Climate sensitivity of peatland methane emissions mediated by seasonal hydrologic dynamics

Xue Feng[1*], M. Julian Deventer[1], Rachel Lonchar[1], G.H. Crystal Ng[1], Stephen D. Sebestyen[2], D. Tyler Roman[2], Timothy J. Griffis[1], Dylan B. Millet[1], Randall K. Kolka[2]

[1]University of Minnesota, Minneapolis, MN

[2]Northern Research Station, USDA Forest Service, Grand Rapids, MN

Contact: (feng@umn.edu)

Project Lead Principal Investigator (PI): Xue Feng

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Project Abstract: Our project aims to guide future representations of peatland hydrology and water-carbon feedbacks within Earth System Models, by developing analytical insights and a series of parsimonious, stochastic, and process-based hydrological models that can quantify the effects of temporal hydroclimatic variability and spatial heterogeneity on peatland carbon emissions.

Recently, we used a newly developed dataset from the Marcell Experimental Forest (MEF) (Minnesota) spanning an exceptionally long 11 years to analyze the influence of soil temperature and water table elevation on peatland CH_4 emissions. We show that higher water tables dampen the springtime increases in CH_4 emissions as well as their subsequent decreases during late summer to fall. These results imply that any hydro-climatological changes in northern peatlands that shift seasonal water availability from spring to summer will increase annual CH_4 emissions, even if temperature remains unchanged. Thus, advancing hydrological understanding in peatland watersheds will be crucial for improving predictions of CH_4 emissions.

With one transect already in place, we also installed new water level loggers (in the fall of 2019) at the bog-forest boundary at MEF across three new transects to provide insight on the timing and amount of inputs to the bog from surrounding upland forests. These lateral inputs are expected to magnify the hydrological response within the bog during high intensity rainfall and snowmelt events. Currently, we are working to incorporate the seasonal dynamics of specific yield, lateral flow, and precipitation into a water balance model that will be used to predict the daily and seasonal variations in water table depths. This water balance model will be coupled to a new, stochastic reaction kinetics model to predict peatland carbon emissions in response to variable hydroclimatic forcing.