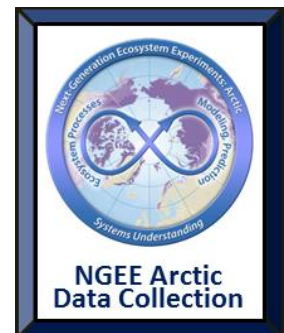# CO2 and CH4 Fluxes across Polygon Geomorphic Types, Barrow, Alaska, 2006-2010

For NGEE Arctic Project use only.

Review and follow the current NGEE Data and Fair-Use Policies prior to using these data (http://ngee-arctic.ornl.gov/content/ngee-arctic-data-management-policies-and-plans).

Summary:

Carbon flux data are reported as Net Ecosystem Exchange (NEE), Gross Ecosystem Exchange (GEE), Ecosystem Respiration (ER), and Methane (CH4) flux. Measurements were made at 82 plots across various polygon geomorphic classes at research sites on the Barrow Environmental Observatory (BEO), the Biocomplexity Experiment site on the BEO, and the International Biological Program (IBP) site a little west of the BEO.

This product is a compilation of data from 27 plots as presented in Lara et al. (2012), data from six plots presented in Olivas et al. (2010); and from 49 plots described in (Lara et al. 2014). Measurements were made during the peak of the growing seasons during 2006 to 2010.
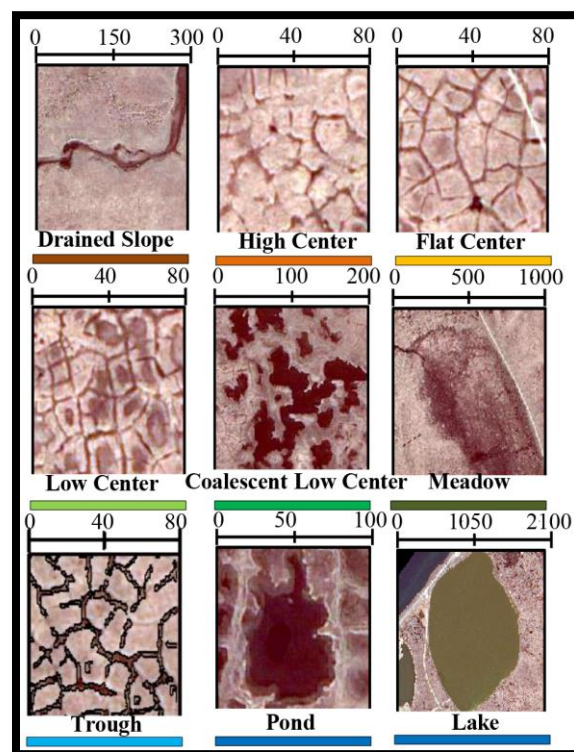
Figure 1: Tundra geomorphic types as shown on 2002 Quickbird satellite imagery. Scale bars are in meters (Lara et al. 2014).

At each of the measurement plots (except Olivas et al., 2010) four different thicknesses of shade cloth were used to generate CO2 light response curves. Light response curves were used to normalize photosynthetically active radiation that is diurnally variable to a peak growing season average ~400 umolm-2sec-1. At the Olivas et al. (2010) plots, diurnal patterns were characterized by repeated sampling. CO2 measurements were made using a closed-chamber photosynthesis system and CH4 measurements were made using a photo-acoustic multi-gas analyzer.

In addition, plot-level measurements for thaw depth (TD), water table depth (WTD), leaf area index (LAI), and normalized difference vegetation index (NDVI) are summarized by geomorphic polygon type.

Please use this citation to reference the data.

Lara, M., Tweedie, C. 2014. CO2 and CH4 Fluxes across Polygon Geomorphic Types, Barrow, Alaska, 2006-2010. Next Generation Ecosystem Experiments Arctic Data Collection, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA. Data set accessed at http://dx.doi.org/10.5440/1156852.

