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Assessing mercury methylation and methylmercury demethylation in thermokarst lakes in a sporadic permafrost region, Canadian Subarctic

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The increase in global atmospheric temperature, and consequently soil temperature, has led to a dramatic amplified change in polar regions. Thermokarst lakes are unique freshwater ecosystems recently formed due to permafrost thaw and widely spread in the Subarctic and Arctic. Over the years, nutrients, carbon and contaminants have been sequestered and accumulated in permafrost soils. Due to soil warming, these are rapidly released and exported in thermokarst lakes thus impacting biogeochemical processes and contaminants behavior. One of these is mercury (Hg), a naturally occurring element, that when present in the environment can be uptake by bacteria producing methylmercury (MMHg). Indeed, thermokarst lakes are rich in organic matter and are therefore ideal ecosystems for certain microbial communities, such as methylating bacteria. Methylmercury has severe neurotoxic effects and can easily bioaccumulate and biomagnify through food webs and directly impacts northern communities' health.

Methylmercury concentration in thermokarst lakes depends on the Hg pool and the equilibrium between the Hg methylation and MMHg demethylation reactions. To better understand Hg dynamics, two thermokarst lakes in a sporadic permafrost region near the Cree and Inuit Communities of Whapmagoostui-Kuujjuarapik, Nunavik (Canada) were sampled in the winter and summer of 2022. Methylation and demethylation rates were assessed in water and sediments using Hg stable isotopes. Results showed that in water samples between 0.01-0.78% of Hg was methylated in 24h in summer increasing to 0.13-7.62% in winter. In sediment samples, between 0.13-0.60% of Hg was methylated in 24h in summer increasing to 1.78-7.94% in winter. Moreover, experiments with amendments were conducted to identify the microorganisms responsible for methylation and demethylation.