CARVE: L1 In-situ Carbon and CH4 Flux and Meteorology at EC Towers, Alaska, 2011-2015

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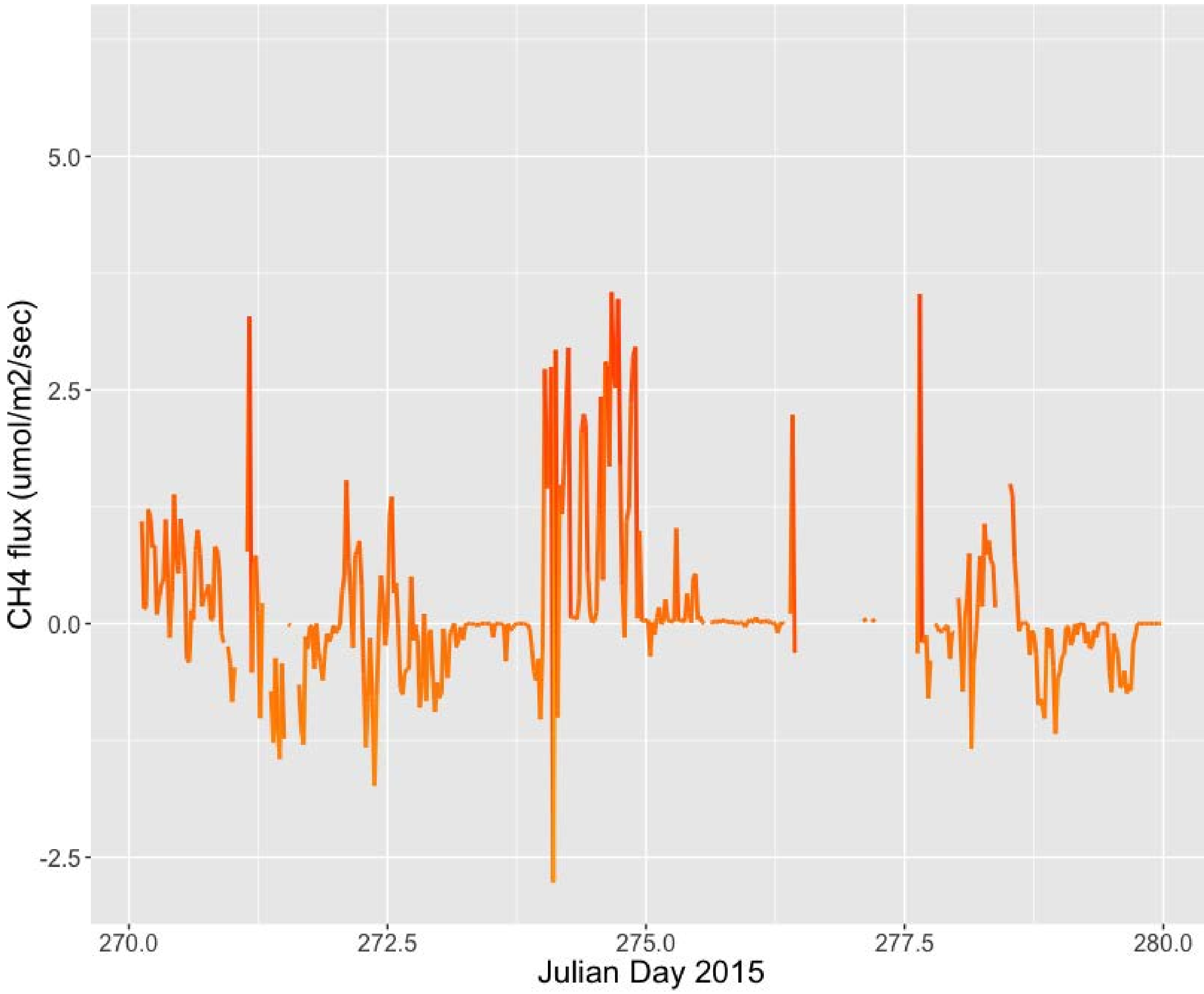
Documentation Revision Date: 2016-12-09

