Innovative Optical Methods for Characterization of Chemical Dynamics

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Understanding Contaminant Dynamics with **OPTICS**

CHALLENGE

The **dynamic nature of rivers and estuaries** presents a challenge to understanding the processes that drive contaminant transport and lead to human and ecological exposure.

SOLUTION

OPTically based In-situ Characterization System (OPTICS) supports characterization of contaminant concentrations in the context of biophysical processes at **unprecedented temporal resolution** to enable an understanding of contaminant dynamics that cannot be achieved through conventional monitoring approaches.

What Is **OPTICS?**

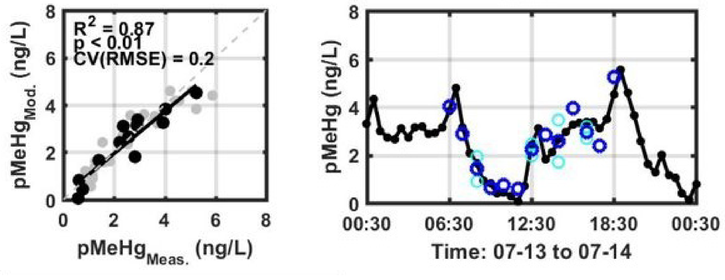
OPTICS uses a suite of *in situ*, autonomous sensors to provide high temporal resolution observations as input to a regression model calibrated and validated to discrete water samples.

Result: A predictive model to estimate contaminant concentrations at high temporal resolution over an extended period

Optical Data

Modeling

Calibration Data



Example of OPTICS regression model calibration

Case Study: Berry's Creek Study Area

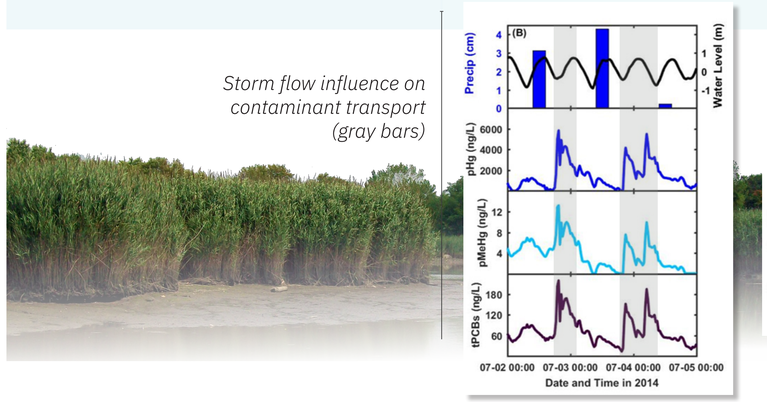
OVERVIEW

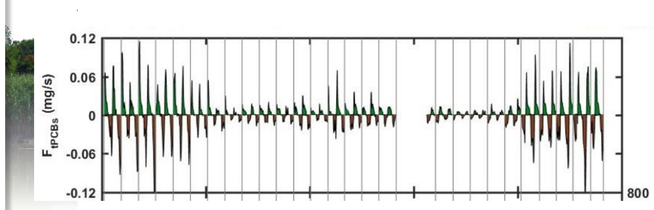
- 1,029 acres of waterways and marshes
- Mercury, PCBs, and other contaminants present

APPROACH

- **OPTICS** instrumentation deployed at multiple locations to quantify contaminant concentrations

Storm flow influence on contaminant transport (gray bars)





Calculated mass flux into (green) and out of (brown) a Berry's Creek Study Area marsh showing net transport into the marsh

FINDINGS

- Particulate resuspension at peak tidal velocities and deposition at slack tide
- Significant resuspension during storm events
- Net mass flux of particulates and particulate-bound contaminants from waterways to the marshes, where they are accumulated
- Key line of evidence supporting an adaptive management remedy

Case Study: South River, Virginia

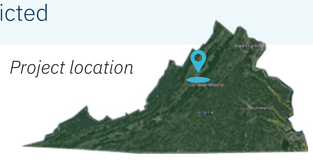
OVERVIEW

- Mercury from rayon production impacted the river in Virginia
- Natural recovery and monitoring recommended in 1980s, but fish tissue mercury is not declining as predicted

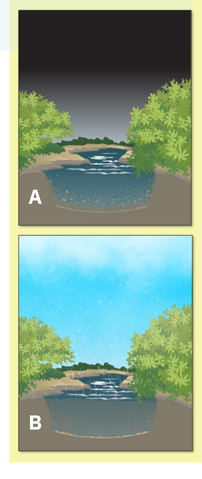
APPROACH

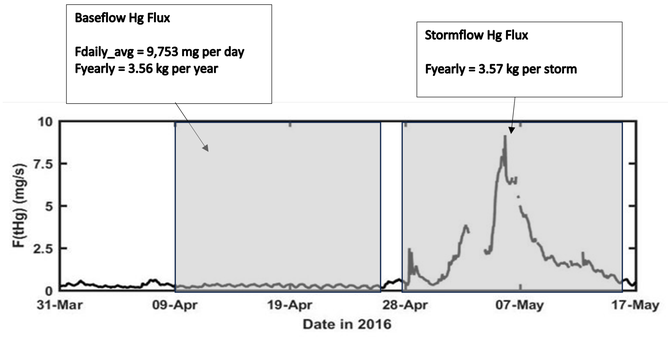
- **OPTICS** monitoring performed to characterize mercury and methylmercury transport under base flow and freshet conditions

Project location



Conceptual site model for South River showing sediment resuspension A) at night and B) during storm events





Total mercury flux under baseflow conditions and storm flow conditions

FINDINGS

- **Storm flow conditions:** Increase in particulate phase concentrations, consistent with sediment resuspension and bank erosion processes
- **Base flow conditions:** Particulate resuspension due to diel cycling, consistent with nocturnal bioturbation processes
- Mercury and methylmercury mass mobilized annually by diel cycling is nearly equivalent to that mobilized by the freshet

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