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Applications of optical sensors for high frequency water quality monitoring and research in rivers and streams

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U.S. Department of the Interior
U.S. Geological Survey

Optical sensor presentations

TUESDAY

D3: Continuous Monitoring: Innovations in Applications and Instrumentation

E5: Nutrient Monitoring and Modeling to Restore and Protect Freshwaters

WEDNESDAY

G5: Quantifying the Source and Fate of Nutrients

I2: Assessing the Effects of Prolonged Drought and Wildfires on Water Quality and Habitat

I3: Megadata – Working with Continuous Time-Series Water Quality Data

THURSDAY

L6: Spatial and Temporal Approaches for Monitoring

M8: Dissolved Organic Matter – What, Why, How

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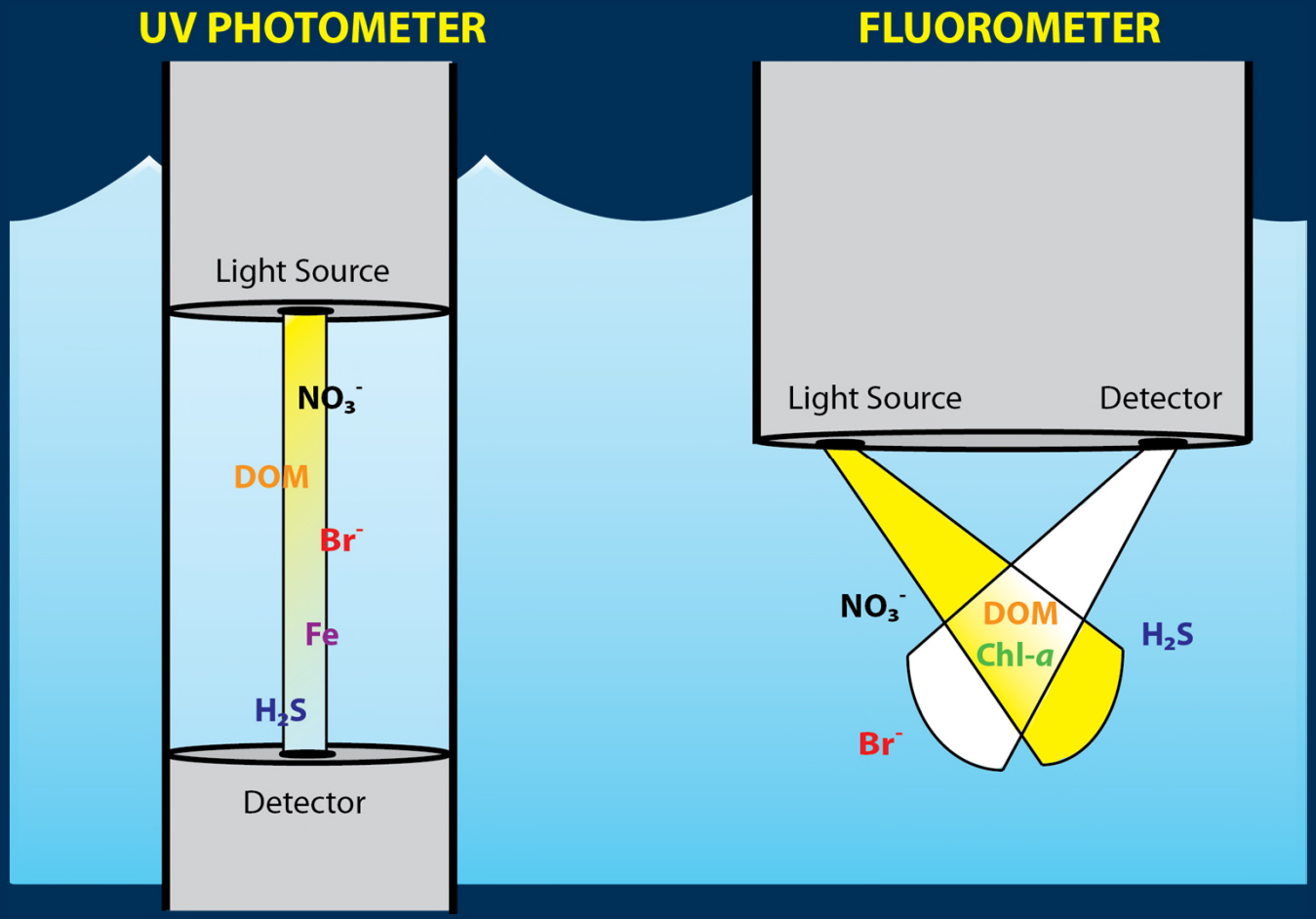
Optical sensors

- Measure the interaction between light and optically-active constituents in water
- **Photometers** mainly sold as UV nitrate analyzers (Hach, Satlantic, s::can, TriOS)
- **Fluorometers** mainly sold for algal pigments, fluorescent DOM (FDOM), oils, fuels, etc.