Data Set Version: V1

Summary

This data set provides ground in situ flux and meteorological science data from fixed instruments at three eddy covariance tower sites located in the Alaskan Arctic tundra. Real and gap-filled observations of carbon dioxide, methane, water vapor, and latent energy flux in addition to standard meteorological and environmental variables are reported at half-hourly intervals between 2011 and 2015 for sites at Atqasuk, Barrow, and Ivotuk, Alaska. The three sites form a 300-km north-south transect on the North Slope of Alaska, each site representing distinct Arctic vegetation communities. These tower measurements create a long-term record of one of the largest, most volatile carbon stocks on the planet. Observations from these towers are being used to determine the seasonal and inter-annual patterns of CO2 and CH4 flux, and their relationship to changes in environmental factors.

There are 14 data files in comma-separated (*.csv) text format with this data set, one per year of data collected at each of the towers.



Micromols of methane per square meter per second observed at the Ivotuk site between Oct. 2-7, 2015.

Citation

Oechel, W., J. Verfaillie, G. Vourlitis, and R. Zulueta. 2016. CARVE: L1 In-situ Carbon and CH4 Flux and Meteorology at EC Towers, Alaska, 2011-2015. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1424

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1. Data Set Overview

Project: Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE)

The Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE) is a NASA Earth Ventures (EV-1) investigation designed to quantify correlations between atmospheric and surface state variables for Alaskan terrestrial ecosystems through intensive seasonal aircraft campaigns, ground-based observations, and analysis sustained over a 5-year mission. CARVE collected detailed measurements of greenhouse gases on local to regional scales in the Alaskan Arctic and demonstrated new remote sensing and improved modeling capabilities to quantify Arctic carbon fluxes and carbon cycle-climate processes. CARVE science fills a critical gap in Earth science knowledge and satisfies high priority objectives across NASA's Carbon Cycle and

Ecosystems, Atmospheric Composition, and Climate Variability & Change focus areas as well as the Air Quality and Ecosystems elements of the Applied Sciences program. CARVE data also complements and enhances the science return from current NASA and non-NASA sensors.

Related Data:

A full list of CARVE data products is available at: https://carve.ornl.gov/dataproducts.html

2. Data Characteristics

Spatial Coverage: Atqasuk, Barrow, and Ivotuk eddy covariance towers, North Slope, Alaska

Spatial Resolution: Point resolution

Temporal Coverage: 20110530 - 20160107

Temporal Resolution: half-hourly

Study Area (coordinates in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Atqasuk (ATQ)	-157.409	-157.409	70.470	70.470
Barrow (BRW)	-156.597	-156.597	71.323	71.323
Ivotuk (IVO)	-155.748	-155.748	68.486	68.486

Data File Information

All data are stored in comma separated value (*.csv) text files. The value -9999 is used to denote missing values. Filenames contain the indicate the tower operator (San Diego State University), 3-letter tower code, and year of observations. *Ex: SDSU_IVO_2012.csv*

Table 1. Column headers, description, units, and instrument from Atqasuk (ATQ), Barrow (BRW), and Ivotuk (IVO) eddy covariance towers.

Note: Quality flags are: 0 = observation value; 1 = interpolated value

Column Header	Description	Units	Instrument
BP	Barometric pressure	mbar/10	CS106
CH4_Flux_7700	CH_4 flux	umol m-2 s-1	LI-7700
CH4_Flux_gf_7700	Gap-filled CH_4 flux	umol m-2 s-1	LI-7700
CH4_q_7700	Quality flag	*	
CH4_Flux_LGR	CH_4 flux	umol m-2 s-1	LGR FGGA
CH4_Flux_gf_LGR	Gap-filled CH_4 flux	umol m-2 s-1	LGR FGGA
CH4_q_LGR	Quality flag	*	
CO2_Flux_7200	CO_2 flux	umol m-2 s-1	LI-7200
CO2_Flux_gf_7200	Gap-filled CO_2 flux	umol m-2 s-1	LI-7200
CO2_q_7200	Quality flag	**	
CO2_Flux_LGR	CO_2 flux	umol m-2 s-1	LGR FGGA
CO2_Flux_gf_LGR	Gap-filled CO_2 flux	umol m-2 s-1	LGR FGGA
CO2_q_LGR	Quality flag	**	
Date	Date	yyyy-mm-dd HH:MM	
Day	Day of year and decimal hour	DOY.H	

