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

Forrest G. Hall and Shelaine Curd, Editors

Volume 154
BOREAS TE-9 NSA Canopy Biochemistry

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October 2000
BOREAS TE-9 NSA Canopy Biochemistry

Hank Margolis, Martin Charest, Mikailou Sy

Summary

The BOREAS TE-9 team collected several data sets related to chemical and photosynthetic properties of leaves. This data set contains canopy biochemistry data collected in 1994 in the NSA at the YJP, OJP, OBS, UBS, and OA sites, including biochemistry lignin, nitrogen, cellulose, starch, and fiber concentrations. These data were collected to study the spatial and temporal changes in the canopy biochemistry of boreal forest cover types and how a high-resolution radiative transfer model in the mid-infrared could be applied in an effort to obtain better estimates of canopy biochemical properties using remote sensing. The data are available in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS TE-09 NSA Canopy Biochemistry

1.2 Data Set Introduction

These data describe the canopy biochemistry (lignin, nitrogen, cellulose, starch, fiber) at the BOREal Ecosystem-Atmosphere Study (BOREAS) Northern Study Area (NSA) Young Jack Pine (YJP), Old Jack Pine (OJP), Old Black Spruce (OBS), Upland Black Spruce (UBS), and Old Aspen (OA) sites.

These data were collected to study the spatial and temporal changes in the canopy biochemistry of boreal forest cover types and how a high-resolution radiative transfer model in the mid-infrared could be applied in an effort to obtain better estimates of canopy biochemical properties using remote sensing.
1.3 Objective/Purpose

These data were collected to study the spatial and temporal changes in the canopy biochemistry of boreal forest cover types and how a high-resolution radiative transfer model in the mid-infrared could be applied in an effort to obtain better estimates of canopy biochemical properties using remote sensing. Canopy biochemistry (lignin, nitrogen, cellulose, starch, fiber) can be related to a number of ecosystem processes, such as litter decomposition, nutrient cycling rates, soil CO2 fluxes, carbon allocation between belowground and aboveground components, and photosynthetic capacity. There is some evidence suggesting that several aspects of canopy biochemistry can be estimated using high-resolution reflectance data in the mid-infrared. While several biochemical components can be accurately measured in the laboratory with ground plant material, making reliable estimates in real forests is difficult because the structure of shoots, branches, and trees influences the reflectance spectra.

1.4 Summary of Parameters

Sampling period, site identification, sample identification, fiber concentration (%), cellulose concentration (%), lignin concentration (%), total soluble sugars (%), nitrogen concentration (%), and starch concentration (%).

1.5 Discussion

At the NSA (Thompson, Manitoba), foliage from the upper third of the canopies of the YJP, OJP, OBS, and UBS stands was sampled five times during 1994 in conjunction with each field campaign (Focused Field Campaign Winter (FFC-W), FFC-Thaw (FFC-T), Intensive Field Campaign (IFC)-1, IFC-2, and IFC-3), while samples from OA were taken only during IFCs. Samples were taken either on the day of or on the day following the Airborne Visible and Infrared Imaging Spectrometer (AVIRIS) missions in the NSA. Five samples were taken from five different dominant trees at each site at each date. Trees sampled were black spruce (Picea mariana), jack pine (Pinus banksiana), and aspen (Populus tremuloides). Samples were lyophilisated and ground (Tecator Cyclotec 1093 sample mill) to pass through a 0.40-mm mesh screen. For each biochemical component, analyses were conducted on two random subsamples that were equivalent to 100 mg dry weight for total soluble sugars or starch concentration; 1 g for fiber, cellulose, or lignin concentrations; and 500 mg for nitrogen concentration. Data given in TABLE 1 were averaged for the two subsamples.

