Poster #9-7

Whole-Ecosystem Warming in a Boreal Peatland Ecosystem Alters Stream Flow and Total Organic Carbon Fluxes

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We are investigating the effects of warming and elevated CO_2 on stream flow and solute concentrations and export as part of the SPRUCE project. SPRUCE is a large-scale, long-term experiment that is examining the effects of above and belowground warming and elevated atmospheric CO_2 concentrations on boreal peatland ecosystem processes. Ten enclosures were constructed in a black spruce-*Sphagnum* bog in northcentral Minnesota, with five temperature treatments (+0, +2.25, +4.5, +6.75, +9°C) each at ambient and elevated (+500 ppm) CO_2 concentrations. Surrounding each enclosure is a subsurface corral, and lateral outflow (i.e., stream flow) passively flows from each enclosure/corral into a collection basin for quantification. Sample collection for chemical analyses is automatic and flow-weighted using an autosampler. While a variety of solutes are measured in stream water, total organic carbon (TOC) responses are the focus of this presentation.

Stream flow, and TOC concentrations and fluxes have changed substantially with warming. Warming decreased stream flow, as cumulative annual outflow from the +9°C enclosures was 56%, 63%, and 19% lower than from the +0°C enclosures in 2016, 2017, and 2018, respectively. The effect of elevated CO_2 was less clear, but outflow tended to be lower from the elevated CO_2 enclosures. Warming has also increased TOC concentrations in stream water, but the responses were not consistent over time. In the first two years of whole-ecosystem warming, TOC concentrations were ~20 mg/L higher in the +9°C (~74 mg/L) than the +0°C (~53 mg/L) enclosures. However, in 2018, TOC concentrations were almost 50 mg/L higher in the warmer enclosures (101 mg/L vs 54 mg/L). Despite these higher TOC concentrations, annual cumulative TOC fluxes were lower from the warmer enclosures in 2016 and 2017 because fluxes were primarily driven by lower stream flow. In 2018, there appeared to be a shift in this response, as cumulative annual TOC fluxes were now higher from the +9°C than the +0°C enclosures. This suggests that the higher TOC concentrations played a larger role in driving TOC fluxes in 2018. Overall, a central focus of SPRUCE is to assess whether peatlands may shift from carbon sinks to sources under climate change. Our findings thus far suggest that TOC export from peatlands is not straightforward and will depend on whether climate change more strongly impacts the factors affecting stream flow (e.g., evapotranspiration) or TOC concentrations (e.g., peat mineralization, leaching of recently produced photosynthate).