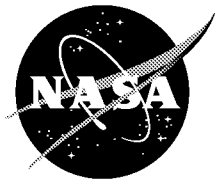
NASA/TM—2000–209891, Vol. 191



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

Forrest G. Hall and Karl Huemmrich, Editors

Volume 191

BOREAS TF-1 SSA-OA Weekly Tower CH_4 and N_2O Flux

George Thurtell and Grant Edwards, University of Guelph, Ontario
Isobel Simpson, University of California, Irvine

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

October 2000

The NASA STI Program Office ... in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA Scientific and Technical Information (STI) Program Office plays a key part in helping NASA maintain this important role.

The NASA STI Program Office is operated by Langley Research Center, the lead center for NASA's scientific and technical information. The NASA STI Program Office provides access to the NASA STI Database, the largest collection of aeronautical and space science STI in the world. The Program Office is also NASA's institutional mechanism for disseminating the results of its research and development activities. These results are published by NASA in the NASA STI Report Series, which includes the following report types:

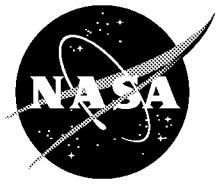
- TECHNICAL PUBLICATION. Reports of completed research or a major significant phase of research that present the results of NASA programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA's counterpart of peer-reviewed formal professional papers but has less stringent limitations on manuscript length and extent of graphic presentations.
- TECHNICAL MEMORANDUM. Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.
- CONTRACTOR REPORT. Scientific and technical findings by NASA-sponsored contractors and grantees.
- CONFERENCE PUBLICATION. Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or cosponsored by NASA.
- SPECIAL PUBLICATION. Scientific, technical, or historical information from NASA programs, projects, and mission, often concerned with subjects having substantial public interest.
- TECHNICAL TRANSLATION. English-language translations of foreign scientific and technical material pertinent to NASA's mission.

Specialized services that complement the STI Program Office's diverse offerings include creating custom thesauri, building customized databases, organizing and publishing research results . . . even providing videos.

For more information about the NASA STI Program Office, see the following:

- Access the NASA STI Program Home Page at http://www.sti.nasa.gov/STI-homepage.html
- E-mail your question via the Internet to help@sti.nasa.gov
- Fax your question to the NASA Access Help Desk at (301) 621-0134
- Telephone the NASA Access Help Desk at (301) 621-0390
- Write to:
  NASA Access Help Desk
  NASA Center for AeroSpace Information
  7121 Standard Drive
  Hanover, MD 21076-1320

NASA/TM—2000–209891, Vol. 191



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

Forrest G. Hall and Karl Huemmrich, Editors

Volume 191

BOREAS TF-1 SSA-OA Weekly Tower CH_4 and N_2O Flux

George Thurtell and Grant Edwards, University of Guelph, Ontario
Isobel Simpson, University of California, Irvine

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

October 2000

Available from:

NASA Center for AeroSpace Information
7121 Standard Drive
Hanover, MD 21076-1320
Price Code: A17

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Price Code: A10

BOREAS TF-1 SSA-OA Weekly Tower CH_4 and N_2O Flux

George Thurtell, Grant Edwards, Isobel Simpson

Summary

The BOREAS TF-1 team collected various trace gas and energy flux data in its efforts to characterize the temporal energy and gas exchanges that occurred over the SSA-OA site. This data set contains methane (CH_4) and nitrous oxide (N_2O) fluxes that were measured at the BOREAS SSA-OA site. These fluxes were measured from 16-Apr to 16-Sep-1994. The data were averaged to weekly values and are available in tabular ASCII files.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS TF-01 SSA-OA Weekly Tower CH_4 and N_2O Flux

1.2 Data Set Introduction

Fluxes of CH_4 and N_2O were measured at the BOReal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA) Old Aspen (OA) site. These fluxes were measured through the growing season of 1994. The tower-based fluxes were determined using a high-resolution tunable diode laser Trace Gas Analysis System (TGAS) together with micrometeorological techniques. The fluxes were small and required long averaging times to be resolved. Half-hour averages were determined and these were averaged to weekly values.

1.3 Objective/Purpose

The global budgets of CH_4 and N_2O are poorly constrained, and several priority trace gas research areas have been specified, including the boreal forest. The objectives of this research were to quantify the exchange of CH_4 and N_2O at the aspen site and to better understand the factors that control their exchange.

