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Air-Sea Exchange of Inorganic Mercury and Dimethylmercury in the Amundsen Sea During the U.S. GEOTRACES GP17-ANT Cruise

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Air-sea exchange plays a central role in the global mercury (Hg) cycle by regulating ocean-atmosphere Hg fluxes, influencing atmospheric residence time, and controlling the fate of methylated species such as monomethylmercury (MMHg) and dimethylmercury (DMHg) in ocean. Although substantial progress has been made in quantifying the evasion of elemental Hg (Hg^0) and the deposition of oxidized Hg (Hg^{II}), the role of DMHg in air-sea exchange, particularly in polar regions, remains poorly constrained. The U.S. GEOTRACES GP17-ANT cruise (Jan-Mar 2024) provided a unique opportunity to investigate the distribution and air-sea exchange of dissolved Hg^0 and DMHg in the Amundsen Sea sector of the Southern Ocean. This region is undergoing rapid climate-driven change, including enhanced glacial melt associated with intrusions of warm Circumpolar Deep Water onto the continental shelf. These processes influence regional stratification, biogeochemistry, primary productivity, and trace metal supply, with implications for both ecosystem dynamics and deep-water formation. We conducted high-resolution, continuous measurements of dissolved Hg^0 and DMHg in surface seawater using an equilibrium flow chamber coupled to automated Hg^0 and DMHg analyzers. Concurrent atmospheric measurements of Hg^0, reactive gaseous Hg (RGM), and particulate Hg (Hg^P) were completed using Tekran speciation systems. Aerosol and precipitation samples were also collected to quantify total Hg and methylmercury concentrations. Our results allow for the characterization of the spatial variability of Hg^0 and DMHg distributions and quantify the air-sea fluxes across hydrographic gradients from the continental shelf to the Antarctic Circumpolar Current. These results provide new constraints on the role of DMHg in polar Hg cycling and improve our understanding of how climate-driven physical and biogeochemical changes are influencing ocean-atmosphere Hg exchange in the Southern Ocean.