3D Fluorescence analysis of dissolved organic carbon in Tempe Town Lake

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Introduction and Background

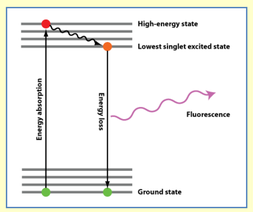
- Tempe Town Lake (TTL) was constructed in 1999 and provides both recreational and flood control services for the cities of Tempe and Phoenix.
- We've monitored water chemistry and dissolved organic carbon (DOC) in Tempe Town Lake since 2005. DOC concentrations change seasonally and reflect both climatological variation (monsoons) and human water management (dam releases).
- Fluorescence spectroscopy using excitation-emission matrices (EEM's) provides information about the chemical character of the organic carbon compounds lake water.
- EEM's are easy to measure, non-destructive, and provide chemical information complementary to other optical techniques (e.g., $SUVA_{254}$).
- We present EEM's from Tempe Town Lake samples collected from June 2011 to Dec. 2012.
- We use parallel factor analysis (PARAFAC) to assess the distribution of typical aquatic fluorophores. Model EEM's allow us to calculate fluorescence indices that reveal information bout the character of the organic compounds present.

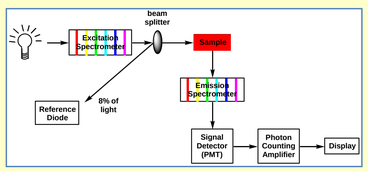
Analytical Methods

High Temperature Combustion (HTCO) tells the amount of Carbon in the sample

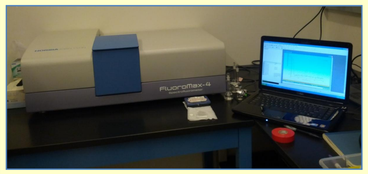
- Organic C is combusted to CO_2 and detected by IR absorption
- High sensitivity, low background!

Fluorescence spectroscopy tells us about the composition of organic carbon molecules

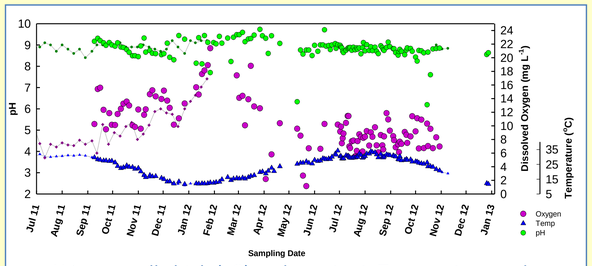




- Excite from 240-500 nm
- Measure emission from 350-500 nm
- Careful attention to blanks, Raman normalization, and instrument corrections
- High sensitivity!

