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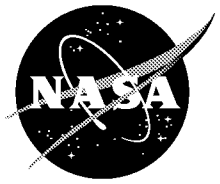

Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and David E. Knapp, Editors

Volume 217

BOREAS TF-11 SSA-Fen 1996 Water Surface Film Capping Data

David P. Billesbach
University of Nebraska-Lincoln

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

November 2000

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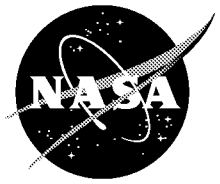

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BOREAS TF-11 SSA-Fen 1996 Water Surface Film Capping Data

David P. Billesbach

Summary

The BOREAS TF-11 team gathered a variety of data to complement its tower flux measurements collected at the SSA-Fen site. The data described in this document were made by the TF-11 team at the SSA-Fen site to quantify the effect that the films observed to form on open water surfaces had on the transfer of carbon dioxide and methane from the water to the air. Measurements of fluxes of carbon dioxide and methane were made in 1994 and in 1996 using the chamber flux method. A gas chromatograph and a LI-COR LI-6200 were used to measure concentrations and to calculate the fluxes. The data are stored in tabular ASCII files.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS TF-11 SSA-Fen 1996 Water Surface Film Capping Data

1.2 Data Set Introduction

This data set was collected by the Tower Flux (TF)-11 team at the BOReal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA)-Fen site to quantify the effect that the films observed to form on open water surfaces had on the transfer of carbon dioxide and methane from the water to the air. Measurements of fluxes of carbon dioxide and methane were made in 1994 and in 1996 using the chamber flux method. A gas chromatograph (GC) and a LI-COR LI-6200 were used to measure concentrations and to calculate the fluxes.

1.3 Objective/Purpose

The objectives of this study were to quantify the effect of the film that forms on the water surface of the SSA-Fen on fluxes of carbon dioxide and methane and to investigate the growth dynamics of the film after it has been broken up or destroyed.

1.4 Summary of Parameters

In this study, fluxes of carbon dioxide and methane were measured as functions of the time since the film was removed from the water surface. These measurements allowed the investigator to determine how much the film inhibited fluxes from the water surface and how quickly it reformed.

1.5 Discussion

During the Intensive Field Campaigns (IFCs) of the 1994 BOREAS campaign, the TF-11 team noticed that an oily-looking film formed on the surface of standing water in the SSA-Fen. Initially, this film was very thin and resembled an oil slick. With time, the film grew thicker and lost the rainbow-like interference colors associated with new, thin films. We also noticed during IFC-2 that during periods of rain, the instantaneous concentrations of methane and carbon dioxide showed large spikes, and that after the rain, the fluctuations were much larger than before the rain. This led us to speculate that the film was "capping" the water surface and causing an excess of dissolved gases (compared to a clean surface). The rain caused the film to break up, releasing the excess gas. Further, the agitation of the surface caused by the raindrop impacts caused even more gas to be released to the atmosphere. After the rain, the water surface was clean with no capping film, and gas continued to be released to the atmosphere at a rate in excess of that when a film was present.

We attempted to test this hypothesis in 1994, using the components of the chamber flux system that we were employing for other parts of our program. In this experiment, we placed a flux chamber collar in an area of standing water and removed any vegetation above the water surface. The collar was left undisturbed for several days until a thick film had formed in it. We then carefully placed a flux chamber over the collar and collected syringe samples according to our standard sampling protocol. After this first flux measurement, the chamber was removed and the film was gently "blotted" away from the surface with paper towels. The chamber was then replaced on the collar, and a second set of syringe samples was collected. The fluxes of methane and carbon dioxide calculated from these samples indeed showed that the film was affecting the movement of material to and from the surface. In 1996, we mounted a low-intensity effort to further quantify this effect and to explore the regrowth dynamics of the film. A LI-COR LI-6200 portable photosynthesis analyzer and a LI-COR 1-liter soil flux chamber were used to measure carbon dioxide fluxes from the water surface (at the SSA-Fen site) as a function of time since removal of the film. A GC was also set up to attempt to measure the effect of the film on methane, but problems with the GC limited this effort to only one set of carbon dioxide and methane fluxes.