Data Characteristics

- One data file contains data on 82 measured plots provided as a comma-delimited data file (.csv).
  - These 82 records represent 304 individual CO2 flux measurement as used for light response curve calculation (see Data Acquisition Methods and Materials)
  - There are 76 CH4 measurements. CH4 was not measured by Olivas et al., 2010.
  - The 82 plots are distributed across all geomorphic classes (drained slope=11, high center polygon=13, flat center polygon=6, low center polygon=18, coalescent low center polygon=6, trough=10, meadow=6, and pond=12)
  - Twenty-seven sites are presented in Lara et al., (2012), six sites are presented in Olivas et al., 2010, and forty-nine sites are presented in Lara et al., (2014)
  - The location of each plot (Lat/Long and UTM) is included with each record. Note that some plots were adjacent to each other and appear to be co-located due to coordinate resolution.
  - Measurements were made during the peak of the growing seasons during 2006 to 2010. Only measurement year is provided.
  - Uncertainty estimates for all parameters associated with geomorphic types are presented in Lara et al. (2014).
  - Missing values are reported as -9999.

Data Files:
CO2_and_CH4_Barrow_2006_2010.csv

Data Dictionary

Column_name	Units/format	Description
region*		North Slope
locale*		Barrow
administrative_area*		Values: BEO=Barrow Environmental Observatory, BE=Biocomplexity Experiment, IBP=International Biological Program
site*		Values: BEO=Barrow Environmental Observatory, BE=Biocomplexity Experiment, IBP=International Biological Program
area*		Values: drained slope=DS, high center polygon=HC, flat center polygon=FC low center polygon=LC, coalescent low center polygon=CLC, trough=Tr, meadow=Mdw, and pond=Pond
plot_type*		Gas Flux
plot_ID		Values are unique plot codes within a Site. Combination of Area and the individual plot number within that area (e.g., DS1, DS2, DS3).
Latitude	Decimal degrees	Measurements taken with Garmin Rino GPS and Tremble DGPS (WGS84).
Longitude	Decimal degrees	Measurements taken with Garmin Rino GPS and Tremble DGPS (WGS84).
Easting	m	Measurements taken with rino Garmin GPS and Tremble DGPS. Data were transformed to NAD 83 and UTM Zone 4N. [Footnote 1]

Column_name	Units/format	Description
Northing	m	Measurements taken with rino Garmin GPS and Tremble DGPS. Data were transformed to NAD 83 and UTM Zone 4N. [Footnote 1]
Year	yyyy	All measurements were recorded within peak growing season (i.e. July 25-Aug. 10 of the year)
gross_ecosystem_exchange	gC-CO2 m2/day	CO2 fluxes were measured and gross ecosystem exchange (GEE) was calculated as described in the corresponding reference.
ecosystem_respiration	gC-CO2 m2/day	CO2 fluxes were measured and ecosystem respiration (ER) was calculated as described in the corresponding reference.
net_ecosystem_exchange	gC-CO2 m2/day	CO2 fluxes were measured and net ecosystem exchange (NEE) was calculated as described in the corresponding reference.
CH4_flux	mgC-CH4 m2/day	Methane (CH4) fluxes were measured as described in the corresponding reference.
C-CO2eq	gC-CO2 m2/day	Calculated greenhouse warming potential. See Data Acquisition and Materials and Methods Section for calculation.
thaw_depth	cm	Depth of thawed soil layer relative to the ground surface.
water_table_depth	cm	Depth to water table relative to ground surface.
normalized_difference_vegetation_index	index	NDVI= (NIR-VIS)/NIR+VIS), measured using a plot level dual channel hyperspectral spectrometer (UNISPEC DC)
leaf_area_index	index	Measured using the point frame technique.
References		See reference section

* Values for these location fields have been standardized for NGEE Arctic and are required fields for all data dictionaries. (https://ngee-

arctic.ornl.gov/sites/ngee.ornl.gov/files/NGEE_Arctic_Data_Management_Guides_stylesheet_20131127.pdf)

