Modeling mercury, carbon and sulfur dynamics and biogeochemistry in the Florida Everglades

WILLIAM OREM[1]*, DAVID KRABBENHOFT[2] AND GEORGE AIKEN[3]

[1]U.S. Geological Survey, Reston, VA, USA
[2]U.S. Geological Survey, Middleton, WI, USA
[3]U.S. Geological Survey Boulder, CO, USA

Despite concerted efforts at mitigation over the past two decades, mercury (Hg) remains a pronounced environmental problem for the Florida Everglades and its ecosystem restoration effort. This is because of the multiple factors contributing to the formation and bioaccumulation of methylmercury (MeHg), the major form of Hg of concern to environmental health. High loading of inorganic mercury (from atmospheric deposition) and sulfate (from surface runoff) are the principal drivers of MeHg formation, while DOC plays a key role in solubilizing and enhancing the bioavailability of inorganic mercury, and in the transport of MeHg.

Restoration of the Everglades will require changes in flow path, and possible additional loading of sulfate from aquifer storage and recovery. These changes will likely alter the dynamics of MeHg production in the ecosystem. It is essential for resource managers to understand how these changes will impact sensitive areas such as Everglades National Park (ENP), where many species are vulnerable to toxic impacts from MeHg exposure. Our group has developed models to predict how restoration will change the magnitude of sulfate loading, and the areas of the ecosystem most sensitive to MeHg formation from these changes in sulfate loading. Model output includes estimates for the loading, the flow paths for sulfate and DOC, rates of sulfate removal as flow moves across the marshes (calculated removal rate ranging from 1 to 4 mg/L - km), and complex biogeochemistry involving interactions among different forms of mercury, sulfur and DOC. Our results suggest that sheet flow of surface water across the Water Conservation Areas upstream of ENP may remove enough sulfate to mitigate the impact of MeHg production in ENP. Delivery of sulfate laden water to ENP in canal flows results in much greater loading of sulfate and subsequent production of MeHg in ENP that would circumvent modeled sulfate uptake by sheet flow across marshes.