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A mercury input-output budget of a boreal lake: climate signals and in-lake processing.

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Fish in northern, oligotrophic, humic lakes often have mercury (Hg) levels higher than advisories for human consumption. The Hg in these lakes is primarily from current and legacy long-range transported air pollution sources. Foodweb exposure to aquatic Hg is regulated by through dissolved organic matter (DOM) as a transportation vector, source of energy, and regulator of bioavailability of Hg species. Long-term records of Hg in inlets, lakes, and outlets enable understanding of the role of catchments and lakes in regulation of foodweb exposure to Hg.

The inlet and outlet streams of lake Langtjern in southern Norway have been monitored for water chemistry and hydrology since the 1970s, and since 2004, aquatic Hg species (methyl-Hg (MeHg), total Hg (HgT)) have been analysed; since May 2008 on a monthly basis. Langtjern is acidified, humic and oligotrophic. The catchment is recovering from acid deposition and displays a significant browning trend. The ratio of mean annual lateral catchment Hg inputs and direct atmospheric deposition of Hg to the lake is circa 8:1. The lake dissolved organic carbon (DOC) retention is on average 8% of the catchment inputs, while photo-oxidation is a significant loss-factor for lake MeHg on an annual basis.

Here we present long-term data on concentrations and fluxes of HgT and MeHg, and evaluate how interactions between Hg and DOM, in addition to climate and deposition, impact catchment and lake Hg cycling. In addition, we present a first assessment of potential methylation rates along a gradient from profundal and littoral sediments to riparian peatlands.

Long-term mean concentrations of HgT and MeHg in the outlet are 3.5 and 0.08 ng/L, respectively. Annual mean concentrations of HgT and DOC were stable in the outlet between 2009 and 2017, while MeHg and the ratio of MeHg to HgT show a significant linear decrease ($p<0.05$). Annual patterns in inlet and outlet concentrations are similar, suggesting that lake processing does not have a major impact on outlet Hg dynamics, but is rather driven by catchment processes. However, the Hg to DOC ratio in the outlet is significantly higher than in the inlets, an indication of lake DOC removal through in-lake processing, and redistribution of Hg to remaining DOC.