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Assessing Hg deposition pathways from the atmosphere to forest plants and soils using Hg stable isotopes

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Soils are one of the most important sinks of mercury (Hg), with uptake of gaseous elemental mercury (GEM) by plants and subsequent deposition via litterfall and throughfall being one of the main pathways of Hg into soils. Previous studies show that plants preferentially take up isotopically lighter GEM, which likely results in isotopically more positive GEM in the atmosphere in terms of mass dependent fractionation (MDF). There is also a small shift in mass independent fractionation (MIF) during uptake by plants that is thought to be due to photochemical reactions on plant surfaces or within stomata. The MDF and MIF offsets between plants and atmospheric GEM are crucial components of models utilizing Hg isotopes to quantify and understand deposition pathways to soils as well as the role of plant uptake on atmospheric GEM. However, how much the MDF and MIF offsets vary within and between different plant types and due to other ecosystem parameters (i.e., primary productivity, canopy cover) is not well known. For example, with limited data, the MDF offset between atmospheric GEM and plants ranges from 1 to 3 permil with an average about -2.6 permil [1].

The purpose of our study was to evaluate the consistency of the MDF and MIF offset between plants and atmospheric GEM and to assess how well Hg isotopic signatures of plants are preserved in soils of a deciduous forest biome. We measured the Hg concentrations and isotopic compositions of foliage from replicates of the same plant species, different plant species, mixed litterfall, soil profiles, and GEM from multiple sites within the Limberlost Forest and Wildlife Reserve in Ontario, Canada. The measured Hg concentrations showed similar results as previous studies and the isotopic composition of foliage had more negative MDF than atmospheric GEM. Overall, the MDF offset between plants and the atmosphere was larger at Limberlost than at other locations (-2.9 to -3.7 permil), with some species varying little between replicates and others varying by up to 1 permil. Additionally, both litterfall and soils show more positive MDF than plants.

[1] Wang *et al*. (2021), *Crit Rev Environ Sci Technol* 52, 1-24.