Mercury and ozone depletion events in the Arctic linked to sea-ice dynamics

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This is an aerial photo of sea ice leads and the clouds generated directly above a sea ice lead due to the large temperature differences between the water and air near Barrow, Alaska. Credit: Lars Kaleschke

This week a new study published in *Nature* and co-authored by Drs. Chris Moore and Daniel Obrist of Nevada's Desert Research Institute establishes, for the first time, a link between Arctic sea ice dynamics and the region's changing atmospheric chemistry potentially leading to increased amounts of mercury deposited to the Earth's northernmost and

most fragile ecosystems.

The opening and closing of sea ice leads (large cracks in the ice that expose warmer seawater to the cold polar atmosphere) create a pumping effect, explained Moore, an assistant research professor in DRI's atmospheric science division, that in turn causes atmospheric depletion events. These events are coupled with the destruction of ozone and ultimately the deposition of atmospheric mercury onto snow and ice, a portion of which can enter Arctic ecosystems during snowmelt.

"The atmospheric mixing created when thinner, seasonal sea ice opens to form leads is so strong," Moore said, "that it actually pulls down mercury from a higher layer of the atmosphere to near the surface."

Scientists have long known that complex chemical reactions involving sunlight deposit mercury out of the air to the surface, but these processes normally stop once the mercury near ground level is completely removed. The newly discovered mixing induced by sea ice leads forces down additional mercury to restart and sustain these reactions.

Moore and his colleagues, including researchers from NASA's Jet Propulsion Laboratory in Pasadena, Calif., measured increased concentrations of mercury near ground level after leads opened near Barrow, Alaska, in 2012 during the NASA-led Bromine, Ozone, and Mercury Experiment (BROMEX) field project. They also used images from the Moderate Resolution Imaging Spectroradiometer instrument on NASA's Terra satellite to observe sea ice and a National Oceanic and Atmospheric Administration model of air transport to gain insight into what was upwind of their mercury measurements.

This site on the frozen Arctic Ocean was visited twice daily and all data was retrieved. Credit: Alexandra Steffen

Obrist, also a research professor at DRI and co-leader of the Institute's Environmental Mercury Laboratory, said, "the 'aha' moment came when we combined satellite data with the air transport model and surface measurements. We considered a variety of chemical processes and sources to explain the increased levels of mercury we observed, until we finally realized it was this pumping process."

The authors estimate the mercury pumping occurs about a quarter-mile (400 meters) above the Arctic surface, the height where visible roiling clouds spewing out of sea ice leads extend.

Moore said while the initial findings support needed actions to curb mercury pollution across the globe, future research will be needed to establish the degree to which changes in sea ice dynamics across the

Arctic alter ozone chemistry and impact mercury deposition throughout the sensitive region.

More information: *Nature* paper: dx.doi.org/10.1038/nature12924
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