Initial Responses of Methane Cycling to Deep Peat Warming 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 global flux of the potent greenhouse gas CH_4 to the atmosphere. A pressing question in global biogeochemistry remains whether warming will enhance the release of CO_2 and/or CH_4 from this massive soil carbon pool. A mechanistic answer to this question is necessary for Earth system models to accurately predict ecosystem-climate feedbacks in response to ongoing global change. 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. Warming though the entire ~2 m peat profile was initiated in June of 2014, allowing for the unique exploration of the impact of in situ deep warming on carbon mineralization dynamics in this peatland. In September 2014, soil cores were collected at 25, 50, 100, and 200 cm depths from each experimental plot at the SPRUCE site and anaerobically incubated at in situ temperatures with a $^{14}CO_2$ tracer to measure rates of hydrogenotrophic CH_4 production, with rates of acetoclastic methanogenesis determined by difference from total CH_4 production. The CH_4, CO_2, and CH_4:CO_2 temperature responses varied by depth ($p = 0.002$), with surface peat being more responsive to temperature than deeper peat. Additionally, the proportion and rate of acetoclastic methanogenesis significantly increased with temperature in surface peat (rates were below the detection limit in deeper peat). However, warming had no impact on the concentration and isotopic signature of porewater CH_4 through the peat profile. While SPRUCE will continue for many years, our initial results suggest that the vast carbon stores at depth in peatlands will be less responsive to warming than surface peat. Moreover, shifts in the CH_4 production pathway reveal that increased warming can cause changes in microbial community dynamics in as little as three months. Finally, we have compared CH_4 cycling in the S1 Bog (the home of the SPRUCE project) to two other *Sphagnum* moss-dominated peatlands in the region to highlight differences in the controls of CH_4 cycling - and the potential for different responses to warming - even within bog-like northern peatlands.