1.4 Summary of Parameters and Variables

Half-hour observations were combined to produce weekly CH_4 and N_2O flux values. The data set includes weekly average, standard error, and number of half-hourly values used to calculate the average, for both CH_4 and N_2O. By convention, a positive flux indicates trace gas emission, and a negative flux indicates uptake.

1.5 Discussion

Boreal forests have been reported as net sinks of CH_4, although the uptake of CH_4 by soils has not been well characterized. CH_4 oxidation in moist soils may be a negative feedback on atmospheric CH_4 increases. Generally, there is a lack of N_2O for all northern ecosystems.

1.6 Related Data Sets

BOREAS TF-02 SSA-OA Tower Flux and Meteorological Data
BOREAS TF-01 SSA-OA Undercanopy Flux, Meteorological, and Soil Temperature Data
BOREAS TF-04 CO2 and CH4 Chamber Flux Data from the SSA

2. Investigator(s)

2.1 Investigator(s) Name and Title

George Thurtell, University of Guelph
Grant Edwards, University of Guelph

2.2 Title of Investigation

Boreal Forest Atmosphere Interactions: Exchanges of Energy, Water Vapor, and Trace Gases

2.3 Contact Information

Contact 1:
Isobel Simpson
Chemistry Department
University of California, Irvine
Irvine, CA 92697
(949) 824-6024
(949) 824-2905 (fax)
isimpson@uci.edu

Contact 2:
Grant Edwards
University of Guelph
Department of Land Resource Science
Guelph, Ontario
Canada N1G 2W1
(519) 824-5730 (fax)
gedwards@net2.eos.uoguelph.ca

Contact 3:
George Thurtell
University of Guelph
Department of Land Resource Science
Guelph, Ontario
Canada N1G 2W1
(519) 824-4120
(519) 824-5730 (fax)
gthurtel@lrs.uoguelph.ca

Contact 4:
K. Fred Huemmrich
University of Maryland
Code 923
NASA GSFC
Greenbelt, MD 20771
(301) 286-4862
(301) 286-0239 (fax)
Karl.Huemmrich@gsfc.nasa.gov

3. Theory of Measurements

The tower-based fluxes were determined using the flux-gradient method. Measurements were made of the concentration differences of CH_4 and N_2O between 26.8 and 37.5 m above the forest floor. The canopy height was 22 m. Air was alternately sampled from either level every 4 seconds, and the resulting concentration differences were averaged over half an hour. Micrometeorological data collected at 39.1 m using a sonic anemometer were used to determine a transfer coefficient. Together, the concentration differences and stability-corrected transfer coefficient were used to determine the flux of CH_4 and N_2O in the following flux-gradient relationship:

$$\text{Flux} = \frac{-\left[\, \text{ustar}\ k\ (\text{conc2} - \text{conc1}) \,\right]}{0.74 \left[\, \ln\left\{ \frac{(z2 - d)}{(z1 - d)} \right\} - \text{psih2} + \text{psih1} \,\right]}$$

where ustar is the friction velocity [m/s]; k is von Karman's constant (taken as 0.4); z2 and z1 are the upper (37.5 m) and lower (26.8 m) sampling heights, respectively; conc2 and conc1 are the respective concentrations [ng/m^3] at z2 and z1; d is the zero plane displacement; and psih2 and psih1 are the respective scalar diabatic correction functions at z2 and z1.

A value for the zero plane displacement was determined before, during, and after leaf-out using sonic anemometer data collected during times of neutral atmospheric stability.

4. Equipment

4.1 Sensor/Instrument Description

4.1.1 Collection Environment

Data were collected through the growing season of 1994. The site was burned approximately 80 years ago, and the primary forest cover was trembling aspen (Populus tremuloides) with some balsam poplar (Populus balsamifera). The aspen canopy architecture features an open trunk space with the crown concentrated at the top 5-6 m of the trees. The maximum aspen leaf area index in 1994 was 2.4. There was a rich understory comprising 60% hazelnut (Corylus cornuta) and 15% wild rose (Rosa woodsii). The soil is classified as an Orthic Gray Aluvisol, featuring a well- to moderately well-drained loam to clay loam till and an organic layer depth less than 8 cm.

4.1.2 Source/Platform

Measurements were made from a 37-m double-scaffold walk-up tower. Two Campbell Scientific tunable diode laser TGAS were used to measure the concentration differences of CH_4 and N_2O between 26.8 and 37.5 m above the forest floor. Air was alternately sampled from either level every 4 seconds, and the resulting concentration differences were averaged over half an hour. Micrometeorological data collected at 39.1 m using a 20-cm-path Kaijo-Denke sonic anemometer were used to determine a transfer coefficient.

