Soil CO_2 and CH_4 Chamber Fluxes in Tussock Tundra, Council Road Mile Marker 71, Seward Peninsula, Alaska, 2016-2019

NGEE Arctic Record_id: NGA241

Summary:

In August-September 2016, June-August 2017, June-August 2018, and June 2019, co-located measurements were made of surface CH_4 and CO_2 flux, soil temperature, moisture, and thaw depth. Measurements were made at 35 chamber locations at the Council Mile Marker 71 Site (CN_MM71) on the Seward Peninsula, Alaska. Chamber locations include upland moist acidic tussock tundra, thermo-erosional slopes, and periodically inundated lowland water channels. The dataset includes measurements using transparent and opaque chambers (CO_2 and CH_4 fluxes in light and dark).

Please use this citation to reference the data.

Oriana Chafe, Ian Shirley, Stan Wullschleger, and Margaret Torn. 2020. Soil CO_2 and CH_4 Chamber Fluxes in Tussock Tundra, Council Road Mile Marker 71, Seward Peninsula, Alaska, 2016-2019. Next Generation Ecosystem Experiments Arctic Data Collection, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, USA. Dataset accessed on [date] at https://doi.org/10.5440/1765733.

Related dataset(s)

These measurements are located near the NGEE Arctic CO_2 and CH_4 eddy covariance and meteorological tower at the Council Road Site (see Fig. 1). Meteorological and ancillary data can be accessed through the NGEE Arctic data portal at https://doi.org/10.5440/1526749.

Near these soil CO_2 and CH_4 chamber measurements, soil temperature-profile measurements to 1m were made from September 2017- August 2019 as part of ambient pre-treatment data for a soil microwarming experiment (see Fig. 1). These soil temperature-profile data can be accessed through the NGEE Arctic data portal at https://doi.org/10.5440/1634215. Eddy covariance data for CO_2, CH_4, energy, and water exchange can be accessed through the AmeriFlux data portal at ameriflux.lbl.gov and referenced at https://doi.org/10.17190/AMF/1634883.

NGEE Arctic Project Summary

The Next-Generation Ecosystem Experiments: Arctic (NGEE Arctic), was a 10-year research effort (2012-2022) to reduce uncertainty in Earth System Models by developing a predictive understanding of carbon-rich Arctic ecosystems and feedbacks to climate. NGEE Arctic was supported by the Department of Energy's Office of Biological and Environmental Research.

The NGEE Arctic project had two field research sites: 1) located within the Arctic polygonal tundra coastal region on the Barrow Environmental Observatory (BEO) and the North Slope near Utqiagvik (Barrow), Alaska and 2) multiple areas on the discontinuous permafrost region of the Seward Peninsula north of Nome, Alaska.

Through observations, experiments, and synthesis with existing datasets, NGEE Arctic provided an enhanced knowledge base for multi-scale modeling and contributed to improved process representation at global pan-Arctic scales within the Department of Energy's Earth system Model (the Energy Exascale Earth System Model, or E3SM), and specifically within the E3SM Land Model component (ELM).

Data Characteristics

- Chamber measurements were grouped into three sets of locations for sampling purposes. The three sets have the prefixes of "BGC" (biogeochemistry transect), "EC" (eddy covariance tower footprint), and "MW" (microwarming experiment vicinity). Not all locations were sampled on each sampling day, typically one or two sets of chamber locations were measured per day.
- Chamber flux measurements were made using two different Greenhouse Gas Analyzers (see Data Acquisition Materials and Methods section for more detail). Briefly, in 2016-2018, measurements were made with the Ultraportable Greenhouse Gas Analyzer by Los Gatos Research, Inc. (LGR). In 2018 and 2019, measurements were made with a G4301 Greenhouse Gas Analyzer by Picarro, Inc. The dataset for each analyzer is provided as a separate comma-separate (.csv) file. Note that for comparison purposes, both instruments were used to measure chamber fluxes on July 18, 2018.
- Missing values are represented by "NA" and indicate that the parameter was not measured due to sampling limitations.

