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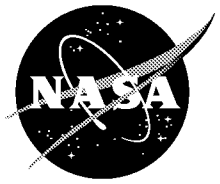

Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Sara Conrad, Editors

Volume 198

BOREAS TF-4 CO_2 and CH_4 Chamber Flux Data from the SSA

Dean Anderson, Robert Striegl and Kimberly Wickland
U.S. Geological Survey, Denver

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

October 2000

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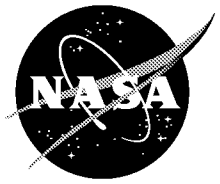

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BOREAS TF-4 CO_2 and CH_4 Chamber Flux Data from the SSA

Dean Anderson, Robert Striegl, Kimberly Wickland

Summary

The BOREAS TF-4 team measured fluxes of CO_2 and CH_4 across the soil-air interface in four ages of jack pine forest at the BOREAS SSA during August 1993 to March 1995. Gross and net flux of CO_2 and flux of CH_4 between soil and air are presented for 24 chamber sites in mature jack pine forest, 20-year-old, 4-year-old, and clear cut areas. The data are stored in tabular ASCII files.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS TF-04 CO_2 and CH_4 Chamber Flux Data from the SSA

1.2 Data Set Introduction

Data presented in this document were collected at the Old Jack Pine (OJP) and Young Jack Pine (YJP) tower flux sites and nearby clear cut areas at the BOReal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA). The BOREAS Tower Flux (TF)-04 team measured fluxes of carbon dioxide (CO_2) and methane (CH_4) across the soil-air interface in four ages of jack pine forest at the SSA during August 1993 to March 1995. Gross and net flux of CO_2 and flux of CH_4 between soil and air are presented for 24 chamber sites in mature jack pine forest, 20-year-old and 4-year-old stands, and a clear cut area. The data are stored in tabular American Standard Code for Information Interchange (ASCII) files.

1.3 Objective/Purpose

This study presents data relevant to understanding the transfer and storage of carbon among soil, the unsaturated zone, ground cover vegetation, and understory air in jack pine forest at the SSA. The data were collected continuously from May through September 1994 and during March 1995.

1.4 Summary of Parameters

The primary focus is on the net fluxes of CO_2 and CH_4 measured.

1.5 Discussion

Jack pine woodlands are an important component of the boreal forest, covering more than 2 x 10^{12} m^2 of predominantly well-drained uplands in northern North America. As part of BOREAS, our study objectives were (1) to compare soil respiration at an undisturbed 65- to 90-year-old mature jack pine-lichen woodland with soil respiration at a formerly continuous portion of the stand that was clear-cut harvested during the previous winter, and (2) to identify and quantify the sources of CO_2 and CH_4 production within the soil profile.

1.6 Related Data Sets

BOREAS TGB-01 NSA CH4 and CO2 Chamber Flux Data
BOREAS TGB-01 CH4 Concentration and Flux Data from NSA Tower Sites
BOREAS TGB-01 NSA SF6 Chamber Flux Data
BOREAS TGB-01/TGB-03 CH4 Chamber Flux Data over the NSA Fen
BOREAS TGB-01/TGB-03 NEE Data over the NSA Fen
BOREAS TGB-03 Plant Species Composition Data over the NSA Fen
BOREAS TGB-03 CH4 and CO2 Chamber Flux Data over NSA Upland Sites
BOREAS TF-04 CO2 and CH4 Soil Profile Data from the SSA

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. Rob Striegl, Hydrologist
United States Geological Survey

Dr. Kimberly Wickland
United States Geological Survey

2.2 Title of Investigation

Automated Measurements of CO_2 Exchange at the Moss Surface of a Black Spruce Forest

2.3 Contact Information

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(301) 286-0239 (fax)
Jeffrey.Newcomer@gsfc.nasa.gov