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Benefits

- 24/7 data collection
- Time dense data
- Real-time opportunities
- Wide range of constituents
- Remote access
- No wet chemistry
- Few moving parts
- Highly sensitive

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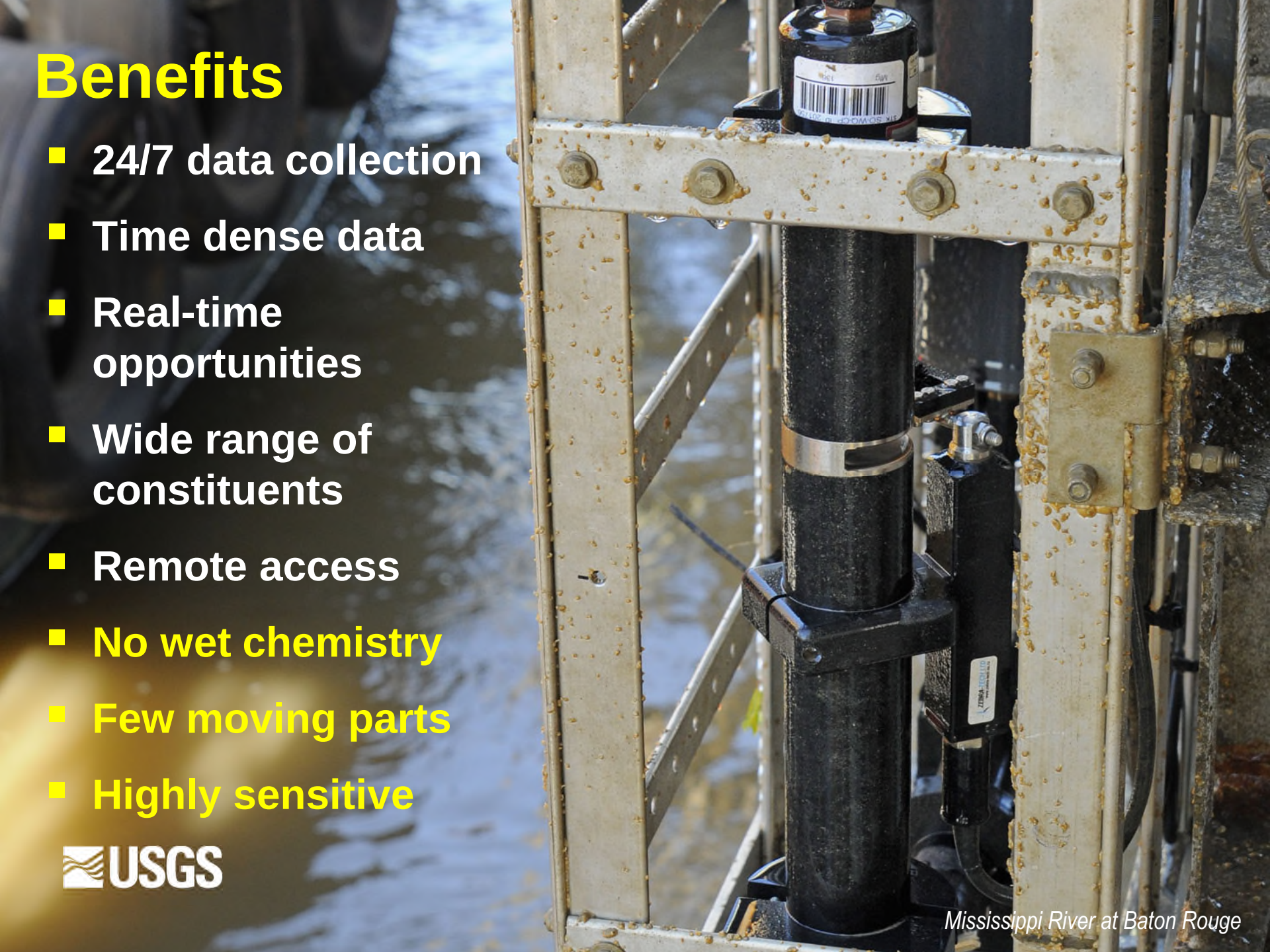

Mississippi River at Baton Rouge

“You can observe a lot just by watching”

