Title:

BE CH4 Fall 2009

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Funding Source:

This research was conducted as part of the Biocomplexity Program of the National Science Foundation, grant number OPP-0421588.

Summary

This data set contains half-hourly vertical fluxes of CO_2, CH_4, and related environmental measurements taken at the Biocomplexity Experimental Site in northern Alaska during the autumn of 2009. Sampling was conducted as part of a large-scale water manipulation experiment to test the effect of altered tundra moisture on ecosystem carbon exchange.

The variables measured were: CO_2 flux, CH_4 flux, H_2O flux, latent and sensible heat fluxes, turbulence characteristics, radiation, meteorological variables, ground heat flux (5 replicates), soil temperature (10, 20, and 30 cm depths), and soil moisture (0 – 30 cm depth). Sample date and time are also given.

This research was conducted as part of the Biocomplexity Program of the National Science Foundation, grant number OPP-0421588.

Citing These Data:

Oechel, W.C., C.S. Sturtevant. 2011. *Autumn carbon fluxes at the Biocomplexity Experiment Site, Barrow, AK, 2009.* Boulder, CO: National Center for Atmospheric Research, ARCSS Data Archive.

Overview Table

Category	Description
Data format	Comma-delimited ASCII text
Spatial coverage and resolution	Biocomplexity Experiment Site near Barrow, Alaska at 71.284º N, 156.598º W. Three meteorological towers spaced approximately 300 m apart in a North-South direction.
Temporal coverage and resolution	2009-08-19 to 2009-10-25; measurements recorded in half-hourly intervals

File size	3 files. BECH4Fall2009_North.csv = 650 KB BECH4Fall2009_Central.csv = 456 KB BECH4Fall2009_South.csv = 167 KB
Parameter(s)	Fc, Fm, H, FH2O,LE, TAU, Ta, Rh, VPD, Rn, Rgs, Rgs_out, PAR, WS, WD, UST, ZL, PRESS, FG1, FG2, FG3, FG4, FG5, TS10, TS20, TS30, SWC30

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1. Contacts and Acknowledgments:

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2. Detailed Data Description:

Format:

The data are available as comma-delimited ASCII text files. Separate files contain data from each section (North, Central, South), and are labeled accordingly. In each file, a 5-row header indicates:
Site name: <BEN = North (flooded), BEC = Central (drained), BES = South (intermediate)>
Contact email
Date of file creation
Column variable names

Column variable units

File Size:

The file size for each file is as follows:
BECH4Fall2009_North.csv = 650 KB
BECH4Fall2009_Central.csv = 456 KB
BECH4Fall2009_South.csv = 167 KB

Spatial Coverage:

Data were collected at the Biocomplexity Experimental Site in northern Alaska, located at 71.284º N, 156.598º W.

The Biocomplexity Experiment site is situated in the Barrow Environmental Observatory and located approximately 6 km east of Barrow village and 7 km south of the Arctic Ocean. The tundra in this region is considered wet-sedge meadow and is underlain by continuous permafrost with an average active layer of approximately 37 cm. Soils for this site are Gelisols of the suborder Histel. Mean annual temperature is -12ºC, while mean summer temperature (June-August) is 3.3ºC. Annual precipitation averages 106 mm.

The Biocomplexity Site is an approximately 1.5 km x 0.5 km vegetated thaw lake basin which is estimated to have drained 50-300 years ago. This basin has been divided into three sections by dikes. In 2009, water was pumped into or out of each section such that the North section represented wetter than ambient conditions, the Central section drier than ambient conditions, and the South section intermediate moisture conditions. The sections are about 300 m apart in the north-south direction. This was the second successful year of manipulation.

Spatial Resolution:

All reported measurements were collected at the eddy-covariance tower located in the east of each section. Flux values are representative of each section, with 80% of the flux typically attributed to the first 135 m upwind from the tower. Data from each section are contained in separate files.

Temporal Coverage:

Data were collected from August 19, 2009 to October 25, 2009 (Julian days 231 - 298).

Temporal Resolution:

All measurements are reported in half-hour intervals, with the indicated time of measurement as the beginning of the half-hour.

Parameters or Variables:

Parameter Description:

Year: Year of measurement.

DOY: Day of year of measurement.

HRMIN: Hour and minute of measurement given as a 2 to 4 value integer, with the hour indicated in the first two values and the minute in the second two values. Ex. 12:30am is represented as 30, 8:30am is represented as 830, and 6:00pm is represented as 1800.