3. Theory of Measurements

Atmospheric chemistry measurements and modeling studies identify a global imbalance between known CO_2 production and uptake, with a potentially large terrestrial carbon sink possible in boreal forests. Northern woodlands are also perceived to be very sensitive to climate change. The predicted warming and drying of the boreal region could profoundly affect regional carbon sources and sinks. Carbon cycling of the boreal forest has consequently been a central theme of much recent field research. With the intent of eventually extrapolating land-based carbon, energy, and water flux measurements to the entire boreal forest biome, BOREAS subdivided the northern and southern sections of Canadian boreal forest into aspen, jack pine, and bog-fen landscapes for intensive study. Studies within these vegetation types focused on a variety of factors that influence carbon cycling, including forest stand age and land surface disturbances (Sellers et al., 1995).

Soil respiration, the second largest flux in the global carbon cycle, includes all CO_2 produced by roots, soil organisms, and oxidation that is emitted across the soil-air interface. Although globally important, soil respiration is not well characterized spatially or seasonally for most ecosystems.

We derived response curves of measured soil CO_2 emission versus soil temperature for the measurement transects and applied them to soil temperatures that were continuously recorded at the BOREAS OJP flux tower, located approximately 0.2 k, northwest of the OJP transect. This allowed for simulation of continuous soil CO_2 emissions for May-September 1994. The simulation results, when considered with the winter tree removal, the deep well-sorted sandy soil, and the lack of complexity of the plant and soil communities, permitted separation of surface-soil, deep-soil, and tree-root respiration at the OJP stand. The OJP fluxes quantify the amount of CO_2 that is transported across the forest floor and is available for photosynthetic uptake by ground cover and understory plants and tress or for emission to the atmosphere. Because the groundcover was destroyed and all trees were removed by clear-cutting, the "CC" site fluxes represent net CO_2 emission to the atmosphere during the period between forest harvest and re-establishment of plant cover.

4. Equipment

4.1 Sensor/Instrument Description

4.1.1 Collection Environment

Data were collected under all environmental conditions.

4.1.2 Source/Platform

Ground.

4.1.3 Source/Platform Mission Objectives

Support investigators and chambers.

4.1.4 Key Variables

CO_2 and CH_4 flux.

4.1.5 Principles of Operation

CO_2 and CH_4 fluxes were measured by the static chamber technique, which involves measuring the accumulation or loss of gas concentration within chambers placed on the soil surface versus time. The chambers, which are cylindrical with an open bottom and a closed top, are constructed from 0.30-m inside diameter polyvinylchloride (PVC) irrigation pipe. To prevent gas leakage to or from the chambers during measurement, they were affixed by a gasket to a collar, constructed from the same pipe material, that was inserted permanently into the soil to a depth of 0.10 m. When deployed, the collars and chambers had a combined height of 0.28 to 0.30 m. The chambers have a coiled 1.6-mm inside diameter aluminum tube installed through the sidewall near the top to equalize inside and outside pressure and are fitted with various gas ports for air circulation and sample collection. Gross soil CO_2 flux is the total amount of CO_2 that passes across the soil-groundcover/air interface in the absence of photosynthesis. Chambers for measurement of gross CO_2 flux and CH_4 flux have opaque PVC tops that create a dark chamber environment. Net soil CO_2 flux is gross flux minus CO_2 uptake by groundcover photosynthesis. Chambers for measurement of net CO_2 flux have clear polycarbonate tops that are optically transparent across the window of photosynthetically active radiation, allowing plant photosynthesis to occur. Air is recirculated inside the chambers at a rate of 0.25 chamber volume per minute to ensure mixing.

Gross and net CO_2 flux were measured by continuously monitoring the CO_2 concentration in air circulating in a chamber placed on the soil surface. CO_2 concentrations were recorded at 20-second intervals for 8 minutes using a LI-COR 6200 infrared gas analyzer (IRGA).