- Yogi Berra

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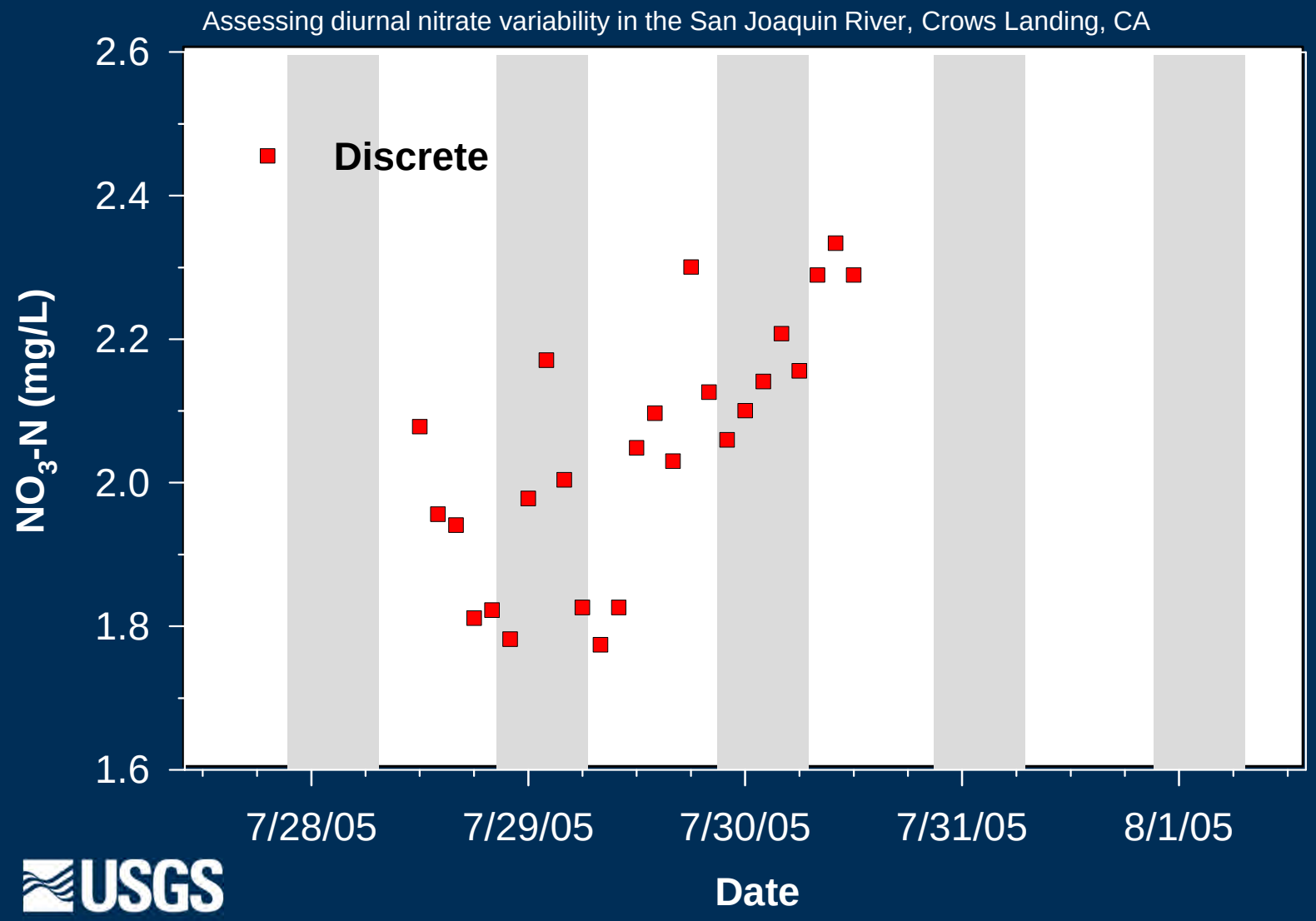

Pellerin et al., 2009

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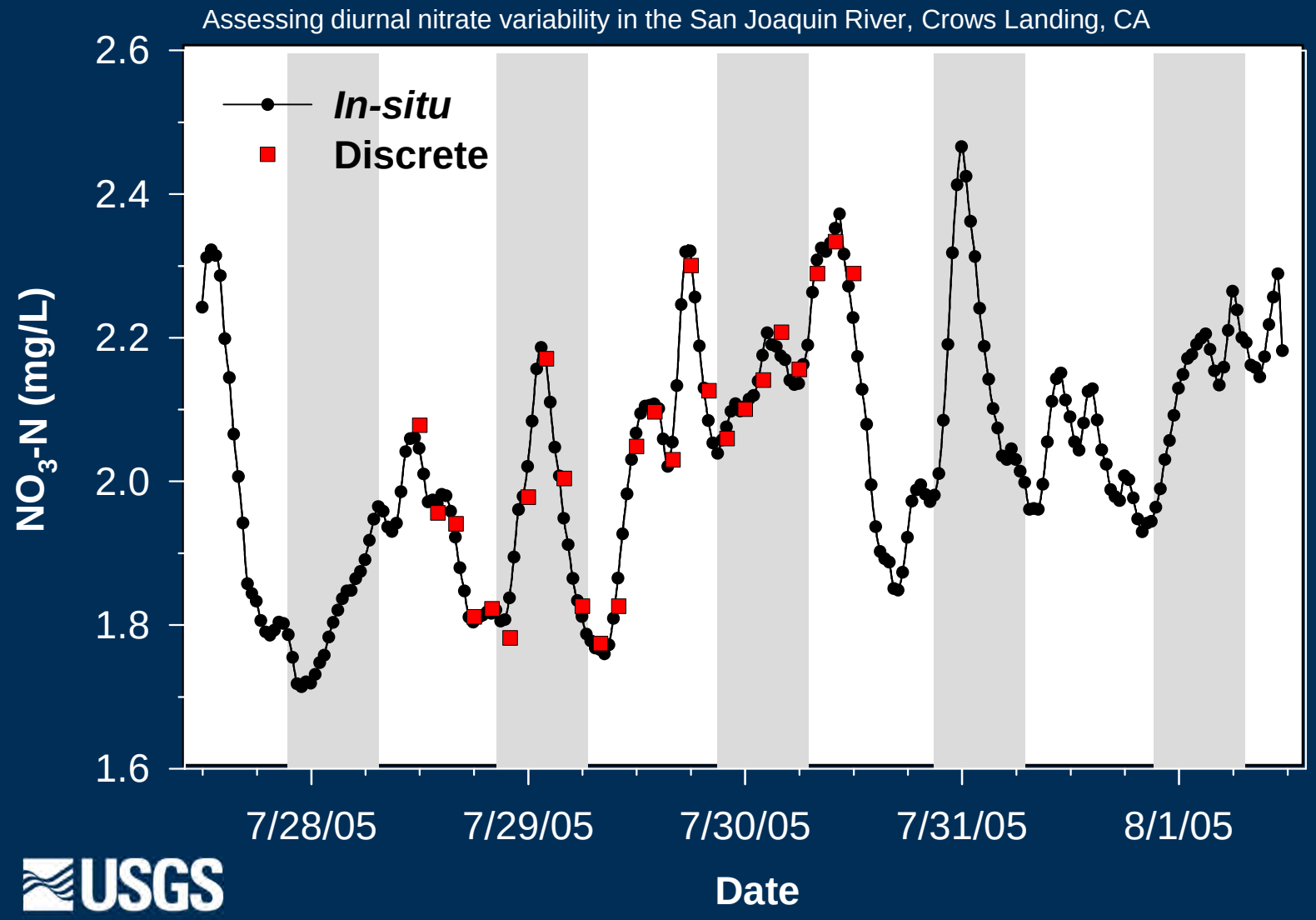