1.6 Related Data Sets
BOREAS TE-09 NSA Photosynthetic Capacity and Foliage Nitrogen Data
BOREAS TE-09 PAR and Leaf Nitrogen Data for NSA Species
BOREAS TE-09 In Situ Diurnal Gas Exchange of NSA Boreal Forest Stands

2. Investigator(s)

2.1 Investigator(s) Name and Title
Hank Margolis, Ph.D.
Universite Laval
Faculte de foresterie et de geomatique

2.2 Title of Investigation
Relationship Between Measures of Absorbed and Reflected Radiation and the Photosynthetic Capacity of Boreal Forest Canopies and Understories
2.3 Contact Information

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Faculte de foresterie et de geomatique
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Contact 3:
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Faculte de foresterie et de geomatique
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shelaine.curd@gsfc.nasa.gov

3. Theory of Measurements

For total soluble sugars and starch concentrations, each subsample was extracted in a 15-ml aliquot of methanol-chloroform-water solvent (M-C-W: 12:5:3). Extracts were centrifuged three times for 5 minutes each time at 3,500 rpm. Two 75-ml aliquots were used to quantify soluble sugars (Dubois et al., 1956), and another group of two 75-ml aliquots was used for starch (Boehringer Mannheim Company, 1993). Spectrophotometric measurements were made using a Spectronic 20 (Bausch and Lomb). Transmittance readings first were made using glass cells and were then converted to corresponding absorbencies.

Fiber, lignin, and cellulose analyses were conducted following material extraction in a mixture of H₂SO₄ 0.5 M and cetyltrimethylammonium bromide (Ryan et al., 1990). Fiber concentration was analyzed from these first extracts while lignin and cellulose were conducted on insoluble residues (Ryan et al., 1990). A second extraction in 72% H₂SO₄ for 3 hours at 20-23 °C removed the cellulose
concentration (Ryan et al., 1990). Residues were then ashed at 450 °C for 8 hours to obtain the ash-free lignin concentration (Ryan et al., 1990).

Nitrogen concentration analysis was conducted using the micro-Kjeldahl method (Parkinson and Allen, 1975). The sample distillation was conducted using a Kjeltec 1030 autoanalyzer, which is a single unit for fast and automatic distillation, titration, and calculation using the Kjeldahl method. Results from this distillator model are presented on a digital display or printed.

4. Equipment

4.1 Sensor/Instrument Description

- Shotgun, cooler with icebags, plastic bags, pruner, automatic dispenser, glass test tubes, Eppendorf pipet, high-precision balance grinding machine, centrifuge, distillator, spectrophotometer, glass cells, chemical products, lyophilisator.

4.1.1 Collection Environment

Sites: Samples were collected from five sites at the NSA in Thompson, Manitoba. The sites are described in Appendix I and can be identified in Figure 5.1.5a of the BOREAS Experiment Plan, Version 3.0.

- NSA-YJP: T8S9T
- NSA-OJP: T7Q8T
- NSA-OBS: T3R8T
- NSA-BS: T6R3S
- NSA-OA: T2Q6A

Sampling: Sampling dates, except those in the winter and thaw periods, correspond with either the day of or the day following the AVIRIS missions in the NSA. For each site, branches were taken from the upper third of the canopy of five dominant trees in a representative location using a shotgun. Branches were kept in labeled plastic bags, stored in a cooler containing icebags, and transported to the laboratory in Thompson. From each bag, an appropriate amount of foliage was lyophilisated and ground. Two equivalent subsamples were then taken and extracted for each biochemical component. Analyses were conducted on those extracts.

Extracts: Automatic dispensers were used to deliver the 15-ml aliquots of methanol-chloroform-water solvent (M-C-W: 12-5-3) in glass test tubes containing ground material for soluble sugars and starch analysis.

Raw fiber concentration is strongly correlated to the proximate carbon fraction (Ryan et al., 1990) and is used in entomology to estimate the non-nutritive component of foliage. It was determined from a mixture of H₂SO₄ 0.5 M and cetyltrimethyl-ammonium extracts. Residues of this first extraction were extracted in 72% H₂SO₄ for 3 hours at 20-23 °C to remove cellulose concentration. Residues were then ashed at 450 °C for 8 hours to obtain the ash-free lignin concentration. For nitrogen analysis, samples were digested using a solution mixing 350 ml of H₂O₂, 0.42 g Se powder, and 14 g Li₂SO₄. H₂O in a flat-bottomed, boiling flask and carefully adding 420 ml H₂SO₄ while swirling and cooling the mixture was stored at 1 °C.

Quantities estimated: Components were calculated according to respective references and were expressed in percentage of foliage material dry weight basis.
4.1.2 **Source/Platform**
One or two persons collected branches at all sites, put them in labeled plastic bags in a cooler containing icebags, and transported them to laboratory. Foliage was then sampled, lyophilised, and ground. Subsamples were taken for extractions and analyses.

