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ll and Sara K. Conrad, Editors

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S TGB-1 CH_4 Concentration
NSA Tower Sites

R.K. Varner

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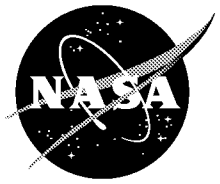

Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Sara K. Conrad, Editors

Volume 220

BOREAS TGB-1 CH_4 Concentration and Flux Data from NSA Tower Sites

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National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

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BOREAS TGB-1 CH_4 Concentration and Flux Data from NSA Tower Sites

Patrick M. Crill, Ruth K. Varner

Summary

The BOREAS TGB-1 team made numerous measurements of trace gas concentrations and fluxes at various NSA sites. This data set contains half-hourly averages of ambient methane (CH_4) measurements and calculated fluxes for the NSA-Fen in 1996 and the NSA-BP and NSA-OJP tower sites in 1994. The purpose of this study was to determine the CH_4 flux from the study area by measuring ambient CH_4 concentrations. This flux can then be compared to the chamber flux measurements taken at the same sites. The data are provided in tabular ASCII files.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS TGB-01 CH_4 Concentration and Flux Data from NSA Tower Sites

1.2 Data Set Introduction

Ambient CH_4 was measured at two heights on a tower at the Northern Study Area (NSA) Tower Fen (TF), Beaver Pond (BP), and Old Jack Pine (OJP) sites during the summers of 1994 and 1996 by the BOReal Ecosystem-Atmosphere Study (BOREAS) Trace Gas Biogeochemistry (TGB)-01 team. Gradients were calculated and fluxes were determined from the available meteorological data.

1.3 Objective/Purpose

The purpose of this study was to determine the CH_4 flux from the study area by measuring ambient CH_4 concentrations. This flux can then be compared to the chamber flux taken at the same sites.

1.4 Summary of Parameters

Ambient CH_4 concentrations in parts per million (ppm), CH_4 fluxes in micromoles/m^2/sec, air temperature in °C, and air pressure in kPa are reported.

1.5 Discussion

The ambient CH_4 measurements at the tower were collected semicontinuously once every 3 minutes over the field period from 15-Apr through 22-Oct-1996 at the TF site. The measurements were collected every 6 minutes over the field period from 03-Jun through 17-Sep-1994 at the BP site and from 29-May through 19-Sep-1994 at the OJP site. The tower measurements of ambient methane are used to calculate an integrated flux from a larger area than that which is measured with the chambers. The tower flux calculations can be compared with the chamber flux measurements to show plant community effects on flux rates. The towers had some problems throughout the field season that are addressed in Section 6.

1.6 Related Data Sets

BOREAS TGB-01 NSA CH4 and CO2 Chamber Flux Data
BOREAS TGB-01 Soil CH4 and CO2 Profile Data from NSA Tower Sites
BOREAS TGB-03 CH4 and CO2 Chamber Flux Data from NSA Tower Sites

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. Patrick M. Crill
Research Associate Professor
University of New Hampshire

2.2 Title of Investigation

Magnitude and Control of Trace Gas Exchange in Boreal Ecosystems

2.3 Contact Information

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3. Theory of Measurements

Tower measurements were completed to determine the turbulent exchange of energy and mass between the atmosphere and a variety of surface types as well as the processes controlling these fluxes. The towers measured radiation, heat, water, CO_2, and CH_4 fluxes. Using the meteorological data, the flux of trace gases like CH_4 can be determined and then compared with the chamber flux data. Refer to TF-10, Harry McCaughey, and TF-08, David Fitzjarrald, for tower information at the TF and OJP sites. Refer to BOREAS TGB-04 Water Table and Sediment Temperature, Nigel Roulet, for tower information at the BP site.