4.1.3 Source/Platform Mission Objectives

The purpose of the tower was to suspend instruments to measure trace gas, energy fluxes, and meteorological variables above a mature aspen stand.

4.1.4 Key Variables

Half-hour observations were combined to produce weekly CH_4 and N_2O flux values. The data set includes weekly average, standard error, and number of half-hourly values used to calculate the average, for both CH_4 and N_2O. By convention, a positive flux indicates trace gas emission, and a negative flux indicates uptake.

4.1.5 Principles of Operation

Laser-based trace gas analysis is based on absorption spectroscopy, whereby each molecule is known to absorb radiation in a characteristic spectrum. In the TGAS unit, a lead-salt laser is housed in a liquid nitrogen-cooled Dewar. The laser beam is sent through a single-path, 1.5-m sample tube, and then is split into sample and reference gas cells, each housing a Peliter-cooled cadmium-mercury-telluride detector. Air sampled from outside is pumped through the sample tube, where it encounters the laser beam. A good absorption line is selected based on its strength and the absence of interference by other absorbing gases. The laser emission is tunable, and the laser is modulated to scan back and forth across the entire absorption feature 500 times a second. The area under the absorption feature is integrated to determine the concentration of the trace gas within the air sample. Concentration readings are output at 10 Hz, and each reading is calibrated in real time against a reference gas (in this case CH_4 or N_2O) of known concentration.

4.1.6 Sensor/Instrument Measurement Geometry

Air intakes were located on the SSA-OA flux tower at 0.5, 5.0, 18.1, 26.8, and 37.5 m above the ground. Concentration differences were determined in 4-hour cycles between each pair of intakes with an emphasis on the above canopy measurements (the 26.8- and 37.5-m intakes). The air from the upper and lower intakes passed through an equal amount of 0.5-inch inner diameter (i.d.) high-density polyethylene tubing to a common Perma Pure dryer located on the tower. A total of four dryers were installed on the tower, one for each pair of intakes.

4.1.7 Manufacturer of Sensor/Instrument

TGAS units:
Campbell Scientific, Inc.
815 West 1800 North
Logan, UT 84321-1784
(435) 753-2342
(435) 750-9540 (fax)
info@campbellsci.com

4.2 Calibration

4.2.1 Specifications

Concentration readings from TGAS were output at 10 Hz. Each reading is calibrated in real time against a reference gas (in this case CH_4 or N_2O) of known concentration.

4.2.1.1 Tolerance

See Section 9.2.1.

4.2.2 Frequency of Calibration

Calibration against a reference gas was done in real time.

4.2.3 Other Calibration Information

None.

5. Data Acquisition Methods

A suite of four concentration differences was measured between five levels both above and within the aspen canopy. The concentration differences were determined in a 4-hour cycle, with emphasis on the above-canopy measurements. The TGAS units operated 24 hours a day over the 5 months of measurement, with about 1 hour of data edited out each day during liquid nitrogen fills.

A five-way Whitey ball valve (model SS-45ZF8-42ACZ) with an electric actuator (model MS-142ACZ) was used to switch the sampling among air intakes. For a given pair of intakes, a Numatics solenoid valve (model 152SS-400K) located on the tower was used to alternately draw sample air from the upper and lower intakes every 4 s. Rapid switching between the two levels acts as a high-pass filter and therefore reduces the low-frequency noise.

The air from the upper and lower intakes passed through an equal amount of 0.5-inch i.d. high density polyethylene tubing to a common Perma Pure dryer (model PD-1000-SS48) located on the tower. A total of four dryers were installed on the tower, one for each pair of intakes. Drying is necessary to avoid corrections to the flux measurements for density effects caused by water vapor transfer.

The dried air then was pumped at low pressure through tubes from the tower to a hut housing the TGAS units. Travel through a common long tube ensured that the upper and lower air samples had a common temperature by the time they reached the TGAS units. A Whitey needle valve (model SS-3NRM4) positioned at the end of each dryer was used to create a pressure drop, and the pressure in each TGAS unit was maintained at 75 mbar. The concentration readings recovered from the solenoid valve switch in 0.6-0.7 s, and the first 0.8 s of data were discarded following each 4-s switch. Delay times to account for the travel time down the tubes were also set in the TGAS units.