Temporal Range:
Periodic measurements cover the time between August 2016 through June 2019.

Spatial Range:

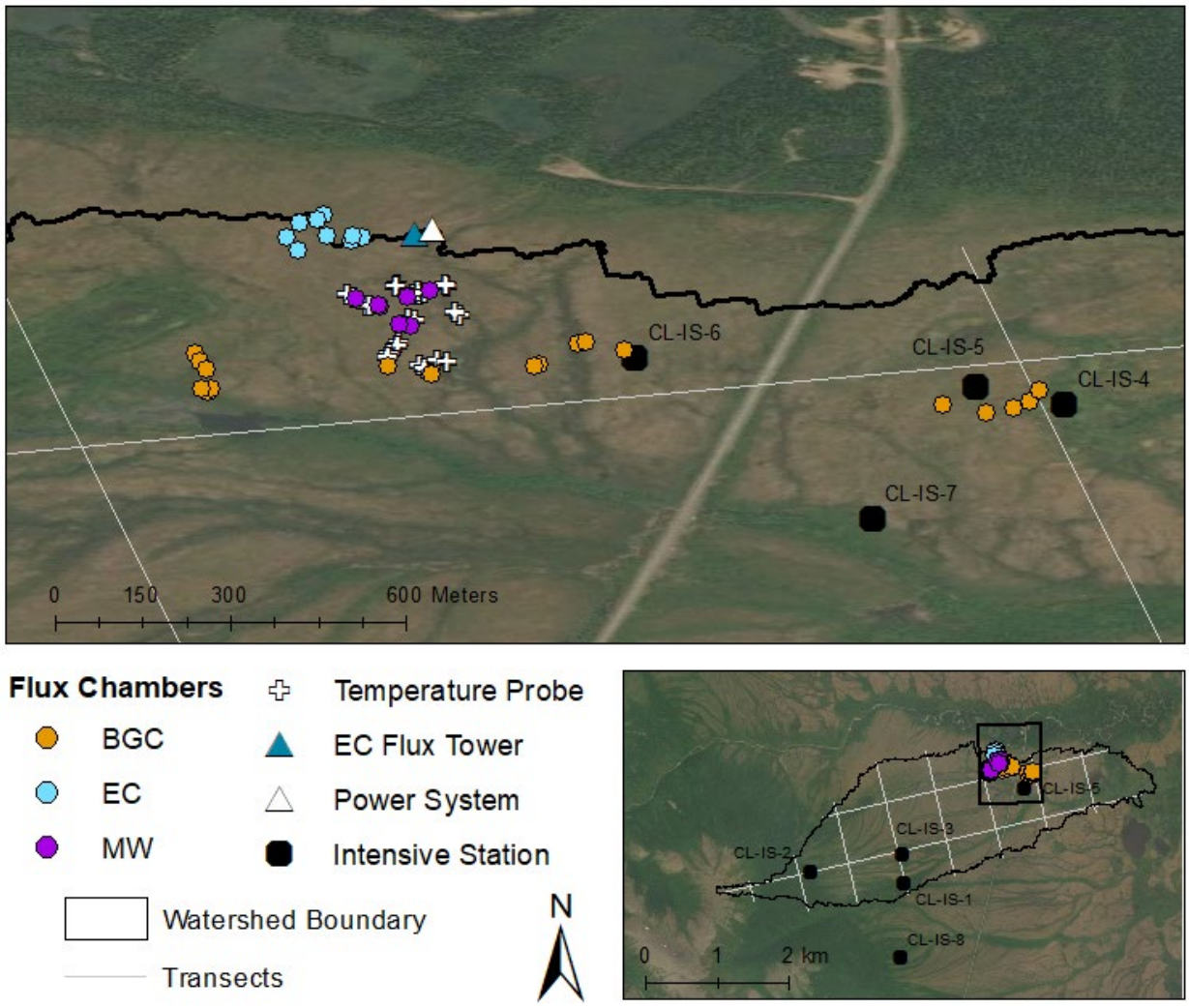

Figure 1: Map showing the main location of the flux chambers by sampling set (BGC, EC, and MW) and adjacent infrastructure within the Council watershed. Geographic coordinates are shown in Table 1.