4. Equipment

4.1 Sensor/Instrument Description

CH_4 was quantified with a Shimadzu GC-MINI2-Gas Chromatograph (GC) with a flame ionization detector (FID) operated at 125 °C after separation on a HayeSepQ column at 40 °C using ultrapure (99.999%) N_2 as a carrier gas flowing at 30 mL/min. Analog signals (0-1 V) from the detectors were digitized at 10 Hertz (Hz) with a Hewlett Packard (HP) 35000D A/D board and quantified and logged using HP ChemStation software. Rotary valve switching and chromatography start/stop were controlled with the HP board and software and a relay driver.

4.1.1 Collection Environment

The samples were collected with pumps pulling air through 1/8-inch Nyaflow tubing that ran from the tower to the shack that housed the MINI2-GC. The equipment was operated under a range of ambient atmospheric conditions during the period.

4.1.2 Source/Platform

Rohn towers located at NSA TF, OJP, and BP sites.

4.1.3 Source/Platform Mission Objectives

The mission objective was to measure surface fluxes at the NSA TF, OJP, and BP sites.

4.1.4 Key Variables

Ambient CH_4 was measured at two different heights on a tower at the two sites.

4.1.5 Principles of Operation

The Shimadzu MINI2-GC is equipped with a hydrogen FID. The FID uses a hydrogen flame in an air atmosphere to burn components as they exit the column. In the flame, carbon-carbon bonds are fragmented so that various organic ions and free electrons exist. Application of a voltage across a collector electrode over the flame causes an ion current to flow, which is amplified and then measured as the output signal. This single signal output is for a data processor, integrator, recorder, or computer (Instruction Manual: MINI2-GC; Shimadzu Corporation, Kyoto, Japan).

4.1.6 Sensor/Instrument Measurement Geometry
Not applicable.

4.1.7 Manufacturer of Sensor/Instrument
Shimadzu Scientific Instruments, Inc.
7102 Riverwood Drive
Columbia, MD 21046
(410) 381-1227

Hewlett Packard

4.2 Calibration
A 1.898-ppmv (NSA-BP) or a 2.462-ppmv (NSA-OJP) working standard (1994) was run after each sample. Working standards were calibrated against two Canadian Atmospheric Environment Services (AES) certified primary standards by plumbing the standards into the sampling system and running the system for 12 hours. The working standard was also calibrated in the lab before deployment.

4.2.1 Specifications
None given.

4.2.1.1 Tolerance
The FID's maximum sensitivity is 3E x 10^{-12} g/s for diphenyl.

4.2.2 Frequency of Calibration
Calibration gases were run after every set of high and low samples.

4.2.3 Other Calibration Information
Not applicable.

5. Data Acquisition Methods

Sampling ports were suspended at 6.65 m and 3.59 m on the NSA-TF tower and at 0.25 and 1.5 m above ground level on the NSA-BP. The tower was located 88.0 m into the fen area from the access road and 150 m into the beaver pond. A continuous stream of air was pulled through 1/8-inch outer diameter (o.d.) nylon tubing at 2.5 L/min with diaphragm pumps. Using electronically actuated rotary valves, a subsample of this flow is diverted through a 1-m perma-pure drier (to ensure consistent humidity over a run period), then into the 1-mL sample loop, and then injected into the GC. A 1.898-ppmv working standard was run after each sample. The OJP ambient CH_4 sampling was completed in much the same manner as the BP sampling. The sampling ports were suspended at 13.5 m and 30 m above ground level on the tower. A continuous stream of air was pulled through 1/8-inch o.d. nylon tubing at 2.5 L/min with diaphragm pumps. Using electronically actuated rotary valves, a subsample of this flow was diverted through a 1-m hydropurge tube in the NSA-TF and through a 1-m perma-pure drier (to ensure consistent humidity over a run period), then into the 1-mL sample loop, and then injected into the GC. At the NSA-TF, a 1.519-ppmv working standard (14-Apr through 22-Aug) and a 1.517-ppmv working standard (23-Aug through 22-Oct) were used. A 1.898-ppmv CH_4 working standard was run after each sample at the BP site. The standard for the OJP site was 2.462-ppmv CH_4.

6. Observations

6.1 Data Notes

None given.