DTIME: Decimal day of year.

Fc: CO_2 flux in µmol CO_2 m^{-2} s^{-1}.

Fm: CH_4 flux in nmol CH_4 m^{-2} s^{-1}

H: Sensible heat flux in W m^{-2}

FH_2O: Water vapor flux in mmol H_2O m^{-2} s^{-1}

LE: Latent heat flux in W m^{-2} s^{-1}

TAU: Momentum flux in kg m^{-1} s^{-2}
Ta: Air temperature at 1.6 m height in °C
Rh: Relative humidity at 1.6 m height in %
VPD: Vapor pressure deficit in kPa
Rn: Net radiation in W m^{-2}
Rgs: Downwelling global shortwave radiation (310 – 2800 nm)
Rgs_out: Reflected global shortwave radiation (310 – 2800 nm)
PAR: Downwelling photosynthetically active radiation (400 – 700 nm)
WS: Wind speed in m s^{-1}
WD: Wind direction in degrees clockwise from North
UST: Friction velocity in m s^{-1}
ZL: Stability parameter (measurement height divided by the Obukhov Length) in m m^{-1}
PRESS: Atmospheric pressure in kPa
PREC: Precipitation summed for period of record in mm
FG1: Soil heat flux at 2 cm below surface in W m^{-2}
FG2: Soil heat flux at 2 cm below surface in W m^{-2}
FG3: Soil heat flux at 2 cm below surface in W m^{-2}
FG4: Soil heat flux at 2 cm below surface in W m^{-2}
FG5: Soil heat flux at 2 cm below surface in W m^{-2}
TS10: Soil temperature at 10 cm depth in degrees Celsius
TS20: Soil temperature at 20 cm depth in degrees Celsius
TS30: Soil temperature at 30 cm depth in degrees Celsius
SWC30: Volumetric soil water content from 0 – 30cm depth in %
Missing/bad records are indicated with a -9999 value. Positive flux values (Fc, Fm, FH_2O, H, LE, TAU) indicate upward fluxes. Positive radiation values (Rn, Rgs, PAR, FG) indicate downward fluxes, with the exception of Rgs_out in which positive values indicate upward fluxes.

Sample Data Record:

YEAR	DOY	HRMIN	DTIME	Fc	Fm	H	FH2O
				umol CO2 m-2 s-1	nmol CH4 m-2 s-1	W m-2	mmol H2O m-2 s-1
2009	232	1330	232.57	-1.4554	33.222	64.936	1.4662
2009	232	1400	232.59	-1.6581	36.678	83.818	1.9148
2009	232	1430	232.61	-1.246	30.538	54.37	1.4058
2009	232	1500	232.64	-1.0416	28.328	44.312	0.98996

3. Data Access and Tools:

Data Access:

Data are available for ordering from NCAR.

4. Data Acquisition and Processing:

Sensor or Instrument Description:

Fluxes were measured at a height of 1.9 m above the terrain using traditional eddy covariance instrumentation with the addition of a newly developed open path CH_4 analyzer. Flux data were taken at 10 Hz and recorded with a datalogger. Three-dimensional wind speed and virtual sonic temperature were collected with a CSAT3 sonic anemometer (Campbell Scientific, Logan, Utah, USA). Molar densities of CO_2 and H_2O were collected with an open path LI-7500 infrared gas analyzer (LI-COR Biosciences, Lincoln, NE, USA). Methane molar density was measured with a pre-production version of the now-commercial open path LI-7700 methane analyzer (LI-COR Biosciences, Lincoln, NE, USA).

The North tower was outfitted with a methane analyzer from August 19 to October 25 while the time periods of the other two towers were limited by the availability of an instrument: from August 19 to September 7 for the South tower and from September 9 to October 25 for the Central tower.

The LI-7500 and LI-7700 gas analyzers were calibrated via a 2-point linear equation. Ultra high purity nitrogen was used as the zero for CH_4, CO_2, and H_2O and high precision gases well above expected field concentrations were used as span values for CH_4 and CO_2. The span value for H_2O was generated with a LI-610 dew point generator (LI-COR Biosciences, Lincoln, NE, USA).