Spatial Resolution:

Table 1. Geographic coordinates for each of the 35 soil temperature measurement locations.

Chamber	Latitude	Longitude
BGC_1	64.85995	-163.70358
BGC_2	64.85983	-163.70351
BGC_3	64.86009	-163.69769
BGC_4	64.85978	-163.69829
BGC_5	64.85936	-163.70338
BGC_6	64.85941	-163.70335
BGC_9	64.85976	-163.70061
BGC_10	64.85963	-163.69995

BGC_11	64.85941	-163.70348
BGC_12	64.85974	-163.69836
BGC_13	64.8597	-163.70341
BGC_14	64.86012	-163.69757
BGC_15	64.85999	-163.69698
BGC_16	64.85915	-163.69208
BGC_17	64.85904	-163.69142
BGC_18	64.85911	-163.69101
BGC_19	64.85921	-163.69075
BGC_20	64.85937	-163.69061
EC_1	64.86172	-163.70102
EC_2	64.86169	-163.7012
EC_3	64.86176	-163.70117
EC_4	64.86176	-163.70157
EC_5	64.86208	-163.7016
EC_6	64.86201	-163.70172
EC_7	64.86172	-163.70218
EC_8	64.86195	-163.70198
EC_9	64.861537	-163.702015
MW_C	64.860663	-163.700755
MW_D	64.860695	-163.700762
MW_E	64.860823	-163.700318
MW_F	64.860792	-163.701118
MW_G	64.860792	-163.701112
MW_H	64.860918	-163.69998
MW_I	64.86036	-163.700287
MW_J	64.860387	-163.700453

Data Dictionary

Data Files

Table 2. List of data files included in the current data package.

File Names	Description
CN_MM71_soil_chamber_fluxes_**LGR**_20210120.csv	CO_2 and CH_4 chamber fluxes measured with a LGR Ultraportable Greenhouse Gas Analyzer
CN_MM71_soil_chamber_fluxes_**Picarro**_20210120.csv	CO_2 and CH_4 chamber fluxes measured with a Picarro G4301 Greenhouse Gas Analyzer

CN_MM71_ chamber_soil_temp_moist_thaw_20210120.csv	Soil temperature, moisture, and thaw depth at chamber flux locations

Table 3: Column headers for the two chamber-flux files.

column_name	units/format	Description
region		Seward Peninsula
locale		Council
administrative_area		NA
site		CN_MM71
area		CN_MM71_BGC, CN_MM71_EC, or CN_MM_71_MW
plot_type		Soil
plot_ID		Unique identifier for each chamber
latitude	Decimal degrees	Chamber location
longitude	Decimal degrees	Chamber location
easting	m	Chamber location in UTM Zone 3
northing	m	Chamber location in UTM Zone 3
measurement_date	yyyy-mm-dd	Measurement date
time	HH:MM AKDT	Local time when the measurement was taken (Alaska Daylight Time)
landscape_position		Qualitative landscape position (upland, slope, or lowland)
chamber_type		opaque (Opq) or transparent (Trns) chamber
flux_CO2	umol_m^{-2}_s^{-1}	CO_2 flux rate, estimated as the slope of the linear portion of the concentration vs. time curve
flux_CO2_se	umol_m^{-2}_s^{-1}	Standard error of the slope from the CO_2 linear concentration vs. time model
flux_CO2_Pvalue		P-value of the linear CO_2 concentration vs. time model. If $p < 0.05$, flux is significantly different from 0 umol$m^{-2}s^{-1}$.
flux_CO2_Rsquared		Adjusted R squared of the CO_2 linear concentration vs. time model
flux_CH4	nmol_m^{-2}_s^{-1}	CO_2 flux rate, estimated as the slope of the linear portion of the concentration vs. time curve
flux_CH4_se	nmol_m^{-2}_s^{-1}	Standard error of the slope from the CO_2 linear concentration vs. time model

column_name	units/format	Description
CH4_Pvalue		P-value of the linear CO_2 concentration vs. time model. If $p < 0.05$, flux is significantly different from 0 $nmolm^{-2}s^{-1}$.
CH4_Rsquared		Adjusted R squared of the CH_4 linear concentration vs. time model