Soil CH_4 flux was measured by gas chromatograph (GC) analysis of a time series of six syringe samples of air collected from the center of volume of the chamber. Deployment times ranged from 24 to 40 minutes, depending on the anticipated flux rate. Rate of gas emission of consumption were determined by the equation:

$$J = dC/dt \times h$$

where J is the rate of gas flux across the soil surface ($mol/m^2/s$) C is the gas concentration in the chamber at ambient temperature and pressure (mol/m^3), t is time, h is chamber height (m), and dC/dt is the slope of the best fit of the time series of concentration in the chamber as time approaches zero.

4.1.6 Sensor/Instrument Measurement Geometry

Not applicable.

4.1.7 Manufacturer of Sensor/Instrument

The chambers, which are cylindrical with an open bottom and a closed top, are constructed from 0.30 m inside diameter polyvinylchloride (PVC) irrigation pipe. To prevent gas leakage to or from the chambers during measurement, that were affixed by a gasket to a collar, constructed from the same pipe material, that was inserted permanently into the soil to a depth of 0.10 m. When deployed, the collars and chambers had a combined height of 0.28 to 0.30 m. The chambers have a coiled 1.6-mm inside diameter aluminum tube installed through the sidewall near the top to equalize inside and outside pressure and are fitted with various gas ports for air circulation and sample collection.

IRGA, Model 6262
LI-COR, Inc.
Lincoln, NE

4.2 Calibration

4.2.1 Specifications
None given.

4.2.1.1 Tolerance
None given.

4.2.2 Frequency of Calibration
Traceable gas calibration standards for all CO_2 and CH_4 analyses were provided by the BOREAS project.

4.2.3 Other Calibration Information
None given.

5. Data Acquisition Methods

Soil respiration was measured using closed chambers that attached to chamber collars permanently installed in the soil. Three pairs of the 0.38 m diameter chamber collars were inserted 0.10 m into the soil at each site along a 60-m transect, having 30 m between pairs of collars and 1 m between collars within pairs.

Traceable gas calibration standards for all CO_2 and CH_4 analyses were provided by BOREAS operations. CO_2 concentrations were measured using nondispersive IRGAs calibrated to span the expected concentration range. Three different IRGAs were used for measuring CO_2 concentration at the jack pine soil gas transects. Accumulation of CO_2 in soil gas flux chambers was measured using LI-COR model 6200. In situ soil CO_2 concentrations exceed the range of the LI-COR 6200, so two PP System model EGM IRGAs were used, one having a range up to 5000 parts per million (ppm) CO_2 and the second having a range up to 10,000 ppm CO_2.

CH_4 concentrations were measured using a Chrompack model 438A GC having a 2-meter 80-100 mesh Porapak-N column and a flame ionization detector. Carrier gas was nitrogen and the oven temperature was maintained at 38 °C. CH_4 concentrations were calculated from standards curves established from a series of CH_4 Standards run between every 8 to 10 samples. Concentrations smaller than 0.49 ppm were calculated by linear extrapolation of integrator response between a 0.49 ppm CH_4 standard and a nitrogen blank.

The measurements were made by sealing a 0.30-m tall opaque polyvinyl chloride chamber cover over a chamber collar and continuously circulating air from the chamber at top center, through a LI-COR 6200 CO_2 analyzer, and back into the chamber through a perforated air-dispersion ring on the inside of the chamber base. Chamber CO_2 concentrations were measured at 1-s intervals and mean concentrations were recorded at 15-s intervals for 8 minutes. Insertion of the chamber collars into the soil, circulation of chamber air through the gas analyzer, the relatively large chamber diameter, and the relatively short chamber deployment times were all intended to minimize chamber effects known to influence soil gas flux measurements. CO_2 emission rates were calculated using:

$$J = dC/dt \times h$$

where J is the rate of CO_2 flux across the soil surface (mol/(m^2 s)), C is the CO_2 concentration in the chamber at ambient temperature and pressure (mol/m^3), t is time, h is chamber height (m), and dC/dt is the slope of the best fit of the time series of CO_2 concentration in the chamber as time approaches zero.