6.2 Field Notes NSA-Fen (TF):

- 14-Apr-1996 - Hooked up gases and instrument at TF tower site.
- 15-Apr-1996 - MINI2-GC up and running.
- 30-Apr-1996 - Replaced valve fitting of CH_4 standard due to small leak.
- 02-May-1996 - Generator turned off for maintenance at 09:00.
- 06-May-1996 - Changed regulator on CH_4 standard.
- 16-May-1996 - Generator turned off for maintenance at 11:30.
- 25-May-1996 - Column temperature of MINI2-GC reduced to 45 °C at 11:22 run#00048.
- 30-May-1996 - Generator turned off for maintenance at 10:11. Replaced fallen air intake tubes on tower in their original places. Restarted at 11:47.
- 02-Jun-1996 - Generator off for unknown reason. Restarted at 18:15.
- 05-Jun-1996 - Shut off CH_4 standard at 10:19 and moved standard cylinder outside of fen hut. Restarted at 10:54.
- 07-Jun-1996 - Generator down at 11:11. Turned off CH_4 standard, H_2, air compressor, MINI2-GC, and unplugged pumps. Started back up at 13:15.
- 10-Jun-1996 - Switched the pump intakes from high point (6.65 m) to low point (3.59 m).
- 13-Jun-1996 - Generator turned off for maintenance at 10:15. Restarted at 14:08.
- 23-Jun-1996 - Turned off MINI2-GC at 10:53.
- 24-Jun-1996 - Generator down for maintenance at 12:50. Switched intake pumps back to original configuration. Relit GC 14:21.
- 27-Jun-1996 - Generator down for maintenance at 10:15. Restarted at 12:40.
- 11-Jul-1996 - Generator down for maintenance. Restarted at 12:45.
- 14-Jul-1996 - At run #01323 computer clock is 14:03, and 'real' time is 13:53.
- 21-Jul-1996 - GC not operating, last file recorded was run#1532 on 19-Jul-1997 at 02:57. Restarted sequence on run #01533 at 15:59. Computer clock reads 16:11.
- 25-Jul-1996 - Generator down for maintenance at 13:41. Started up at 14:30.
- 27-Jul-1996 - Stopped sequence at run #01801, column temperature of MINI2-GC raised to 120 °C at 12:44. Turned column temperature to 45 °C at 13:55. Restarted with run #01802 at 13:59.
- 01-Aug-1996 - Generator water pump replacement, system down at 12:30. Restarted for run #02030. Shut down again at 13:45, run #2031.
- 08-Aug-1996 - Shut down system for generator maintenance at 12:47. Restarted at 13:55.
- 22-Aug-1996 - Generator down for maintenance at 12:47. Stopped sequence at run #02979. New CH4 standard, 1.517 ppm at site now. At 14:30 quality standard peaks begin to appear due to the CH_4 standard regulator pressure.
- 23-Aug-1996 - Upper tower intake moved horizontally but kept at the same level. Tower work done in the vicinity of the intake from 21:15 to 23:00.
- 25-Aug-1996 - Upper tower intake moved to original position at 20:20.
- 29-Aug-1996 - Changed Hydro Purge cylinder. Restarted sequence at 11:55.
- 07-Sep-1996 - Generator stopped due to power surge, restarted on 09-Sep-1997 at 11:00. Last run recorded was run #03622.
- 09-Sep-1996 - Small fire in generator hut, system down at 11:15.
- 11-Sep-1996 - Bad filter in generator, system down for a few days. Fuse blew in MINI2-GC.
- 13-Sep-1996 - Replaced fuse in MINI2-GC. Started sequence at 11:15 with run #03623. Looks good!
- 19-Sep-1996 - Generator down for maintenance at 09:30. Restarted at 13:45.
- 04-Oct-1996 - Generator down for maintenance at 12:08.
- 17-Oct-1996 - Generator down for maintenance at 12:00. Restarted at 12:30 with run #05097.
- 22-Oct-1996 - Sequence stopped after run #05328 (last run). Tape backup of data files, system shut down for season at 13:40.

