Mercury Depletion, Deposition, and Re-emission in Snowpack over the Arctic Tundra and Ocean

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In a recent publication we showed atmospheric cycling of gaseous elemental mercury (GEM) and ozone in Barrow, Alaska, was directly impacted by the presence of sea ice leads through initiation of shallow atmospheric convection. The convection mixed mercury (Hg) and ozone into the depleted atmospheric surface layer where it has the potential to reinvigorate mercury depletion chemistry and promote conversion and subsequent deposition of Hg. In this presentation we show corresponding surface-atmosphere exchange fluxes of Hg and snow Hg levels. Measurements were taken during the Bromine, Ozone, and Mercury Experiment (BROMEX) in Barrow, Alaska in March/April 2012. During the campaign we established two measurement sites, one 2 km out on the frozen Chukchi Sea and one 5 km inland over tundra. Atmospheric Hg speciation, measured and modeled deposition (based on wet deposition sampling and speciation measurement), and surface snow Hg and ion concentrations were determined at both sites, and net surface-atmosphere GEM fluxes were measured over the frozen sea ice site using micrometeorological techniques. Net exchange fluxes of GEM were unrelated to surface snow Hg contents and showed both emissions and depositions; low atmospheric concentrations of GEM favored GEM emission and high GEM concentrations favored deposition. Temporal patterns of atmospheric GEM concentrations at the sea ice and tundra site tracked each other well, but the tundra site showed higher midday GEM concentrations possibly related to higher surface re-emission from snow. We also observed significant differences in snow chemistry: higher Hg levels, dominated by soluble Hg, were found in snow with higher ionic strength over the sea ice as compared to the inland site. These patterns show a complex interplay of mercury depletion events, surface-atmosphere exchange, and snow chemistry in Arctic environments.