Autonomous fixed station measurements and synoptic spatial characterization provide insights into dynamics of organic matter, nutrients and algal pigments in the SF Bay-Delta

Bryan Downing, Brian Bergamaschi, Brian Pellerin, Tamara Kraus, Elizabeth Stumpner, Scott Nagel, Katy O'Donnell, Amy Story, John Franco Saraceno, Travis von Dessonneck and Roger Fujii, and many others.

2014 Bay-Delta Mtg Tuesday, October 28, 2014 @3:35 pm Room

USGS science for a changing world

SFCWA

Overarching Monitoring Goals

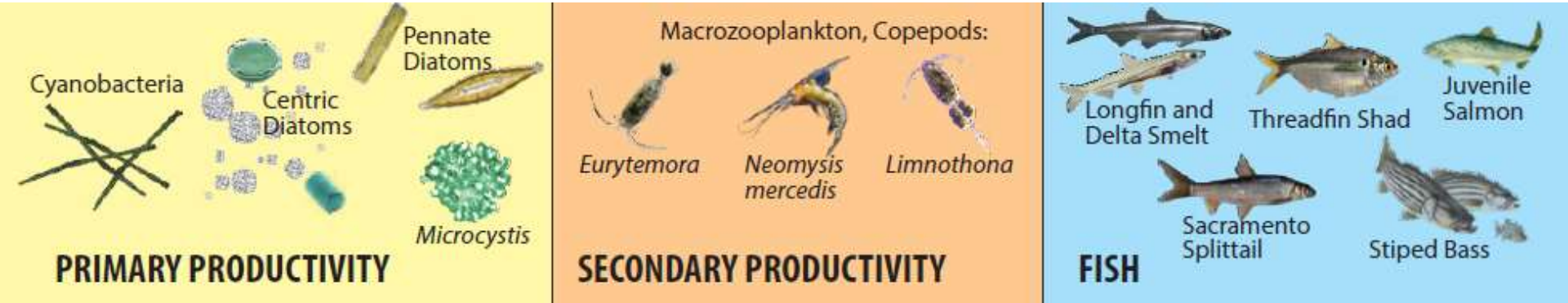
I. Assess and improve methods to better explain water quality conditions.
II. Characterization and interpretation of spatial and temporal patterns of nutrient and phytoplankton conditions.
III. Support other research activities through availability of consistent and scientifically valid time series.

Assessing Habitat Conditions

- When, where and why does phytoplankton production occur in the CSC?
- How are nutrient, DOM, and particle dynamics affected by increased flows and changes in source waters in the CSC?
- Does the CSC act as a subsidy for dissolved and particulate material to the rest of the estuary?
- Is particle composition related to physical dynamics such as flow and turbulence?

Assessing habitat conditions

- What are the attributes of “good” pelagic aquatic habitat?
  - More phytoplankton – of the right type.
    - Evidence that existing zooplankton stocks are food-limited
  - More zooplankton – of the right type.
  - An environment conducive to feeding and avoiding predation; not too warm
- Where and when and under what conditions do we observe “good” pelagic aquatic habitats?
- Can we expand the spatial and temporal extent of “good” pelagic aquatic habitat?



What, Where and When are NO_3 and Chl-a gradients in Cache Slough Complex found?

Sensors

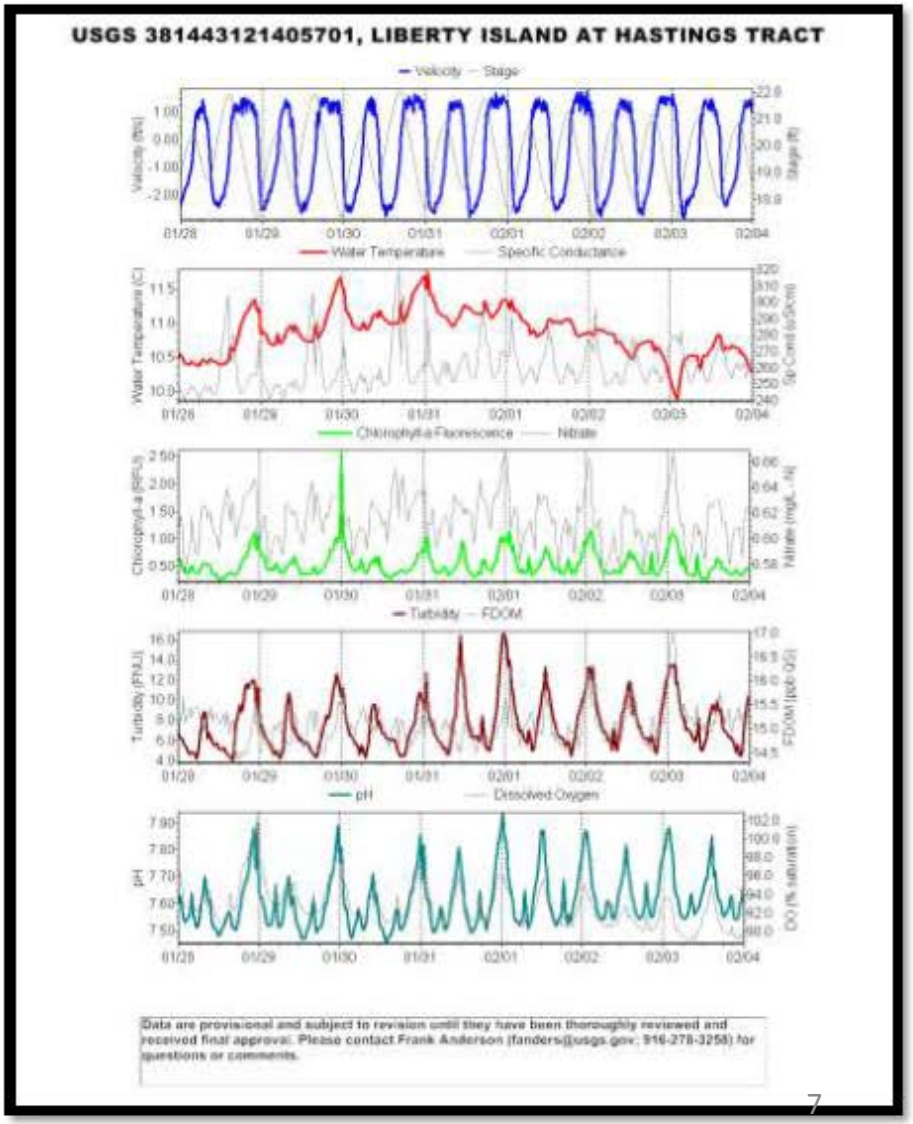
YSI model EXO 2: 6-port multiparameter water quality sonde with anti-fouling wiper

- **CTD**
- **pH**
- **Turbidity (0 to 4000 FNU)**
- **Dissolved Oxygen**
- **fDOM (0 to 300 ppb QSE)**
- **Chlorophyll-a (0 to 400 ug/L)**
- **Phycocyanin (0 to 100 ug/L)**

