Geophysical Research Abstracts
Vol. 21, EGU2019-4635, 2019
EGU General Assembly 2019

Tracking mercury from the snowpack through spring melt in a high Arctic watershed near Utqiaġvik, Alaska

Thomas Douglas (1) and Joel Blum (2)

(1) Cold Regions Research and Engineering Laboratory, Biogeochemical Sciences, Fort Wainwright, United States (thomas.a.douglas@usace.army.mil), (2) Department of Earth & Environmental Sciences, University of Michigan, Ann Arbor Michigan, United States

Mercury (Hg) is a bioaccumulative toxin that has been found at high concentrations in snow and ice at Arctic coastal locations. It is likely that atmospheric deposition is the source of this elevated Hg but the ultimate fate of snowpack Hg is largely unknown. To investigate this, we measured mercury (Hg) and major ion concentrations and Hg stable isotope ratios of snowpack and melt water through spring melt runoff for two years at a site near Utqiaġvik (formerly Barrow), Alaska. We also collected peat and permafrost sediment cores for Hg concentration and Hg stable isotope measurements. The field site is a small (2.5 ha) watershed on the Arctic coastal plain. The area is known to be exposed to Arctic Mercury Depletion Events (AMDEs) with Hg concentrations in snow and sea ice sometimes approaching 1,000 ng/L. AMDEs are unique high Arctic atmospheric events in which reactive halogens in air, snow, and sea ice facilitate oxidation of atmospheric Hg and deposition to the snowpack.
In late winter prior to snow melt (April) and during snowmelt runoff (May and June) in 2008 and 2009, we made more than 10,000 snow depth measurements and 80 snowpack water equivalent measurements in the watershed. Snowpack, meltwater, and runoff from a small stream were sampled and analyzed for total dissolved Hg, major ions, and stable oxygen and hydrogen isotopes. Airborne LiDAR and and high resolution GPS surveys allowed delineation of the watershed area.
Based on our variety of samples we identified an “ionic pulse” of mercury and major ions in snowmelt runoff during both seasons. Total dissolved Hg in runoff was 14.3 (+/- 0.7) mg/ha in 2008 and 8.1 (+/- 0.4) mg/ha in 2009. This is five to seven times higher than what has been reported from lower latitudes. We calculate 78% of snowpack Hg was exported with snowmelt runoff in 2008 and 41% in 2009. Hg stable isotope measurements indicate the majority of Hg in snow melt originated as gaseous elemental mercury (Hg(0)) and was likely oxidized in the snowpack by reactive halogens. ∼75% of the Hg exported from our watershed in snow melt came from non-AMDE sources while we attribute ∼25% to AMDEs.
Our Hg stable isotope analyses indicate Hg was deposited directly to the snowpack as GEM (Hg(0)) and converted to Hg(II) in the snowpack by reactive halogens. We surmise the halogen rich snowpack facilitated oxidation and retention of gaseous elemental Hg. This Hg comprises the majority of the mercury that remains until snowmelt and discharged into surface meltwaters of our Arctic coastal ecosystem. Projected future warming in the Arctic will produce an increasingly dynamic sea ice regime with more first year ice and open sea ice leads. This will likely enhance the source of reactive halogens, promote GEM oxidation, and lead to greater Hg deposition to coastal and marine snowpacks.