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 North American Datum of 1983 (NAD83) coordinates of the sites are:

```
SSA-OJP:          53.91634° N, 104.69203° W
SSA-YJP:          53.87581° N, 104.64529° W
Clear Cut (CC):   53.9090° N, 104.6595° W
Recent Cut (RC):  53.9091° N, 104.6671° W
```

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

These are point measurements made 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

The data set covers the period from 26-May-1994 to 21-Mar-1995.

7.2.2 Temporal Coverage Map

Not available.

7.2.3 Temporal Resolution

Gross and net CO_2 flux were measured by continuously monitoring the CO_2 concentration in air circulating in a chamber placed on the soil surface. CO_2 concentrations were recorded at 20-second intervals for 8 minutes using a LI-COR 6200 IRGA.

Soil CH_4 flux was measured by GC analysis of a time series of six syringe samples of air collected from the center of volume of the chamber. Deployment times ranged from 24 to 40 minutes, depending on the anticipated flux rate.

7.3 Data Characteristics

7.3.1 Parameter/Variable

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

TF04_CH4_CHAMBER_FLUX:

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
TIME_OBS
CHAMBER_ID
CH4_FLUX
REVISION_DATE
CRTFCN_CODE

TF04_GROSS_CO2_CHAMBER_FLUX:

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
TIME_OBS
CHAMBER_ID
GROSS_CO2_FLUX
REVISION_DATE
CRTFCN_CODE

TF04_NET_CO2_CHAMBER_FLUX:

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
TIME_OBS
CHAMBER_ID
NET_CO2_FLUX
REVISION_DATE
CRTFCN_CODE

7.3.2 Variable Description/Definition

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

TF04_CH4_CHAMBER_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.
TIME_OBS	The Greenwich Mean Time (GMT) when the data were collected.
CHAMBER_ID	Identifier assigned to the chamber measured
CH4_FLUX	Methane flux.
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.
CRTFCN_CODE	The BOREAS certification level of the data. Exa Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).

TF04_GROSS_CO2_CHAMBER_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.
TIME_OBS	The Greenwich Mean Time (GMT) when the data were collected.
CHAMBER_ID	Identifier assigned to the chamber measured
GROSS_CO2_FLUX	The gross CO2 flux measured within the chamber.
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.
CRTFCN_CODE	The BOREAS certification level of the data. Exa Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).

TF04_NET_CO2_CHAMBER_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.
TIME_OBS	The Greenwich Mean Time (GMT) when the data were collected.
CHAMBER_ID	Identifier assigned to the chamber measured
NET_CO2_FLUX	The net CO2 flux measured within the chamber.
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.
CRTFCN_CODE	The BOREAS certification level of the data. Exa 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:

TF04_CH4_CHAMBER_FLUX:

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
CHAMBER_ID	[none]
CH4_FLUX	[micromoles][meter^-2][second^-1]
REVISION_DATE	[DD-MON-YY]
CRTFCN_CODE	[none]

TF04_GROSS_CO2_CHAMBER_FLUX:

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
CHAMBER_ID	[none]
GROSS_CO2_FLUX	[micromoles][meters^-2][second^-1]
REVISION_DATE	[DD-MON-YY]
CRTFCN_CODE	[none]

TF04_NET_CO2_CHAMBER_FLUX:

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
CHAMBER_ID	[none]
NET_CO2_FLUX	[micromoles][meter^-2][second^-1]
REVISION_DATE	[DD-MON-YY]
CRTFCN_CODE	[none]

7.3.4 Data Source

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

TF04_CH4_CHAMBER_FLUX:

Column Name	Data Source
SITE_NAME	[Assigned by BORIS Staff]
SUB_SITE	[Assigned by BORIS Staff]
DATE_OBS	[Investigator]
TIME_OBS	[Investigator]
CHAMBER_ID	[Investigator]
CH4_FLUX	[Gas Chromatograph]
REVISION_DATE	[Assigned by BORIS Staff]
CRTFCN_CODE	[Assigned by BORIS Staff]