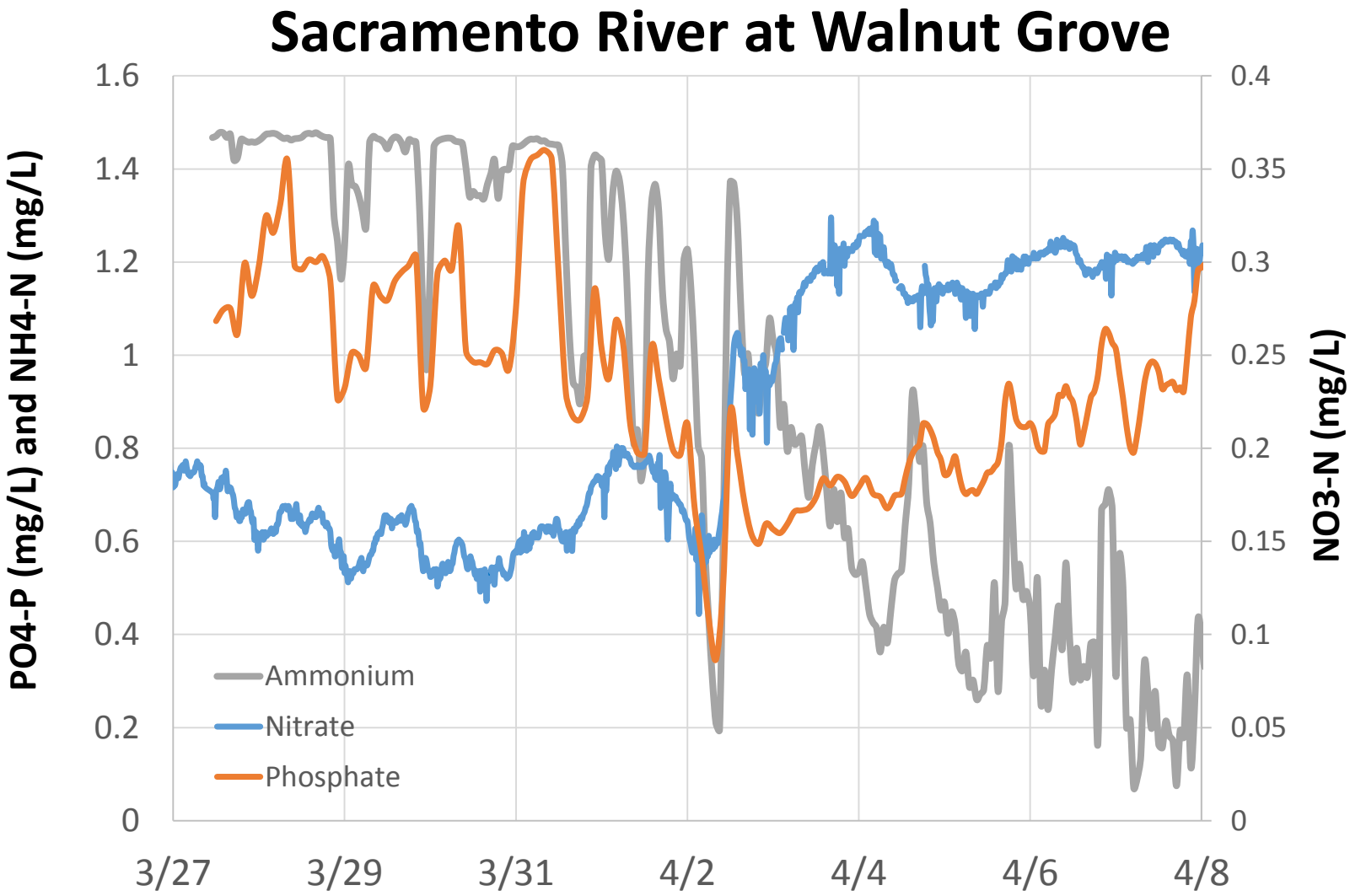
Satlantic SUNA *in situ* optical nitrate analyzer.

Accuracy	± 2 µM (±0.028 mg/l-N) or ± 10% of reading, whichever is greater (10 mm pathlength, σ under laboratory conditions)
Precision [at 3σ]	0.3 µM (freshwater or seawater with T-S-Correction) 2.4 µM (seawater [0-40 psu])
Turbidity Range	625 NTU* (10 mm path length) 1250 NTU (5 mm path length)
Detection Range	0.5 to 4000 µM (0.007 to 56 mg/l-N)