1.6 Related Data Sets

BOREAS TF-11 SSA-Fen Tower Flux and Meteorological Data
BOREAS TF-11 SSA-Fen Leaf Gas Exchange Data
BOREAS TF-11 SSA-Fen Soil Surface CO2 Flux Data
BOREAS TF-11 SSA-Fen 1995 Leaf Area Index Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. David P. Billesbach
Center for Laser Analytical Studies of Trace Gas Dynamics
University of Nebraska-Lincoln

Dr. Shashi B. Verma, Professor
Department of Agricultural Meteorology
University of Nebraska-Lincoln

2.2 Title of Investigation

Field Micrometeorological Measurements, Process-Level Studies and Modeling of Methane and Carbon Dioxide Fluxes in a Boreal Wetland Ecosystem (SSA-Fen)

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3. Theory of Measurements

A LI-COR LI-6200 soil chamber was placed on polyvinylchloride (PVC) collars that were mounted in the fen such that the upper lip was just above the water surface. Soft foam tape ensured that a gas-tight seal was maintained. The soil chamber was a metal cylinder that had a volume of 1,149 cubic cm and a cross-sectional area of 72.38 square cm. The larger chamber used for the GC measurements was a rectangular parallelepiped formed by aluminum angle pieces. The walls of the chamber were made of transparent Aclar plastic (impervious to carbon dioxide and methane). The chamber was 40.5 cm tall and 31.3 cm x 31.3 cm in cross-section. Like the LI-COR chamber, this too was sealed to a collar planted in the fen by soft foam and spring clamps. A small-diameter plastic tube with a syringe valve that extended through one of the corner structural pieces allowed for gas sampling.

4. Equipment

4.1 Sensor/Instrument Description

The instruments used for this experiment were a LI-COR LI-6200 portable photosynthesis analyzer and a Shimadzu GC8 GC equipped with a Flame Ionization Detector (FID), a Shimadzu methanizer, a Shimadzu Chromatopak integrator, and a precision sample injection valve. The LI-6200 was used with a 1-liter soil flux chamber.

4.1.1 Collection Environment

Measurements were made between 15:00 and 24:00 Greenwich Mean Time (GMT) (9:00 to 18:00 local time). No measurements were made during periods of rain. Air temperature in the LI-6200 chamber ranged between 17 °C and 27 °C.

4.1.2 Source/Platform

The LI-6200 flux chamber was placed on PVC collars anchored into the peat with approximately 2 cm protruding above the water surface. The flux chambers used with the GC-FID instrument were mounted on stainless steel collars that were also fixed into the peat.

4.1.3 Source/Platform Mission Objectives

Not applicable.

4.1.4 Key Variables

Water surface flux of carbon dioxide and methane.

4.1.5 Principles of Operation

The LI-6200 calculates carbon dioxide concentrations by measuring the amount of light absorbed in a narrow band around 4.2 microns. The GC-FID measures concentrations by first separating the components by diffusion through a column, then measuring the number of ions produced in a flame. Fluxes are calculated in both cases by measuring the time rate of change of the density of the component (as calculated from the concentration).

4.1.6 Sensor/Instrumentation Measurement Geometry

The LI-6200 collars were located approximately 0.5 meters from either side of the main boardwalk, about 60 meters from the shore. Four collars were used. Collars 1, 2, and 3 were located on the south side of the boardwalk and collar 4 was on the north side. The bottom of collar 1 rested on moss, and the bottoms of the other collars were above the moss surface. Collar 3 was placed in an area where water was observed to flow from north to south. Collar 4 was suspended in deeper water, inside one of the GD-FID flux collars. The two GC-FID flux collars were similarly located, with one on the north side of the boardwalk and one on the south side. All above-surface vegetation was removed from all collars.

4.1.7 Manufacturer of Sensor/Instrument

LI-COR, Inc.
Environmental Division
4421 Superior Street
Lincoln, NE 68504 USA
(402) 467-3576
http://www.licor.com/ [Internet Link]

Shimadzu Scientific Instruments, Inc.
7102 Riverwood Drive
Columbia, MD 21046 USA
(410) 381-1227
http://www.shimadzu.com/ [Internet Link]

4.2 Calibration

The LI-6200 was calibrated by first allowing the instrument to warm up for 30 minutes. After this, the soil chamber was placed on a plastic-covered, flat surface to seal it off from the ambient atmosphere. The airflow was switched to pass through a soda lime "scrubber" column and analyzed. The instrument offset was then adjusted to read zero. The scrubber was then bypassed, and gas from a calibrated cylinder (348.6 ppmv) was introduced into the chamber with a 1/4" diameter tube. The instrument span was then adjusted to match the cylinder concentration value. The procedure was then repeated to verify the calibration.

