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Detection of atmospheric oxidized mercury at a mountain top site in Colorado, U.S.A.: Understanding origins and oxidation mechanisms

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Mercury is an environmental toxin that is emitted into the atmosphere as either elemental or oxidized mercury, through natural and anthropogenic sources. Once in the atmosphere, mercury readily undergoes oxidation and reduction, and is eventually deposited into ecosystems around the world via wet and dry deposition. This can have detrimental effects on wildlife and human health.

Uncertainty surrounds the mechanisms by which mercury is oxidized in the atmosphere, and it has been thought that reactive bromine may be the globally-dominant mercury oxidant. It has been shown that reactive bromine dominates in costal and marine air masses, however, its role in the continental free troposphere and planetary boundary layer remains unclear. There may in fact be multiple different oxidation pathways that occur in different regions of the atmosphere at different times.

Previous measurements of oxidized atmospheric mercury have been made with systems that utilize a KCl coated denuder. These measurements have been proven to be biased low due to conversion of oxidized mercury into elemental mercury in the denuder. New systems are needed to measure oxidized mercury with a greater degree of certainty, and to be able to understand the mechanisms by which mercury is oxidized in the atmosphere. We have developed a cation-exchange membrane-based dual-channel oxidized mercury measurement system that avoids the bias created by the KCl coated denuder.

We are deploying our system at Storm Peak Laboratory in Colorado, U.S.A. (a mountain top site where high levels of oxidized mercury have been previously observed in the free troposphere) during spring and summer 2021. The dual channel system will be deployed alongside a suite of chemical and meteorological instrumentation, including a MAX-DOAS for detecting halogens and other reactive gasses. This study will elucidate the origins of oxidized mercury at Storm Peak Laboratory and the oxidation pathways that lead to its formation in the continental atmosphere. We will present first results from this campaign, including a discussion of instrument performance with respect to calibration standards, a comparison of current and previous measurements of oxidized mercury (previous measurements used a KCl denuder), and observed associations between oxidized mercury and atmospheric constituents.