Example Chamber Flux Data Record

region,locale,administrative_area,site,area,plot_type,plot_ID,latitude,longitude,easting,northing,measurement_date,time,landscape_position,chamber_type,flux_CO2,flux_CO2_se,flux_CO2_Pvalue,flux_CO2_Rsquared,flux_CH4,flux_CH4_se,CH4_Pvalue,CH4_Rsquared
,,,,,,,,,,,,,,,,,umol_m-2_s-1,umol_m-2_s-1,,,nmol_m-2_s-1,nmol_m-2_s-1,,
Seward_Peninsula,Council,NA,CN_MM71,CN_MM71_BGC,Biogeochemistry,BGC_1,64.85995,-163.70358,561451,7193476,2016-08-03,17:25,upland,Opq,2.464,0.027,7.45E-154,0.979,-0.059,0.008,5.49E-12,0.228

Table 4: Column headers for the soil temperature, moisture, and thaw depth

column_name	units/format	Description
region		Seward Peninsula
locale		Council
administrative_area		NA
site		CN_MM71
area		CN_MM71_BGC, CN_MM71_EC, or CN_MM_71_MW
plot_type		Soil
plot_ID		Unique identifier for each chamber
latitude	Decimal degrees	Chamber location
longitude	Decimal degrees	Chamber location
easting	m	Chamber location in UTM Zone 3
northing	m	Chamber location in UTM Zone 3
measurement_date	yyyy-mm-dd	Measurement date
landscape_position		Qualitative landscape position (upland, slope, or lowland)
inundated	Y/N	Whether the plot was inundated when the measurement was taken
standing_water_depth	cm	Depth of standing water
time	HH:MM AKDT	Local time when the measurement was taken (Alaska Daylight Time)

column_name	units/format	Description
soil_temp_10_cm	Celsius	Soil temperature at 10 cm below ground surface
soil_temp_20_cm	Celsius	Soil temperature at 20 cm below ground surface
air_temp	Celsius	Air temperature (measured at variable heights, ranging 0-2 m above ground)
thawdepth	cm	Depth to permafrost table. Measurement made from the top of the moss layer.
thawdepth_flag		Flags: V0 = Valid value; V2 = Minimum estimated value
VWC	%	Volumetric Water Content, calculated using the instrument's internal calibration (integrated over the top 20 cm of the soil profile)
Ka		Apparent dielectric constant, measured with a Soilmoisture Equipment Corp Minitrase TDR (integrated over the top 20 cm of the soil profile)

Example Soil Temperature, Moisture, Thaw Depth Data Record

```
region,locale,administrative_area,site,area,plot_ID,latitude,longitude,easting,northing,measure
ment_date,time,landscape_position,inundated,standing_water_depth,soil_temp_10_cm,soil_te
mp_20_cm,air_temp,thawdepth,thawdepth_flag,VWC,Ka
,,,,,,,,,yyyy-mm-dd,AKDT,,Y/N,cm,C,C,C,cm,,,
Seward_Peninsula,Council,NA,CN_MM71,CN_MM71_BGC,BGC_1,64.85995,-
163.70358,561451,7193476,2018-08-31,13:38,upland,N,0,4.3,2.8,11.6,46,V0,NA,NA
```