TF04_GROSS_CO2_CHAMBER_FLUX:

Column Name	Data Source
SITE_NAME	[Assigned by BORIS Staff]
SUB_SITE	[Assigned by BORIS Staff]
DATE_OBS	[Investigator]
TIME_OBS	[Investigator]
CHAMBER_ID	[Investigator]
GROSS_CO2_FLUX	[LI-COR 6200 CO2 analyzer]
REVISION_DATE	[Assigned by BORIS Staff]
CRTFCN_CODE	[Assigned by BORIS Staff]

TF04_NET_CO2_CHAMBER_FLUX:

Column Name	Data Source
SITE_NAME	[Assigned by BORIS Staff]
SUB_SITE	[Assigned by BORIS Staff]
DATE_OBS	[Investigator]
TIME_OBS	[Investigator]
CHAMBER_ID	[Investigator]
NET_CO2_FLUX	[LI-COR 6200 CO2 analyzer]
REVISION_DATE	[Assigned by BORIS Staff]
CRTFCN_CODE	[Assigned by BORIS Staff]

7.3.5 Data Range

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

TF04_CH4_CHAMBER_FLUX:

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9JP-CLRCT	SSA-YJP-FLXTR	None	None	None	None
SUB_SITE	9TF04-FLX01	9TF04-FLX02	None	None	None	None
DATE_OBS	31-MAY-94	21-MAR-95	None	None	None	None
TIME_OBS	1420	2341	None	None	None	None
CHAMBER_ID	A	X	None	None	None	None
CH4_FLUX	-643	0	None	None	None	None
REVISION_DATE	09-NOV-98	10-NOV-98	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None

TF04_GROSS_CO2_CHAMBER_FLUX:

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9JP-CLRCT	SSA-YJP-FLXTR	None	None	None	None
SUB_SITE	9TF04-FLX01	9TF04-FLX02	None	None	None	None
DATE_OBS	26-MAY-94	20-MAR-95	None	None	None	None
TIME_OBS	0	2350	None	None	None	None
CHAMBER_ID	A	X	None	None	None	None
GROSS_CO2_FLUX	-.18	9.15	None	None	None	None
REVISION_DATE	10-NOV-98	10-NOV-98	None	None	None	Blank
CRTFCN_CODE	CPI	CPI	None	None	None	None

TF04_NET_CO2_CHAMBER_FLUX:

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9JP-CLRCT	SSA-YJP-FLXTR	None	None	None	None
SUB_SITE	9TF04-FLX01	9TF04-FLX02	None	None	None	None
DATE_OBS	02-JUN-94	15-SEP-94	None	None	None	None
TIME_OBS	234	2308	None	None	None	None
CHAMBER_ID	A	X	None	None	None	None
NET_CO2_FLUX	-1.82	6.63	None	None	None	None
REVISION_DATE	10-NOV-98	10-NOV-98	None	None	None	None
CRTFCN_CODE	CPI	CPI	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.

TF04_CH4_CHAMBER_FLUX:

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,CHAMBER_ID,CH4_FLUX,REVISION_DATE,
CRTFCN_CODE
'SSA-9JP-CLRCT','9TF04-FLX01',10-JUN-94,1620,'S',-101.0,09-NOV-98,'CPI'
'SSA-9JP-CLRCT','9TF04-FLX01',10-JUN-94,1621,'T',-172.0,09-NOV-98,'CPI'
'SSA-9JP-CLRCT','9TF04-FLX01',10-JUN-94,1643,'V',-158.0,09-NOV-98,'CPI'
'SSA-9JP-CLRCT','9TF04-FLX01',10-JUN-94,1644,'U',-76.0,09-NOV-98,'CPI'
```

TF04_GROSS_CO2_CHAMBER_FLUX:

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,CHAMBER_ID,GROSS_CO2_FLUX,REVISION_DATE,
CRTFCN_CODE
'SSA-9JP-CLRCT','9TF04-FLX01',26-MAY-94,2326,'W',1.75,10-NOV-98,'CPI'
'SSA-9JP-CLRCT','9TF04-FLX01',26-MAY-94,2338,'X',1.55,10-NOV-98,'CPI'
'SSA-9JP-CLRCT','9TF04-FLX01',26-MAY-94,2350,'V',1.51,10-NOV-98,'CPI'
```