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Pellerin et al., 2009

Applications

- Monitoring concentrations
  - Drinking water applications
  - Wastewater discharge
- Refining loads
  - Coastal eutrophication
  - TMDLs
- Interpreting sources and processes
  - Identify key contributing areas
  - Quantify aquatic retention
  - Flow path tracers

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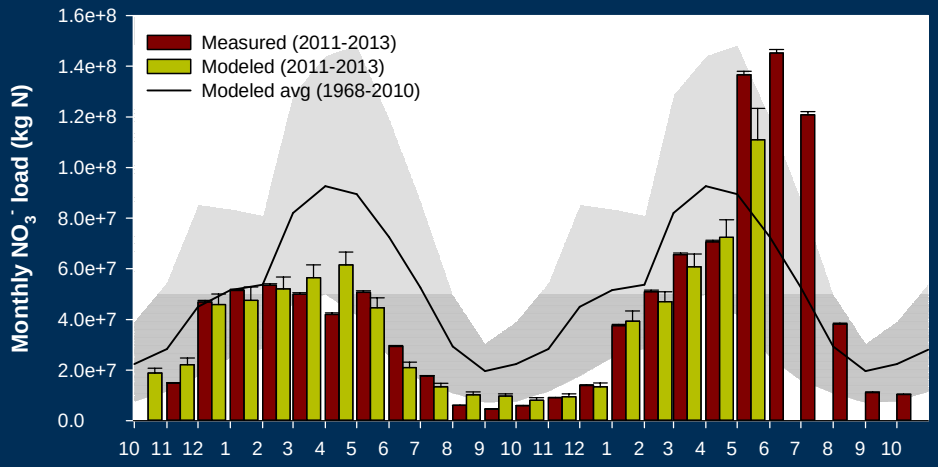
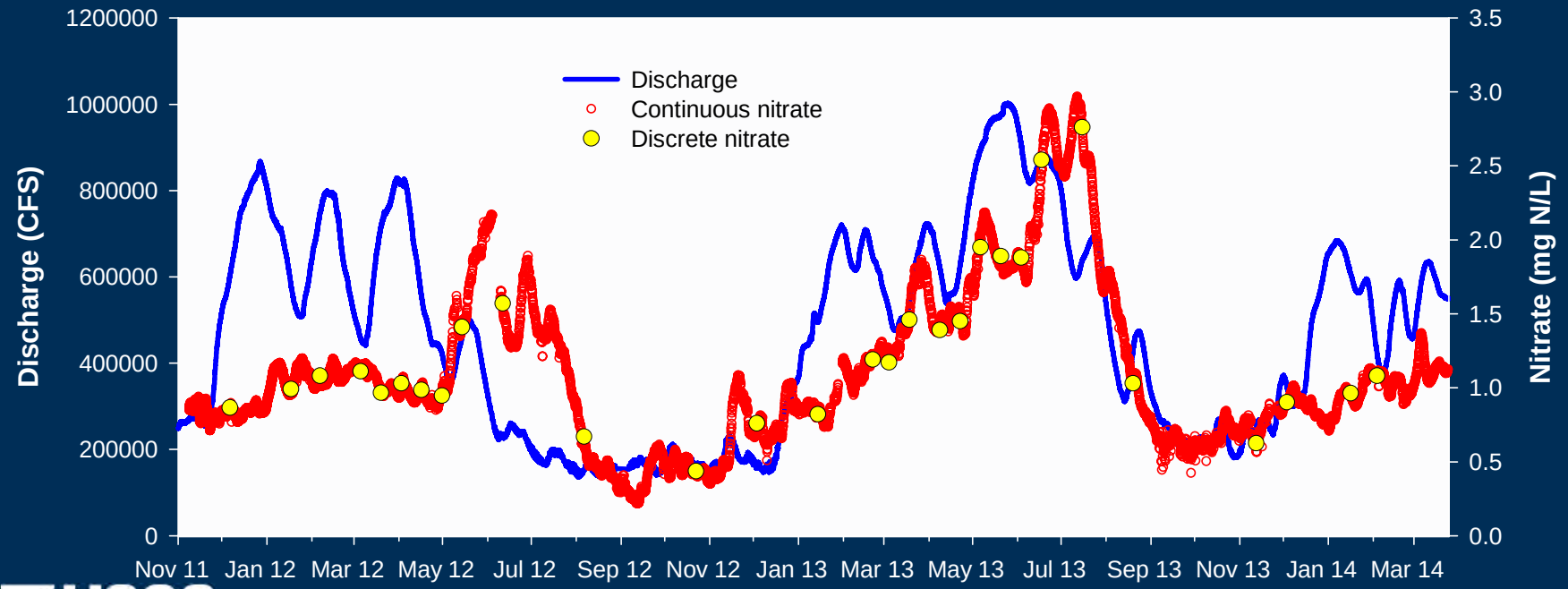
Mississippi River Nitrate

