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Sources, transport, and cycling of mercury in Greenland over an ice-to-ocean gradient

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Mercury (Hg) is a toxic element of global interest because it bioaccumulates and biomagnifies in aquatic food webs. High yields of Hg from glaciated catchments have been observed in Arctic environments and environmentally elevated Hg concentrations have previously been attributed to atmospheric deposition, ice melt, geogenic sources, and permafrost thaw. While anthropogenic emissions are likely the principal source of current Hg accumulation in the Arctic, the storage of Hg, and transformations occurring on, in, and under glaciers remain poorly quantified in the Arctic Hg cycle. The sources of Hg in glacial meltwater are difficult to individually quantify and will include atmospheric deposition, subglacial weathering, and proglacial processes, such as inputs from melting permafrost. Glaciers play an important role in the global cycles of water, sediment, and elements mainly due to efficient physical erosion and chemical weathering of finely ground mineral surfaces, including trace reactive components of rocks, in the subglacial environment. Glacial erosion and meltwater transport may therefore be a climatically sensitive source of Hg into riverine and coastal systems. The Greenland Ice Sheet (GrIS) is the second largest ice sheet on Earth and its behavior is highly responsive to climatic warming. GrIS mass loss is likely to increase sediment delivery to coastal oceans, which will include Hg-bearing minerals, even if found at trace concentrations. Glacially mobilized Hg may increase the Hg inventory in coastal ecosystems surrounding the GrIS, so is of importance. Concentrations and associated fluxes of Hg from the ice sheet remain poorly understood and more extensive field datasets in both space and time are needed to address potential Hg mobilization from ice to coastal fjords in Greenland. Here, we present Hg concentrations, speciation, and isotopic composition from atmosphere to ice to ocean over spatial and temporal gradients for a melt season in Greenland. This Hg geochemical information provides an improved picture of the sources and cycling of Hg in Greenland. Establishing how glacier recession and a greening Arctic contribute to the mobilization and export of Hg is important for predicting future perturbations on the Arctic Hg biogeochemical cycle.