FIU | Applied Research Center
FLORIDA INTERNATIONAL UNIVERSITY

U.S. DEPARTMENT OF ENERGY

FIU PROJECT 3 - 2012 FACT SHEET

Parameterization of Major Transport Processes of Mercury Species

FIU's Applied Research Center (ARC) is experimentally investigating the biogeochemical processes of mercury complexes in the laboratory. The effect of various biogeochemical factors on the rate of methylation/demethylation is being studied. In particular, the research is focused on the involvement of nutrients, organics, and inorganic species (including sulfur) in the fate, transport, and transformation of mercury species.

Laboratory incubation experiments are in progress to study critical mercury (Hg) transport, transformation, and exchange processes (i.e., methylation/demethylation (M&D), and dissolution) to be used in the numerical flow, transport and chemical reaction model developed for the watersheds surrounding the Oak Ridge Reservation (ORR), TN. Laboratory experimental work provides insight on parameters relevant to ORR and which are required in the numerical model, such as dissolution rate of mercury and the proportion of mercury species available for methylation/demethylation in sediments. In addition, experimental work will be conducted to analyze the effect of significant environmental factors (pH, Eh, sunlight) on the major transport and transformation processes of Hg.

Project Objectives

- Systematic investigation of the stability, bioavailability, and mobility of aged Hg species in soils and sediments. The proportion of Hg species available for M&D in sediments will be estimated by using isotope addition techniques.
- Investigation of the dissolution of cinnabar and Hg bead, which have often been observed at this site and are thought to be recalcitrant mercury species, by using both experimental and theoretical calculation methods.
- Investigation of 3 factors including oxidation-reduction, pH, and complexation with organic ligands (e.g., low molecular weight thiols such as cysteine and glutathione and large molecular NOM), for their role in mobilizing aged Hg species.

Project Benefits

- These studies will provide a better understanding of the bioavailability and dissolution of aged Hg species in soils and sediments.
- Assists in calibration as well as sensitivity and uncertainty analyses of numerical models, and verification of numerical results.

Project Accomplishments

- Acquired experimental kinetic and equilibrium data about important parameters related to Hg transport, speciation and methylation/demethylation kinetics in EFPC watershed.
- Assisted in calibration and sensitivity analysis of the numerical model developed for the different ORR watersheds (LEFPC, UEFPC, and WOC), by determining acceptable ranges of values for some of the effective parameters (i.e., partition coefficients and desorption rates) in the sedimentation and water quality modules.

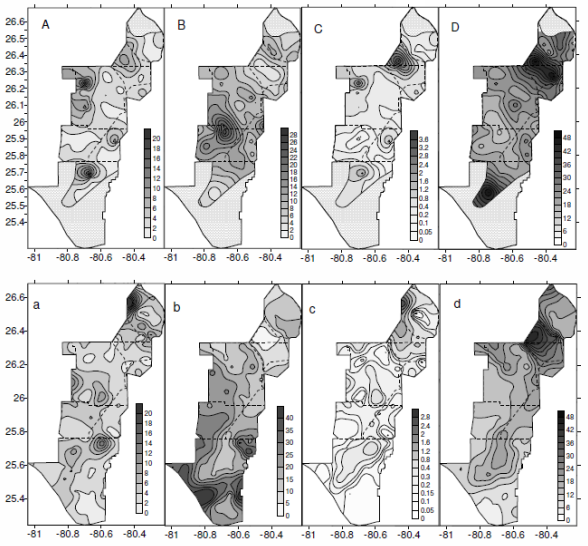

Figure 1. (A,a) Spatial patterns of MeHg photo-degradation rate (ng $m^{-2}d^{-1}$), (B,b) MeHg photo-degradation potential $\times 10^3$ (md^{-1}), (C,c) Aqueous MeHg concentration (ng L^{-1}), (D,d) DOC concentration (mg L^{-1}) in the dry (A,B,C,D) and wet (a,b,c,d) seasons.

- Published several scientific articles in peer-reviewed journals from the experimental results, including:
  - "Progress in the study of mercury methylation and demethylation in aquatic environments," Chinese Science Bulletin, Fall 2012,.
  - "Estimation of the Major Source and Sink of Methylmercury in the Florida Everglades," Environmental Science and Technology Journal online, April 26, 2012 (DOI: 10.1021/es204410x).
  - "Degradation of Methylmercury and Its Effects on Mercury Distribution and Cycling in the Florida Everglades," Environmental Science and Technology Journal, November 2010.
  - "Spatial Variability in Mercury Cycling and Relevant Biogeochemical Controls in the Florida Everglades," Environmental Science and Technology Journal, May 2009.

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