Title: **The response of greenhouse gas production (GHG) pathways to elevated temperature in the SPRUCE peatland**

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Project Abstract: GHG emission from peatlands is hypothesized to increase in response to warming from climate change. Although methanogenesis is considered as the dominant terminal electron accepting process (TEAP) coupled to organic matter degradation, the ratio of GHGs (CO_2:CH_4) emitted from these wetlands often does not match with predicted stoichiometry. The objectives of this study are to validate field observations and modeling efforts through understanding the mechanisms and controls of GHG production in the SPRUCE peatland. Over the past 4 years, GHG production rates were quantified in microcosm experiments with fresh peat and porewater collected from the S1 bog of the Marcell Experimental Forest in parallel with field observations. Microcosm treatments included porewater alone, porewater plus peat, a range of temperatures (4 to 25 ℃), and amendment with potential electron acceptors/ donors.

Warming resulted in a substantial increase in CH_4 and CO_2 production rates and a decline in CO_2:CH_4 ratio. Acetate accumulated in treatments at near in situ temperature (4 ℃), indicating a threshold at which acetogenesis outcompetes methanogenesis. In contrast, although hydrogenotrophic methanogens show a higher relative abundance in field observations, acetoclastic methanogenesis predominates, with methane production becoming more hydrogenotrophic with warming as indicated by stable isotope data. Lower CO_2:CH_4 ratios were found at the onset of incubations and with DI water in comparison to porewater, suggesting that organic electron acceptors in the porewater suppress methane production under in situ conditions. Amendment with potent electron acceptors (e.g. nitrate) stimulate a large increase in CO_2 production and a suppression in methane production, pointing to electron acceptor limitation. Overall, the results corroborate field data to indicate that GHG production will increase and become more methanogenic with warming in SPRUCE soils. This is troubling since the sustained-flux global warming potential of CH_4 is now estimated at 45-times greater than that of CO_2 on a 100 y timescale.