Poster #1-28

Rain Increases Methane Production and Methane Oxidation in a Boreal Thermokarst Bog

Rebecca B Neumann[1*], Colby J Moorberg[1,2], Jesse C Turner[1], Andrea Wong[1] Mark P Waldrop[3], Eugenie Euskirchen[4], Colin Edgar[4], and Merritt R Turetsky[5]

[1]University of Washington, Seattle, WA
[2]Kansas State University, Manhattan, KS
[3]United States Geological Survey, Menlo Park, CA
[4]University of Alaska Fairbanks, Fairbanks, AK
[5]University of Guelph, Guelph, Ontario, Canada

Contact: rbneum@uw.edu

BER Program: TES
Project: Early Career Research Program
Project Website: https://www.uwhydrobiogeochem.com/plants-wetland-methane/

Bottom-up biogeochemical models of wetland methane emissions simulate the response of methane production, oxidation and transport to wetland conditions and environmental forcings. One reason for mismatches between bottom-up and top-down estimates of emissions is incomplete knowledge of factors and processes that control microbial rates and methane transport. To advance mechanistic understanding of wetland methane emissions, we conducted a multi-year field investigation and plant manipulation experiment in a thermokarst bog located near Fairbanks, Alaska. The edge of the bog is experiencing active permafrost thaw, while the center of the bog thawed 50 to 100 years ago. Our study, which captured both an average year and two of the wettest years on record, revealed how rain interacts with vascular vegetation and recently thawed permafrost to affect methane emissions.

In the floating bog, rain water warmed and oxygenated the subsurface, but did not alter soil saturation. The warmer peat temperatures increased both microbial methane production and plant productivity at the edge of the bog near the actively thawing margin, but minimally altered microbial and plant activity in the center of the bog. These responses indicate processes at the edge of the bog were temperature limited while those in the center were not. The compounding effect of increased microbial activity and plant productivity at the edge of the bog doubled methane emissions from treatments with vascular vegetation during rainy years. In contrast, methane emissions from vegetated treatments in the center of the bog did not change with rain. The oxygenating influence of rain facilitated greater methane oxidation in treatments without vascular vegetation, which offset warming-induced increases in methane production at the edge of the bog and decreased methane emissions in the center of the bog.

These results elucidate the complex and spatially variable response of methane production and oxidation in thermokarst bogs to energy and oxygen inputs from rain, and have implications for how boreal wetland methane emissions may respond in the future to altered precipitation patterns. Advective delivery of energy and oxygen to wetland subsoils via rainwater is not currently a mechanism included in bottom-up wetland methane models.