Session C3: Emerging Technologies and Techniques in Real-time Monitoring

Room B117-119
3:30 – 5:00 pm

0525
C3-1

Dissolved Organic Matter as a Proxy for Mercury in Aquatic Ecosystems

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A number of biogeochemical processes that influence the fate, bioavailability, and transport of mercury (Hg) in aquatic ecosystems are mediated by interactions with dissolved organic matter (DOM). In field studies of rivers and streams across a range of watershed types, we have almost universally observed strong linear correlations between DOM and total dissolved Hg concentrations. Further, relationships between dissolved total Hg concentration and hydrophobic organic acid (HPOA) content (aquatic humic substances) were stronger than those observed between Hg and DOM, suggesting that the HPOA fraction drives the transport of Hg in aquatic ecosystems. The relationships between methylmercury (MeHg) and DOM and HPOA content were often significant, but not as strong as those observed with Hg. In these ecosystems, DOM optical properties (UV absorbance and fluorescence) also correlated strongly with DOM, HPOA content, MeHg, and Hg concentrations. These observations suggest that optical properties of DOM, such as UV absorbance and fluorescence, may be useful as proxies for DOM, HPOA and Hg concentrations within a given system. DOM optical measurements are relatively inexpensive to obtain, can be designed into *in situ* monitoring devices (*e.g.*, fluorometers) and, when combined with discharge data, can be used to tighten estimates of both DOM and Hg flux in streams, rivers, and estuaries. In turn, data related to flux and DOM composition can facilitate our understanding of Hg dynamics in complex environments. For instance, we recently determined significant relationships between fluorescing DOM (FDOM) and DOC ($r^2 = 0.99$), filtered total Hg ($r^2 = 0.82$), and filtered MeHg ($r^2 = 0.90$) in waters draining tidal mangroves to the Shark River in Everglades National Park. These relationships combined with continuous FDOM and discharge measurements indicate that export of both Hg and MeHg from these mangroves to the Shark River and nearby coastal waters is 5 to 100 times greater than values for non-tidal wetlands.

0153
C3-2

What Can We Learn from Continuous Measurements of Water Quality in Large Rivers?

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Determining the annual loads of key constituents from large rivers of the United States to coastal waters has been a primary research priority for the USGS and others. However, developing a clear understanding of the dominant processes affecting water quality in these large basins is difficult owing to the myriad effects of land use, climate and water management that occur over large spatial areas. Presently, much of our understanding of water quality in large rivers relies on monthly or bimonthly sample collection. The recent advent of commercially available *in situ* optical sensors and data platforms - together with new techniques for data analysis - provides the opportunity to monitor water quality over time scales at which real-world processes and changes occur. But is there a need for higher resolution (*e.g*., continuous) water quality data in large rivers or are traditional approaches adequate for capturing processes and loads?

Here we present results from continuous water quality monitoring in large rivers across the Unites States as part of the USGS Climate Effects Network and a National Water Quality Assessment (NAWQA) pilot study. In particular, optical sensors for continuous measurements of chromophoric dissolved organic matter fluorescence (FDOM) and nitrate by UV absorption were used to evaluate the timing and magnitude of dissolved organic carbon and nitrate transport. Results from our study show that FDOM dynamics are coupled with runoff, but with seasonal variability in the magnitude of FDOM response (relative to discharge) due to factors such as water residence times, reservoir releases, and connectivity to organic matter-rich riparian floodplains and wetlands. In additional, storm events and diel cycling in large rivers resulted in FDOM and nitrate variability that is not captured by traditional discrete monitoring approaches. The implications of higher resolution data collection for concentration and load estimations will be discussed, as well as the potential role for optical sensors in monitoring, assessment and decision-making in large river basins.