Footnotes:
   (1) Recorded as Lat/Long, transformation used in ArcGIS from GPS (WGS84) to NAD83 UTM Zone 4N. Transformation output was double checked using tool from http://www.earthpoint.us/BatchConvert.aspx

Example Data Records:

Filename:,BGC_CO2_and
CH4_Fluxes_across_Polygon_Geomorphic_Types_Barrow_Alaska_2006_2010,,,,,,,,,,,,,,,,,,
Contact:,"Mark J. Lara (mjlara@alaska.edu, mjlara71@gmail.com) or Craig E. Tweedie
(ctweedie@utep.edu)",,,,,,,,,,,,,,,,,,
Date modified:,9/19/2014,,,,,,,,,,,,,,,,,,
NGEE Arctic Dataset DOI:,10.5440/1156852 or http://dx.doi.org/10.5440/1156852,,,,,,,,,,,,,,,,,,,
Data citation:,"Lara, M., Tweedie, C. 2014. CO2 and CH4 Fluxes across Polygon Geomorphic
Types, Barrow, Alaska, 2006-2010. Next Generation Ecosystem Experiments Arctic Data
Collection, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak
Ridge, Tennessee, USA. ",,,,,,,,,,,,,,,,,,
Notes:,"Units for CO2 fluxes are in gC-CO2 m² day?¹, CH4 fluxes are in mgC-CH4 m² day?¹, C-
CO2eq are in gC-CO2eq m² day?¹ assuming CH4 has a warming potential of 28 times that of
CO2 (IPCC 2013).",,,,,,,,,,,,,,,,,,
region,locale,administrative_area,site,area,plot_type,Latitude,Longitude,easting,northing,year,gr
oss_ecosystem_exchange,ecosystem_respiration,net_ecosystem_exchange,CH4_flux,C-
CO2eq,thaw_depth,water_table_depth,normalized_difference_vegetation_index,leaf_area_index,
reference
,,,,,,Decimal degrees,Decimal degrees,m,m,yyyy,gC-CO2 m2/day,gC-CO2 m2/day,gC-CO2
m2/day,mgC-CH4 m2/day,gC-CO2 m2/day,cm,cm,index,index,
North Slope,Barrow,BEO,CLC,1,CLC1,71.29573,-156.66473,583565,7911994,2010,-
2.526,1.31,-1.215,91.8,1.355,35,0,0.583,0.19,Lara et al. 2012
North Slope,Barrow,BEO,CLC,2,CLC2,71.29571,-156.66469,583566,7911992,2010,-
1.895,1.551,-0.344,54.3,1.178,38,1,0.602,0.19,Lara et al. 2012
North Slope,Barrow,BEO,CLC,3,CLC3,71.2957,-156.66467,583567,7911991,2010,-
2.113,1.032,-1.081,63.9,0.708,35,0.5,0.567,0.095,Lara et al. 2012
North Slope,Barrow,BE,CLC,5N,CLC5,71.28615,-156.59787,585999,7911019,2006,-
0.984,0.518,-0.466,-9999,-9999,-9999,-9999,-9999,-9999,Olivas et al. 2010
North Slope,Barrow,BE,CLC,6N,CLC6,71.28615,-156.59787,585999,7911019,2007,-
1.088,0.933,-0.155,-9999,-9999,-9999,-9999,-9999,-9999,Olivas et al. 2010
North Slope,Barrow,BE,CLC,7N,CLC7,71.28615,-156.59787,585998,7911019,2008,-
0.622,0.362,-0.259,-9999,-9999,-9999,-9999,-9999,-9999,Olivas et al. 2010
North Slope,Barrow,BEO,DS,1,DS1,71.29775,-156.66404,583580,7912219,2010,-
1.377,1.886,0.509,6.5,0.693,67,-67,0.536,0.38,Lara et al. 2012
North Slope,Barrow,BEO,DS,2,DS2,71.29774,-156.66397,583583,7912218,2010,-
1.262,1.41,0.147,3.7,0.253,31,-31,0.614,0.142,Lara et al. 2012
North Slope,Barrow,BEO,DS,3,DS3,71.29776,-156.66394,583584,7912220,2010,-2.458,1.872,-

