May 29, 2020

Greenhouse Gas Production and Soil Chemistry in Anaerobic Soil Microcosm Incubations after Nitrogen Addition, Teller Road Site, Seward Peninsula, 2018-2019

Record_id: NGA188

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

Summary:

This dataset provides the results of laboratory soil microcosm incubation experiments conducted under anaerobic conditions with and without the addition of ammonium chloride (NH_4Cl). The microcosms contained soil collected in April 2017 from the NGEE Arctic Teller Road Site at mile marker 27 (TL_MM27) near Intensive Site 9 ("Toeslope") and Intensive Site 5 ("Plateau"). Incubations were conducted at 8°C for 55 days, with repeated measurements of headspace greenhouse gas concentrations. Microcosms were destructively harvested and extracted using ultrapure water and 0.1 M KCl for analysis of the porewater geochemistry.

Please use this citation to reference the data.

Michael Philben, David Graham, Baohua Gu. 2020. **Greenhouse Gas Production and Soil Chemistry in Anaerobic Soil Microcosm Incubations after Nitrogen Addition, Teller Road Site, Seward Peninsula, 2018-2019**. Next Generation Ecosystem Experiments Arctic Data Collection, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, USA. Dataset accessed on [insert_date] at https://doi.org/10.5440/1529003

Related publication

Philben, M., Taş, N., Chen, H., Wullschleger, S. D., Kholodov, A., Graham, D. E., & Gu, B. (2020). Influences of hillslope biogeochemistry on anaerobic soil organic matter decomposition in a tundra watershed. Journal of Geophysical Research: Biogeosciences, 125, e2019JG005512. https://doi.org/10.1029/2019JG005512

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.

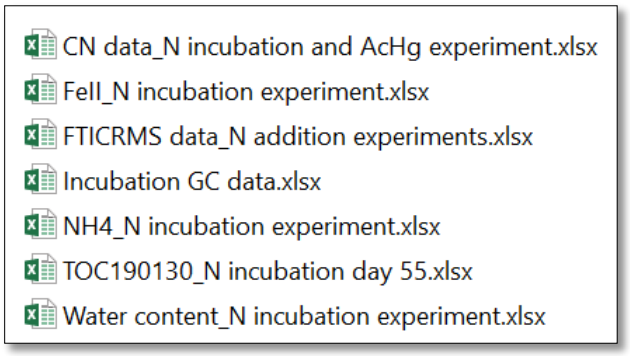
Through observations, experiments, and synthesis with existing datasets, NGEE Arctic provided an enhanced knowledge base for multi-scale modeling and contributed to improved process representation at global pan-Arctic scales within the Department of Energy's Earth system Model (the Energy Exascale Earth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

Data Characteristics

There are two data files provided in comma separate value (*.csv) format.

Data File Names
N_incubation_Gas_production.csv
N_incubation_Soil_extracts.csv

Raw data files are archived and only available by request.



User Notes:

- Values less than the analytical detection limit (<DL) for a compound are reported as zero (0). All zero values represent results that are <DL.

Detection Limits

Compound	Units	DL
Acetate	µmol g dry weight^{-1}	0.07
Propionate	µmol g dry weight^{-1}	0.07
Butyrate	µmol g dry weight^{-1}	0.07
Pyruvate	µmol g dry weight^{-1}	0.07
Succinate	µmol g dry weight^{-1}	0.07
Oxalate	µmol g dry weight^{-1}	0.07
Chloride	mg g dry weight^{-1}	.0069
Bromide	mg g dry weight^{-1}	.0069
Nitrate	mg g dry weight^{-1}	.0069
Sulfate	mg g dry weight^{-1}	.0069
DOC	µmol g dry weight^{-1}	0.06
Ferrous	µmol g dry weight^{-1}	0.03
NH4-N	µmol g dry weight^{-1}	0.09
Acetate	µmol g dry weight^{-1}	0.07

Common Variables for all data files.

Values for these location fields have been standardized for NGEE Arctic and are required fields for all data files. These columns and values may be prepended to the provided data files for improved project data integration.