NSA-BP:

- 02-Jun-1994 - Hooked up gases at BP tower.
- 03-Jun-1994 - MINI2-GC up and running.
- 04-Jun-1994 - Generator was down, back up at 15:16. Power down again at 16:57 in the middle of run #45. Power back on line at 17:15. Started sequence with run #45 at 18:41.
- 05-Jun-1994 - Power down again. Started with run #45 again. Switched out drierite column.
- 06-Jun-1994 - Generator down again. Instruments back up and running at 14:16. Start with run #66.
- 08-Jun-1994 - Found machines off. Generator maintenance. Turned everything on at 14:24. Run sequence started at 14:28.
- 10-Jun-1994 - Problem with automatic backup onto tape drive. Had delayed program for 51 minutes. Copied *.txt files, don't like the look of peaks. Paused sequence after run #254. Started sequence at 18:02.
- 13-Jun-1994 - Had stopped after run #268, 06-11-94, 01:11. Lit flame using a similar set-up to OJP for fuel air. Restart at 18:22.
- 14-Jun-1994 - Power off. The standard was off. Power bar got moved. Appears to be working beautifully.
- 15-Jun-1994 - Snowed last night. Everything was down since 17:30 yesterday. Last run was #311. Even the pump was switched off. Got everything up, replaced Isobar with another surge suppressor. Heated ovens and detectors to 150 °C and 165 °C respectively, for 2 hours. Capped air flow to second detector. Started sequence at run #312 at 12:35.
- 16-Jun-1994 - Generator down at 17:30. Started back up at 18:50, run #1847.
- 18-Jul-1994 - Mini2-GC down for a week due to generator failure. Flow turned on at 11:00.
- 20-Jul-1994 - Generator was down. Run started at 12:43, Run #1604.
- 04-Jul-1994 - Restart of system.
- 21-Jul-1994 - Compressor went down at 15:03, back up at 15:05 with run #1552.
- 25-Jul-1994 - Oil addition to generator.
- 02-Aug-1994 - Generator off. Start-up at 15:40.
- 05-Sep-1994 - Switched generators and added oil to big one, 17:27.
- 14-Sep-1994 - Sequence stopped, restarted at 15:29.
- 15-Sep-1994 - Calibrating field standard with AES calibrated standard.
- 19-Sep-1994 - Breakdown of system, stopped running at 09:53.

NSA-OJP:

- 28-May-1994 - GC on at 14:00. Started sequence at 14:26.
- 29-May-1994 - Pumps off briefly.
- 06-Jun-1994 - Having problems with pumps; finally up and running at 18:00.
- 09-Jun-1994 - Down for generator maintenance.
- 19-Jul-1994 - Very noisy baseline. Radio transmission appears to interfere with GC baseline trace.
- 04-Aug-1994 - Problem with GC; stopped sequence and rebooted. At 15:26 started up again.
- 06-Aug-1994 - Aborted sequence at Run #2961. Spike outs in baseline. Baked out column at 105 °C for 26 min. Started up again at 12:40. Not much flow.
- 07-Aug-1994 - Run #3007 screwed up due to messing with pumps to fix flow problem.
- 09-Aug-1994 - Baked out column again due to messy baseline; back up at 11:55.
- 29-Aug-1994 - Peaks look good; inject valve sounds bad!!!
- 01-Sep-1994 - Auto GC looks good.
- 02-Sep-1994 - Generator went down; restarted and relit at 15:02.
- 04-Sep-1994 - Generator has been down for maintenance this morning. Baked out column for 2 hrs. at 180 °C. Restarted at 14:05.
- 05-Sep-1994 - Baseline looks good!
- 10-Sep-1994 - Shut down. Restarted at 11:22.
- 15-Sep-1994 - Running calibration of cylinders through automatic system. Started at 20:00.
- 19-Sep-1994 - Shut down entire system for the season!