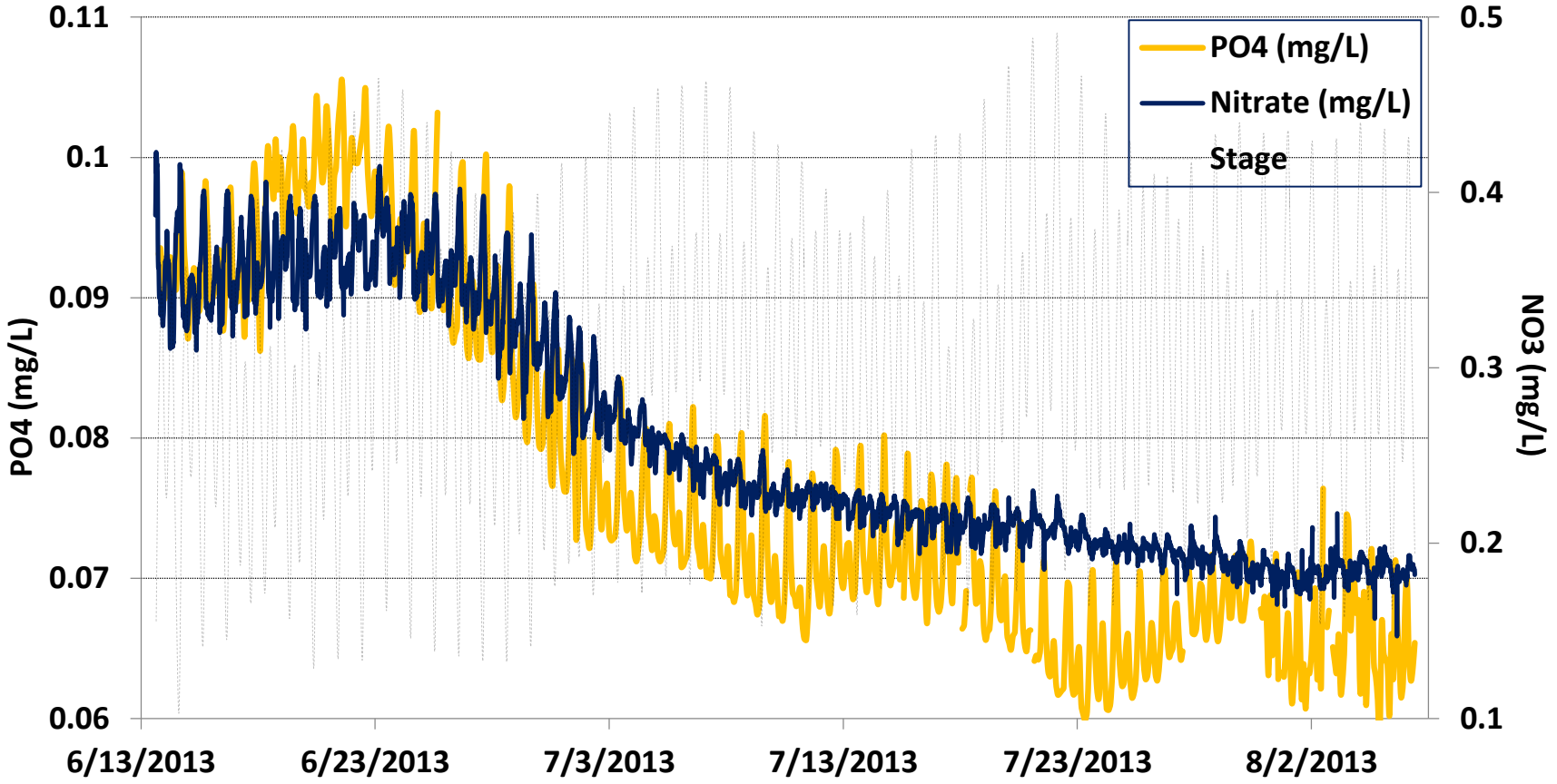
Continuous monitoring at flow stations



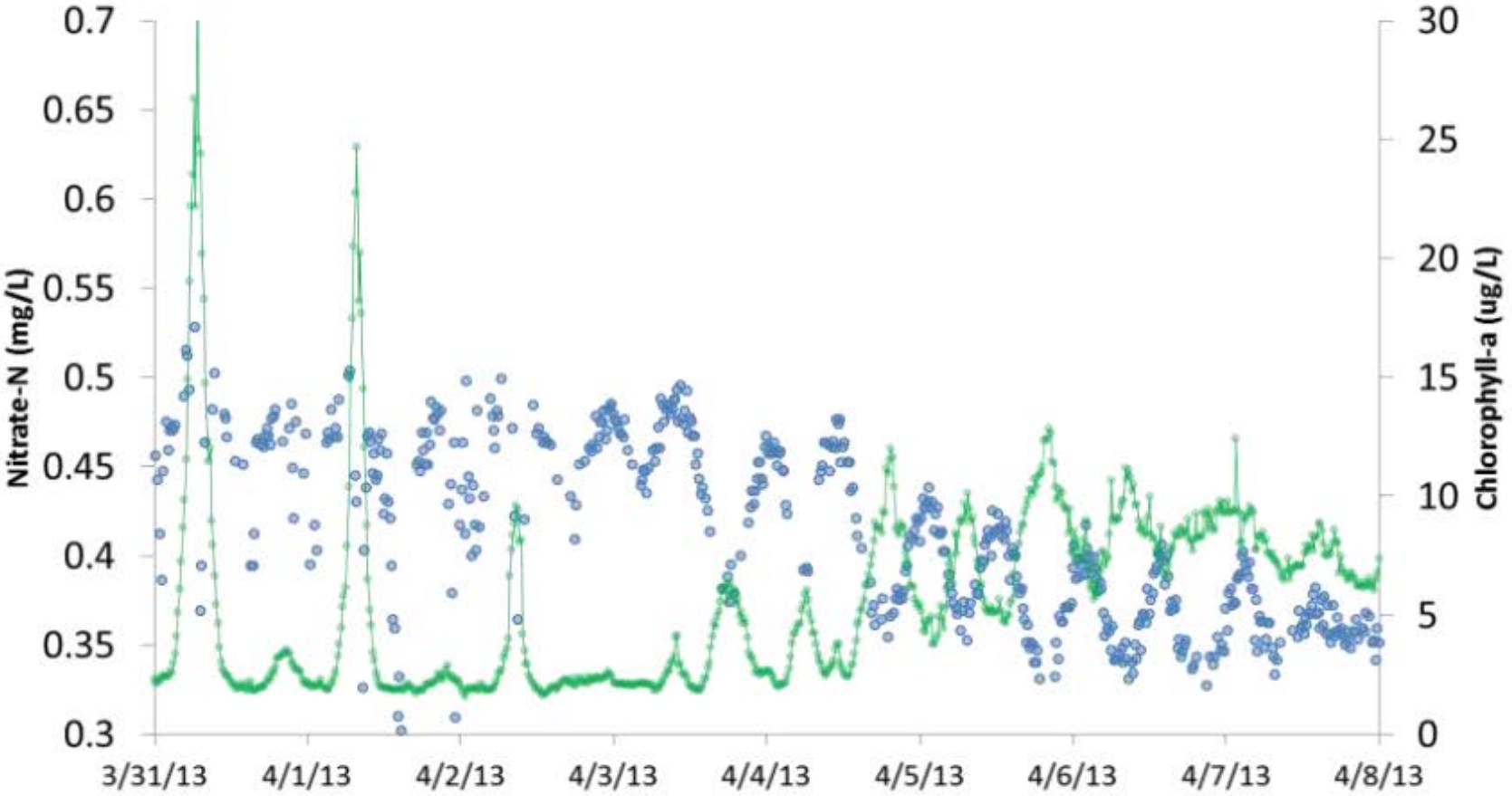
Nutrient concentrations and ratios change rapidly



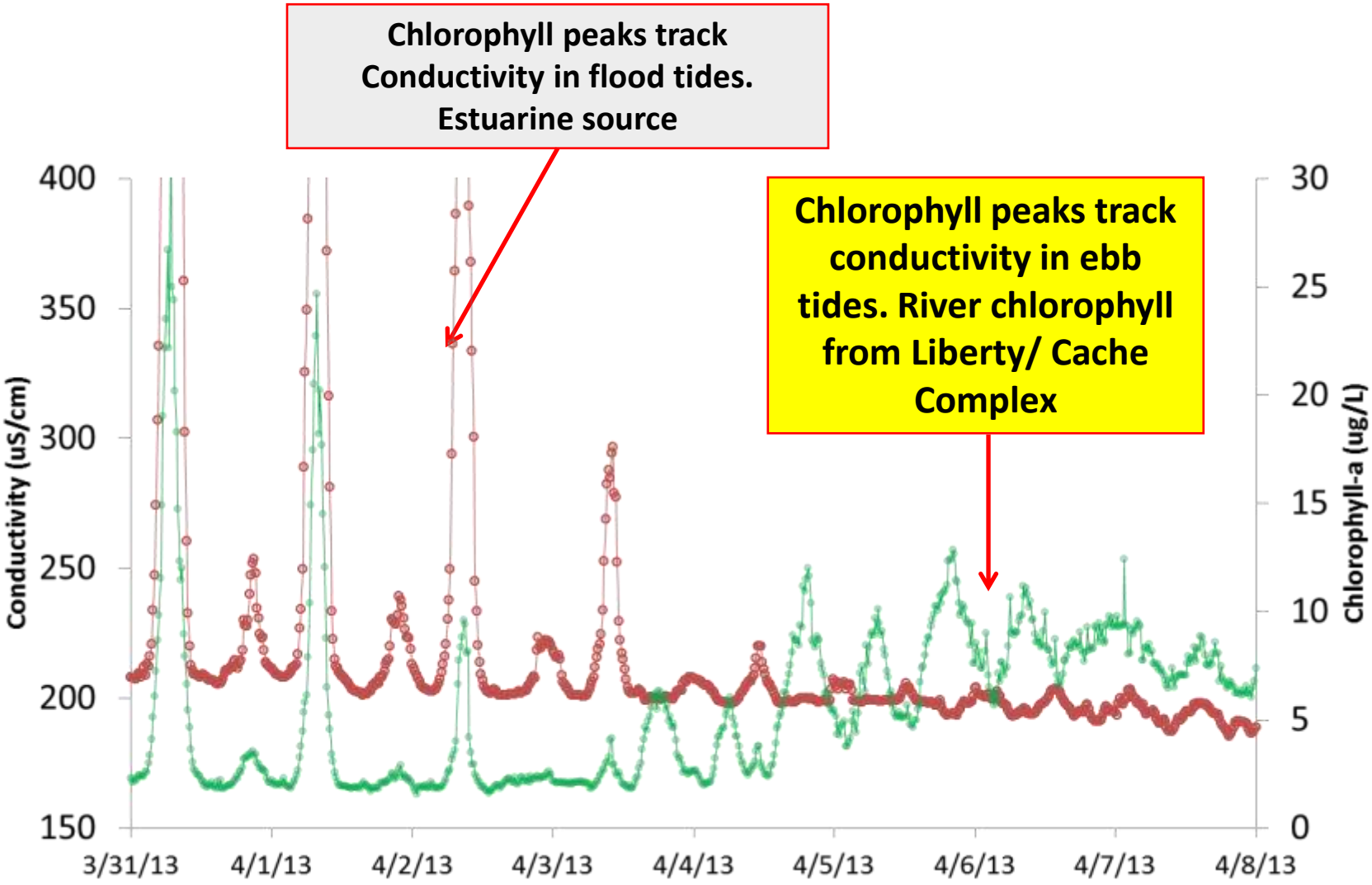
Nitrate and Phosphate dynamics in Cache Slough