Dsnow	Snow depth	m	SR50a
ER_7200	Ecosystem respiration	umol m-2 s-1	LI-7200
ER_LGR	Ecosystem respiration	umol m-2 s-1	LGR FGGA
G_1	Ground heat flux profile 1	Wm-2	HFT3
G_2	Ground heat flux profile 2	Wm-2	HFT3
G_3	Ground heat flux profile 3	Wm-2	HFT3
G_4	Ground heat flux profile 4	Wm-2	HFT3
Global_radiation	Solar radiation	Wm-2	Delta T v3
GPP_7200	Gross primary production	umol m-2 s-1	LI-7200
GPP_LGR	Gross primary production	umol m-2 s-1	LGR FGGA
H_7200	Sensible heat flux	Wm-2	CSAT-3
H_LGR	Sensible heat flux	Wm-2	CSAT-3
H2O_Flux_7200	H_2O flux	umol m-2 s-1	LI-7200
H2O_Flux_LGR	H_2O flux	umol m-2 s-1	LGR FGGA
H2O_Flux_gf_LGR	Gap-filled H_2O flux	umol m-2 s-1	LGR FGGA
H2O_q_LGR	Quality flag	**	
LE_Flux_7200	Latent energy flux	Wm-2	LI-7200
LE_Flux_gf_7200	Gap-filled latent energy flux	Wm-2	LI-7200
LE_Flux_q_7200	Quality flag	**	
LE_LGR	Latent energy flux	Wm-2	LGR FGGA
LE_Flux_gf_LGR	Gap-filled latent energy flux	Wm-2	LGR FGGA
LE_q_LGR	Quality flag	**	
NEE_7200	Net ecosystem exchange	g m-2 s-1	LI-7200
NEE_LGR	Net ecosystem exchange	g m-2 s-1	LGR FGGA
P1_SWC_5	Soil moisture at -5cm, profile 1	VWC	CS616
P1_SWC_10	Soil moisture at -10cm, profile 1	VWC	CS616
P1_SWC_15	Soil moisture at -15cm, profile 1	VWC	CS616
P1_SWC_20	Soil moisture at -20cm, profile 1	VWC	CS616
P1_SWC_30	Soil moisture at -30cm, profile 1	VWC	CS616
P2_SWC_5	Soil moisture at -5cm, profile 2	VWC	CS616
P2_SWC_10	Soil moisture at -10cm, profile 2	VWC	CS616
P2_SWC_15	Soil moisture at -15cm, profile 2	VWC	CS616
P2_SWC_20	Soil moisture at -20cm, profile 2	VWC	CS616
P2_SWC_30	Soil moisture at -30cm, profile 2	VWC	CS616
P3_SWC_5	Soil moisture at -5cm, profile 3	VWC	CS616
P3_SWC_15	Soil moisture at -15cm, profile 3	VWC	CS616
P3_SWC_30	Soil moisture at -30cm, profile 3	VWC	CS616
PARdown	Photosynthetically active radiation incoming	µmols-1m-2	LI-190SB
PARup	Photosynthetically active radiation outgoing	µmols-1m-2	LI-190SB
PPT	Precipitation	mm	TE525WS
RH	Relative humidity	%	HMP-45c
Rnet	Net radiation	Wm-2	REBS Q7
Rsolar	Solar radiation	Wm-2	CMP3