TF04_NET_CO2_CHAMBER_FLUX:

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,CHAMBER_ID,NET_CO2_FLUX,REVISION_DATE,
CRTFCN_CODE
'SSA-9JP-CLRCT','9TF04-FLX01',28-JUN-94,1824,'S',1.37,10-NOV-98,'CPI'
'SSA-9JP-CLRCT','9TF04-FLX01',28-JUN-94,1840,'T',1.87,10-NOV-98,'CPI'
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by the BOREAS Information System (BORIS) is the measurement(s) made for a given site at a given time.

8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain 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

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

CO_2 emission rates were calculated using J = dC/dt x h, where J is the rate of CO_2 flux across the soil surface (mol/(m^2 s)), C is the CO_2 concentration in the chamber at ambient temperature and pressure (mol/m^3), t is time, h is chamber height (m), and dC/dt is the slope of the best fit of the time series of CO_2 concentration in the chamber as time approaches zero.

9.4 Graphs and Plots

None given.

10. Errors

10.1 Sources of Error
None given.

10.2 Quality Assessment

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

None given.

13. Future Modifications and Plans

None given.

14. Software

14.1 Software Description

None given.

14.2 Software Access

Not applicable.

15. Data Access

The CO_2 and CH_4 chamber flux 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 given.

17.2 Journal Articles and Study Reports

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.

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.

Striegl, R.G. and K.P. Wickland. 1998. Effects of a clear-cut harvest on soil respiration in a jack-pine lichen woodland. Can. Jour. Forest Research 28:534-539.

Wickland, K.P. and R.G. Striegl. 1997. Measurements of soil carbon dioxide and methane concentrations and fluxes, and soil properties at four ages of jack pine forest in the Southern Study Area of the Boreal Ecosystem Atmosphere Study, Saskatchewan, Canada, 1993-1995. U.S. Geological Survey Open-File Report. 97-49.

17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

ASCII - American Standard Code for Information Interchange
BOREAS - BOReal Ecosystem-Atmosphere Study
BORIS - BOREAS Information System
CC - Clear Cut site
CD-ROM - Compact Disk-Read-Only Memory
DAAC - Distributed Active Archive Center
EOS - Earth Observing System
EOSDIS - EOS Data and Information System
GC - Gas Chromatograph
GIS - Geographic Information System
GMT - Greenwich Mean Time
GSFC - Goddard Space Flight Center
HTML - HyperText Markup Language
IRGA - Infrared Gas Analyzer
NAD83 - North American Datum of 1983
NASA - National Aeronautics and Space Administration
NSA - Northern Study Area
OBS - Old Black Spruce
OJP - Old Jack Pine
ORNL - Oak Ridge National Laboratory
PANP - Prince Albert National Park
PPFD - Photosynthetically Active Photon Flux Density
PVC - Polyvinylchloride
RC - Recently Cut site
SSA - Southern Study Area
TF - Tower Flux
TGB - Trace Gas Biochemistry
URL - Uniform Resource Locator
YJP - Young Jack Pine

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Striegl, R.G. and K.P. Wickland. 1998. Effects of a clear-cut harvest on soil respiration in a jack-pine lichen woodland. Can. Jour. Forest Research 28:534-539.

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

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The BOREAS TF-4 team measured fluxes of CO_2 and CH_4 across the soil-air interface in four ages of jack pine forest at the BOREAS SSA during August 1993 to March 1995. Gross and net flux of CO_2 and flux of CH_4 between soil and air are presented for 24 chamber sites in mature jack pine forest, 20-year-old, 4-year-old, and clear cut areas. The data are stored in tabular ASCII files.

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