Environmental measurements were recorded in the immediate vicinity of each tower and within the manipulation footprint. Air temperature and relative humidity were measured at 1.6 m height with a HMP45C probe with radiation shield (Vaisala, Helsinki, Finland). Atmospheric pressure was measured at the Central tower with a PTB 101B electronic barometer (Vaisala, Helsinki, Finland). Temperatures at 10 cm, 20cm and 30cm depths were measured with type T thermocouples. Soil moistures were recorded with CS616 time domain reflectometry probes (Cambell Scientific, Logan, Utah, USA). A 1.5 m tripod housed radiation instruments measuring: downwelling and reflected global shortwave radiation (310 – 2800 nm) with CMP3 pyranometers (Kipp and Zonen, Delft, The Netherlands), downwelling photosynthetically-active radiation (PAR, 400-700 nm) with LI-190 quantum sensors (LI-COR Biosciences, Lincoln, NE, USA), and net radiation (0.25 – 60 µm) with a Q7 net radiometer (REBS, Bellvue, Washington, USA). Ground heat flux at 2 cm depth was recorded with five HFT3 ground heat flux plates (REBS, Bellvue, Washington, USA). Finally, a TR-525M tipping rain gauge bucket measured liquid precipitation (Texas Electronics, Dallas, Texas, USA) at the Central section. These environmental variables were measured at 1 Hz and averaged into half-hour blocks.

Processing:

Half-hourly flux calculations of methane, carbon dioxide, water vapour, energy, and momentum were made using the eddy covariance method (Baldocchi et al. 1988) and coded in MATLAB v. 7.2 (Mathworks, Natick, Massachusetts, USA). Prior to covariance computations for each half hour, the sonic anemometer coordinate frame was double-rotated to align with the mean streamline and signals from separate sensors were time-aligned by maximizing the cross-correlation between vertical wind speed and scalar concentration. Appropriate corrections were applied for the simultaneous vertical transfer of heat and water vapour (Webb et al. 1980, McDermitt 2010) as well as for high frequency spectral loss due to sensor separation and path length averaging (Moore 1986). No gap-filling was performed.

Quality control was applied pre- and post- flux computation. Raw data were de-spiked (> 6 standard deviations from the running mean) and removed of periods clearly demonstrating error due to heavy mist, rain, or snow. Computed fluxes were filtered according to stationarity and integral turbulence characteristics tests following Foken at al. (2004). Fluxes calculated under low turbulence conditions (friction velocity < 0.1 m/s) or when winds flowed from outside the manipulation footprint were excluded.

5. References and Related Publications

References:

Baldocchi DD, Hicks BB, Meyers TP. 1988. MEASURING BIOSPHERE-ATMOSPHERE EXCHANGES OF BIOLOGICALLY RELATED GASES WITH MICROMETEOROLOGICAL METHODS. *Ecology* 69(5):1331-1340.

Foken T, Gockede M, Mauder M *et al*: Post-field data quality control. In: *Handbook of micrometeorology: a guide for surface flux measurement and analysis.* Edited by Lee X, Massman WJ, Law BE. Dordrecht: Kluwer Academic Publishers; 2004.

McDermitt D, Burba G, Xu L *et al*. 2010. A new low-power, open-path instrument for measuring methane flux by eddy covariance. *Applied Physics B: Lasers and Optics*:1-15. 10.1007/s00340-010-4307-0.

Moore CJ. 1986. FREQUENCY-RESPONSE CORRECTIONS FOR EDDY-CORRELATION SYSTEMS. *Boundary-Layer Meteorology* 37(1-2):17-35.

Webb EK, Pearman GI, Leuning R. 1980. CORRECTION OF FLUX MEASUREMENTS FOR DENSITY EFFECTS DUE TO HEAT AND WATER-VAPOR TRANSFER. *Quarterly Journal of the Royal Meteorological Society* 106(447):85-100.

Related Publications:

Sturtevant, CS and W Oechel. Submitted. Soil moisture control over autumn season methane flux, Arctic Coastal Plain of Alaska.

Zona D, Oechel WC, Kochendorfer J, Paw U KT, Salyuk AN, Olivas PC, Oberbauer SF, and Lipson DA. 2009. Methne fluxes during the initiation of a large-scale water table manipulation experiment in the Alaskan Arctic tundra. Global Biogeochemical Cycles 23. GB2013. Doi: 10.1029/2009GB003487.

6. Document Information:

Document Creation Date:

2011-05-06