Title: Warming alters solute concentrations and fluxes from peatland streams

Authors: Griffiths, Natalie A., Oak Ridge National Laboratory, griffithsna@ornl.gov
Sebestyen, Stephen D., USDA Forest Service, stephen.sebestyen@usda.gov
Oleheiser, Keith C., Oak Ridge National Laboratory, oleheiserkc@ornl.gov
Hanson, Paul J., Oak Ridge National Laboratory, hansonpj@ornl.gov

Abstract:
Northern peatlands are high-carbon, nutrient-limited ecosystems that are vulnerable to climatic and environmental change. We examined how warming may affect peatland stream solute concentrations and fluxes within the SPRUCE (Spruce and Peatland Responses Under Changing Environments) experiment. SPRUCE is examining the effects of warming (+0, +2.25, +4.5, +6.75, +9°C) and elevated CO_2 (+500 ppm) over 10 years using a whole-ecosystem manipulation in an ombrotrophic bog in northern Minnesota (USA). Warming is added both above and belowground within ten 12-m diameter, 8-m tall enclosures installed in the peatland. A belowground corral hydrologically isolates each plot, and two lateral, slightly sloped, slotted pipes installed in the near-surface peat allow for lateral, passive drainage of water akin to stream flow. The pipes drain into a subsurface basin, which is equipped with a water-level sensor to estimate stream flow. An automated sampler collects flow-weighted water samples from the subsurface basin (before the water reaches the reservoir where water level is measured). Water samples are retrieved weekly and analyzed for a suite of solutes, including total organic carbon (TOC), inorganic and total nutrients, anions, cations, and metals. After 7 years of warming, the most notable change in stream water chemistry was a large increase in TOC concentrations with warming, from 52 mg/L (+0°C enclosures) to 87 mg/L (+9°C enclosures), likely due to warming-induced increases in peat mineralization and leaching of recently produced photosynthate. While TOC concentrations have increased with warming, stream flow has decreased, likely due to increased evapotranspiration, resulting in an overall decrease in the efflux of TOC from the peatland. In contrast to the response of TOC to warming, the response of nutrients has been minimal, possibly because of rapid microbial and vegetative uptake of mineralized nutrients in this nutrient-limited ecosystem. Our findings to date suggest that climate change may alter the chemistry and volume of stream water flowing from peatlands, with potential cascading effects to downstream ecosystems.