

Session B6: Source, Fate and Transport of Mercury

Room C120-122

1:30 – 3:00 pm

0042

B6-1

Modeling Mercury Exposure at Different Scales in the McTier Creek watershed and Edisto River Basin, S.C., USA

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Mercury is the toxicant responsible for the largest number of fish advisories across the United States, with 1.25 million miles of rivers under advisory. The processes governing fate, transport, and transformation of mercury in lotic ecosystems are not well-understood, in large part because these systems are intimately linked with their surrounding watersheds. To understand the mercury exposure concentrations within streams and rivers, mercury fate and transport within the watershed must be understood and linked to the in-stream fate and transport processes. However, current advancements in the science of watershed Hg processing typically develop at distinct spatial scales and lack an understanding of linkages between Hg fate and transport processes among a variety of system sizes. This presentation serves to model the fate and transport of mercury at three different scales: a focused reach study (0.11 km²), a watershed scale (79 km²) and a basin scale (7,071 km²). These three systems were represented by linking a watershed hydrology and biogeochemical cycling (Hg, N and C) model (VELMA, Visualizing Ecosystems for Land Management Assessment) with a surface water mercury fate and transport model (WASP 7, Water Quality analysis Simulation Program). Both the watershed and water body models simulate three mercury species (Hg(0), Hg(II), and MeHg) and hydrology. The focused reach study used VELMA to parameterize and understand the processes governing Hg fate and transport, tracking mercury deposition and precipitation on the land surface, Hg transformation reactions and loss processes, and subsequent transport to the receiving stream. The process understanding and parameterization of the focus study were then applied at the watershed-scale to understand and represent mercury fate and transport by modeling individual sub-watersheds and linking them using WASP 7. This work was then further expanded to simulate mercury fate and transport at the basin scale, where state and national management strategies, such as TMDLs and emissions regulations, are applied.

0113

B6-2

Temporal and Spatial Variability of Mercury, pH, and Non-Sea Salt Sulfate Fluxes Associated with Changes in Anthropogenic Emissions in the Pensacola Bay Region

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Anthropogenic sulfur dioxide, nitrogen oxides and mercury emissions can lead to enhanced atmospheric deposition of these constituents and associated negative environmental impacts. During the past two years, local industries have completed multiple environmental projects that aim to reduce the emissions of chlorides, mercury, and sulfur to the environment. Examples of these projects include the installation of a flue gas Desulfurization System by a coal-fired power plant, Plant Crist. However, previous research indicates that sources of mercury are not necessary local and may originate from regional or global activities. During the past two years, four collectors spatially distributed across the Pensacola bay have collected event based wet deposition to evaluate if there are statistical significant spatial and temporal variations in mercury deposition, pH, and non-sea salt sulfate depositions associated with changes in rain patterns and gas emissions by local industries. Our analyses indicated that there are statistical significant differences in the pH of wet samples collected in summer and winter compared with samples collected in spring and fall. We examined the effect of near regional sources (*i.e.*, nearby coal power plants, cement plants, ocean) and their effect on rainwater pH, major ions, and mercury deposition. We compared our results with nearby sites in the Mercury Deposition Network and National Atmospheric Deposition Program.

0454
B6-3

The Importance of Dry Gas-Phase Mercury Deposition to Aquatic Ecosystems

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While it has been long recognized that atmospheric mercury (Hg) dry-gas deposition occurs, the relative difficulty of measuring and estimating dry-gas flux (compared to wet deposition measurements) has impeded our ability to understand its relative importance at large scales. In addition, in the limited number of studies where both dry and wet fluxes have been measured, a question has remained as to the ecological significance of dry-gas deposited Hg.

