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Exploring the response of West Siberian wetland methane emissions to potential future changes in climate, vegetation, and soil microbial metabolism

Theodore Bohn (1), Jed Kaplan (2), and Dennis Lettenmaier (3)

(1) Arizona State University, School of Earth and Space Exploration, Tempe, United States (theodore.bohn@asu.edu), (2) University of Lausanne, Lausanne, Switzerland (jed.kaplan@unil.ch), (3) Department of Geography, University of California, Los Angeles, CA, United States (dlettenm@ucla.edu)

Methane emissions from northern peatlands depend strongly on environmental conditions, wetland plant species assemblages (via root zone oxidation and plant-aided transport), and soil microbial behavior (via metabolic pathways). While the responses of wetland methane emissions to potential future climate change have been extensively explored, the effects of future changes in plant species and soil microbial metabolism are not as well studied. We ran the Variable Infiltration Capacity (VIC) land surface model over the West Siberian Lowland (WSL), with methane emissions parameters that vary spatially with dominant plant species, and forced with outputs from 32 CMIP5 models for the RCP4.5 scenario. We compared the effects of changes in climate and vegetation (in terms of both leaf area index and species abundances) on predicted wetland CH4 emissions for the period 2071-2100, relative to the period 1981-2010. We also explored possible acclimatization of soil microbial communities to these changes. We evaluated the effects of climate change, potential northward migration of plant species, and potential microbial acclimatization on end-of-century methane emissions over the WSL, in terms of both total annual emissions and the spatial distribution of emissions. Our results suggest that, while microbial acclimatization mitigates the effects of warmer temperatures, the northward migration of plant species enhances the response to warming (due to plant-aided transport), and additionally shifts the location of maximal emissions northward, where the possible release of ancient carbon with permafrost thaw is a concern. Our work indicates the importance of better constraining the responses of wetland plants and soil microbial communities to changes in climate as they are critical determinants of the region's future methane emissions.