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The spatial positions of the areas from which the measured trace gasses originated vary depending on the prevailing winds. The North American Datum of 1983 (NAD83) coordinates of the sites where the measurement equipment was set up are:

NSA-OJP Tower (55.93°N, 98.62°W)
NSA-BP Tower (55.84°N, 98.03°W)
NSA-Fen (TF) Tower (55.91481°N, 98.42072°W)

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

The spatial resolution of the area of the measurement sites varies depending on the prevailing winds.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

The automatic sampling of ambient CH_4 at the TF sites was approximately every 3 minutes, and at the BP and the OJP sites was approximately every 6 minutes, semicontinuously over the period from 15-Apr through 22-Apr-1996, and 28-May through 19-Sep-1994.

7.2.2 Temporal Coverage Map

TIME PERIOD	SITE	COLLECTION NOTES
15-Apr-1996	Tower Fen	Start of semicontinuous data collection
IFC-1	Tower Fen	Semicontinuous data collection
June	Tower Fen	Semicontinuous data collection
July	Tower Fen	Semicontinuous data collection
IFC-2	Tower Fen	Semicontinuous data collection
August	Tower Fen	Semicontinuous data collection
September	Tower Fen	Semicontinuous data collection
October	Tower Fen	Semicontinuous data collection
IFC-3	Tower Fen	Semicontinuous data collection
22-Oct-1996	Tower Fen	End of semicontinuous data collection

7.2.3 Temporal Resolution

The ambient CH_4 at the towers was measured approximately every 3 minutes in 1996 and every 6 minutes in 1994.

7.3 Data Characteristics

7.3.1 Parameter/Variable

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

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
TIME_OBS
CH4_CONC_HI
CH4_CONC_LO
GRADIENT
DIFFUSION_COEF
AIR_TEMP_1M
AIR_PRESS_1M
CH4_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:

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, or TRN; TTT identifies the cover type for the site (999 if unknown); and CCCCC is the for site (exactly what it means will vary with site type).
SUB_SITE	The identifier assigned to the subsite by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the subsite instrument (e.g.) HYD06 or STAFF, and IIIII is the identifier for the subsite (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.
CH4_CONC_HI	Methane concentration at 30 meters above ground.
CH4_CONC_LO	Methane concentration at 13.5 meters above ground.
GRADIENT	Gradient for methane measurement.
DIFFUSION_COEF	Diffusion coefficient.
AIR_TEMP_1M	The temperature of the air as taken 1 meter above the ground.
AIR_PRESS_1M	Air pressure at 1 meter above the ground.
CH4_FLUX	Methane flux.
REVISION_DATE	The most recent date that the information in the referenced data base table record was revised.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are Checked by PI (CPI) , Certified by Group (CGR), Preliminary (PRE), and CPI but questionable (PI_???).

7.3.3 Unit of Measurement

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

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
CH4_CONC_HI	[parts per million]
CH4_CONC_LO	[parts per million]
GRADIENT	[parts per million][meter-1]
DIFFUSION_COEF	[meters2][second-1]
AIR_TEMP_1M	[degrees Celsius]
AIR_PRESS_1M	[kiloPascals]
CH4_FLUX	[micromoles][meter-2][second-1]
REVISION_DATE	[DD-MON-YY]
CRTFCN_CODE	[none]

7.3.4 Data Source

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

Column Name	Data Source
SITE_NAME	Not Applicable
SUB_SITE	Not Applicable
DATE_OBS	Investigator
TIME_OBS	Investigator
CH4_CONC_HI	Shimadzu MINI2-GC
CH4_CONC_LO	Shimadzu MINI2-GC
GRADIENT	Calculated by Investigator
DIFFUSION_COEF	See TGB-04
AIR_TEMP_1M	See TGB-04
AIR_PRESS_1M	See TGB-04
CH4_FLUX	Calculated by Investigator
REVISION_DATE	Not Applicable
CRTFCN_CODE	Not Applicable

