EGU24-4799, updated on 20 Mar 2025
https://doi.org/10.5194/egusphere-egu24-4799
EGU General Assembly 2024

Modeling the Mercury Cycle in the Sea Ice Environment: A Buffer between the Polar Atmosphere and Ocean

Shaojian Huang, Feiyue Wang, Tengfei Yuan, Zhengcheng Song, Peipei Wu, and Yanxu Zhang
Nanjing University, School of Atmospheric Sciences, Nanjing, China (shaojianhuang@126.com)

Sea ice (including overlying snow) is a dynamic interface between the atmosphere and the ocean, influencing the mercury (Hg) cycling in polar oceans. However, a large-scale and process-based model for the Hg cycle in the sea ice environment is lacking, hampering our understanding of regional Hg budget and critical processes. Here, we develop a comprehensive model for the Hg cycle at the ocean–sea ice–atmosphere interface with constraints from observational polar cryospheric data. We find that seasonal patterns of average total Hg (THg) in snow are governed by snow thermodynamics and deposition, peaking in springtime (Arctic: 5.9 ng/L; Antarctic: 5.3 ng/L) and minimizing during ice formation (Arctic: 1.0 ng/L, Antarctic: 0.5 ng/L). Arctic and Antarctic sea ice exhibited THg concentration peaks in summer (0.25 ng/L) and spring (0.28 ng/L), respectively, governed by different snow Hg transmission pathways. Antarctic snow-ice formation facilitates Hg transfer to sea ice during spring, while in the Arctic, snow Hg is primarily moved through snowmelt. Overall, first-year sea ice acts as a buffer, receiving atmospheric Hg during ice growth and releasing it to the ocean in summer, influencing polar atmospheric and seawater Hg concentrations. Our model can assess climate change effects on polar Hg cycles and evaluate the Minamata Convention's effectiveness for Arctic populations.