The sample air was split and diverted through the two TGAS units in parallel,. The air was then exhausted through a Busch pump (model RA-0040-A005-1002) at 22 actual ft^3/min.

6. Observations

6.1 Data Notes

None.

6.2 Field Notes

The TGAS concentration differences were edited out during liquid nitrogen fills (twice daily), power surges, laser alignment, etc.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

All data were collected at the BOREAS SSA-OA site. North American Datum of 1983 (NAD83) coordinates for the site are latitude 53.62889° N, longitude 106.19779° W, and elevation of 600.63 m.

7.1.2 Spatial Coverage Map

Not applicable.

7.1.3 Spatial Resolution

Large eddy simulations using characteristics appropriate for the aspen site indicated that under neutral atmospheric stability, 90% of the measured trace gas flux, was expected to originate from within a distance of 2 km upwind of the tower, with a peak influence distance of 200 m.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

Fluxes were measured from 16-Apr to 16-Sep-1994. The data were averaged to weekly values.

7.2.2 Temporal Coverage Map

None.

7.2.3 Temporal Resolution

The fluxes were small and required long averaging times to be resolved. Half-hour averages were determined, and these were averaged to weekly values.

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
START_DATE
END_DATE
MEAN_WEEKLY_CH4_FLUX
STD_ERR_WEEKLY_CH4_FLUX
NUM_WEEKLY_CH4_FLUX
MEAN_WEEKLY_N2O_FLUX
STD_ERR_WEEKLY_N2O_FLUX
NUM_WEEKLY_N2O_FLUX
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:

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.
START_DATE	The date on which the collection of data commenced.
END_DATE	The date on which the collection of the data was terminated.
MEAN_WEEKLY_CH4_FLUX	The weekly averaged methane flux, based on half hour methane fluxes.
STD_ERR_WEEKLY_CH4_FLUX	The standard error of the weekly averaged methane flux, based on half hour methane fluxes.
NUM_WEEKLY_CH4_FLUX	The number of half hour flux values used in calculating the weekly averaged methane flux.
MEAN_WEEKLY_N2O_FLUX	The weekly averaged nitrous oxide flux, based on half hour nitrous oxide fluxes.
STD_ERR_WEEKLY_N2O_FLUX	The standard error of the weekly averaged nitrous oxide flux, based on half hour nitrous oxide fluxes.
NUM_WEEKLY_N2O_FLUX	The number of half hour flux values used in calculating the weekly averaged nitrous oxide flux.

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:

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
START_DATE	[DD-MON-YY]
END_DATE	[DD-MON-YY]
MEAN_WEEKLY_CH4_FLUX	[nanomoles][meters^-2][second^-1]
STD_ERR_WEEKLY_CH4_FLUX	[nanomoles][meters^-2][second^-1]
NUM_WEEKLY_CH4_FLUX	[counts]
MEAN_WEEKLY_N2O_FLUX	[nanomoles][meters^-2][second^-1]
STD_ERR_WEEKLY_N2O_FLUX	[nanomoles][meters^-2][second^-1]
NUM_WEEKLY_N2O_FLUX	[counts]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

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	[Assigned by BORIS.]
SUB_SITE	[Assigned by BORIS.]
START_DATE	[Supplied by Investigator.]
END_DATE	[Supplied by Investigator.]
MEAN_WEEKLY_CH4_FLUX	[TGAS and sonic anemometer]
STD_ERR_WEEKLY_CH4_FLUX	[TGAS and sonic anemometer]
NUM_WEEKLY_CH4_FLUX	[Supplied by Investigator.]
MEAN_WEEKLY_N2O_FLUX	[TGAS and sonic anemometer]
STD_ERR_WEEKLY_N2O_FLUX	[TGAS and sonic anemometer]
NUM_WEEKLY_N2O_FLUX	[Supplied by Investigator.]
CRTFCN_CODE	[Assigned by BORIS.]
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.

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9OA-FLXTR	SSA-9OA-FLXTR	None	None	None	None
SUB_SITE	9TF01-FLX01	9TF01-FLX01	None	None	None	None
START_DATE	17-APR-94	11-SEP-94	None	None	None	None
END_DATE	23-APR-94	17-SEP-94	None	None	None	None

```
MEAN_WEEKLY_CH4_FLUX -.22375        5.33          None    None   None    None
STD_ERR_WEEKLY_CH4_  .30813         2.09          None    None   None    None
FLUX
NUM_WEEKLY_CH4_FLUX  35             115           None    None   None    None
MEAN_WEEKLY_N2O_FLUX -.1225         .16341        None    None   None    None
STD_ERR_WEEKLY_N2O_  .04023         .11909        None    None   None    None
FLUX
NUM_WEEKLY_N2O_FLUX  35             120           None    None   None    None
CRTFCN_CODE          CPI            CPI           None    None   None    None
REVISION_DATE        24-MAY-99      24-MAY-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 record from a sample data file on the CD-ROM.