Feedback

SoilT1_Surf	Soil temperature at surface, profile 1	C	Type E thermocouple
SoilT1_5	Soil temperature at -5cm, profile 1	C	Type E thermocouple
SoilT1_15	Soil temperature at -15cm, profile 1	C	Type E thermocouple
SoilT1_30	Soil temperature at -30cm, profile 1	C	Type E thermocouple
SoilT1_40	Soil temperature at -40cm, profile 1	C	Type E thermocouple
SoilT2_Surf	Soil temperature at surface, profile 2	C	Type E thermocouple
SoilT2_5	Soil temperature at -5cm, profile 2	C	Type E thermocouple
SoilT2_15	Soil temperature at -15cm, profile 2	C	Type E thermocouple
SoilT2_30	Soil temperature at -30cm, profile 2	C	Type E thermocouple
SoilT2_40	Soil temperature at -40cm, profile2	C	Type E thermocouple
SoilT3_Surf	Soil temperature at surface, profile 3	C	Type E thermocouple
SoilT3_5	Soil temperature at -5cm, profile 3	C	Type E thermocouple
SoilT3_15	Soil temperature at -15cm, profile 3	C	Type E thermocouple
SoilT3_30	Soil temperature at -30cm, profile 3	C	Type E thermocouple
SoilT3_40	Soil temperature at -40cm, profile 3	C	Type E thermocouple
SoilT4_Surf	Soil temperature at surface, profile 3	C	Type E thermocouple
SoilT4_5	Soil temperature at -5cm, profile 4	C	Type E thermocouple
SoilT4_15	Soil temperature at -15cm, profile 4	C	Type E thermocouple
SoilT4_30	Soil temperature at -30cm, profile 4	C	Type E thermocouple
SoilT4_40	Soil temperature at -40cm, profile 4	C	Type E thermocouple
Tair	Air temperature	C	HMP-155A
Tsurf	Ground surface temperature	C	SI-111
u*_7200	Friction velocity	ms-1	LI-7200
u*_LGR	Friction velocity	ms-1	LGR FGGA
WD	Wind direction, degrees from north	°	Young 05103
WS	Wind speed	ms-1	Young 05103

* Gap filling done using methods described in Watts et al, 2014

** Gap filling done with http://www.bgc-jena.mpg.de/~MDIwork/eddyproc/method.php

3. Application and Derivation

These data are used to monitor seasonal variation of CO_2, H_2O, and CH_4 fluxes and the inter-annual differences in Arctic landscapes. The data may also be used to identify patterns in Arctic-boreal CO_2 and CH_4 fluxes to determine environmental drivers of GPP v. ecosystem respiration and changes in landscape carbon sink and source activity. Measurements from eddy covariance towers are also necessary to calibrate and validate ecosystem models.

4. Quality Assessment

Gap-filling of the observations from the three towers was performed using a satellite data driven modeling approach described in Watts et al. (2014). Gap-filled data are susceptible to model inaccuracies. CH_4 gap-filling used a method devised by the Max Planck Institute for Biogeochemistry (http://www.bgc-jena.mpg.de/~MDIwork/eddyproc/method.php). Gap-filled data points are denoted by a value of *1* in the quality flag columns of the data files.

5. Data Acquisition, Materials, and Methods

Flux data at each of the sites were calculated at half-hourly intervals following standard eddy covariance data processing procedures (Baldocchi et al., 1988). Carbon dioxide, methane, water vapor, sensible heat and latent energy fluxes were estimated using measurements from LI-7200 infrared open-path gas analyzers (LI-COR Biosciences) and Fast Greenhouse Gas Analyzers (Los Gatos Research) instruments. Environmental measurements include temperature and relative humidity (HMP45c; Vaisala), photosynthetically active radiation (LI-190SB; LI-COR Biosciences) soil temperature (Type-

E thermocouples; Omega), net radiation (Q7; Radiation Energy Balance Systems), ground heat fluxes (HFT3; Radiation Energy Balance Systems), wind speed and direction (03001 Wind Sentry Set; R.M. Young), and precipitation (TE525WS; Texas Electronics).

Eddy covariance sites

Atqasuk

The Atqasuk tower site is located 100 km south of Barrow. Site elevation is 25 meters ASL and instrument heights are at 2 meters. Vegetation at the site is a variety of moist-wet coastal sedge tundra and moist-tussock tundra surfaces in the more well-drained upland. The International Geosphere-Biosphere Programme (IGBP) land cover is classified as permanent wetlands.