4.1.3 **Source/Platform Mission Objectives**
The mission was undertaken to establish the relationship between biochemical patterns and high-resolution mid-infrared reflectance data taken with AVIRIS on the National Aeronautics and Space Administration (NASA) ER-2 aircraft.

4.1.4 **Key Variables**
Foliar concentrations in fiber (%), cellulose (%), lignin (%), total soluble sugars (%), nitrogen (%), and starch (%).

4.1.5 **Principles of Operation**
Not applicable.

4.1.6 **Sensor/Instrument Measurement Geometry**
Samples were harvested from the upper third of the canopy of five dominant trees for all sites at all sampling dates.

4.1.7 **Manufacturer of Sensor/Instrument**

Grinding machine
Tecator Cyclotec 1093 sample mill
Tecator, Inc.
P.O. Box 405
Herndon, VA 22070 USA
(703) 435-3300

Weighing balance
Mettler-Toledo AG, Type AB104
IM Langacher, CH-8606 Greifensee
Switzerland
(01) 944 22 11
Telex: 82 61 50

Chemical Products
Sigma Chemical Company
P.O. Box 14508
St. Louis, MO 63178-9916 USA
1 (800) 325-3010

Centrifuge
IEC Model HN-SII Centrifuge
300 Second Avenue
Needham Heights, MA 02194 USA

Spectrophotometer
Spectronic 20
Bausch and Lomb
Glass cells
Hellma
Fisher Scientific,
8505 Devonshire Rd., Montreal (Quebec)
Canada H4P 2 L4
4.2 Calibration

4.2.1 Specifications
The weighing balance was accurate to within 0.0001 g. The automatic dispenser was accurate to within 1%. The spectrophotometer was accurate to within 0.001 absorbance unit.

4.2.1.1 Tolerance
Not applicable.

4.2.2 Frequency of Calibration
The control level on the spectrophotometer was verified (0 absorbance unit) after each group of five samples.

4.2.3 Other Calibration Information
Not available.

5. Data Acquisition Methods

Sites: Samples were collected from five NSA sites in Thompson, Manitoba. The sites are described in Appendix I and can be identified in Figure 5.1.5a of the BOREAS Experiment Plan (Version 3.0).

NSA-YJP: T8S9T
NSA-OJP: T7Q8T
NSA-OBS: T3R8T
NSA-BS: T6R5S
NSA-OA: T2Q6A

Sampling: Sampling dates, except those in the winter and thaw periods, correspond with either the day of or the day following the AVIRIS missions in the NSA. For each site, branches were taken from the upper third of the canopy of five dominant trees in a representative location using a shotgun. Branches were kept in labeled plastic bags, stored in a cooler containing icebags, and transported to the laboratory in Thompson. From each bag, an appropriate amount of foliage was lyophilised and ground. Two equivalent subsamples were then taken and extracted for each biochemical component. Analyses were conducted on those extracts.
Extractions: Automatic dispensers were used to deliver the 15-ml aliquots of methanol-chloroform-water solvent (M-C-W: 12-5-3) in glass test tubes containing ground material for soluble sugars and starch analysis.

Raw fiber concentration is strongly correlated to the proximate carbon fraction (Ryan et al., 1990) and is used in entomology to estimate the non-nutritive component of foliage. It was determined from a mixture of H₂SO₄ 0.5 M and cetyltrimethyl-ammonium extracts. Residues of this first extraction were extracted in 72% H₂SO₄ for 3 hours at 20-23 °C to remove cellulose concentration. Residues were then ashed at 450 °C for 8 hours to obtain the ash-free lignin concentration. For nitrogen analysis, samples were digested using a solution of 350 ml of H₂O₂, 0.42 g of Se powder, and 14 g of Li₂SO₄. H₂O in a flat-bottomed 1-liter boiling flask and carefully adding 420 ml H₂SO₄ while swirling and cooling the mixture, which was stored at 1 °C.

Quantities estimated: Components were calculated according to respective references and were expressed in percentage of foliage material dry weight basis.

