Warming effects on peat column CH_4 dynamics in a Minnesota bog

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Northern peatlands store roughly one-third of terrestrial soil carbon and are responsible for a significant fraction of the flux of the potent greenhouse gas methane (CH_4) to the atmosphere. An important question in global biogeochemistry remains whether peatland soil carbon will be released to the atmosphere as CH_4 in response to global change. An answer to this requires a mechanistic understanding of both CH_4 production and CH_4 oxidation. The Spruce and Peatland Responses Under Climatic and Environmental Change (SPRUCE) project will ultimately manipulate temperature (+0, +2.25, +4.5, +6.75 and +9 °C) and atmospheric CO_2 concentrations (Ambient, +850 ppmv) within a northern Minnesota bog. Deep peat heating was initiated in June of 2014; whole ecosystem warming, including above-ground warming, was initiated in August of 2015; and elevated CO_2 treatments will begin in the summer of 2016. This project provides a unique opportunity to investigate the mechanistic controls of both CH_4 production and oxidation.

To explore the controls of CH_4 production, we collected soil cores through the 2 m soil profile in September of 2014 and June of 2014 (during deep peat heating) and in August and September of 2015 (during whole ecosystem warming). Soils were incubated anaerobically at in situ temperatures with the addition of a $^{14}HCO_3^-$ tracer to explore the effects of warming on total CH_4 production as well as hydrogenotrophic and acetoclastic methanogenesis. Warming stimulated net CH_4 production in surface depths, but did not have an effect in deeper soils. However, warming decreased CO_2:CH_4 ratios throughout the peat column, with greatest effects in surface peat. Warming had little impact on the concentrations of fermentation products, including the methanogenic substrates acetate and H_2. Overall, the lack of temperature effects suggest that deep peat soils are resistant, at least initially, to warming.

The same soil cores described above were incubated with $^{14}CH_4$, and preliminary evidence suggests that anaerobic CH_4 oxidation may be occurring in these soils (calculated as the production of $^{14}CO_2$ in these samples). Additionally, the use of an in situ isotope dilution protocol shows promise for measuring net CH_4 oxidation at the ecosystem scale. Taken together, measurements of CH_4 production and CH_4 oxidation in the SPRUCE project will provide important insights into the mechanistic controls of CH_4 cycling in the context of ongoing global change.