Nitrate and Chlorophyll dynamics in Cache Slough

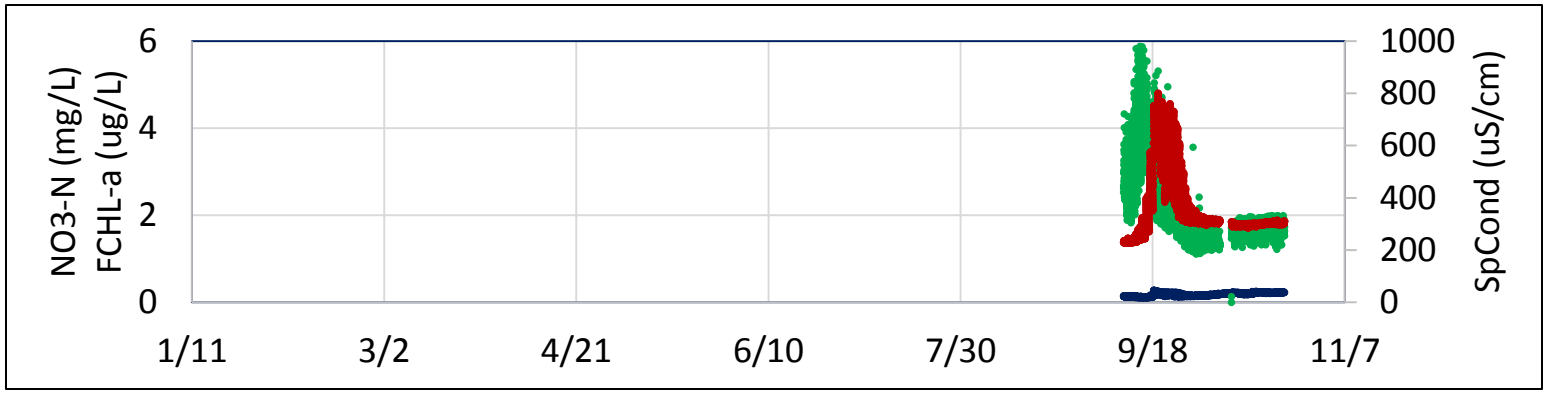


Chlorophyll Source Identification

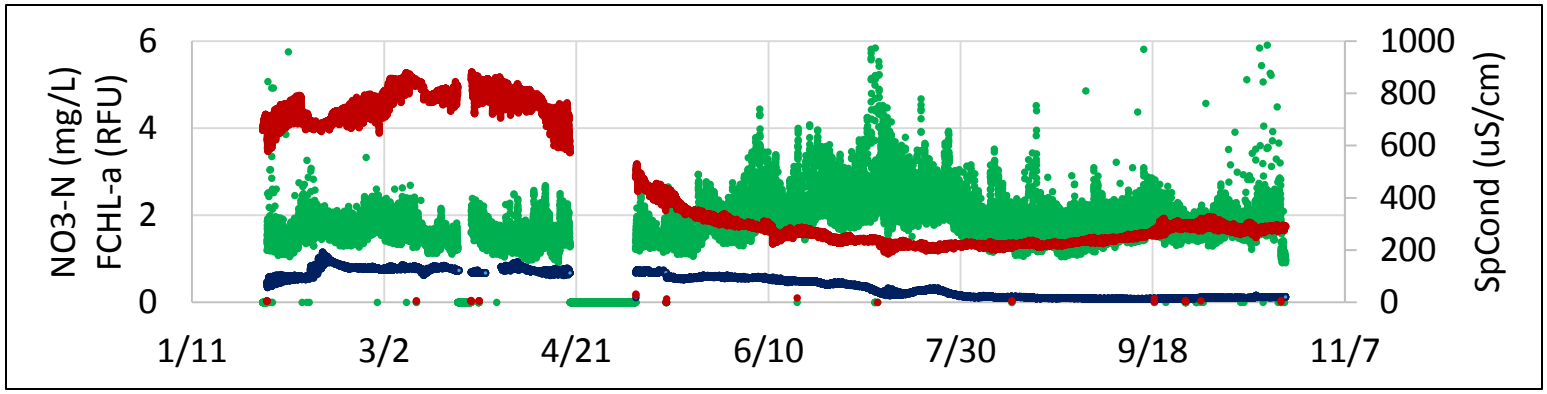


CSC North to South Jan-Oct 2014

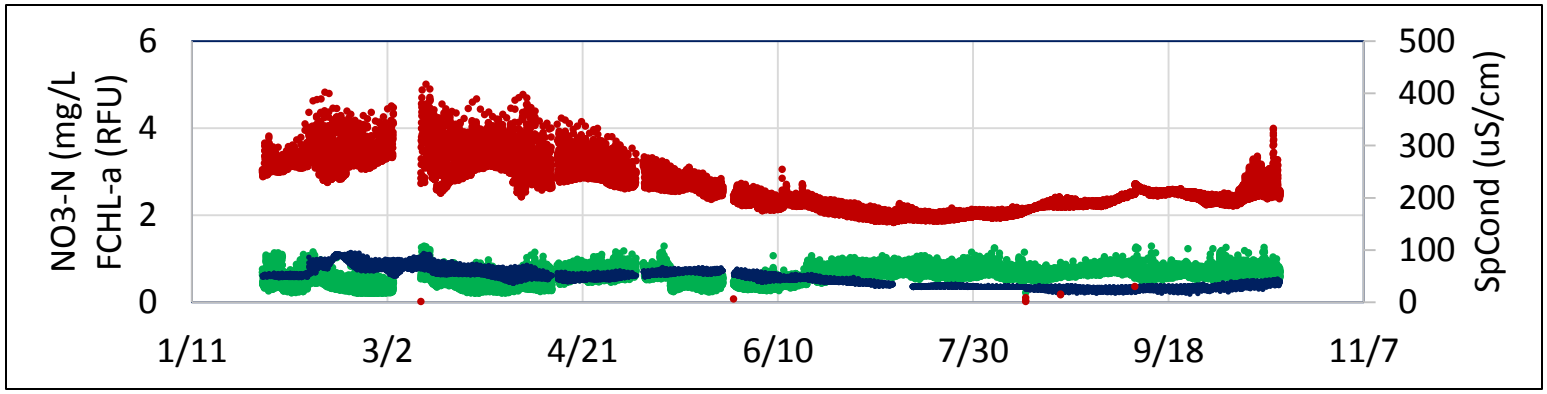
TOE DRAIN



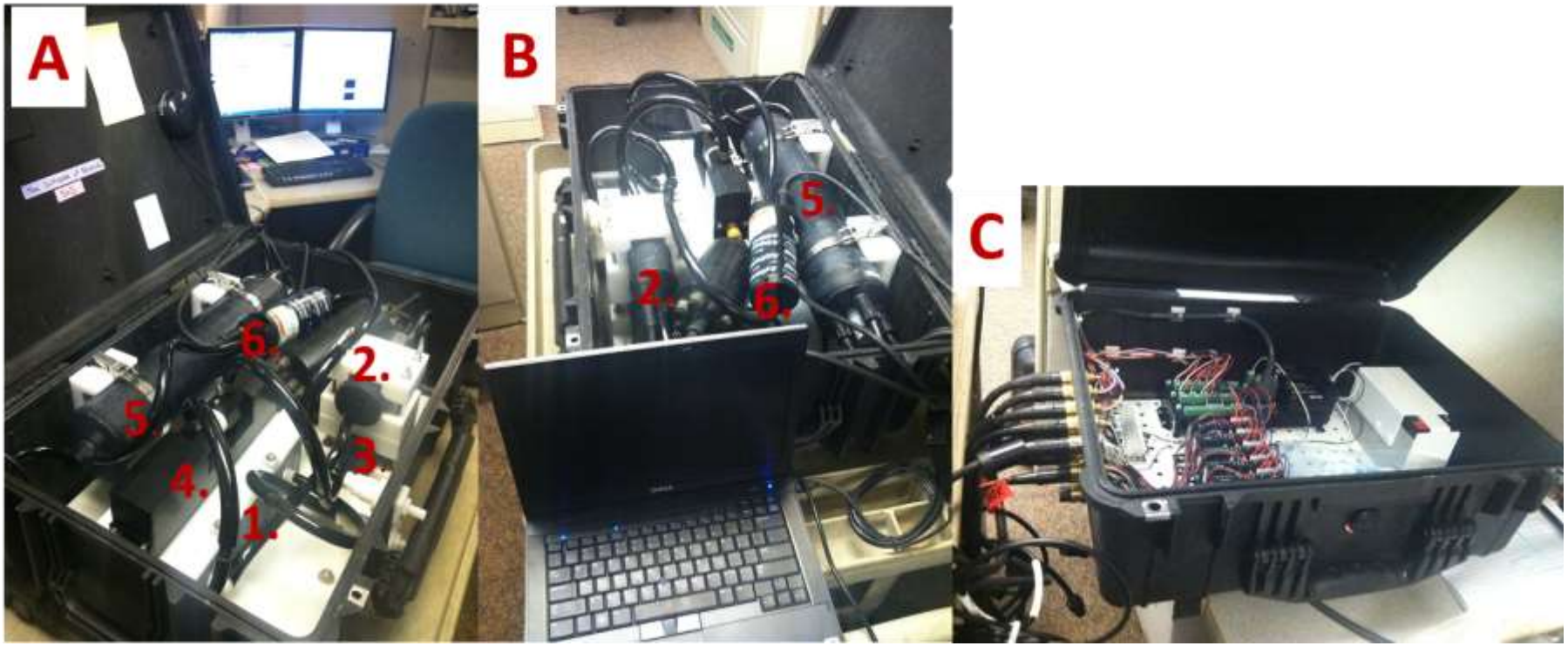
LIBERTY CUT



LIBERTY MOUTH



Spatial mapping using underway measurements



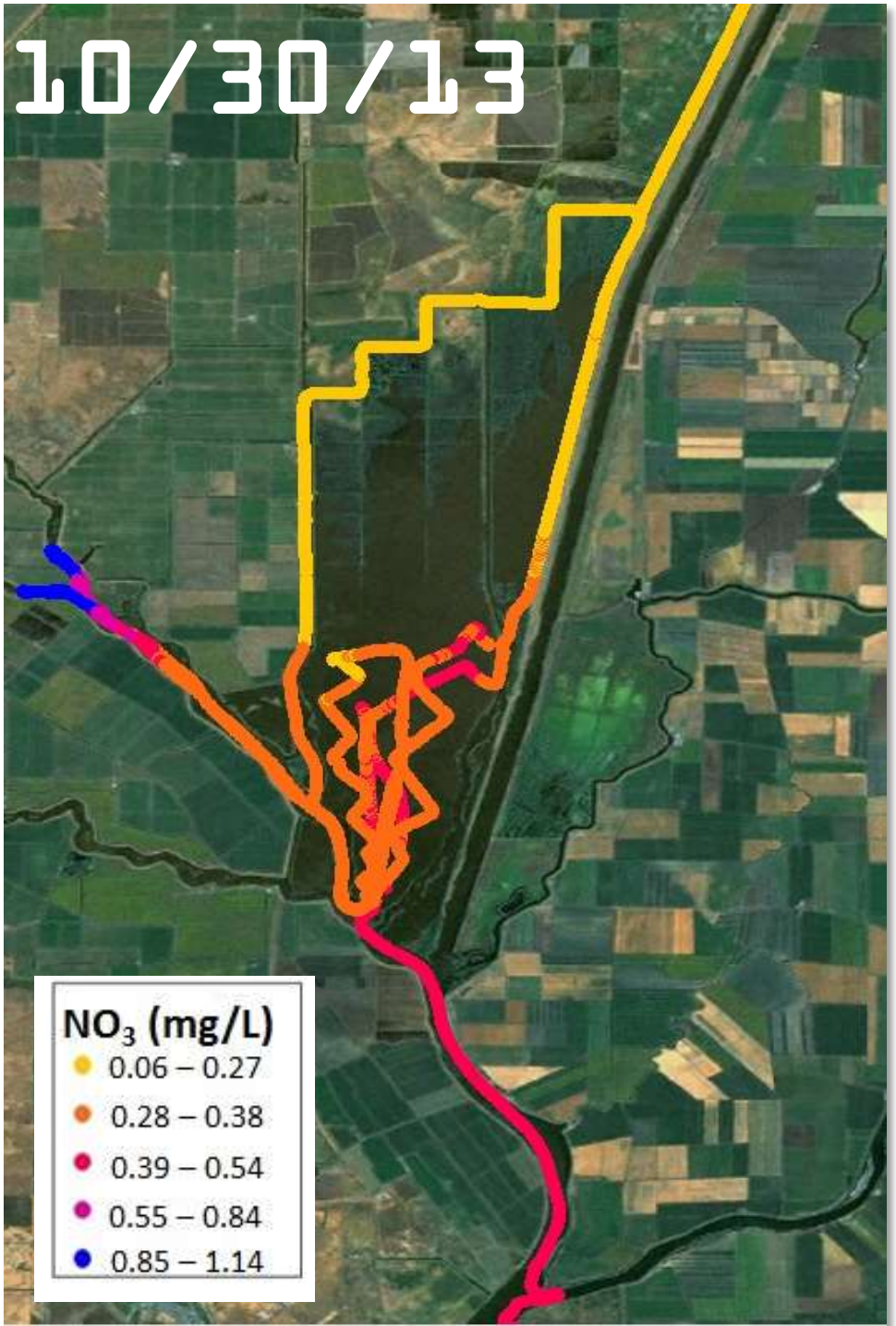
