the data indicate that times were not provided by TE-02.

6.2 Field Notes
None.

7. Data Description

7.1 Spatial Characteristics
7.1.1 Spatial Coverage
The measurement sites and associated North American Datum of 1983 (NAD83) coordinates are:
- NSA-OA canopy access, operational grid 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
- NSA-OBS canopy access tower, operational grid site id T3R8T, Lat/Long: 55.88007°N, 98.48139°W, UTM Zone 14, N: 6,192,853.4, E: 532,444.5
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
Measurements were made during June, July, August, and September of 1994.

7.2.2 Temporal Coverage Map
None given.

7.2.3 Temporal Resolution
Measurements were made every 10-20 days. Each sample represents flux for that particular chamber for 5-10 minutes. TIME_OBS times of -999 in the data indicate that times were not provided by TE-02.

7.3 Data Characteristics

7.3.1 Parameter/Variable
The parameters contained in the data files on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
</tr>
<tr>
<td>SUB_SITE</td>
</tr>
<tr>
<td>DATE_OBS</td>
</tr>
<tr>
<td>TIME_OBS</td>
</tr>
<tr>
<td>SPECIES</td>
</tr>
<tr>
<td>SAMPLE_ID</td>
</tr>
<tr>
<td>CHAMBER_HEIGHT</td>
</tr>
<tr>
<td>AIR_TEMP</td>
</tr>
<tr>
<td>SAP_TEMP</td>
</tr>
<tr>
<td>CO2_CONC_CHAMBER</td>
</tr>
<tr>
<td>STEM_AREA_CHAMBER</td>
</tr>
<tr>
<td>TOTAL_STEM_AREA</td>
</tr>
<tr>
<td>STEM_RESP_CHAMBER_SAP_TEMP</td>
</tr>
<tr>
<td>STEM_RESP_CHAMBER_15C</td>
</tr>
<tr>
<td>STEM_SEGMENT_RESP_CHAMBER_15C</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
</tr>
<tr>
<td>REVISION_DATE</td>
</tr>
</tbody>
</table>
7.3.2 Variable Description/Definition
The descriptions of the parameters contained in the data files on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
<td>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.</td>
</tr>
<tr>
<td>SUB_SITE</td>
<td>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.</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>The date on which the data were collected.</td>
</tr>
<tr>
<td>TIME_OBS</td>
<td>The Greenwich Mean Time (GMT) when the data were collected.</td>
</tr>
<tr>
<td>SPECIES</td>
<td>Botanical (Latin) name of the species (Genus species).</td>
</tr>
<tr>
<td>SAMPLE_ID</td>
<td>The sample identifier used by data collectors (see documentation for a detailed description).</td>
</tr>
<tr>
<td>CHAMBER_HEIGHT</td>
<td>The height above the ground at which the chamber was placed.</td>
</tr>
<tr>
<td>AIR_TEMP</td>
<td>The air temperature.</td>
</tr>
<tr>
<td>SAP_TEMP</td>
<td>The sapwood temperature.</td>
</tr>
<tr>
<td>CO2_CONC_CHAMBER</td>
<td>The CO2 concentration of the air in the chamber.</td>
</tr>
<tr>
<td>STEM_AREA_CHAMBER</td>
<td>The surface area of bark physically covered by the chamber.</td>
</tr>
<tr>
<td>TOTAL_STEM_AREA</td>
<td>The total surface area of a cylinder with height equal to the length of the chamber and circumference proportional to the radius of the measured stem.</td>
</tr>
<tr>
<td>STEM_RESP_CHAMBER_SAP_TEMP</td>
<td>The CO2 respiration of the stem covered by the chamber at the sapwood temperature.</td>
</tr>
<tr>
<td>STEM_RESP_CHAMBER_15C</td>
<td>The CO2 respiration of the stem covered by the chamber at 15 degrees Celsius.</td>
</tr>
<tr>
<td>STEM_SEGMENT_RESP_CHAMBER_15C</td>
<td>The CO2 respiration of the stem segment at 15 degrees Celsius.</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
<td>The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).</td>
</tr>
<tr>
<td>REVISION_DATE</td>
<td>The most recent date when the information in the referenced data base table record was revised.</td>
</tr>
</tbody>
</table>
### 7.3.3 Unit of Measurement