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 North American Datum of 1983 (NAD83) coordinates for the sites are:
- NSA-YJP flux tower site: Lat/Long: 55.89575°N, 98.28706°W; UTM Zone 14, N: 6194706.9, E: 544583.9
- NSA-OJP flux tower site: Lat/Long: 55.842°N, 98.62396°W; UTM Zone 14, N: 6198176.3, E: 523496.2
- NSA-OA canopy access tower site (auxilliary site number T2Q6A, BOREAS Experiment Plan, Version 3.0): Lat/Long: 55.88691°N, 98.67479°W; UTM Zone 14, N: 6193540.7, E: 520342
- NSA-OBS flux tower site: Lat/Long: 55.88007°N, 98.48139°W; UTM Zone 14, N: 6192853.4, E: 532444.5
- NSA-UBS canopy access tower site (auxilliary site number T6R5S, BOREAS Experiment Plan, Version 3.0): Lat/Long: 55.90802°N, 98.51865°W; UTM Zone 14, N: 6195947 E 530092

7.1.2 Spatial Coverage Map
Not applicable.

7.1.3 Spatial Resolution
These data represent point source measurements that may be generally representative.

7.1.4 Projection
Not applicable.
7.1.5 Grid Description
Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage
The overall time period of sample acquisition was from 01-Feb-1994 through 18-Sep-1994.

7.2.2 Temporal Coverage Map
Samples were collected on the following dates:

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<tr>
<th>IFC</th>
<th>Sites (NSA) and Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFC-W</td>
<td>OJP, OBS, and YJP on 17-Feb-1994</td>
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<tr>
<td></td>
<td>TE-BS on 18-Feb-1994</td>
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<tr>
<td>FFC-T</td>
<td>OJP, OBS, and YJP on 28-Apr-1994</td>
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<td>TE-BS on 29-Apr-1994</td>
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<td>IFC-1</td>
<td>OA, OJP, and YJP on 08-Jun-1994</td>
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<td>OBS and BS on 09-Jun-1994</td>
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<td>IFC-2</td>
<td>OASP, OJP, and BS on 04-Aug-1994</td>
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<td></td>
<td>OBS and YJP on 05-Aug-1994</td>
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<td>IFC-3</td>
<td>OBS on 15-Sep-1994</td>
</tr>
<tr>
<td></td>
<td>OASP, YJP, OJP, and BS on 16-Sep-1994</td>
</tr>
</tbody>
</table>

7.2.3 Temporal Resolution
For each sampling date, branches were collected at 6:00 a.m. (local time) for OBS, at 8:00 a.m. for YJP, and between 3:00 p.m. and 6:00 p.m. for the UBS, OJP, and OA sites.

7.3 Data Characteristics

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

**BIOCHEM_AVG_DATA**

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<th>Column Name</th>
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<td>SITE_NAME</td>
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<td>SUB_SITE</td>
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<tr>
<td>START_DATE</td>
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<td>END_DATE</td>
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The descriptions of the parameters contained in the data files on the CD-ROM are:

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<th>Description</th>
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<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>START_DATE</td>
<td>The date on which the collection of the reference data commenced.</td>
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<tr>
<td>END_DATE</td>
<td>The date on which the collection of the referenced data was terminated.</td>
</tr>
<tr>
<td>SPECIES</td>
<td>Botanical (Latin) name of the species (Genus species).</td>
</tr>
<tr>
<td>MEAN_FIBER_CONTENT</td>
<td>The mean fiber content of the sample.</td>
</tr>
<tr>
<td>STD_ERR_FIBER_CONTENT</td>
<td>Standard error for the fiber content of the sample.</td>
</tr>
<tr>
<td>MEAN_CELLULOSE_CONTENT</td>
<td>The mean cellulose content of the sample.</td>
</tr>
<tr>
<td>STD_ERR_CELLULOSE_CONTENT</td>
<td>Standard error for the cellulose content of the sample.</td>
</tr>
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**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.

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**START_DATE**
The date on which the collection of the reference data commenced.

**END_DATE**
The date on which the collection of the referenced data was terminated.

**SPECIES**
Botanical (Latin) name of the species (Genus species).

**BAG_SAMPLE_ID**
Branches collected from each tree were stored in two bags identified as 1, 2, or A, B. Example: 1.1 = sample 1 from bag 1-- 5.A sample 5 from bag A.