Data Acquisition Materials and Methods

Methods Description: Fluxes of CO_2 and CH_4 were measured using opaque or transparent closed-loop chambers (25 cm diameter, 15-20 cm height). Chambers were tall enough to enclose vegetation and were vented according to Xu et al. (2006), to minimize pressure excursions due to the Venturi effect. In all plots, chambers were seated on PVC bases extending ~15 cm below the soil surface. To minimize disturbance, bases were installed at the beginning of the sampling season and left in place throughout the remainder of the season. For each flux measurement, the chamber was seated in a 3 cm-deep, water-filled trench in the base's top rim to create an airtight seal. Air in the chamber headspace circulated through the greenhouse gas analyzer, which measured and recorded the CO_2 and CH_4 concentrations within the chamber over 4-8 minutes. The flux rate of each gas was calculated from the slope of the linear portion of the concentration vs. time curve. The majority of chamber flux measurements were made using a Los Gatos Research, Inc. (LGR) Ultraportable Greenhouse Gas Analyzer. However, in 2018 and 2019 some measurements were made using a Picarro G4301 Mobile Gas Concentration Analyzer. Both instruments use Cavity Ring-Down Spectroscopy to analyze CO_2 and CH_4 concentrations. On July 18, 2018 chamber fluxes were measured with both instruments for comparison purposes;

these data are in the files for the respective analyzers but can be combined for comparison purposes. Volumetric water content was measured with a MiniTrase TDR (Soilmoisture Equipment Corp.). Soil temperature was measured with a thermocouple probe. Vegetation and inundation status varied between plots; however, depths of moisture and temperature measurements were determined from the top of the moss layer or bare soil regardless of inundation status. Thaw depth was determined by manually inserting an 80-cm long metal tile probe into the soil and measuring the depth of insertion from the top of the moss layer to the frost layer. A value of 80 cm (Flag V2) indicates that the probe was fully inserted and did not reach the permafrost table.

References

Xu L, Furtaw MD, Madsen RA, Garcia RL, Anderson DJ, McDermitt DK (2006) On maintaining pressure equilibrium between a soil CO_2 flux chamber and the ambient air. Journal of Geophysical Research, 111. https://doi.org/10.1029/2005JD006435

Supplemental Files

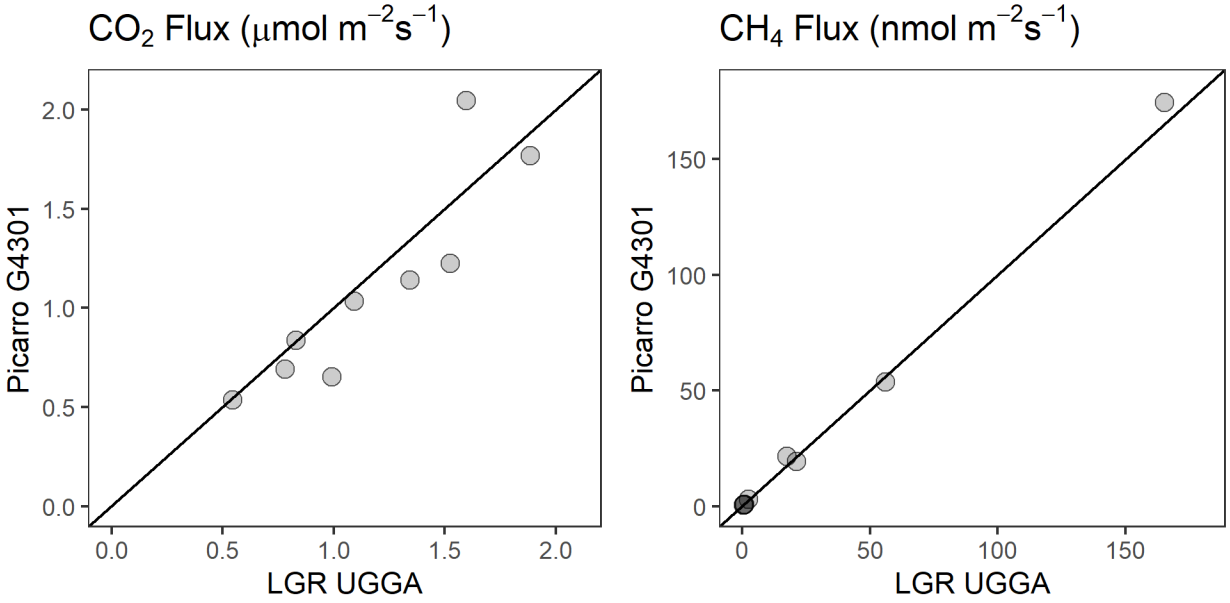

Figure 2: Comparison of ecosystem respiration (μmol CO_2 $m^{-2}s^{-1}$) and net CH_4 flux (nmol CH_4 $m^{-2}s^{-1}$) measurements using the LGR UGGA and Picarro G4301 instruments on July 18, 2018.

