Using high-frequency in-situ optical sensors to understand seasonal and event-driven variability in mercury transport and transformations in a heavily contaminated creek

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Historic activity within the Y-12 National Security Complex (Y-12 NSC) resulted in the release of large amounts (peak of 30,000 kg/year) of Hg into East Fork Poplar Creek (EFPC) in Oak Ridge, TN and subsequently into the adjacent floodplain sediments during high-flow events. Currently, EFPC receives inorganic Hg directly from a pipe outfall at its headwaters in the Y-12 NSC, though at considerably lower levels (2-3 kg/year). Recent characterization of creek water during baseflow conditions identified a downstream pattern of decreasing inorganic Hg and increasing methylmercury (MeHg) concentrations, with the source and controls on mercury methylation currently being examined. In March 2012, in-situ sensors to measure turbidity, fluorescing chromophoric dissolved organic matter (FDOM) and other basic water quality parameters were installed at a field site ~21 km downstream from creek headwaters. Sonde data are being coupled with monthly seasonal and high-frequency storm sampling to investigate relationships between optical parameters, particulate and dissolved organic carbon and Hg and MeHg concentrations. Capturing variability in these parameters with changes in hydrologic connectivity between the creek and surrounding floodplains, which contain contaminated sediments, may help elucidate origins of MeHg contributions to the stream.

A storm event sampled bi-hourly on March 24, 2012 (discharge increased from 70 to 900 cfs) demonstrated order of magnitude increases in particulate Hg (from ~30 to ~ 5,000 ng/L) and MeHg (from ~0.2 to ~4 ng/L) and both had strong correlations with particulate organic carbon (r^2 = 0.99 and 0.97, respectively). Turbidity also had strong correlations with the particulate fractions of Hg and MeHg during the event, showing promise for its use as a viable proxy during high-flow periods when Hg concentrations are not measured. Dissolved Hg concentrations also increased during the event, though not as dramatically (from ~8 to 45 ng/L) and were significantly correlated with DOC (r^2= 0.74). Unlike DOC, dissolved MeHg did not increase during the event, but remained stable. Preliminary comparisons of seasonal patterns of dissolved and particulate Hg with FDOM and turbidity will also be addressed within this presentation.