Panel A and B: 1. Thermosalinograph (Sea-Bird), **2.** CDOM fluorometer (WET Labs), **3.** Chl-a fluorometer (WET Labs), **4.** Transmissometer (WET Labs), **5.** ISUS nitrate sensor (Satlantic), **6.** Custom fluorometer (WET Labs)

Panel C: CR1000 (Campbell Scientific) integrated into the data collection platform

Nutrient concentrations and ratios change vary in space

Cache Slough Complex

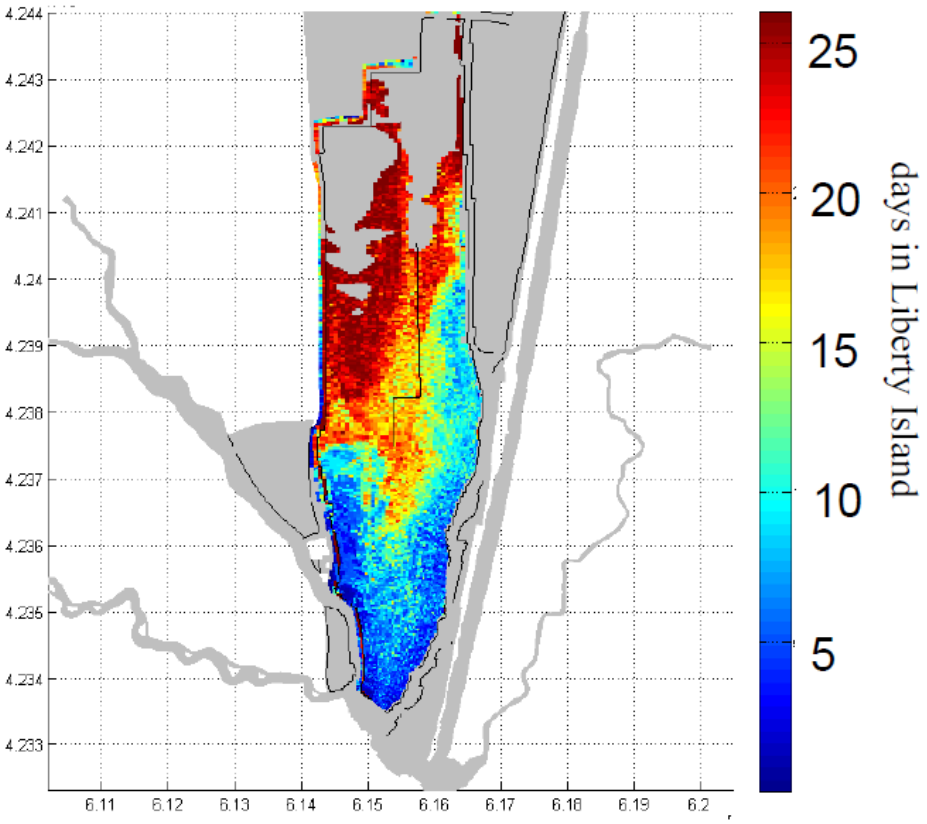
What long residence time does to nutrients