- Strong correlation between in situ and discrete nitrate (depth- and width-integrated)
- Monthly loads vary by up to 30%
- Dynamic nature, not well correlated with Q
- Estimated error ~ ± 4% for daily loads, ± 1-2% monthly





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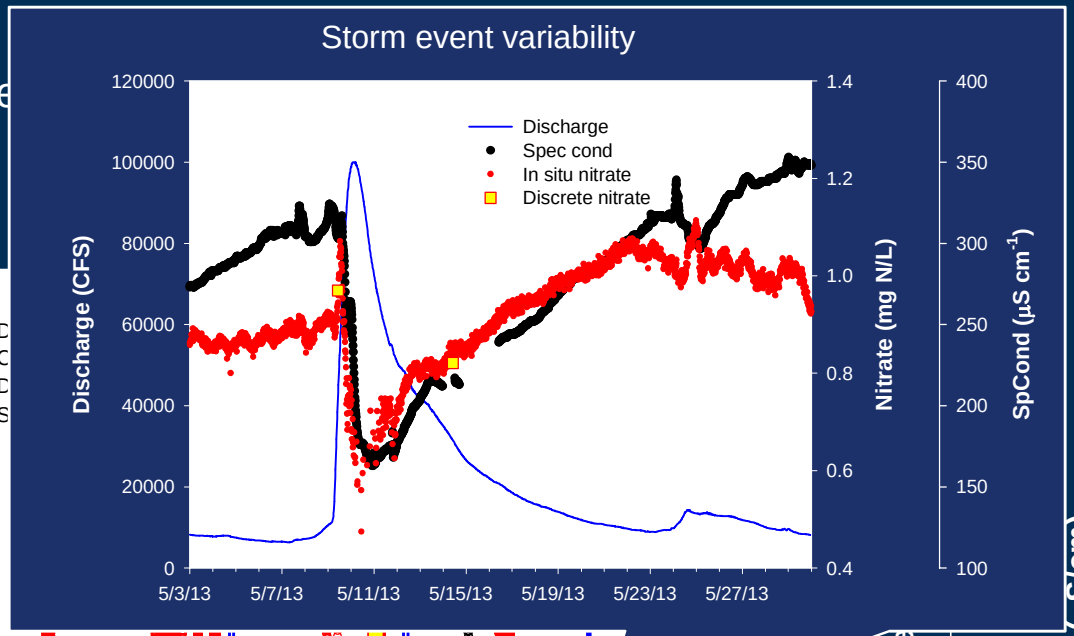
Potomac River – short-term variabiity

- Strong correlation between in
- Dynamic at multiple time scale
- Estimated error ~ ± 4%



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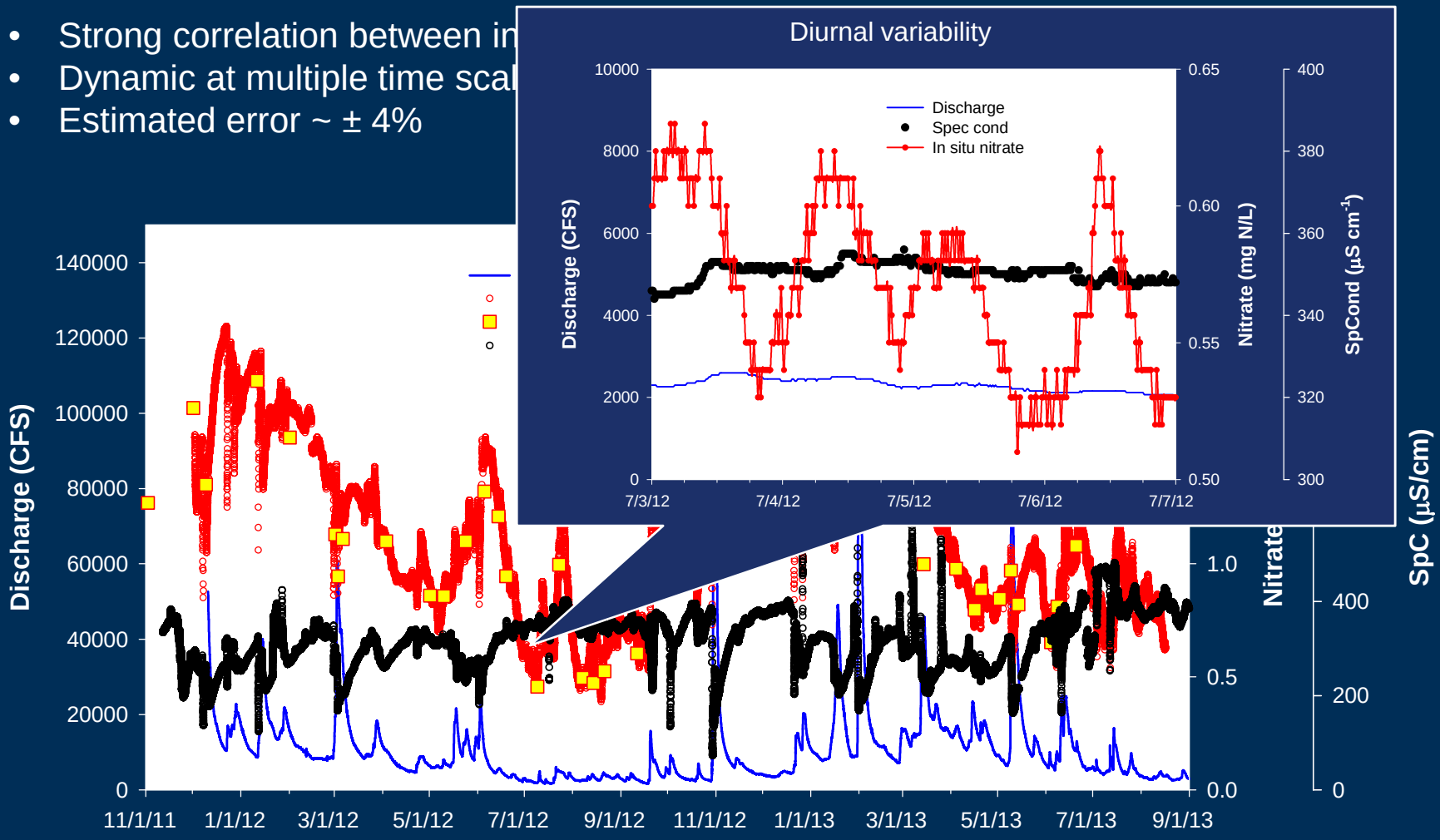