7.3.5 Data Range

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

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	NSA-BVP-FLXTR	NSA-OJP-FLXTR	None	None	None	None
SUB_SITE	TGB01-FLX01	TGB01-FLX01	None	None	None	None
DATE_OBS	28-MAY-94	22-OCT-96	None	None	None	None
TIME_OBS	0	2358	None	None	None	None
CH4_CONC_HI	1.469	4.999	-999	None	None	None
CH4_CONC_LO	1.466	5.129	-999	None	None	None
GRADIENT	-0.3305	1.8834	-999	None	None	None
DIFFUSION_COEF	0	1.3339	None	None	None	Blank
AIR_TEMP_1M	-2.32	28.67	-999	None	None	Blank
AIR_PRESS_1M	98.2	101.7	-999	None	None	Blank
CH4_FLUX	-1.42133612	2.34546945	None	None	None	Blank

```
REVISION_DATE        27-SEP-96      24-NOV-97      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 analysis personnel deemed the
                      value unreliable.
Below Detect Limit -- The value that indicates parameter values below the
                      instrument's 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 BOREAS Information System (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 records from a sample data file on the CD-ROM.

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,CH4_CONC_HI,CH4_CONC_LO,GRADIENT,
DIFFUSION_COEF,AIR_TEMP_1M,AIR_PRESS_1M,CH4_FLUX,REVISION_DATE,CRTFCN_CODE
'NSA-BVP-FLXTR','TGB01-FLX01',01-AUG-94,2303,2.449,2.537,.0702,0,13.84,100.4,
0,27-SEP-96,'CPI'
'NSA-BVP-FLXTR','TGB01-FLX01',01-AUG-94,2334,2.351,2.478,.1012,0,13.3,100.4,
0,27-SEP-96,'CPI'
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by BORIS is the measurements made for a given site on a given day.

8.2 Data Format(s)

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

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

9. Data Manipulations

9.1 Formulae

9.1.1 Derivation Techniques and Algorithms

- **NSA-Fen (TF):** Ambient CH_4 mixing ratios were determined at 3-minute intervals at 6.65m (ppm_CH4_6.65_m) and 3.59 m (ppm_CH4_3.59_m) over the NSA-TF site.
- **NSA-BP:** Ambient CH_4 mixing ratios were determined at 6-minute intervals at 0.25m (ppmv_CH4_25_cm) and 1.5 m (ppmv_CH4_1.5_m) over the NSA-BP site. The concentrations were determined by comparing the unknown ambient peak areas with the known standard peak area that was run immediately following each set of ambient samples:

$R_f = C_{std} / A_{std}$
$C_s = R_f * A_s$
R_f = Response factor
A_{std}> = Standard peak area
C_{std} = Concentration of the standard
C_s = Concentration of the sample
A_s = Peak area of sample

The response factor was calculated for the GC and then multiplied by the ambient air peak to determine the concentration of the tower sample.

The concentration gradients were calculated by subtracting the lower sampling port CH_4 concentrations from the higher sampling port CH_4 concentrations and dividing by the difference in height of the sampling ports (3.06 m, 1996; 1.25 m, 1994).

$$G = (CH_{4low} - CH_{4high}) / (Port_{high} - Port_{low})$$

G = Gradient
CH_{4low} = Methane mixing ratio at the lower sampling port
CH_{4high} = Methane mixing ratio at the upper sampling port
$Port_{high}$ = Height of the upper sampling port above the ground
$Port_{low}$ = Height of the lower sampling port above the ground

Half-hourly averages were determined and used to calculate CH_4 emissions (CH4_flux) by comparing the concentration gradient to the transfer coefficient (K), air temperature at 1 meter, and air pressure. NOTE: The transfer coefficient (K), air temperature at 1 meter, and air pressure data were calculated and provided by N. Roulet and N. Comer, McGill University, BOREAS TGB-03 CO_2 and CH_4 chamber flux data over the NSA. See BOREAS TGB-03 CO_2 and CH_4 chamber flux data over the NSA for details on flux calculation.

