2002/2003 Results from the Barrow Arctic Mercury Study

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The Barrow Arctic Mercury Study (BAMS), ongoing since 1998, researches the dynamics and controls of atmospheric/snowpack mercury in the Barrow, Alaska, region. The project is centered at CMDL/Barrow. Our major reported finding is the rapid oxidation of gaseous elemental mercury (from long-range transport) by atomic bromine (from marine photolyzable bromine sources), and the subsequent mercury deposition to the springtime snowpack, where springtime mercury concentrations often exceed 200 ng L^{-1}. Here we report our findings for 2002 and 2003.

Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT; NOAA/ARL) airmass trajectory computations and polynya sizes and locations show that polynyas (large bodies of open water maintained by upwelling) cannot be the sole marine source of bromine that initiates mercury oxidation events. A much superior match for the distribution and timing of Br concentrations and mercury oxidation events was obtained from airmass trajectories originating from locations of forming/refreezing leads.

During the springtime, falling snow and blowing snow efficiently scrub oxidized mercury from the near-surface air. Blowing snow typically contained higher mercury concentrations than the stationary snowpack. Similarly, falling snow during mercury oxidation events was found to be mercury enriched.

In 2002, a gradient flux system for gaseous elemental mercury was installed. The results show that mercury-enriched soil and vegetation emitted elemental gaseous mercury at an average rate of 0.65 ng m^{-2} h^{-1} during the dark winter. During the springtime, after mercury oxidation/deposition events, the enriched surface snow emitted elemental mercury without melt. During annual melt, approximately 50% of the total collected mercury in the snowpack was emitted as gaseous elemental mercury, with the flux rate strongly correlated to the melt rate. However, flux measurements and manipulation studies indicate that the total elemental gaseous mercury emitted at annual melt snow is independent of the rate of melt.

The gas/particle partitioning of oxidized mercury in the near-surface air remains unanswered. Side-by-side manipulation studies of current sensors indicate that the collection efficiency of reactive gaseous mercury denuder/particulate tube combinations is strongly dependent on slight changes in inlet temperatures. Higher inlet temperatures collect more mercury as gas, less as particulate, and vice versa. In all cases total oxidized mercury (gas + particulate) remains constant.

Atmospheric mercury dynamics and oxidation have been found to be homogeneous over the scale of kilometers in the Barrow region. A set of duplicate measurements at ICEX03 (in the Beaufort Sea) during March/April 2003 is expected to extend these measurements to the sea ice ~150 km upwind (NE) of Barrow.

A major international mercury study at Barrow is being planned for spring 2004.