Column_name	Units/format	Description
region		Seward Peninsula
locale		Teller
administrative_area		NA
site		TL_MM27
area		TL_IS_9 and TL_IS_5
plot_type		measurement
plot_ID		NA

Core Information

Location	Collection Date	Sampling Site	Sample ID	Latitude	Longitude
Intensive Station	Date core was collected	Location of core	Core unique identifier	Decimal degrees	Decimal degrees
IS9	2017-06-01	Toeslope	AK3-17-S3	64.729193	-165.944072
IS5	2017-06-01	Plateau	AK4-17-S4	64.74514	-165.966551

Data Dictionary

N_incubation_Gas_production.csv

Column_name	Units/format	Description
Site		Location of soil core
Horizon		Organic or mineral soil
Temperature	degrees_C	Incubation temperature
Treatment		Addition of DI water (control) or NH4+ (N)
Day		Days after start of incubation
CO2_produced	umol g dry weight^{-1}	Cumulative CO2 produced during incubation
CO2_sd	umol g dry weight^{-1}	Standard deviation of CO2 produced during incubation
CH4_produced	umol g dry weight^{-1}	Cumulative CH4 produced during incubation
CH4_sd	umol g dry weight^{-1}	Standard deviation of CH4 produced during incubation

N_incubation_Soil_extracts.csv

Column_name	Units/format	Description
Site		Location of soil core
Horizon		Organic or mineral soil
Treatment		Addition of DI water (control) or NH4+ (N)
Time		Days after start of incubation
Acetate	µmol g dry weight^{-1}	Concentration of acetate extracted in DI water
Acetate_sd	µmol g dry weight^{-1}	Standard deviation of acetate concentration
Propionate	µmol g dry weight^{-1}	Concentration of propionate extracted in DI water
Propionate_sd	µmol g dry weight^{-1}	Standard deviation of propionate concentration
Formate	µmol g dry weight^{-1}	Concentration of formate extracted in DI water
Formate_sd	µmol g dry weight^{-1}	Standard deviation of formate concentration
Butyrate	µmol g dry weight^{-1}	Concentration of butyrate extracted in DI water
Butyrate_sd	µmol g dry weight^{-1}	Standard deviation of butyrate concentration
Chloride	mg g dry weight^{-1}	Concentration of chloride extracted in DI water
Chloride_sd	mg g dry weight^{-1}	Standard deviation of chloride concentration
Bromide	mg g dry weight^{-1}	Concentration of bromide extraced in DI water
Bromide_sd	mg g dry weight^{-1}	Standard deviation of bromide concentration
Nitrate	mg g dry weight^{-1}	Concentration of nitrate extracted in DI water
Nitrate_sd	mg g dry weight^{-1}	Standard deviation of nitrate concentration
Sulfate	mg g dry weight^{-1}	Concentration of sulfate extracted in DI water

Column_name	Units/format	Description
Sulfate_sd	mg g dry weight^{-1}	Standard deviation of sulfate concentration
Oxylate	µmol g dry weight^{-1}	Concentration of oxylate extracted in DI water
Oxylate_sd	µmol g dry weight^{-1}	Standard deviation of oxylate concentration
Ferrous	µmol g dry weight^{-1}	Concentration of ferrous iron extracted in 0.1 M KCl
Ferrous_sd	µmol g dry weight^{-1}	Standard deviation of ferrous iron concentration
TOC	µmol g dry weight^{-1}	Concentration of dissolved organic carbon extracted in DI water
TOC_sd	µmol g dry weight^{-1}	Standard deviation of dissolved organic carbon
SUVA		Specific ultraviolet absorbance at 254 nm in DI water extracts
SUVA_sd		Standard deviation of specific ultraviolet absorbance at 254 nm
NH4-N	µmol g dry weight^{-1}	Concentration of NH4-N extracted in 0.1 M KCl
NH4-N_sd	µmol g dry weight^{-1}	Standard deviation of NH4-N concentration

Data Acquisition Materials and Methods

Study site and soil collection

Soil cores were collected from two locations within the same watershed in the Teller Road mile 27 site of the Next Generation Ecosystem Experiment (NGEE)-Arctic. One site (hereafter "Plateau") is located on a peat plateau on the top of the hillslope (64.74514°N, 165.966551°W), and the other site ("Toeslope") is located at the base of the hillslope (64.729193°N, 165.944072°W). Both sites are characterized by tussock tundra, sedge-dominated vegetation, and a water table at or near the soil surface.