**FIBER_CONTENT**
The fiber content of the sample.

**CELLULOSE_CONTENT**
The cellulose content of the sample.

**LIGNIN_CONTENT**
The lignin content of the sample.

**TS_SUGAR_CONTENT**
The total soluble sugars content of the sample.

**NITROGEN_CONTENT**
The nitrogen content of the sample.

**STARCH_CONTENT**
The starch content of the sample.

**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.
Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).

**7.3.3 Unit of Measurement**

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

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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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**BIOCHRM_POINT_DATA**

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<td>END_DATE</td>
<td>BORIS Designation</td>
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<td>CELLULOSE_CONTENT</td>
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<td>NITROGEN_CONTENT</td>
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### 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>Data Limit</th>
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#### BIOCHEM_POINT_DATA

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<th>Below Detect</th>
<th>Data Limit</th>
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<tr>
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<td>None</td>
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</tr>
</tbody>
</table>

Minimum Data Value -- The minimum value found in the column.
Maximum Data Value -- The maximum value found in the column.
Missing 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.
Unreliable 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 Collected -- 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 is a sample of the first few records from the data table on the CD-ROM:

**BIOCHEM_AVG_DATA**

```
<table>
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<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>'NSA-9OA-9TETR'</td>
<td>'9TE09-BCA01'</td>
<td>19-JUL-94,08-AUG-94</td>
<td>'Populus tremuloides'</td>
<td>26.22</td>
<td>1.156,11.52,.34,14.0,.795,11.28,.341,2.092,.066,5.932,.41</td>
<td>'CPI',18-SEP-96</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

**BIOCHEM_POINT_DATA**

```
| SITE_NAME           | SUB_SITE   | START_DATE   | END_DATE    | SPECIES         | BAG_SAMPLE_ID | FIBER_CONTENT | CELLULOSE_CONTENT | LIGNIN_CONTENT | TS_SUGAR_CONTENT | NITROGENCONTENT | STARCH_CONTENT | CRTFCN_CODE | REVISION_DATE |
|---------------------|------------|--------------|-------------|-----------------|---------------|---------------|------------------|----------------|----------------|-----------------|---------------|--------------|--------------|---------------|
8. Data Organization

8.1 Data Granularity
The smallest unit of orderable data is data collected on one day at one site.

8.2 Data Format(s)
In BIOCHEM_Avg_DATA, data are presented for each sample (i.e., for each tree) and represent the average of two subsamples. In BIOCHEM_POINT_DATA, the subsequent averaged contents and corresponding standard errors are given on the basis of both site and sampling date.

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
None.

9.2.1 Processing Steps
Data were recorded automatically by a computer and also printed on a printer. Subsequent calculations of different parameters were performed using MS Excel for Windows 5.0.

BOREAS Information System (BORIS) staff processed the data by:
• Reviewing the initial data files and loading them online for BOREAS team access.
• Designing relational data base tables to inventory and store the data.
• Loading the data into the relational data base tables.
• Working with the TE-09 team to document the data set.
• Extracting the standardized data into logical files.

9.2.2 Processing Changes
None.

9.3 Calculations
All variables were measured.

9.3.1 Special Corrections/Adjustments
None.

9.3.2 Calculated Variables
None.
9.4 Graphs and Plots
None.

10. Errors

10.1 Sources of Error
Analyses of all components were conducted on a uniform basis but there are some missing values that have been accounted for in averages and standard error calculations.

10.2 Quality Assessment
None.

10.2.1 Data Validation by Source
Data were checked for obvious problems.

10.2.2 Confidence Level/Accuracy Judgment
High.

10.2.3 Measurement Error for Parameters
None.

10.2.4 Additional Quality Assessments
None.

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.

11.2 Known Problems with the Data
None.

11.3 Usage Guidance
This data file does not contain values for subsamples. A sample represents a tree and comprises two subsamples. The averaged content in TABLE2 is that of five samples (replications). Standard errors are among samples, not between subsamples.