The GC-FID was calibrated by allowing it to warm up for 30 minutes and then injecting calibration gas. The calibration gas used was a 50% mixture of a precision calibration mix (Scott Gases 1% carbon dioxide and 1% methane) with ambient air. The results from two injections were averaged, and calibration coefficients were automatically calculated by the GC-FID system. After this procedure, several injections of the same calibration mixture were measured to ensure instrument stability.

4.2.1 Specifications
None.

4.2.1.1 Tolerance
The carbon dioxide fluxes measured with the LI-6200 are believed to have error bars of between 10% and 20% of the flux value.

4.2.2 Frequency of Calibration
The LI-6200 was calibrated in the morning, before measurements began. At mid-day the calibration was checked and adjusted if necessary. Finally, at the end of the day, the calibration was checked again. The GC-FID was calibrated before sample analysis, and the calibration was checked after all samples had been analyzed.

4.2.3 Other Calibration Information
The LI-6200 had been returned to the manufacturer for maintenance and calibration the month prior to the 1996 field experiment.

5. Data Acquisition Methods

Carbon dioxide fluxes were measured by setting the LI-6200 soil chamber on a collar and initiating a measurement on the main unit. The chamber was sealed to the collar with a ring of soft foam. Two to five flux measurements were first made with a mature (older than 12 hours), intact film on the water surface. After this, the film was carefully removed from the water surface by blotting it up with a paper towel. Another set of two to five flux measurements was made from this "clean" surface. The ratio of the means of these measurements indicates the amount of "capping" caused by the mature film. After clean surface measurements were made, further measurements were made at fixed time intervals, ranging from 30 seconds to 2 hours. The soil flux chamber was removed from the collar between measurements to prevent the excessive build up of carbon dioxide inside the chamber. In this way, all flux measurements were made at carbon dioxide concentrations that were near ambient levels.

Samples for analysis with the GC-FID were collected by clamping the flux chamber to the collar and extracting 60-ml gas samples with a Teflon syringe. Samples were taken every 5 minutes for 30 minutes. Because of the lengthy sampling procedure, only "intact" and "clean" fluxes were measured by this technique. The ratio of intact to clean carbon dioxide fluxes was compared to that obtained with the LI-6200 as a cross-check of data.

6. Observations

6.1 Data Notes
It is believed that data from LI-6200 collar 3 are the most reliable. This is based on better day-to-day reproducibility.

6.2 Field Notes
Planned time sequence fluxes were interrupted on 25-Jul-1996, 26-Jul-1996, and 27-Jul-1996.

7. Data Description

7.1 Spatial Characteristics

This experiment made point source flux measurements at the SSA-Fen site, at essentially four closely spaced locations.

7.1.1 Spatial Coverage

Collar locations relative to the boardwalk leading to the tower are described in Section 4.1.6. The North American Datum of 1983 (NAD83) coordinates of the SSA-Fen tower are:

Latitude	Longitude	BOREAS_X	BOREAS_Y	UTM Northing	UTM Easting
53.80206°N	104.61798°W	419.527	330.991	5961566.6	525159.8

7.1.2 Spatial Coverage Map

Not applicable.

7.1.3 Spatial Resolution

The LI-6200 flux measurements were for collar areas of 72.4 cm^2. The GC-FID flux measurements were for collar areas of 979.7 cm^2.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

Data were collected between 24-Jul-1996 and 30-Jul-1996 (middle of IFC-2 in 1996). A single GC-FID measurement was made on 14-Sep-1994 (during IFC-3 in 1994).

7.2.2 Temporal Coverage Map

None.

7.2.3 Temporal Resolution

Carbon dioxide flux measurements were made with the LI-6200 on time scales that ranged from 30-second intervals to 6-hour intervals. Each GC-FID flux measurement took 30 minutes.