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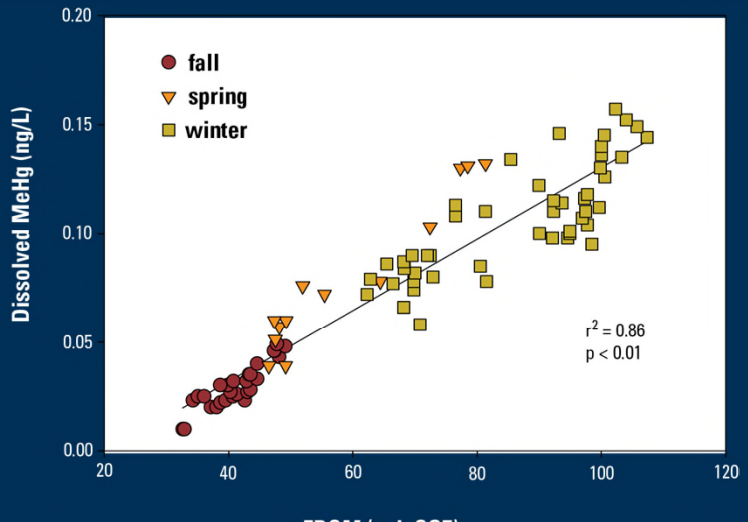
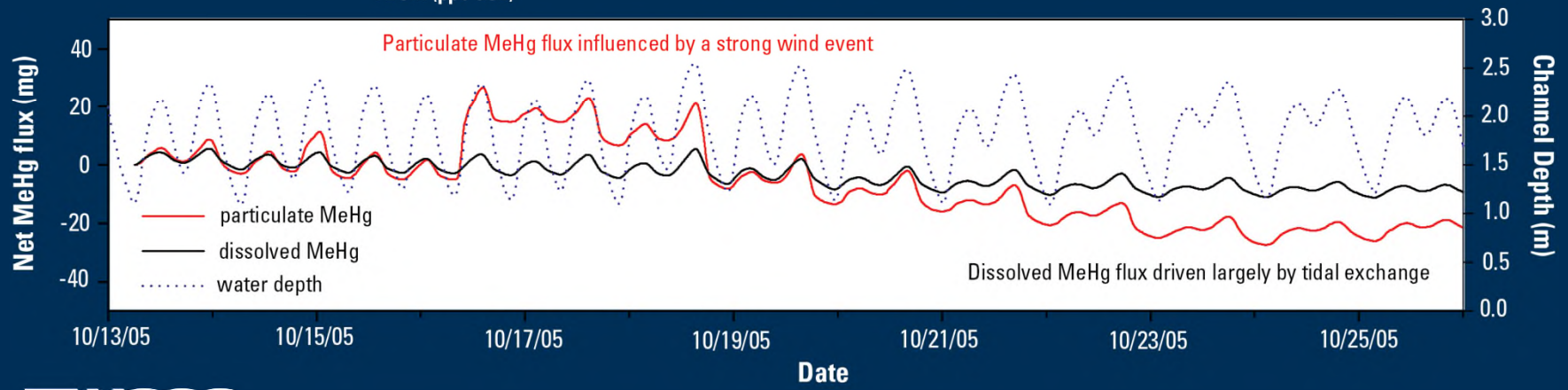
FDOM as a proxy for mercury

"Surrogate" measurements for high resolved methylmercury (MeHg) flux from a tidal wetland, Browns Island, CA