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

<table>
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<th>Column Name</th>
<th>Units</th>
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<tr>
<td>SUB_SITE</td>
<td>[none]</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>[DD-MON-YY]</td>
</tr>
<tr>
<td>TIME_OBS</td>
<td>[HHMM GMT]</td>
</tr>
<tr>
<td>SPECIES</td>
<td>[none]</td>
</tr>
<tr>
<td>SAMPLE_ID</td>
<td>[none]</td>
</tr>
<tr>
<td>CHAMBER_HEIGHT</td>
<td>[meters]</td>
</tr>
<tr>
<td>AIR_TEMP</td>
<td>[degrees Celsius]</td>
</tr>
<tr>
<td>SAP_TEMP</td>
<td>[degrees Celsius]</td>
</tr>
<tr>
<td>CO2_CONC_CHAMBER</td>
<td>[parts per million]</td>
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<tr>
<td>STEM_AREA_CHAMBER</td>
<td>[meters^2]</td>
</tr>
<tr>
<td>TOTAL_STEM_AREA</td>
<td>[meters^2]</td>
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<tr>
<td>STEM_RESP_CHAMBER_SAP_TEMP</td>
<td>[nanomoles CO2][second^-1]</td>
</tr>
<tr>
<td>STEM_RESP_CHAMBER_15C</td>
<td>[nanomoles CO2][second^-1]</td>
</tr>
<tr>
<td>STEM_SEGMENT_RESP_CHAMBER_15C</td>
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</tr>
<tr>
<td>CRTFCN_CODE</td>
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<td>[DD-MON-YY]</td>
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### 7.3.4 Data Source

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

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<th>Column Name</th>
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<tr>
<td>SUB_SITE</td>
<td>[BORIS Designation]</td>
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<tr>
<td>DATE_OBS</td>
<td>[Human Observer]</td>
</tr>
<tr>
<td>TIME_OBS</td>
<td>[Human Observer]</td>
</tr>
<tr>
<td>SPECIES</td>
<td>[Human Observer]</td>
</tr>
<tr>
<td>SAMPLE_ID</td>
<td>[Human Observer]</td>
</tr>
<tr>
<td>CHAMBER_HEIGHT</td>
<td>[Human Observer]</td>
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<tr>
<td>AIR_TEMP</td>
<td>[Thermometer]</td>
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<tr>
<td>SAP_TEMP</td>
<td>[Thermometer]</td>
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<td>CO2_CONC_CHAMBER</td>
<td>[Laboratory Equipment]</td>
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<tr>
<td>STEM_AREA_CHAMBER</td>
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<tr>
<td>TOTAL_STEM_AREA</td>
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<tr>
<td>STEM_RESP_CHAMBER_SAP_TEMP</td>
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<tr>
<td>STEM_RESP_CHAMBER_15C</td>
<td>[Laboratory Equipment]</td>
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<tr>
<td>CRTFCN_CODE</td>
<td>[BORIS Designation]</td>
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<tr>
<td>REVISION_DATE</td>
<td>[BORIS Designation]</td>
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</table>
7.3.5 Data Range

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

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<th>Missng Data Value</th>
<th>Unrel Data Value</th>
<th>Below Detect Limit</th>
<th>Data Not Cllctd</th>
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</thead>
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<td>NSA-YJP-FLXTR</td>
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<td>None</td>
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<td>None</td>
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<td>AIR_TEMP</td>
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<td>CO2_CONC_CHAMBER</td>
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<td>None</td>
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<tr>
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<tr>
<td>REVISION_DATE</td>
<td>26-OCT-98</td>
<td>26-OCT-98</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

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 that 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, DATE_OBS, TIME_OBS, SPECIES, SAMPLE_ID, CHAMBER_HEIGHT, AIR_TEMP, 
SAP_TEMP, CO2_CONC_CHAMBER, STEM_AREA_CHAMBER, TOTAL_STEM_AREA, 
STEM_RESP_CHAMBER_SAP_TEMP, STEM_RESP_CHAMBER_15C, STEM_SEGMENT_RESP_CHAMBER_15C, 
CRTFCN_CODE, REVISION_DATE 
'NSA-90A-9TETR', '9TE02-WDR01', 15-JUN-94, .999, 'Populus tremuloides', '20', 1.3, 
-999.0, 8.8, 382.0, .011, .0882, 4.24, 6.54, 52.46, 'CPI', 26-OCT-98 
'NSA-90A-9TETR', '9TE02-WDR01', 15-JUN-94, 2103, 'Populus tremuloides', '3', 1.3, 8.3, 
7.6, 447.0, .011, .0768, 5.96, 10.01, 69.87, 'CPI', 26-OCT-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.