7.3 Data Characteristics

7.3.1 Parameter/Variable

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

WATER_SURFACE_FILM_CONCENTRATION

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
ELAPSED_TIME_CHAMBER
SURF_CONDITION
CH4_CONC

CO2_CONC
CH4_CONC_CHANGE_RATE
CO2_CONC_CHANGE_RATE
CRTFCN_CODE
REVISION_DATE

WATER_SURFACE_FILM_FLUX

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
TIME_OBS
ELAPSED_TIME_CLEAN
CHAMBER_ID
SURF_CONDITION
CO2_FLUX_CHAMBER
MEAN_CO2_FLUX_CHAMBER
CRTFCN_CODE
REVISION_DATE

7.3.2 Variable Description/Definition

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

WATER_SURFACE_FILM_CONCENTRATION

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.
ELAPSED_TIME_CHAMBER	The elapsed time since the chamber was placed on the collar.
SURF_CONDITION	The condition of the water surface inside the collar.
CH4_CONC	CH4 concentration.
CO2_CONC	CO2 concentration.
CH4_CONC_CHANGE_RATE	The rate of change of the methane concentration.
CO2_CONC_CHANGE_RATE	The rate of change of the CO2 concentration.
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.

WATER_SURFACE_FILM_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.
ELAPSED_TIME_CLEAN	The elapsed time since the water surface was cleaned.
CHAMBER_ID	Identifier assigned to the chamber measured.
SURF_CONDITION	The condition if the water surface inside the collar.
CO2_FLUX_CHAMBER	The chamber CO2 flux.
MEAN_CO2_FLUX_CHAMBER	The mean CO2 flux measurement for a given chamber, at a given time, for a given surface condition.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

7.3.3 Unit of Measurement

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

WATER_SURFACE_FILM_CONCENTRATION

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
ELAPSED_TIME_CHAMBER	[minutes]
SURF_CONDITION	[none]
CH4_CONC	[parts per million]
CO2_CONC	[parts per million]
CH4_CONC_CHANGE_RATE	[parts per million][minute^-1]
CO2_CONC_CHANGE_RATE	[parts per million][minute^-1]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

WATER_SURFACE_FILM_FLUX

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME_OBS	[HHMM GMT]
ELAPSED_TIME_CLEAN	[minutes]
CHAMBER_ID	[none]
SURF_CONDITION	[none]
CO2_FLUX_CHAMBER	[micromoles][meter^-2][second^-1]
MEAN_CO2_FLUX_CHAMBER	[micromoles][meter^-2][second^-1]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

7.3.4 Data Source

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

WATER_SURFACE_FILM_CONCENTRATION

Column Name	Data Source
SITE_NAME	[Assigned by BORIS.]
SUB_SITE	[Assigned by BORIS.]
DATE_OBS	[Supplied by Investigator.]
ELAPSED_TIME_CHAMBER	[Supplied by Investigator.]
SURF_CONDITION	[Supplied by Investigator.]
CH4_CONC	[Supplied by Investigator.]
CO2_CONC	[Supplied by Investigator.]
CH4_CONC_CHANGE_RATE	[Supplied by Investigator.]
CO2_CONC_CHANGE_RATE	[Supplied by Investigator.]
CRTFCN_CODE	[Supplied by Investigator.]
REVISION_DATE	[Assigned by BORIS.]

WATER_SURFACE_FILM_FLUX

Column Name	Data Source
SITE_NAME	[Assigned by BORIS.]
SUB_SITE	[Assigned by BORIS.]
DATE_OBS	[Supplied by Investigator.]
TIME_OBS	[Supplied by Investigator.]
ELAPSED_TIME_CLEAN	[Supplied by Investigator.]
CHAMBER_ID	[Supplied by Investigator.]
SURF_CONDITION	[Supplied by Investigator.]
CO2_FLUX_CHAMBER	[Supplied by Investigator.]
MEAN_CO2_FLUX_CHAMBER	[Supplied by Investigator.]
CRTFCN_CODE	[Supplied by Investigator.]
REVISION_DATE	[Assigned by BORIS.]