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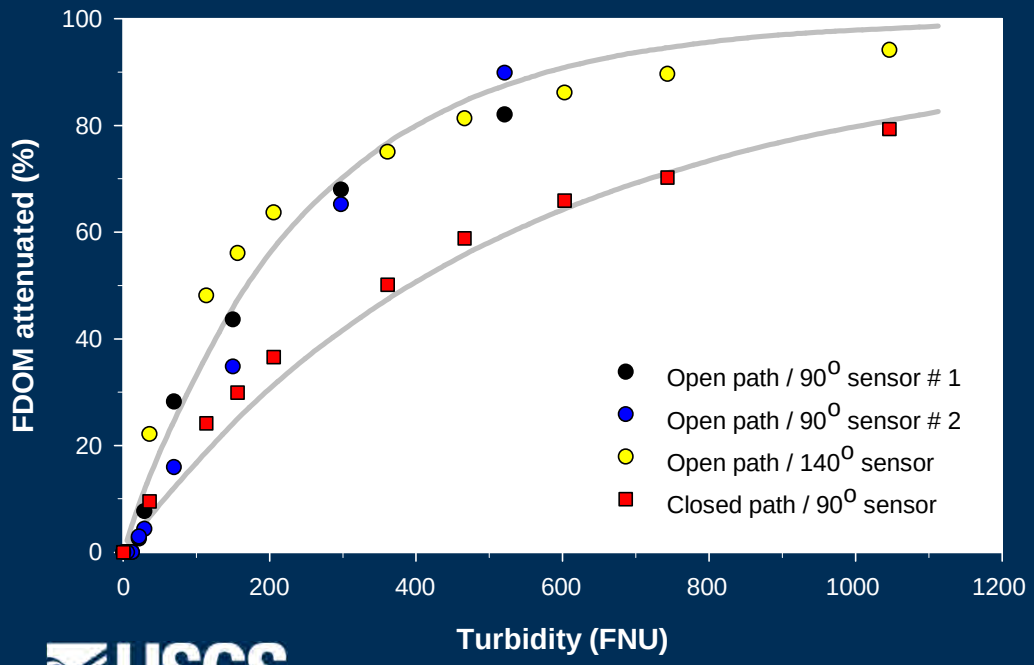
Bergamaschi et al., 2011

(Some) Next steps

- Guidelines and methods
  - Guidance documents for new sensors
  - Instrument characterization
  - Continued interactions with manufacturers
  - Better estimates of uncertainty

Effect of particle interference on FDOM sensor measurements



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Downing et al., 2012

(Some) Next steps

- Next generation sensors
  - Target low UV fluorescence as unique indicator of wastewater presence
  - Indicators for the potential presence of pathogens and bacteria (S. Corsi, WI WSC)

Short Course: "Dissolved Organic Matter – What, Why, How"

Thursday, 3:30, Session M8

G. Aiken, B. Bergamaschi

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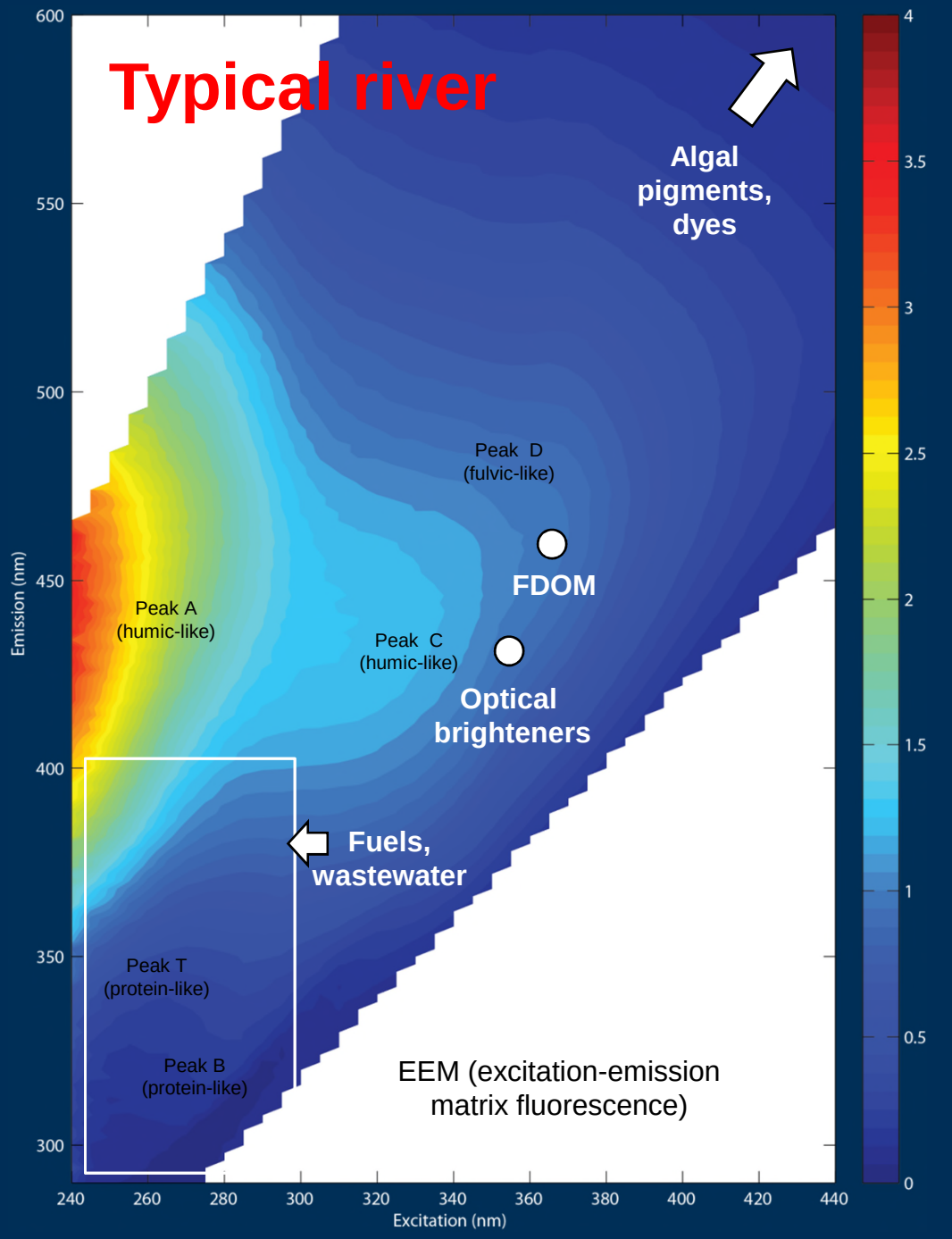