The USGS has recently concluded two large scale assessments of dry-gas Hg deposition across the eastern US using two distinctly different approaches: (1) a nine site study of dry Hg deposition based direct atmospheric Hg measurements and modeled deposition velocities; and, (2) a 23 site study of Hg flux from litterfall. The results of these two studies reveal dry/wet deposition ratios of 0.8 versus 1.3 for the modeled and litterfall results, respectively. At the two sites where the studies overlapped the estimated dry Hg deposition rates were comparable, although the litterfall-based estimates are somewhat larger (9.3 vs. 7.6 $\mu\text{g}/\text{m}^2$ at Cape Romain National Wildlife Refuge, SC; and, 7.8 vs. 6.0 $\mu\text{g}/\text{m}^2$ at Shenandoah National Park, VA). The concurrence of these studies underscores the importance of dry-gas Hg flux to the environment.

Although dry-gas Hg flux is clearly important, few studies have attempted to assess its environmental importance, especially whether it is tied to the formation of methylmercury. Most Hg researchers agree that only “dissolved Hg” is available for methylation. To assess whether dry-gas Hg solubilizes in natural waters, we collected atmospheric particulate matter (PM) along the Mississippi Gulf Coast in coarse and fine (< 2.5 μm) fractions, for two thirty-hour intervals. PM-bearing filters were incubated for periods ranging from 1 to 168 hours in aliquots of two local “end member” surface waters: estuarine (approx. 70% marine) and acidic, high-DOC river waters. For both the fine and coarse size fractions, Hg leached more readily in river versus estuarine water. When the solubilization results are coupled with deposition velocities, the results indicate large (> 10 μm) aerosols are the more important dry-gas Hg source, contributing twice as much Hg as all other size fractions combined.

0467
B6-4

Mercury in Atmospheric Deposition, Sediment Cores, and Fish on the East and West Coasts of North America, and in the Southern Hemisphere: Effects of Regional and Global Atmospheric Emissions

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Mercury deposition at 3 precipitation-monitoring sites, and mercury concentrations in 10 age-dated sediment cores, and in 170 fish were compared for pristine, low-conductance lakes on the east and west coasts of North America: dune lakes of coastal Oregon and drainage lakes of the Olympic Peninsula, Washington; and kettle lakes of Cape Cod National Seashore, Massachusetts, during 2006-2007, to assess relative impacts of regional emission sources. Regional mercury emission sources are few, distant, and downwind on the west coast, but upwind sources are abundant for Cape Cod, although none are known within 65 km of the Cape Cod lakes that were investigated. Mercury wet deposition rates and mercury accumulation rates in cores were similar on the two coasts: in wet deposition, 5.5-6.5 $\mu\text{g}/\text{m}^2/\text{yr}$ on the west coast, 5.2-6.3 $\mu\text{g}/\text{m}^2/\text{yr}$ on the east coast; in cores, 35-63 $\mu\text{g}/\text{m}^2/\text{yr}$ on the west coast, 55-70 $\mu\text{g}/\text{m}^2/\text{yr}$ on the east coast. Absolute concentrations of mercury in filets of largemouth bass and yellow perch were higher on Cape Cod (0.27-3.0 $\mu\text{g}/\text{g}$ ww) than on the west coast (0.10-2.5 $\mu\text{g}/\text{g}$ ww), but when normalized for fish size and lake pH, fish mercury concentrations were nearly equal. Results support a hypothesis that global, not regional, sources dominate accumulation at the study sites on both coasts. The hypothesis is tested by literature investigation of mercury concentrations in fish from low-conductance lakes in the Southern Hemisphere, where total gaseous mercury concentrations are approximately 30 percent lower than in the Northern Hemisphere. In Patos Lagoon, Brazil; Lake Malawi; and Lake Okarekea and Lake Okaro, New Zealand, mercury concentrations in piscivorous fish range from 0.02 to 0.2 $\mu\text{g}/\text{g}$ ww. Increased investigation is warranted to assess the possibility that 30 percent difference in atmospheric mercury concentration between the Northern and Southern Hemispheres can cause 10- to 100-fold difference in mercury concentration in fish tissue.