9.2 Data Processing Sequence

9.2.1 Processing Steps
None given.

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
Sample trees were selected to represent the range of variability in respiration rates, as well as provide an estimate of mean per stem area respiration rates. Because the IRGAs could typically resolve a difference in concentration of CO₂ of one μmol/mol, lower respiration rates have more uncertainty in the measurement.

10.2 Quality Assessment
Flux rates of CO₂ are likely estimated for the sample within +/- 5 percent.

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
Flux rates of CO₂ are likely estimated for the sample within +/- 5 percent.

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
TIME_OBS times of -999 in the data indicate that times were not provided by TE-02.
12. Application of the Data Set

These data can be used to study wood 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 wood 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: ormdaac@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


17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC</td>
<td>Analytical Development Company</td>
</tr>
<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
</tr>
<tr>
<td>BOREAS</td>
<td>BOReal Ecosystem-Atmosphere Study</td>
</tr>
<tr>
<td>BORIS</td>
<td>BOREAS Information System</td>
</tr>
<tr>
<td>CD-ROM</td>
<td>Compact Disk-Read-Only Memory</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>CV</td>
<td>Coefficient of variation</td>
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<tr>
<td>DAAC</td>
<td>Distributed Active Archive Center</td>
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<td>EOS</td>
<td>Earth Observing System</td>
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<tr>
<td>EOSDIS</td>
<td>EOS Data and Information Archive System</td>
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<td>GIS</td>
<td>Geographic Information System</td>
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<td>GSFC</td>
<td>Goddard Space Flight Center</td>
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<tr>
<td>HTML</td>
<td>Hypertext Markup Language</td>
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<tr>
<td>IFC</td>
<td>Intensive Field Campaign</td>
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<tr>
<td>IRGA</td>
<td>Infrared Gas Analyzer</td>
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<tr>
<td>MIX</td>
<td>Mixed</td>
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<tr>
<td>NAD83</td>
<td>North American Datum of 1983</td>
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<tr>
<td>NIR</td>
<td>Near Infrared Radiation</td>
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<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<tr>
<td>NSA</td>
<td>Northern Study Area</td>
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<tr>
<td>OA</td>
<td>Old Aspen</td>
</tr>
<tr>
<td>OBS</td>
<td>Old Black Spruce</td>
</tr>
<tr>
<td>OJP</td>
<td>Old Jack Pine</td>
</tr>
<tr>
<td>ORNL</td>
<td>Oak Ridge National Laboratory</td>
</tr>
<tr>
<td>PANP</td>
<td>Prince Albert National Park</td>
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<tr>
<td>PAR</td>
<td>Photosynthetically Active Radiation</td>
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<td>PPFD</td>
<td>Photosynthetic Photon Flux Density</td>
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<tr>
<td>SSA</td>
<td>Southern Study Area</td>
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<tr>
<td>TE</td>
<td>Terrestrial Ecology</td>
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<tr>
<td>TF</td>
<td>Tower Flux site</td>
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<tr>
<td>URL</td>
<td>Uniform Resource Locator</td>
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<tr>
<td>UTM</td>
<td>Universal Transverse Mercator</td>
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<td>YA</td>
<td>Young Aspen</td>
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<td>YJP</td>
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20. Document Information

20.1 Document Revision Date
Written: 29-Sep-1998
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20.2 Document Review Date(s)
BORIS Review: 01-Dec-1998
Science Review:

20.3 Document ID

20.4 Citation
When using these data, please include the following acknowledgment as well as citations of relevant papers in Section 17.2:
Dr. Michael G. Ryan, USDA Forest Service, Rocky Mountain Research Station, and Dr. Michael Lavigne, Forestry Canada, Maritimes Region

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

Also, cite the BOREAS CD-ROM set as:

20.5 Document Curator

20.6 Document URL
**Title and Subtitle**
Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)
BOREAS TE-2 Wood Respiration Data

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National Aeronautics and Space Administration
Washington, DC 20546-0001

**Abstract**
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 contains measurements of wood respiration conducted in the NSA during the growing season of 1994. The data are stored in tabular ASCII files.