0.586,5.1,-0.441,43,-43,0.57,0.38,Lara et al. 2012
North Slope,Barrow,BEO,DS,4,DS4,71.31089,-156.59562,585969,7913779,2010,-0.941,1.014,0.072,-5.7,-0.086,32,-32,0.47,0.312,Lara et al. 2014

Data Acquisition Materials and Methods

At each of the measurement plots (except Olivas et al., 2010) four different thicknesses of shade cloth were used to generate CO2 light response curves. Light response curves were used to normalize photosynthetically active radiation that is diurnally variable to a peak growing season average ~400 umolm-2sec-1. At the Olivas et al. (2010) plots, diurnal patterns were characterized by repeated sampling. CO2 measurements were made using a closed-chamber photosynthesis system. The reported CO2 flux values for GEE, ER, and NEE are these light normalized values.

CH4 measurements were made using a photo-acoustic multi-gas analyzer. C-CO2 equivalents was calculated by assuming a 100 year atmospheric residence time (i.e. CH4=28 times the greenhouse warming potential as CO2) of both NEE and CH4 fluxes.

Specific to carbon fluxes:
- QA/QC of CO2 fluxes closely followed that noted in Oberbauer et al. 2007
- QA/QC of CH4 fluxes closely followed that noted in Sachs et al. 2010 and Lund et al. 2009

Please refer to the corresponding data reference for more measurement and calculation details.

References

Data References:

Lara et al. 2014
> Lara MJ, McGuire AD, Euskirchen ES, Tweedie CE, Hinkel KM, Skurikhin AN, Romanovsky VE, Grosse G, Bolton WR, Genet H (2014) Polygonal tundra geomorphological change in response to warming alters future CO2 and CH4 flux on the Barrow Peninsula. *Global Change Biology.* DOI: 10.1111/gcb.12757

Lara et al. 2012
> Lara MJ, Villarreal S, Johnson DR, Hollister RD, Webber PJ, Tweedie CE (2012) Estimated change in tundra ecosystem function near Barrow, Alaska between 1972 and 2010. *Environmental Research Letters,* **7**. http://dx.doi.org/10.1088/1748-9326/7/1/015507

Lund et al. 2009
> Lund M, Christensen T R, Mastepanov M, Lindroth A and Strom L 2009. Effects of N and P fertilization on the greenhouse gas exchange in two northern peatlands with contrasting N deposition rates. Biogeosciences. 6 2135-2144.

Oberbauer et al. 2007
> Oberbauer S F et al. 2007. Tundra CO_2 fluxes in response to experimental warming across latitudinal and moisture gradients. Ecological Monograph. 77(2) 221-238.

Olivas et al. 2010
> Olivas PC, Oberbauer SF, Tweedie C, Oechel WC, Lin D, Kuchy A (2011) Effects of Fine-Scale Topography on CO_2 Flux Components of Alaskan Coastal Plain Tundra: Response to Contrasting Growing Seasons. *Arctic Antarctic and Alpine Research,* 43, 256-266. http://dx.doi.org/10.1029/2009JG001254

Sachs et al. 2010
> Sachs T, Giebels M, Boike J and Kutzbach L. 2010. Environmental controls on CH_4 emission from polygonal tundra on the microsite scale in the Lena river delta, Siberia. *Global Change Biology*. 16(11) 3096-3110.

Additional Information:

> NSF Artic Biocomplexity Experiment:
> http://www.ntsg.umt.edu/project/arctic_biocomplexity#data-product

> Point Frame Technique: http://globalrangelands.org/inventorymonitoring/pointframe

Data Access:

Disclaimer of Liability

The complete ORNL disclaimer can be viewed at
http://www.ornl.gov/ornlhome/disclaimers.shtml.

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