Poster #1-20

Stimulation of Anaerobic Organic Matter Degradation by Nitrogen Addition in Tundra Soils

Michael Philben[1*], Jianqiu Zheng[2], David Graham[2], Markus Bill[3], Jeffrey Heikoop[4], Stan Wullschleger[1], and Baohua Gu[1]

[1]Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN
[2]Biosciences Division, Oak Ridge National Laboratory, Oak Ridge, TN
[3]Earth and Environmental Sciences, Lawrence Berkeley National Laboratory, Berkeley, CA
[4]Earth and Environmental Sciences Division, Los Alamos National Laboratory, Los Alamos, NM

Contact: philbenmj@ornl.gov

BER Program: TES
Project: NGEE Arctic
Project Website: https://ngee-arctic.ornl.gov/

Nitrogen (N) availability in arctic soils is hypothesized to increase with warming due to accelerated mineralization of organic N from soil organic matter and the release of labile N from thawing permafrost. The potential for increased N availability to increase plant growth and associated C inputs to the soil is being incorporated into biogeochemical models. However, soil microorganisms will also compete for the additional N, which could stimulate their growth and increase CO_2 and CH_4 emissions via organic matter decomposition. We investigated the effects of N addition on anaerobic organic matter degradation through both field and lab-based experiments. In the field experiment, we injected a solution of ^{13}C- and ^{15}N-labeled glutamate 35 cm below the soil surface in a tundra soil near Nome, Alaska, and observed the resulting changes in porewater geochemistry and dissolved greenhouse gas concentrations. In the lab experiments, we added either a single pulse or a continuous injection of glutamate to an anoxic column filled with soil collected from the same field site. In the field experiment, free glutamate was detected one hour after the tracer injection but the concentration rapidly declined, and the ^{15}N label was recovered as total dissolved N in only small amounts until 62 hours after the injection. These results suggest that most of the added N was rapidly assimilated, consistent with microbial N limitation, which was followed by a later phase of mineralization or release as dissolved organic N. Both lab experiments also exhibited an initial phase of glutamate loss following the injection, consistent with microbial assimilation. We also observed increased concentrations of dissolved CH_4 during the field experiment, and Fe(II) during both the lab and field experiments, indicating stimulation of methanogenesis and Fe(III) reduction. Increasing concentrations of low molecular weight organic acids such as acetate and propionate suggests that N addition stimulated the decomposition and fermentation of more complex organic matter, likely as a result of relieved substrate limitation for anaerobic respiration. However, the resulting organic matter degradation appeared selective: while the total dissolved organic carbon (DOC) concentration declined by as much as 50% during the field experiment, there was no change in the aromatic DOC fraction as indicated by UV-Vis absorbance, resulting in an increase of specific UV absorbance ($SUVA_{254}$). Together, these results indicate that increasing N availability in tundra soils could accelerate warming-induced CO_2 and CH_4 production by relieving N limitation of fermenting microorganisms.