0276
C3-3

Use of Real-Time Data to Monitor the Biogeochemistry and Plankton Ecology of the Lower Columbia River

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This study examined the biogeochemistry and plankton ecology of the lower Columbia River during 2009-2011 at a sampling location equipped with *in situ* autonomous sensors that were designed to provide high temporal resolution water quality data. Since June 2009, near real-time hourly data was acquired from three sensors (Water Quality Monitor, SUNA, and CDOM Fluorometer) that measured conductivity, temperature, dissolved oxygen, turbidity, Colored Dissolved Organic Matter (CDOM), chlorophyll fluorescence, and nitrate. In addition, monthly samples were obtained to quality control chlorophyll and nitrate concentrations and to collect data for dissolved nutrients and phytoplankton/zooplankton abundance and species composition. During the two year operation, clear seasonal cycles were seen in most biogeochemical parameters. Turbidity, nitrate, and CDOM concentrations were lowest during summer, highest in winter, and often coincident with episodic storm events that corresponded to increased contribution of the Willamette River to overall river discharge. Chlorophyll peaked multiple times in spring and summer and displayed a high correlation with nutrient drawdown that demonstrated the important role for phytoplankton in the river ecosystem. Our data show two spring phytoplankton blooms composed dominantly of *Asterionella formosa* and a smaller summer/fall bloom composed dominantly of chain forming centric diatoms reoccurred in 2010 and 2011. River discharge throughout 2011 was much higher than in 2010 and was reflected in the lower level of peak *in situ* chlorophyll and cell counts of large diatoms in May 2011 (3 µg/L, 4000 cells/ml) versus May 2010 (15 µg/L, 6500 cells/ml). *In situ* monitoring of chlorophyll concentrations has allowed for adaptive sampling in order to track annual seasonal succession of diatom species from the spring to fall and to quantify algal loss mechanisms (grazing, lethal parasitism). From this high resolution dataset, phytoplankton seasonal dynamics supports previous research that suggests increased water retention time and decreased turbidity due to dams has “greened” the Columbia River and may represent an important source of organic matter throughout the ecosystem.

0094
C3-4

The Complexities of High-Level Turbidity Measurement – How to Select the Technology to Meet Your Monitoring Needs

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Turbidity is a commonly measured parameter that can serve as a primary assessment of water quality or as a surrogate for numerous other parameters[1]. At a glance, turbidity can appear to be a simplistic measurement, but as the level of turbidity increases the complexity of analysis significantly increases. The interaction between the inherent characteristics within the sample, environmental affects and the technology used can significantly impact the measurement. For example, characteristics such as sample color, particle density, and particle size distribution combined with the wavelength of light source, detection angle, measurement pathlength, and overall optical geometry of the technology all combine to impact the sensitivity of the measurement.

The goals of this presentation will be to analyze this complex interaction between noted sample characteristics and their interaction with features from the different turbidity measurement technologies. These technologies can then be evaluated at a basic level to provide guidance on how to assess which technology will best align to meet the goals of a turbidity monitoring application. This not only covers the sample-instrument interaction, but also looks at how turbidity standards and reference instrumentation best serve the needed roles of field calibration and/or verification for these different turbidity technologies. Data that was collected from previous high-level round-robin studies will be used to help explain the differences in measurement[2].

To achieve these goals, the following objectives will be discussed. The first is to provide an overview of turbidity and its use in assessing water quality. Second is to provide a review of the different available technologies used for high-level monitoring and how they are impacted by noted sample interferences. The third objective is to understand how to reduce the impact of sample interferences through informed technology selection. Once an analyst understands how the different technologies actually measure a sample and address its identified interferences, simple pre-screening tests can be run to help select a technology that will best serve the monitoring goals of the application.

1. Rasmussen, P.P., J.R. Gray, G.D. Glysson and A.C. Ziegler. 2009. Guidelines and procedures for computing

time-series suspended-sediment concentrations and loads from in-stream turbidity-sensor and streamflow data: U.S. Geological Survey Techniques and Methods book 3, chap. C4, U. S. Geological Survey, Reston Va. P. 1-35.

2. Sadar, M. J., et al. 2007. “A Round Robin Study of High-Level Static Turbidity Measurements.” Standardization News, May 2007.