Residence time model for Liberty Island

ESA PWA

Liberty Island Exchange Time Scales

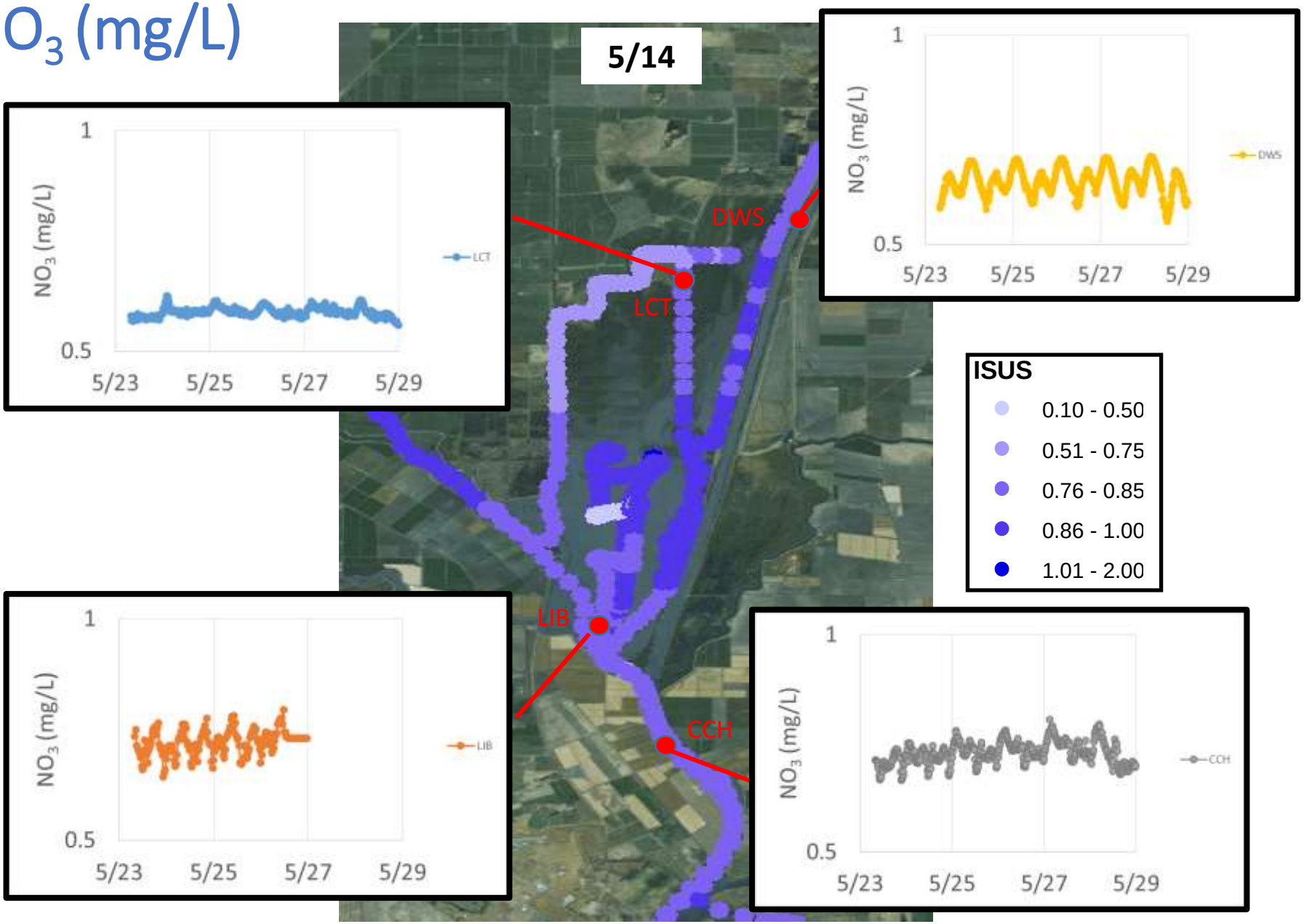


- **ESA PWA residence time model**
- **Sac R, Toe Drain and western sloughs are sources**
- **Northward flow direction**

Source – Matt Brennan, ESA

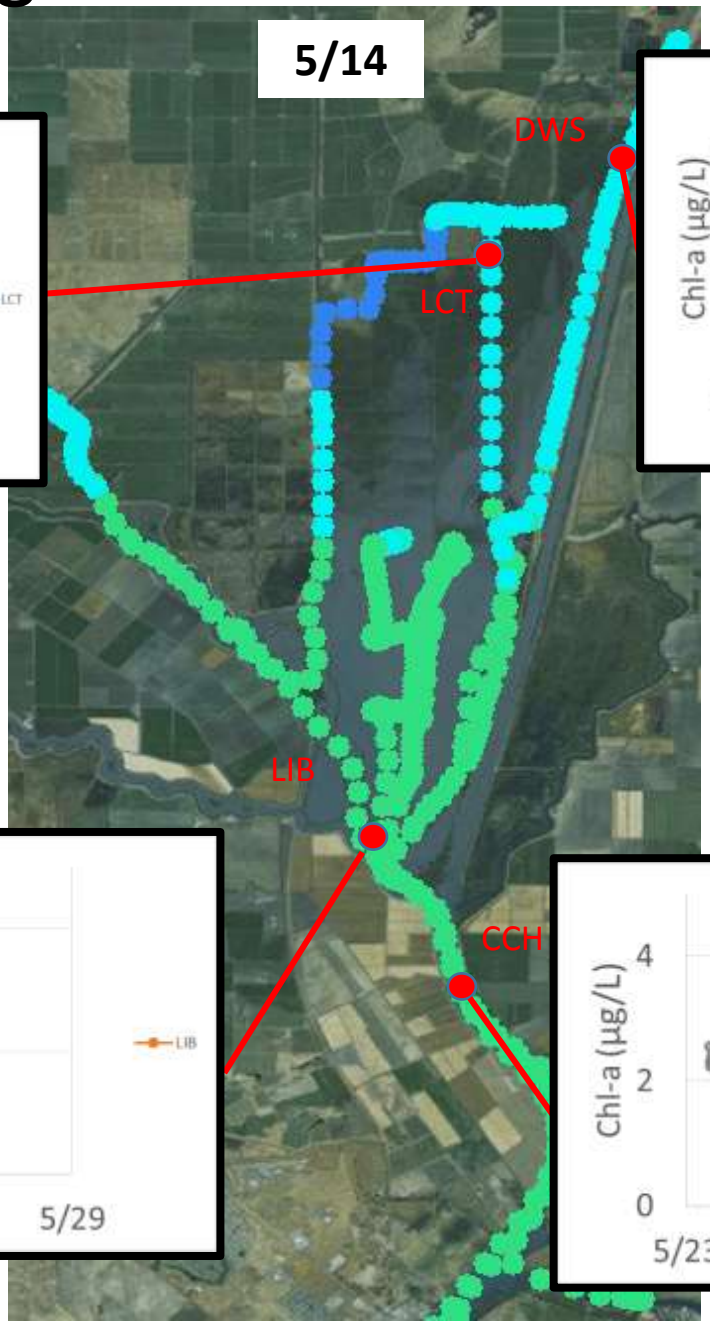
Spatial Mapping & Fixed Stations

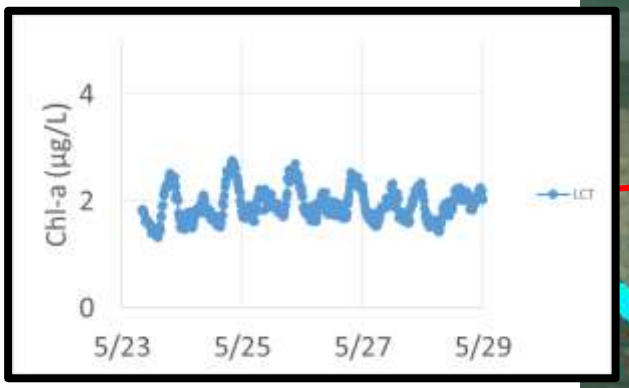
NO_3 (mg/L)

