



Hg⁰ evasion from boreal mires determined with chamber methods and a novel REA design

Stefan Osterwalder (1), Johannes Fritsche (2), Staffan Åkerblom (3), Mats B. Nilsson (4), Christine Alewell (1), Kevin Bishop (3,5)

(1) Department of Environmental Sciences, University of Basel, CH-4056 Basel, Switzerland, (2) Meteotest, CH-3012 Bern, Switzerland, (3) Department of Aquatic Sciences and Assessment, Swedish University of Agricultural Sciences, SE-75236 Uppsala, Sweden, (4) Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, SE-901 83 Umeå, Sweden, (5) Department of Earth Sciences, University of Uppsala, SE-75236 Uppsala, Sweden

Anthropogenic mercury has accumulated in superficial organic soils of boreal mires, hotspots of methylmercury production. We hypothesize that emission from the peat surface is an important factor in regulating the pool of mercury in mires and ultimately the loading of methylmercury to surface waters. To test this hypothesis, we used both dynamic flux chambers (DFCs) and a dual-intake, single analyzer Relaxed Eddy Accumulation (REA) system to quantify the land-atmosphere exchange of elemental mercury (Hg⁰) from a mixed acid mire system situated near Vindelån in the county of Västerbotten, Sweden. Teflon and polycarbonate DFCs were used to (i) investigate the effect of sulfur and nitrogen addition as well as warming and changed moisture regimes on Hg⁰ flux and (ii) to quantify typical all-day summertime fluxes. The novel REA design was developed for long-term, all-year flux monitoring and uses twin inlets at the same level for simultaneous accumulation of up and downdrafts on a pair of gold traps which are then analyzed sequentially on the same detector while another pair of gold traps takes over the accumulation. The exchange of Hg⁰ from the peatland surface was measured continuously with DFC during cloudless conditions in July 2014 and averaged $0.62 \pm 1.3 \text{ ng m}^{-2} \text{ h}^{-1}$. The flux revealed a significant diurnal pattern and a strong linear relationship with air temperature inside ($R^2 = 0.65$, $p < 0.001$) and outside ($R^2 = 0.58$, $p < 0.001$) the DFC. Hg⁰ exchange was significantly lower on experimental plots exposed to elevated sulfur deposition. This indicated either earlier Hg evasion or Hg binding to sulfur in organic matter, making Hg less susceptible to volatilization and more prone to transport in runoff. The REA measurements revealed a seasonal pattern of Hg⁰ fluxes over the year with net evasion during growing season and dominating deposition from autumn to spring. We managed to perform the first conditional sampling of Hg⁰ flux over a boreal mire using REA and were able to determine drivers and inhibitors of Hg⁰ evasion during short-term DFC measurements. Hg removal via volatilization resembled the annual export of Hg in streamwater hence indicating that the estimated time-span for reduced Hg emissions to translate into lower Hg levels in the soil are too long because up to now the emission of Hg from the mire surface to the atmosphere has been ignored.