11.4 Other Relevant Information
None.

12. Application of the Data Set
These data were collected to study the spatial and temporal changes in the canopy biochemistry of boreal forest cover types and how a high-resolution radiative transfer model in the mid-infrared could be applied in an effort to obtain better estimates of canopy biochemical properties using remote sensing.
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 NSA canopy biochemistry 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

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


17.3 Archive/DBMS Usage Documentation
None.

18. Glossary of Terms
None given.

19. List of Acronyms

- ASCII - American Standard Code for Information Interchange
- AVIRIS - Airborne Visible-Infrared Imaging Spectrometer
- BOREAS - BOREal Ecosystem-Atmosphere Study
- BORIS - BOREAS Information System
- CD-ROM - Compact Disk-Read-Only Memory
- CGI - Certified by Group
- CPI - Checked by Principal Investigator
- DAAC - Distributed Active Archive Center
- EOS - Earth Observing System
- EOSDIS - EOS Data and Information System
- FFC-T - Focused Field Campaign-Thaw
- FFC-W - Focused Field Campaign-Winter
- GIS - Geographic Information System
- GSFC - Goddard Space Flight Center
- HTML - Hyper-Text Markup Language
- IFC - Intensive Field Campaign
- NAD83 - North American Datum of 1983
- NASA - National Aeronautics and Space 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
- PRE - Preliminary
- SSA - Southern Study Area
- TE - Terrestrial Ecology
- UBS - Upland Black Spruce
- URL - Uniform Resource Locator
- UTM - Universal Transverse Mercator
- YJP - Young Jack Pine
20. Document Information

20.1 Document Revision Date
Written: 01-Jan-1997
Last Updated: 20-Apr-1999

20.2 Document Review Date(s)
BORIS Review: 08-Sep-1997
Science Review: 05-Nov-1997

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:
Samples were collected by Hank Margolis and other TE-09 members. Results are from laboratory analyses conducted by Martin Charest. Data compilation was conducted by Mikailou Sy.

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
TABLE OF CONTENTS

1. AGENCY USE ONLY (Leave blank)  
2. REPORT DATE  
3. REPORT TYPE AND DATES COVERED  
4. TITLE AND SUBTITLE  
Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)  
BOREAS TE-9 NSA Canopy Biochemistry  
5. FUNDING NUMBERS  
923  
RTOP: 923-462-33-01  
6. AUTHOR(S)  
Hank Margolis, Martin Charest, and Mikailou Sy  
Forrest G. Hall and Shelaine Curd, Editors  
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS (ES)  
Goddard Space Flight Center  
Greenbelt, Maryland 20771  
8. PERFORMING ORGANIZATION REPORT NUMBER  
2000-03136-0  
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS (ES)  
National Aeronautics and Space Administration  
Washington, DC 20546-0001  
10. SPONSORING / MONITORING AGENCY REPORT NUMBER  
TM—2000—209891  
Vol. 154  
11. SUPPLEMENTARY NOTES  
H. Margolis, M. Charest, and M. Sy: Université Laval, Sainte-Foy, Quebec, Canada;  
S. Curd: Raytheon ITSS, NASA Goddard Space Flight Center, Greenbelt, Maryland  
12a. DISTRIBUTION / AVAILABILITY STATEMENT  
Unclassified—Unlimited  
Subject Category: 43  
Report available from the NASA Center for AeroSpace Information,  
7121 Standard Drive, Hanover, MD 21076-1320. (301) 621-0390.  
12b. DISTRIBUTION CODE  
UL  
13. ABSTRACT (Maximum 200 words)  
The BOREAS TE-9 team collected several data sets related to chemical and photosynthetic properties  
of leaves. This data set contains canopy biochemistry data collected in 1994 in the NSA at the YJP,  
OJP, OBS, UBS, and OA sites, including biochemistry lignin, nitrogen, cellulose, starch, and fiber  
concentrations. These data were collected to study the spatial and temporal changes in the canopy  
biochemistry of boreal forest cover types and how a high-resolution radiative transfer model in the  
mid-infrared could be applied in an effort to obtain better estimates of canopy biochemical properties  
using remote sensing. The data are available in tabular ASCII files.  
14. SUBJECT TERMS  
BOREAS, terrestrial ecology, canopy biochemistry.  
15. NUMBER OF PAGES  
20  
16. PRICE CODE  
17. SECURITY CLASSIFICATION OF REPORT  
Unclassified  
18. SECURITY CLASSIFICATION OF THIS PAGE  
Unclassified  
19. SECURITY CLASSIFICATION OF ABSTRACT  
Unclassified  
20. LIMITATION OF ABSTRACT  
UL