- **NSA-OJP:** Ambient CH_4 concentrations were determined at 6-minute intervals at 13.5 m and 30 m over the NSA-OJP site. The concentrations were determined by comparing the unknown ambient peak areas with the known standard peak area that was run immediately following each set of ambient samples using the above-described equations. The concentration gradients were calculated by subtracting the lower sampling port CH_4 concentrations from the higher sampling port CH_4 concentrations and dividing by the difference in height of the sampling ports (16.5 m) as per above. Half-hourly averages were determined.

9.2 Data Processing Sequence

9.2.1 Processing Steps

None given.

9.2.2 Processing Changes
None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments
None given.

9.3.2 Calculated Variables
None given.

9.4 Graphs and Plots
None given.

10. Errors

10.1 Sources of Error
None given.

10.2 Quality Assessment

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
The analytical precision of the GC is 0.2% for CH_4 at near-ambient conditions.

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
The analytical precision of the GC is 0.2% for CH_4.

11.2 Known Problems with the Data
Periodic power failures may cause incongruities in the data.

11.3 Usage Guidance
None given.

11.4 Other Relevant Information
None given.

12. Application of the Data Set

These data sets may be used in comparison with the chamber flux data to determine if the tower flux calculations agree with the small-scale flux calculations. These data can also be compared with the larger scale aircraft studies.

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description

HP ChemStation.

14.2 Software Access

Contact Hewlett Packard.

15. Data Access

The TGB-01 CH_4 concentration and flux data from NSA tower sites 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
Instruction Manual: MINI2-GC Shimadzu Corporation, Kyoto, Japan.

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).

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Sellers, P., F. Hall, and K.F. Huemmrich. 1996. Boreal Ecosystem-Atmosphere Study: 1994 Operations. NASA BOREAS Report (OPS DOC 94).

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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.

17.3 Archive/DBMS Usage Documentation
None.

18. Glossary of Terms

None given.

19. List of Acronyms

AES - Atmospheric Environment Services
ASCII - American Standard Code for Information Interchange
BOREAS - BOReal Ecosystem-Atmosphere Study
BORIS - BOREAS Information System
BP - Beaver Pond
CD-ROM - Compact Disk-Read-Only Memory
CGR - Certified by Group
CMDL - Climate Monitoring and Diagnostics Laboratory
CPI - Checked by PI
CPI-??? - CPI but Questionable
DAAC - Distributed Active Archive Center
ECD - Electron Capture Detector
EOS - Earth Observing System
EOSDIS - EOS Data and Information System
FID - Flame Ionization Detector
GC - Gas Chromatograph
GIS - Geographic Information System
GMT - Greenwich Mean Time
GSFC - Goddard Space Flight Center
HP - Hewlett Packard
HTML - HyperText Markup Language
NAD83 - North American Datum of 1983
NASA - National Aeronautics and Space Administration
NOAA - National Oceanic and Atmospheric Administration
NSA - Northern Study Area
OBS - Old Black Spruce
OJP - Old Jack Pine
ORNL - Oak Ridge National Laboratory
PANP - Prince Albert National Park
PRE - Preliminary
SSA - Southern Study Area
TCD - Thermal Conductivity Detector
TF - Tower Fen
TGB - Trace Gas Biogeochemistry
URL - Uniform Resource Locator
YJP - Young Jack Pine

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13. ABSTRACT *(Maximum 200 words)*

The BOREAS TGB-1 team made numerous measurements of trace gas concentrations and fluxes at various NSA sites. This data set contains half-hourly averages of ambient methane (CH_4) measurements and calculated fluxes for the NSA-Fen in 1996 and the NSA-BP and NSA-OJP tower sites in 1994. The purpose of this study was to determine the CH_4 flux from the study area by measuring ambient CH_4 concentrations. This flux can then be compared to the chamber flux measurements taken at the same sites. The data are provided in tabular ASCII files.

14. SUBJECT TERMS
BOREAS, trace gas biogeochemistry.

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