Upper atmosphere facilitates changes that let mercury enter food chain

December 18 2011

Humans pump thousands of tons of vapor from the metallic element mercury into the atmosphere each year, and it can remain suspended for long periods before being changed into a form that is easily removed from the atmosphere.

New research shows that the upper troposphere and lower stratosphere work to transform elemental mercury into oxidized mercury, which can easily be deposited into aquatic ecosystems and ultimately enter the food chain.

"The upper atmosphere is acting as a chemical reactor to make the mercury more able to be deposited to ecosystems," said Seth Lyman, who did the work as a research assistant professor in science and technology at the University of Washington Bothell.

Lyman, now with Utah State University's Energy Dynamics Laboratory, is lead author of a paper documenting the research published online Dec. 19 by the journal *Nature Geoscience*. Daniel Jaffe, a science and technology professor at UW Bothell, is coauthor of the paper. The work was supported by a grant from the National Science Foundation.

The findings come from data gathered during research flights in October and November 2010 over North America and Europe by a National Center for Atmospheric Research aircraft.

The campaign used a device built at UW Bothell that can detect both

elemental mercury and oxidized mercury in the same air sample, and the device recorded readings every 2.5 minutes. The flights typically are at altitudes of 19,000 to 23,000 feet, well below the confluence of the troposphere and the stratosphere, but several times during the 2010 flights – particularly on a trip from Bangor, Maine, to Broomfield, Colo. – the aircraft encountered streams of air that had descended from the stratosphere or from near it.

The result was the first time that the two mercury forms were measured together in a way that showed that elemental mercury is transformed into oxidized mercury, Lyman said, and evidence indicated the process occurs in the upper atmosphere.

Exactly how the oxidation takes place is not known with certainty but, once the transformation takes place, the oxidized mercury is quickly removed from the atmosphere, mostly through precipitation or air moving to the surface. After it settles to the surface, the oxidized mercury is transformed by bacteria into methyl mercury, a form that can be taken into the food chain and eventually can result in mercury-contaminated fish.

Some areas, such as the Southwest United States, appear to have specific climate conditions that allow them to receive more oxidized mercury from the upper atmosphere than other areas, Lyman noted.

He added that where the mercury settles to the surface can be thousands of miles from where it was emitted. For example, mercury from coal burning in Asia could rise into the atmosphere and circle the globe several times before it is oxidized, then could come to the surface anywhere. Understanding where it is oxidized and deposited would help efforts to predict ecosystem impacts of mercury emissions, he said.

"Much of emitted mercury is deposited far from its original sources,"

Lyman said. "Mercury emitted on the other side of the globe could be deposited right at our back door, depending on where and how it is transported, chemically transformed and deposited."

Provided by University of Washington