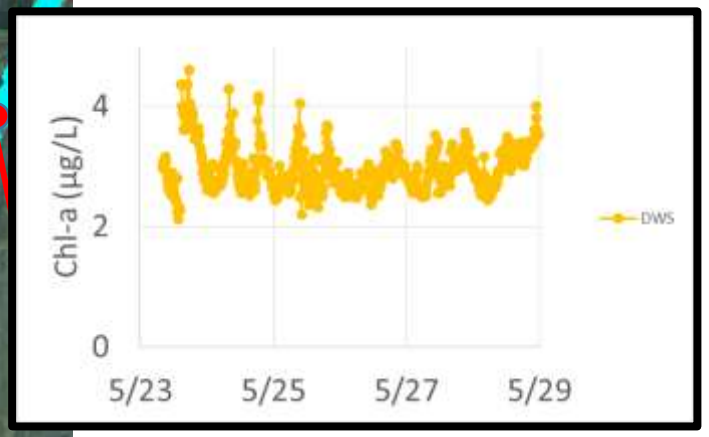


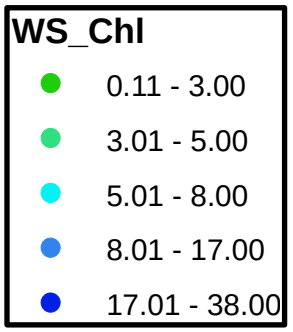
Spatial Mapping & Fixed Stations

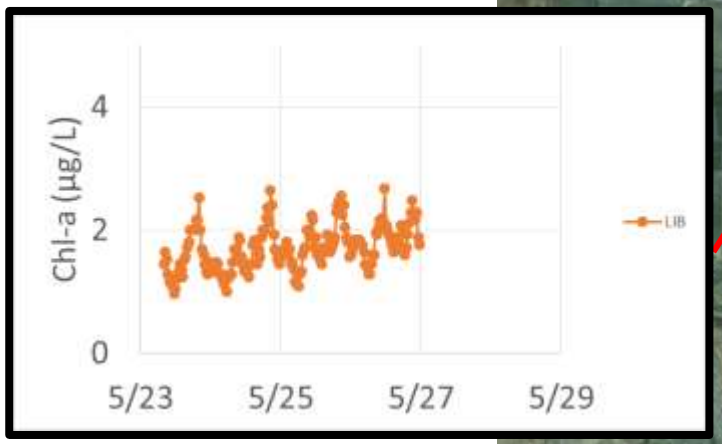
Chl-a (µg/L)