Barrow

The Barrow tower site is located 10 km east of the town of Barrow, AK, adjacent to the NOAA CMDL Laboratory. Site elevation is 4 meters ASL and instrument heights are at 5 meters. The vegetation is mature in an unmanaged and undisturbed Arctic tundra environment and consist of wet sedges, grasses, moss, and assorted lichens. The IGBP land cover is classified as permanent wetlands. The local landscape surrounding the site has a history absent of any disturbances and the terrain was not heavily glaciated during the last period of glaciation. The Barrow tower is pictured in Figure 2 below.

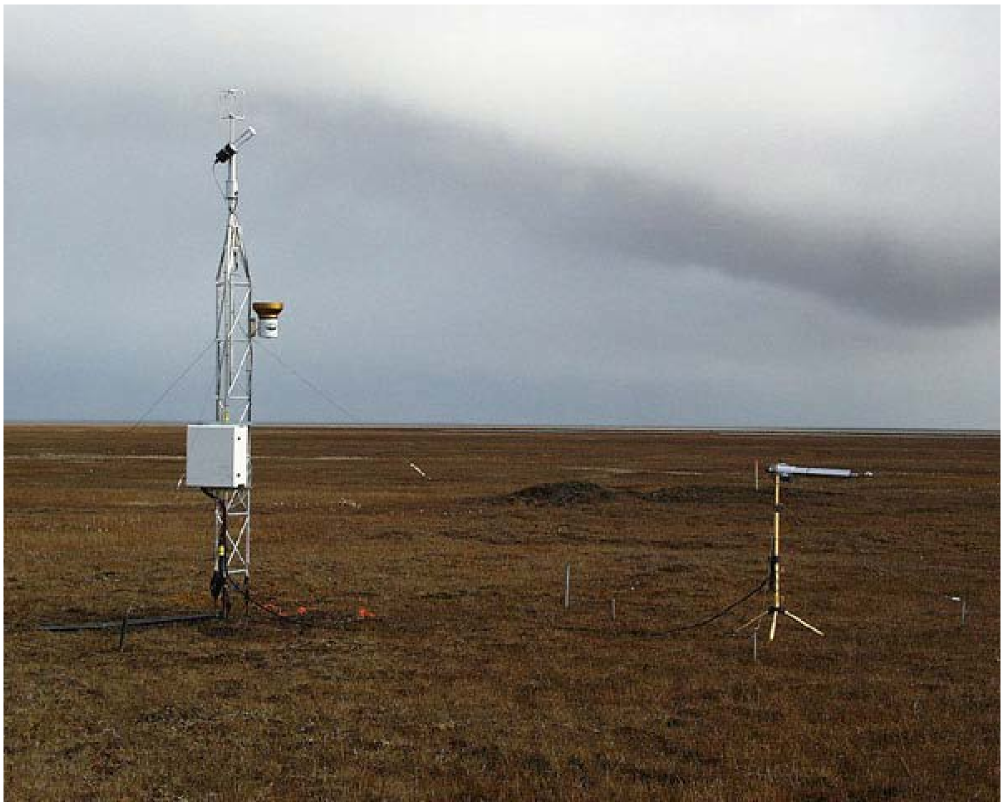

Figure 2. The eddy covariance site at Barrow, Alaska

Ivotuk

The Ivotuk tower site is located 300 km south of Barrow, Alaska, in polar tundra at the foothills of the Brooks Range. Site elevation is 579 meters ASL and instrument height is at 4 meters. The IGBP land cover is classified as permanent wetlands and vegetation of the area is comprised of tussock sedge, dwarf-shrub, and moss tundra.

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

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Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

Baldocchi, D.D., B. B. Hicks, and T. P. Meyers. 1988. Measuring biosphere-atmosphere exchanges of biologically related gases with micrometeorological methods. *Ecology* 69, 1331–1340.

Watts, J.D., J.S. Kimball, F.J.W. Parmentier, T. Sachs, J. Rinne, D. Zona, W. Oechel, T. Tagesson, M. Jackowicz-Korczynski, and M. Aurela. 2014. A satellite data driven biophysical modeling approach for estimating northern peatland and tundra CO2 and CH4 fluxes. *Biogeosciences* 11:1961-1980.