7.3.5 Data Range

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

WATER_SURFACE_FILM_CONCENTRATION

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-FEN-FLXTR	SSA-FEN-FLXTR	None	None	None	None
SUB_SITE	9TF11-SFC01	9TF11-SFC01	None	None	None	None
DATE_OBS	14-SEP-94	24-JUL-96	None	None	None	None
ELAPSED_TIME_CHAMBER	0	30	None	None	None	None
SURF_CONDITION	N/A	N/A	None	None	None	None
CH4_CONC	1.49	18.92	None	None	None	Blank
CO2_CONC	246.7	512.75	None	None	None	Blank
CH4_CONC_CHANGE_RATE	.0789	.909	None	None	None	Blank
CO2_CONC_CHANGE_RATE	.5217	4.276	None	None	None	Blank
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	29-MAR-99	29-MAR-99	None	None	None	None

WATER_SURFACE_FILM_FLUX

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-FEN-FLXTR	SSA-FEN-FLXTR	None	None	None	None
SUB_SITE	9TF11-WFC01	9TF11-WFC01	None	None	None	None
DATE_OBS	24-JUL-96	30-JUL-96	None	None	None	None
TIME_OBS	1515	2337	None	None	None	None
ELAPSED_TIME_CLEAN	0	180	None	None	None	Blank
CHAMBER_ID	1	4	None	None	None	None
SURF_CONDITION	N/A	N/A	None	None	None	None
CO2_FLUX_CHAMBER	-.0038	-.00015	None	None	None	Blank
MEAN_CO2_FLUX_CHAMBER	-.003136	-.000173	None	None	None	Blank
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	01-APR-99	01-APR-99	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 records from sample data files on the CD-ROM.

WATER_SURFACE_FILM_CONCENTRATION

```
SITE_NAME,SUB_SITE,DATE_OBS,ELAPSED_TIME_CHAMBER,SURF_CONDITION,CH4_CONC,
CO2_CONC,CH4_CONC_CHANGE_RATE,CO2_CONC_CHANGE_RATE,CRTFCN_CODE,REVISION_DATE
'SSA-FEN-FLXTR','9TF11-SFC01',14-SEP-94,0,'Cleaned',1.52,246.7,,,'CPI',29-MAR-99
'SSA-FEN-FLXTR','9TF11-SFC01',14-SEP-94,5,'Cleaned',5.05,260.8,,,'CPI',29-MAR-99
'SSA-FEN-FLXTR','9TF11-SFC01',14-SEP-94,10,'Cleaned',7.88,277.4,,,'CPI',
29-MAR-99
```