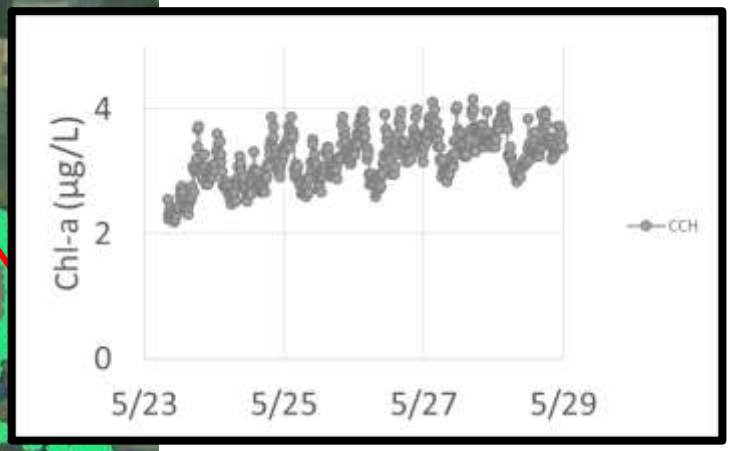




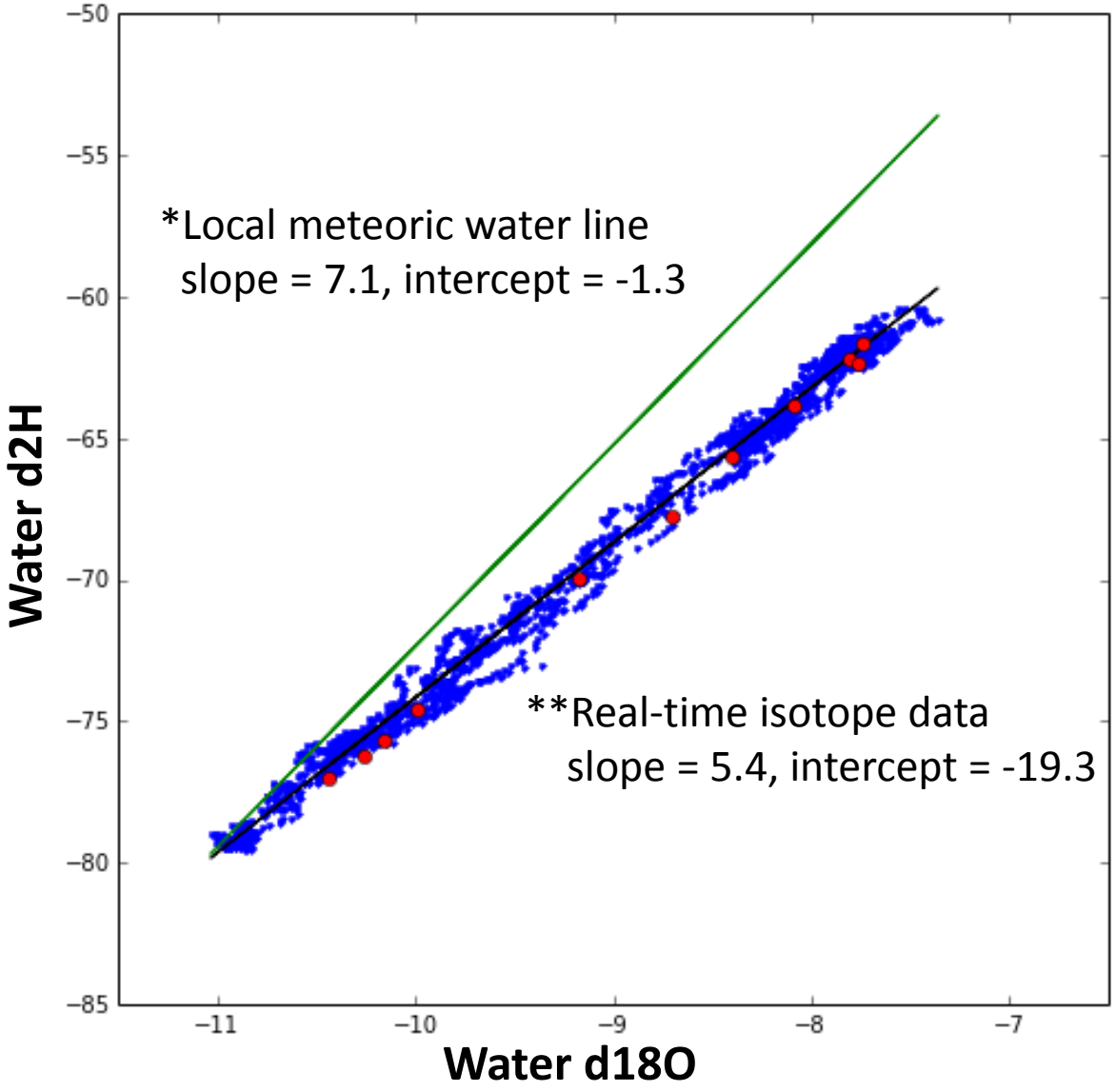








Isotope Hydrology

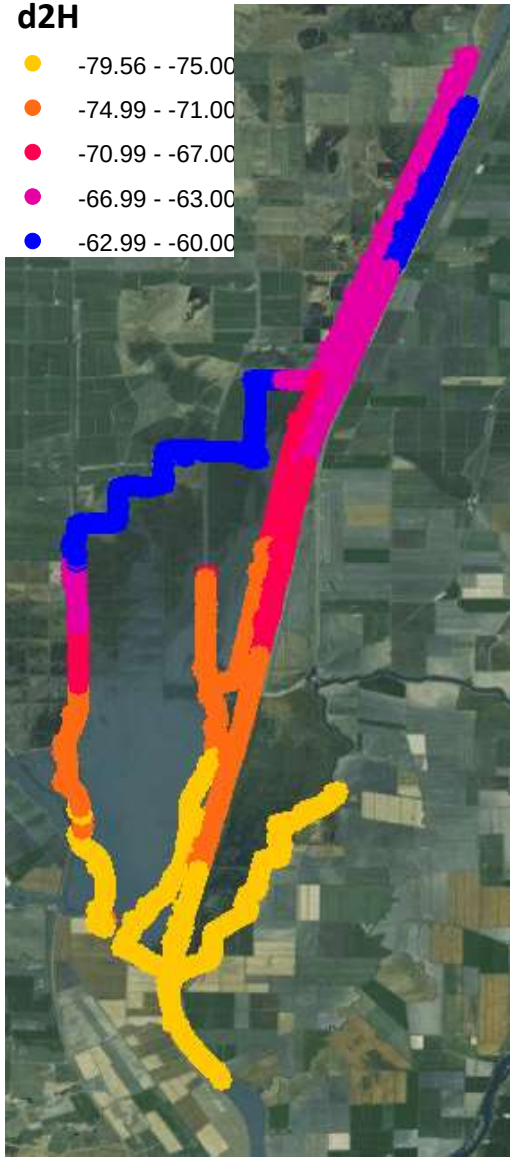


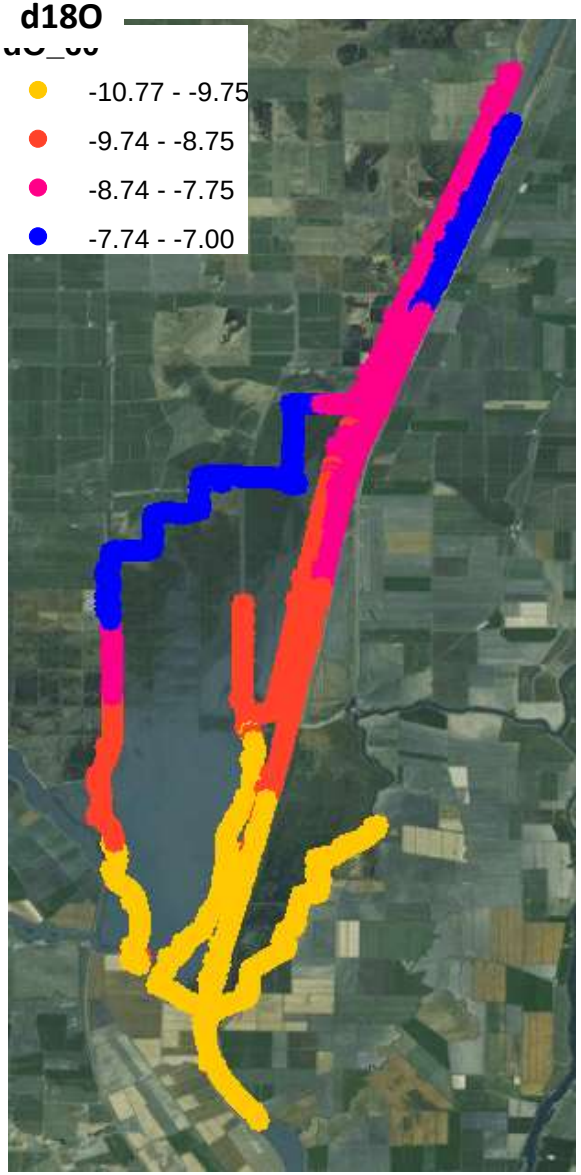
***Carol Kendall USGS, Menlo Park**

**** Kate Dennis and Jeffery Carter, Picarro inc,**

10/1/14 data

Data collection: 8:30 – 15:00
High Tide @ 11:15
Low Tide @15:45





Applications for remote sensing

Simulatenous PRISM flights and field data acquisition over Suisun Marsh/Grizzly Bay

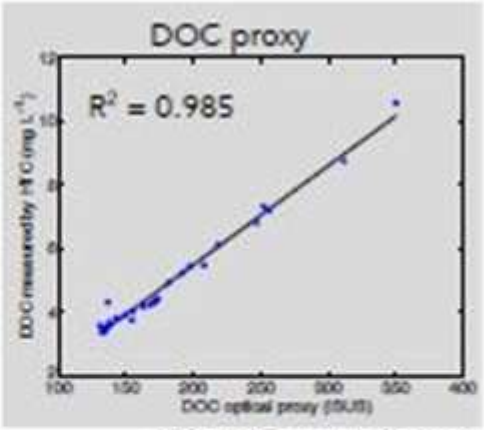
Field measurements

- Turbidity using YSI EXO system

- DOC proxy using Satlantic ISUS

- Underway measurements (pump to probes)

- Sampling rate: 1 s^{-1}



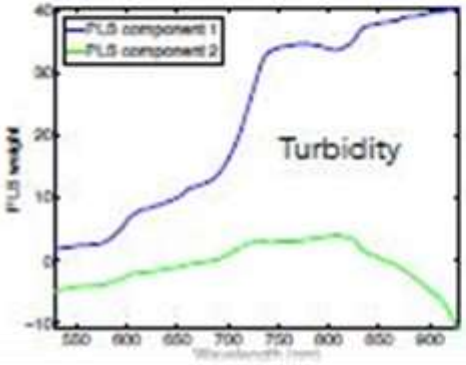
HTC = High Temperature Combustion

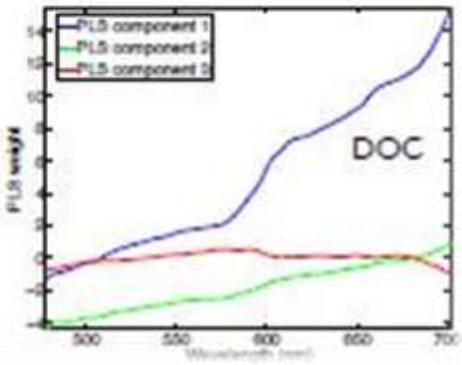
Partial least square (PLS) regression-based algorithms

PLS is used to produce optimal predictors of Turbidity and DOC from hyperspectral remote-sening reflectances.

Turbidity: 2 PLS components = 95% of observed variability in Turbidity
Optimal spectral range: 525-925 nm

DOC: 3 PLS components = 94% of observed variability in DOC
Optimal spectral range: 475-700 nm





Conclusions

- Nutrient concentrations change quickly: need continuous high freq. sampling < 1 hour.
- Continuous sampling useful to understand biological processes associated with nutrient cycling.
- Spatial mapping can help us understand links between nutrients and primary production.
- The combined approach provides additional insight in the shallow water habitat of CSC.

Acknowledgements

We thank Erwin Van Nieuwenhuyse / BOR for funding this project. Jon Burau for continued support, hours of advice and fair warnings. Special thanks to Scott Nagel, Paul Kreun, Katy O'Donnell, Angela Hansen and Travis von Dessonneck for technical and lab support.

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