CARE-C
CLIMATE AND ATMOSPHERE RESEARCH CENTER

THE CYPRUS INSTITUTE
RESEARCH·TECHNOLOGY·INNOVATION

Research Highlight

'Unveiling the molecular identity of oxidized mercury in the polar atmosphere'

Summary

Mercury is a globally transported pollutant with significant impacts on ecosystems and human health, particularly in polar regions where bioaccumulation in marine food webs leads to elevated exposure. While atmospheric oxidation controls where mercury is deposited, the molecular identity of oxidized mercury species has remained largely unresolved due to limitations in measurement techniques.

In this study, we present the first direct, real-time observations of individual oxidized mercury compounds in the polar atmosphere using nitrate-based chemical ionization mass spectrometry (CI-APi-TOF). Measurements conducted in Antarctica and the central Arctic reveal that mercury exists predominantly as mercuric halides, with $HgBr_2$ identified as the dominant oxidized species in both regions.

These observations challenge current atmospheric models, which predict $HgCl_2$ and HOHgBr as the primary oxidized mercury forms. Instead, our results demonstrate a more complex speciation, including contributions from bromine-, chlorine-, and iodine-containing mercury compounds. The findings highlight the importance of halogen chemistry, particularly bromine, in driving mercury oxidation in polar environments.

By providing molecular-level insights into oxidized mercury, this work advances our understanding of mercury cycling and offers critical constraints for improving atmospheric chemistry models and global deposition estimates.

Impact

This study represents a major breakthrough in atmospheric mercury research by enabling direct molecular-level identification of oxidized mercury species in ambient air.

The discovery that $HgBr_2$ dominates oxidized mercury speciation in polar

Authors' bios

Tuija Jokinen is an associate professor and the aerosol formation group leader at the Cyprus Institute and a visiting researcher at the University of Helsinki. She is an ERC Starting Grant (ERC-StG) holder.

Her research focuses on atmospheric new particle formation, trace gas chemistry, and advanced mass spectrometric measurements of atmospheric processes.

regions contradicts long-standing model assumptions and suggests that key chemical pathways are missing from current atmospheric models. Since different mercury species have distinct chemical lifetimes, solubilities, and photochemical behaviors, these findings have direct implications for predicting mercury transport, deposition, and ecosystem exposure.

In particular, the faster photolysis of $HgBr_2$ compared to $HgCl_2$ may imply enhanced recycling of mercury back to its elemental form, potentially increasing its atmospheric lifetime and long-range transport. This could significantly alter current estimates of mercury deposition patterns, especially in remote marine and polar environments.

Beyond mercury chemistry, this work demonstrates the power of advanced mass spectrometric techniques to resolve previously inaccessible atmospheric processes at the molecular level. The approach opens new opportunities for studying trace atmospheric species and refining our understanding of global biogeochemical cycles.

Reference

Jokinen, T., Gómez Martín, J.C., Feinberg, A., Mahajan, A. S., Plane, J.M.C., Ulises Acuña, A, Cuevas, C., Dávalos, J. Z., Quéléver, L. L. J, Laurila, T., Beck, I., Schmale, J., Junninen, H., Sipilä, M., Kulmala, M., Petäjä, T., & Saiz-Lopez, A. Direct observations of atmospheric oxidized mercury speciation in polar areas. *Nat Commun* **17**, 3160 (2026). https://doi.org/10.1038/s41467-026-71146-z

Contact details

Tuija Jokinen – t.jokinen@cyi.ac.cy