WATER_SURFACE_FILE_FLUX

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME_OBS,ELAPSED_TIME_CLEAN,CHAMBER_ID,
SURF_CONDITION,CO2_FLUX_CHAMBER,MEAN_CO2_FLUX_CHAMBER,CRTFCN_CODE,REVISION_DATE
'SSA-FEN-FLXTR','9TF11-WFC01',29-JUL-96,1629,,'1','intact',-.00027,,'CPI',
01-APR-99
'SSA-FEN-FLXTR','9TF11-WFC01',29-JUL-96,1629,,'1','intact',-.00025,,'CPI',
01-APR-99
```

8. Data Organization

8.1 Data Granularity

The smallest amount of data that can be ordered from the water surface film concentration data is the entire data set. The smallest amount of data that can be ordered from the water surface film flux data is a day's worth of data.

8.2 Data Formats

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

- Fluxes computed by the LI-6200 internal software assumed an area of 1 cm^2, and were in units of µmoles/m^2/s. The investigators divided by the actual area of the flux chamber (72.38 cm^2) and multiplied by 44 micrograms/micromole to arrive at units of mg/m^2/s. BOREAS Information System (BORIS) staff divided these values by 44 to convert the values back to micromoles/square meter/second.
- Concentrations were calculated by the GC-FID software. A standard least squares linear regression was applied to these points (as a function of time) to calculate the time rate of change of the concentration inside the chamber.

9.1.1 Derivation Techniques and Algorithms

- Initial fluxes were calculated by the LI-6200 software and were corrected in the Quattro-Pro V4.0 spreadsheet.
- Concentrations were calculated by the GC-FID software and slopes were calculated both with a hand calculator and in the Quattro-Pro V4.0 spreadsheet.

9.2 Data Processing Sequence

9.2.1 Processing Steps

WATER_SURFACE_FILM_CONCENTRATION

- TF-11 collected concentration data from the GC-FID and entered them into a spreadsheet.
- TF-11 ran a linear regression routine in the data.
- BORIS received the data from TF-11 and loaded it into the data base.

WATER_SURFACE_FILM_FLUX

- TF-11 collected data from the LI-6200 output files and entered them into a spreadsheet.
- TF-11 applied correction factors.
- Averages of the fluxes were calculated.
- BORIS received the data from TF-11 and loaded them into the data base.

9.2.2 Processing Changes

None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

See Section 9.1.

9.3.2 Calculated Variables

- Carbon dioxide fluxes and average fluxes.
- Time rates of change of methane and carbon dioxide concentration.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

The main source of flux errors in the LI-6200 data come from cracks induced in the film while placing the flux chamber on the collars. The main source of slope errors in the GC-FID data are from errors in the sampling time.

10.2 Quality Assessment

10.2.1 Data Validation by Source

The two types of carbon dioxide data (LI-6200 and GC-FID) were validated by comparing the ratios of clean to intact fluxes (or slopes). In addition, the LI-6200 data were validated by repetition.

10.2.2 Confidence Level/Accuracy Judgment

The comparison (LI-6200 to GC-FID) of carbon dioxide data showed that the two methods yielded similar results. This leads us to believe that the methane data (from the GC-FID) are also reliable. We found that when we plotted LI-6200 fluxes (from the same collar) as a function of time since cleaning, data from different days fell on the same curve.

10.2.3 Measurement Error for Parameters

We believe that carbon dioxide fluxes measured with the LI-6200 are accurate to between 10% and 20%.

10.2.4 Additional Quality Assessments

None.

10.2.5 Data Verification by Data Center

BORIS loaded the data into the data base and checked for any inconsistencies during loading.

11. Notes

11.1 Limitations of the Data

These data are not representative of the entire Fen site. They are from an extremely limited area.

11.2 Known Problems with the Data

Not all of the GC-FID samples from 24-Jul-1996 analyzed correctly, although enough did work to obtain slopes that agree with those obtained in 1994.

11.3 Usage Guidance

Because of the limited spatial coverage, the flux data should be used only to examine the effect of the film on fluxes.

11.4 Other Relevant Information

None.

12. Application of the Data Set

These data can be used to better understand the role of oily film on carbon dioxide flux. This oily film is commonly found on the water surface of fens.

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description

None given. For specific questions regarding the software mentioned in Section 9.1, please contact Dr. David Billesbach.

14.2 Software Access

None given.

15. Data Access

The SSA-Fen 1996 water surface film capping 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

LI-COR LI-6200 Users Guide.

Shimadzu Chromatopak Users Guide.

Shimadzu GC-8 Users Guide.

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.

Puustjarvi, V. 1952. The Precipitation of Iron in Peat Soils. Acta Agralia Fennica, 78, 1-72.

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.

17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

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ASCII     - American Standard Code for Information Interchange
BOREAS    - BOReal Ecosystem-Atmosphere Study
BORIS     - BOREAS Information System
CD-ROM    - Compact Disk-Read-Only Memory
DAAC      - Distributed Active Archive Center
DOY       - Day of the Year
EOS       - Earth Observing System
EOSDIS    - EOS Data and Information System
GC-FID    - Gas Chromatograph-Flame Ionization Detector
GIS       - Geographic Information System
GMT       - Greenwich Mean Time
GSFC      - Goddard Space Flight Center
HTML      - HyperText Markup Language
IFC       - Intensive Field Campaign
NAD83     - North American Datum of 1983
NASA      - National Aeronautics and Space Administration
NSA       - Northern Study Area
ORNL      - Oak Ridge National Laboratory
PANP      - Prince Albert National Park
PPMV      - Parts Per Million by Volume
PVC       - Polyvinylchloride
SSA       - Southern Study Area
TF        - Tower Flux
URL       - Uniform Resource Locator
UTM       - Universal Transverse Mercator
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13. ABSTRACT *(Maximum 200 words)*

The BOREAS TF-11 team gathered a variety of data to complement its tower flux measurements collected at the SSA-Fen site. The data described in this document were made by the TF-11 team at the SSA-Fen site to quantify the effect that the films observed to form on open water surfaces had on the transfer of carbon dioxide and methane from the water to the air. Measurements of fluxes of carbon dioxide and methane were made in 1994 and in 1996 using the chamber flux method. A gas chromatograph and a LI-COR LI-6200 were used to measure concentrations and to calculate the fluxes. The data are stored in tabular ASCII files.

14. SUBJECT TERMS
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