```
SITE_NAME,SUB_SITE,START_DATE,END_DATE,MEAN_WEEKLY_CH4_FLUX,
STD_ERR_WEEKLY_CH4_FLUX,NUM_WEEKLY_CH4_FLUX,MEAN_WEEKLY_N2O_FLUX,
STD_ERR_WEEKLY_N2O_FLUX,NUM_WEEKLY_N2O_FLUX,CRTFCN_CODE,REVISION_DATE
'SSA-9OA-FLXTR','9TF01-FLX01',17-APR-94,23-APR-94,-.13125,.93125,50,-.1225,
.11909,
50,'CPI',24-MAY-99
'SSA-9OA-FLXTR','9TF01-FLX01',24-APR-94,30-APR-94,.6325,.78688,72,-.05932,
.10727,67,'CPI',24-MAY-99
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by the BOREAS Information System (BORIS) was data collected at a given site on a given date.

8.2 Data Format

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

The fluxes of CH_4 and N_2O were determined in the following flux-gradient relationship:

$$\text{Flux} = \frac{-[\,\text{ustar}\;k\;(\text{conc2} - \text{conc1})\,]}{0.74\,[\,\ln\{(z2 - d)/(z1 - d)\} - \text{psih2} + \text{psih1}\,]}$$

where: ustar is the friction velocity [m/s]
k is von Karman's constant (taken as 0.4)
z2 and z1 are the upper (37.5 m) and lower (26.8 m) sampling heights
conc2 and conc1 are the respective concentrations [ng/m^3] at z2 and z1
d is the zero plane displacement
psih2 and psih1 are the respective scalar diabatic correction functions at z2 and z1

9.2 Data Processing Sequence

9.2.1 Processing Steps

The editing criteria applied to the 39.1-m sonic anemometer data in preliminary analysis include:

- Measured horizontal windspeed (Umeas) > 1.5 m/s.
- Calculated horizontal windspeed (Ucalc) > 1.5 m/s. Ucalc was determined from the logarithmic wind profile equation using ustar from the sonic anemometer.
- Zeta ([z-d]/L) between -10 and 2, where L is the Monin-Obukhov length.
- The ratio of Umeas and Ucalc between 0.8 and 1.2.

BORIS staff processed these data by:

- Reviewing the initial data files and loading them online for BOREAS team access.
- Designing relational data base tables to inventory and store the data.
- Loading the data into the relational data base tables.
- Working with the team to document the data set.
- Extracting the data into logical files.

9.2.2 Processing Changes
None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments
None.

9.3.2 Calculated Variables
See Section 9.1.1.

9.4 Graphs and Plots
None.

10. Errors

10.1 Sources of Error
Wind speed editing was introduced because sonic anemometers can give error at low wind speeds due to flow distortion around the transducers.

10.2 Quality Assessment

10.2.1 Data Validation by Source
Quality checks were made as part of the data processing to remove poor data values. See Section 9.2.1.

10.2.2 Confidence Level/Accuracy Judgment
The half-hour above-canopy trace gas concentration differences were often close to the resolution of the TGAS units for both CH_4 and N_2O.

10.2.3 Measurement Error for Parameters
None.

10.2.4 Additional Quality Assessments
None.

10.2.5 Data Verification by Data Center
BOREAS Information System staff reviewed the data and documentation for clarity and consistency.

11. Notes

11.1 Limitations of the Data
The sonic anemometer and the TGAS units operated 24 hours a day, and the edited data include half hours collected in both the daytime and the nighttime. 1994 was a record warm, frost-free year in the BOREAS SSA.