Cores from the two sites were collected in spring of 2017 prior to the thawing of the active layer. The core from the plateau was 76 cm in length, and the toeslope core was 84 cm. The cores were shipped frozen to Oak Ridge National Laboratory and stored frozen until the start of the incubation. The frozen cores were transferred to an anaerobic chamber and separated into organic and mineral soil layers based on visual inspection. The uppermost layers containing intact vegetation were removed. The 0-38 cm and 0-34 cm intervals were characterized as organic for the toeslope and the plateau soils, respectively. Core sections from 38-84 cm for the toeslope and 61-76 cm for the plateau were used as the mineral soil.

Microcosm construction

The separated cores were cut into small (<0.5 cm^3) pieces using an oscillating cutting tool and mixed with a spoon, creating four homogenized samples (organic and mineral soils for the toeslope and the plateau). Soil microcosms were prepared by adding 7 g (wet soil) to 60 mL serum bottles. 1 mL of either MilliQ water (control treatment) or NH_4Cl solution containing 32

mM N (+N treatment) was added to each microcosm. Three replicate microcosms were prepared for the control and +N treatments to be incubated at -2°C and 8°C for 55 days. In addition, three replicates were constructed for destructive sampling after 15 and 30 days for the 8°C treatment only. There were therefore 96 microcosms in total. The microcosms were sealed with blue rubber septa, crimped with aluminum caps, flushed with N_2 for 10 minutes, and transferred to incubators at the appropriate temperature.

Greenhouse gas and chemical analysis

Concentrations of CO_2 and CH_4 were measured in the headspace of the microcosms every two days for the first two weeks, then every five days thereafter, following Roy Chowdhury et al. (2015). On each sampling day, 0.5 mL of the headspace was analyzed using an SRI 8610C gas chromatograph with a flame ionization detector (FID). CO_2 was converted to CH_4 using a methanizer for analysis by FID. The microcosms incubated at -2°C were kept in a cooler filled with ice packs during analysis to reduce temperature change during the incubation. Headspace CO_2 and CH_4 concentrations were converted to total gas production using Henry's Law based on the temperature of incubation and measured soil pH (Sander, 2015).

Microcosms were destructively sampled after 15, 30, and 55 days of incubation. In an anaerobic chamber, 2 g of each soil was extracted with 10 mL of degassed water or 0.1 M KCl in a 15 mL plastic tube and placed on a reciprocal shaker for 90 minutes. The soil extracts were centrifuged at 3000 RPM for 10 minutes and filtered through a 0.2 μm syringe filter. Aliquots of the KCl extracts were analyzed immediately for pH and ferrous Fe using the 1,10-phenanthroline method (Hach method 8146). NH_4-N concentrations were also analyzed in the KCl extracts using the colorimetric salicylate and cyanurate method (Hach method 10031).

The water extracts were analyzed for major anion content, low-molecular weight organic acid concentration, UV-visible absorbance, and water-extractable organic C (WEOC). Samples were either analyzed within three days of collection or frozen until analysis.

Anions (Cl^-, Br^-, NO_3^-, and SO_4^{2-}) and organic acids (formate, acetate, propionate, butyrate, and oxalate) were analyzed in the water extracts using ion chromatography following Herndon et al. (2015). The ions were separated using a 4μm Dionex IonPac AS11-HC column and gradient elution. The eluent was 1 mM KOH from 0-7 min, ramping to 15 mM from 7-16 min, 30 mM at 25 min, and 60 mM at 33 min. Ions were detected using a Dionex suppressed conductivity detector.

Water-extractable organic carbon (WEOC) concentration in the soil extracts were analyzed using a Shimadzu TOC-L analyzed after acidification with 0.1% HCl. Ultraviolet-visible (UV-Vis) spectroscopy was also conducted on the water extracts in a quartz cuvette over the range 200–800 nm on a Hewlett-Packard 8453 spectrophotometer.

References

Roy Chowdhury, T., Herndon, E. M., Phelps, T. J., Elias, D. A., Gu, B., Liang, L., et al. (2015). Stoichiometry and temperature sensitivity of methanogenesis and CO 2 production from saturated polygonal tundra in Barrow, Alaska. 21(2), 722-737.

Sander, R. (2015). Compilation of Henry's law constants (version 4.0) for water as solvent. 15(8).

Data Center Contact:

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Disclaimer of Liability

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