Poster #1-39

Improved Representations of Methane Emissions from Wet Tropical Forest Soils using a Microbial Functional Group-Based Model

Debjani Sihi[1*], Melanie A. Mayes[1], Xiaofeng Xu[2], Christine O'Connell[3], Whendee Silver[3], Carla López Lloreda[4], Brian Yudkin[4], Ryan Quinn[1], Julia Brenner[1], Jana Phillips[1], Gisela Gonzalez[4], and Brent Newman[5]

[1] Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN
[2] San Diego State University, San Diego, CA
[3] University of California, Berkeley, CA
[4] Luquillo Critical Zone Observatory, Rio Grande, PR
[5]Los Alamos National Laboratory, Los Alamos, NM

Contact: sihid@ornl.gov

BER Program: TES
Project: Early Career Award (Melanie Mayes)
Project Website: https://science.energy.gov/early-career/

Tropical ecosystems contribute significantly to global emissions of methane (CH_4). However, landscape topography largely controls the rate of CH_4 emissions from wet tropical forest soils. Here we attempt to explain the dynamics of CH_4 emissions from two growing seasons (2015 and 2016) across a ridge-slope-valley topographic gradient in the El Yunque National Forest, Puerto Rico using a microbial functional group-based model. In 2016, CH_4 emissions follow the trend of valley>>slope>=ridge, which is different from the observed dynamics of CH_4 emissions during a drought and follow-up wet-up event in 2015. Soil temperature ranges were overlapping across topographic locations for both years. In contrast, soil water (and oxygen) ranges, as well as porewater chemistry (pH and organic acids) were different for the ridge vs. valley soils and were different between drought and non-drought years. These changes are expected to alter the substrate for CH_4 production and CH_4 consumption as well as the dynamics of respective microbial functional groups (acetotrophic or hydrogenotrophic methanogens and methanotrophs), which in turn, can influence net emissions of CH_4. Thus, contrasting patterns of soil water (and oxygen) and associated soil biogeochemistry between ridge vs. valley soils played an instrumental role in CH_4 emissions from the wet tropical soil of Puerto Rico, which were reproduced by a microbial functional group-based model. A variance-based sensitivity analysis further suggested that parameters related to acetotrophic methanogenesis and methanotrophy were critical for simulation of net CH_4 emissions across the topographic locations. To conclude, this study contributes to the ongoing development and improvements of the Earth system models to better simulate the microbial roles on methane cycling at regional and global scales.