11.2 Known Problems with the Data
None.

11.3 Usage Guidance
None.

11.4 Other Relevant Information

Overall, the preliminary analysis indicates a small net upwards N_2O flux of 1.5±0.7 ng/m^2/s from April to September 1994. N_2O is produced by soil bacteria during nitrification and denitrification, and these initial results suggest that this forest is efficient in its use of nitrogen. The data also show an overall CH_4 emission of 24±5 ng/m^2/s during the measurement period. Well-aerated soils in temperate and tropical regions have been shown to consume CH_4, and we had also expected to see CH_4 consumption at the OA site. We have carefully investigated the CH_4 results, and we believe the upwards CH_4 fluxes to be real. We are continuing to investigate the observed emission of CH_4 from the OA stand. However, at this time we expect that CH_4 emissions from warm, wet areas located throughout the footprint were greater than CH_4 uptake in drier areas, to give a net upwards flux of CH_4 during the measurement period.

12. Application of the Data Set

These data are useful for the study of nitrogen and carbon exchange in a mature aspen forest.

13. Future Modifications and Plans

We are continuing to assess our data selection criteria, and we remind BORIS users that these results are preliminary only and may change after further analysis.

14. Software

14.1 Software Description

None given.

14.2 Software Access

None given.

15. Data Access

The SSA-OA weekly tower CH_4 and N_2O 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.

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.

Simpson, I.J., G.C. Edwards, G.W. Thurtell, G. den Hartog, H.H. Neumann, and R.M. Staebler. 1997. Micrometeorological measurements of methane and nitrous oxide exchange above a boreal aspen forest. Journal of Geophysical Research 102(D24): 29,331-29,341.

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
CD-ROM	- Compact Disk-Read-Only Memory
DAAC	- Distributed Active Archive Center
EOS	- Earth Observing System
EOSDIS	- EOS Data and Information System
GIS	- Geographic Information System
GMT	- Greenwich Mean Time
GSFC	- Goddard Space Flight Center
HTML	- Hyper-Text Markup Language
i.d.	- Inner diameter
IFC	- Intensive Field Campaign
NAD83	- North American Datum of 1983
NASA	- National Aeronautics and Space Administration
NSA	- Northern Study Area
OA	- Old Aspen
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert National Park
SSA	- Southern Study Area
TF	- Tower Flux
TGAS	- Trace Gas Analysis System
URL	- Uniform Resource Locator

20. Document Information

20.1 Document Revision Date

Written: 03-Jun-1999
Revised: 22-Nov-1999

20.2 Document Review Date(s)

BORIS Review: 10-Jun-1999
Science Review:

20.3 Document ID

20.4 Citation

When using these data, please include the following acknowledgment:

Data were collected and processed by Isobel Simpson, Grant Edwards, George Thurtell. The results are described in the paper Simpson et al., 1997.

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

Simpson, I.J., G.C. Edwards, G.W. Thurtell, and T.A. Black, "Boreal Forest Atmosphere Interactions: Exchanges of Energy, Water Vapor, and Trace Gases." In Collected Data of The Boreal Ecosystem-Atmosphere Study. Eds. J. Newcomer, 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. CD-ROM. NASA, 2000.

Also, cite the BOREAS CD-ROM set as:

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. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM. NASA, 2000.

20.5 Document Curator

20.6 Document URL

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	October 2000	Technical Memorandum

4. TITLE AND SUBTITLE
Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)
BOREAS TF-1 SSA-OA Weekly Tower CH_4 and N_2O Flux

5. FUNDING NUMBERS
923
RTOP: 923-462-33-01

6. AUTHOR(S)
George Thurtell, Grant Edwards, and Isobel Simpson
Forrest G. Hall and Karl Huemmrich, Editors

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS (ES)
Goddard Space Flight Center
Greenbelt, Maryland 20771

8. PEFORMING ORGANIZATION REPORT NUMBER
2000-03136-0

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS (ES)
National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
TM—2000–209891
Vol. 191

11. SUPPLEMENTARY NOTES
G. Thurtell, G. Edwards, and I. Simpson: University of Guelph, Ontario;
K. Huemmrich: University of Maryland, NASA Goddard Space Flight Center, Greenbelt, Maryland

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Unclassified–Unlimited
Subject Category: 43
Report available from the NASA Center for AeroSpace Information,
7121 Standard Drive, Hanover, MD 21076-1320. (301) 621-0390.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The BOREAS TF-1 team collected various trace gas and energy flux data in its efforts to characterize the temporal energy and gas exchanges that occurred over the SSA-OA site. This data set contains methane (CH_4) and nitrous oxide (N_2O) fluxes that were measured at the BOREAS SSA-OA site. These fluxes were measured from 16-Apr to 16-Sep-1994. The data were averaged to weekly values and are available in tabular ASCII files.

14. SUBJECT TERMS	15. NUMBER OF PAGES
BOREAS, tower flux.	15
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL