The Effect of Climate Change on Coupled Biogeochemistry of Sulfur and Mercury in Organic Soils

BRANDY M. TONER[1], OLHA S. FURMAN[1,2], JESSICA L. M. GUTKNECHT[1], STEPHEN D. SEBESTYEN[2], RANDALL K. KOLKA[2], AND EDWARD A. NATER[1]

[1]Department of Soil, Water, and Climate, University of Minnesota-Twin Cities, MN, USA
[2] Institute for Applied Ecology, University of Canberra, ACT 2601, Australia
[3] USDA Forest Service, Northern Research Station, Grand Rapids, MN, USA

We are studying the coupled biogeochemical cycles of S, Hg, and C in boreal peatland ecosystems as a function of climate. Peatlands are sinks for Hg and S from atmospheric deposition, and potential sources of methyl-Hg through the activity of microorganisms, such as sulfate-reducing bacteria. Projected climate changes may alter internal cycling of Hg, S, and C as well as fluxes of Hg, S, and C to the atmosphere and surface waters. To address this concern, we are using whole-ecosystem experiments with increased soil- and air-temperature and atmospheric CO_2. Peat cores are collected once yearly from treatment and control plots, in addition porewater is collected twice monthly from piezometers and Hg(0) fluxes to the atmosphere are measured using passive sampling approaches. For the peat and porewater samples, we use a suite of analytical methods to track Hg, S, and C chemistry: concentrations of total- and methyl-Hg, total CNS, $\delta^{13}C$, and $\delta^{34}S$, as well as S X-ray absorption spectroscopy. Treatment variables in our experiments are temperature and CO_2. Our response variables, water table depth and soil moisture, should produce drier and more chemically oxidizing conditions within the peat and porewaters. We hypothesize that low water tables and oxidizing conditions in temperature treatment plots will: (1) result in a build-up of oxidized S compounds, such as sulfate, ester-sulfate, sulfonate, and sulfone in peat; (2) during subsequent wetter periods, a pulse of oxidized organic S will be released to porewaters; and (3) oxidized S in peat and porewaters will stimulate production of methyl-Hg in porewaters. A potential outcome of climate change is enhanced release of bioaccumulative methyl-Hg from peatlands to receiving water bodies and this is a concern for human and environmental health.