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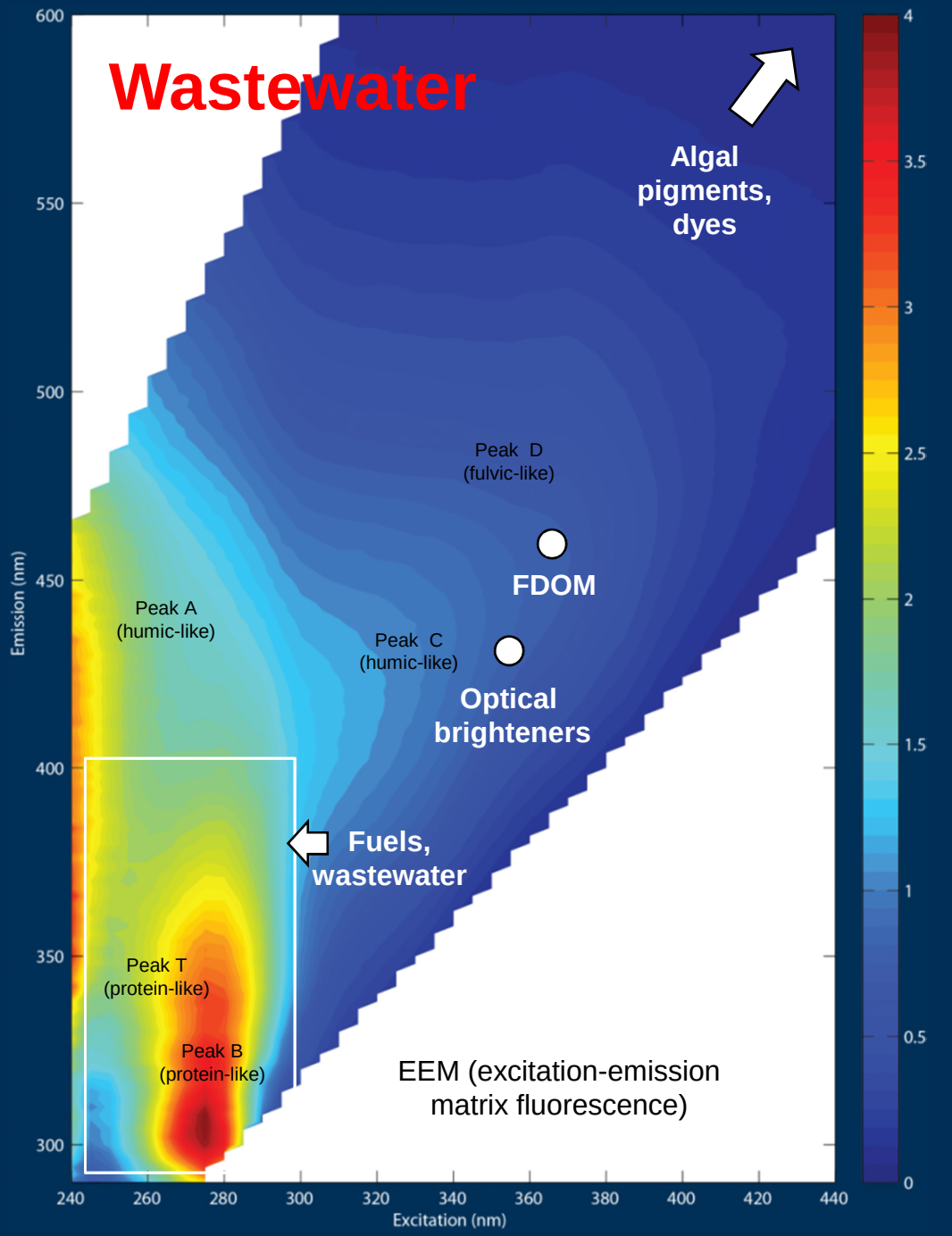

(Some) Next steps

- Event response
  - Wastewater
  - Oil and grease
  - Nutrients
  - Sediments (amount and type)
  - Disinfection by-products
  - ?

Acknowledgements

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