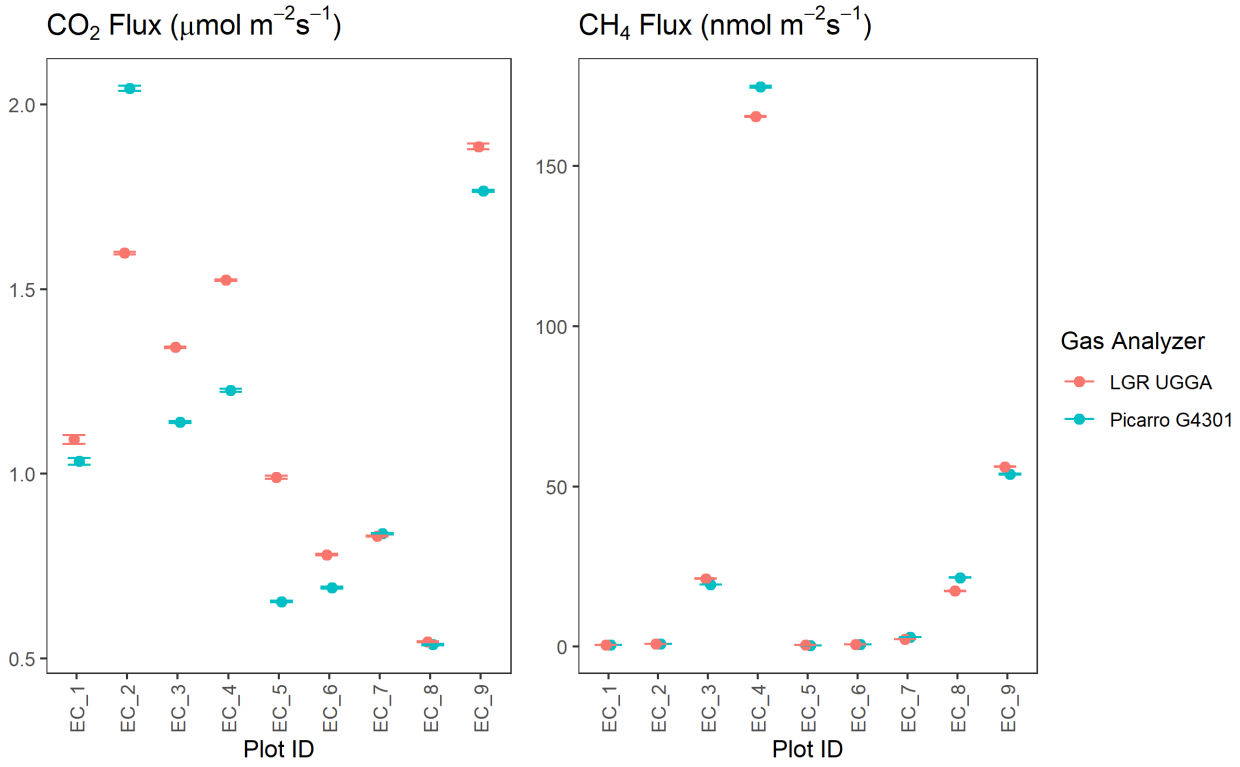

Figure 3: Comparison of ecosystem respiration (μmol CO_2 $m^{-2}s^{-1}$) and net CH_4 flux (nmol CH_4 $m^{-2}s^{-1}$) measurements using the LGR UGGA and Picarro G4301 instruments on July 18, 2018.

Data Access

Data Center Contact

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