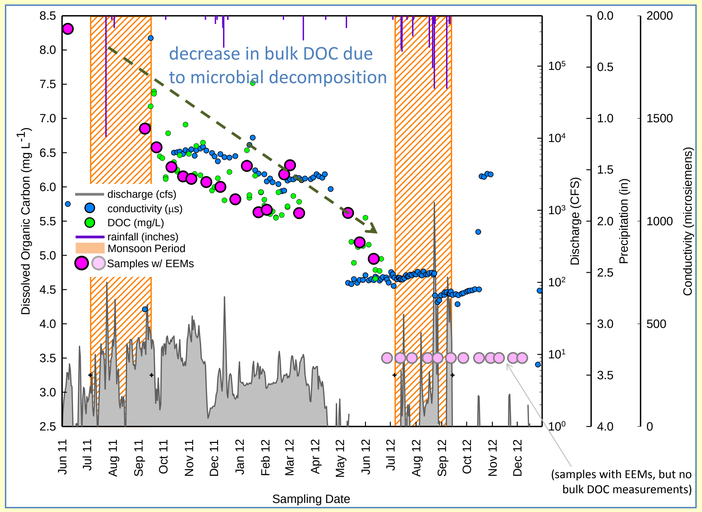


Water Chemistry

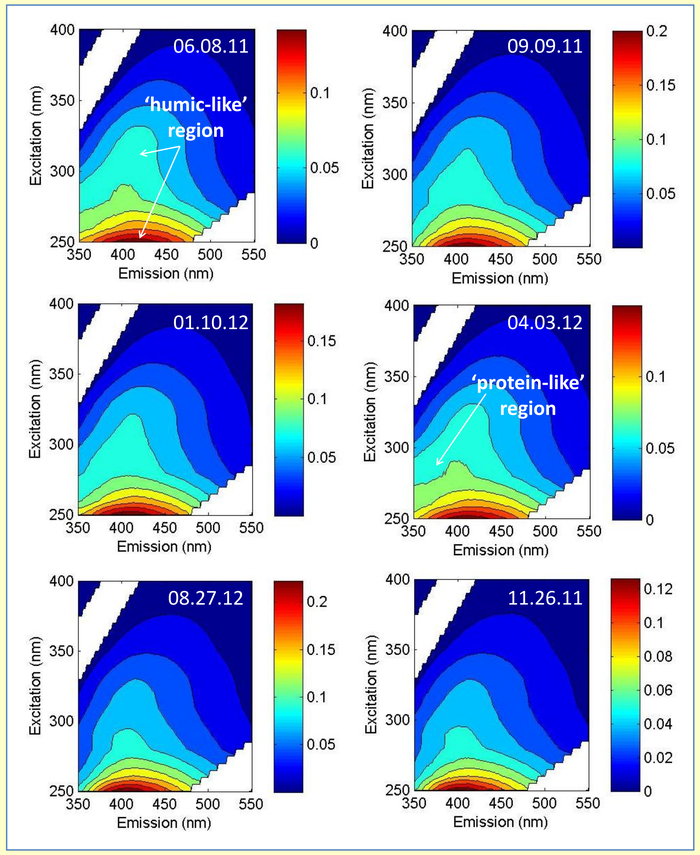


pH is generally high (~9) and constant; Temperature and dissolved oxygen show a strong seasonal pattern.

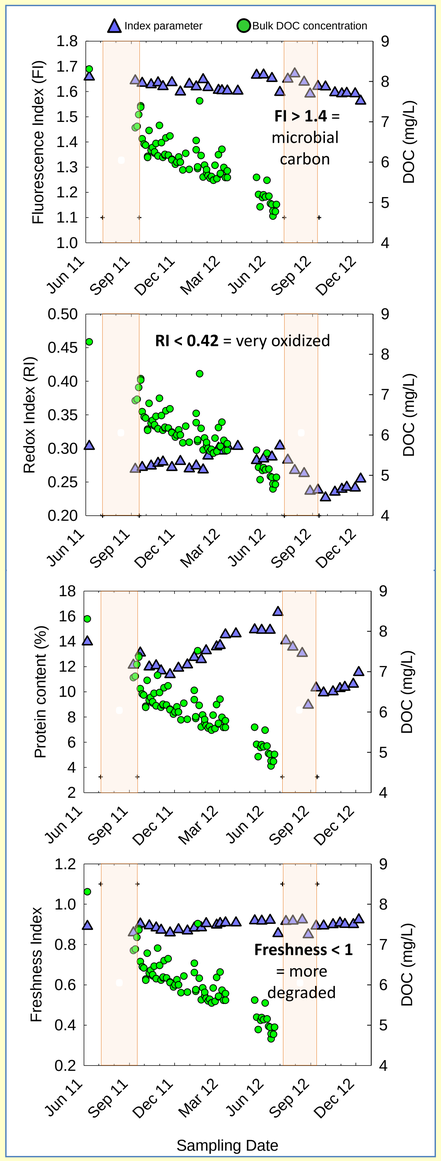
DOC decreases over the study period



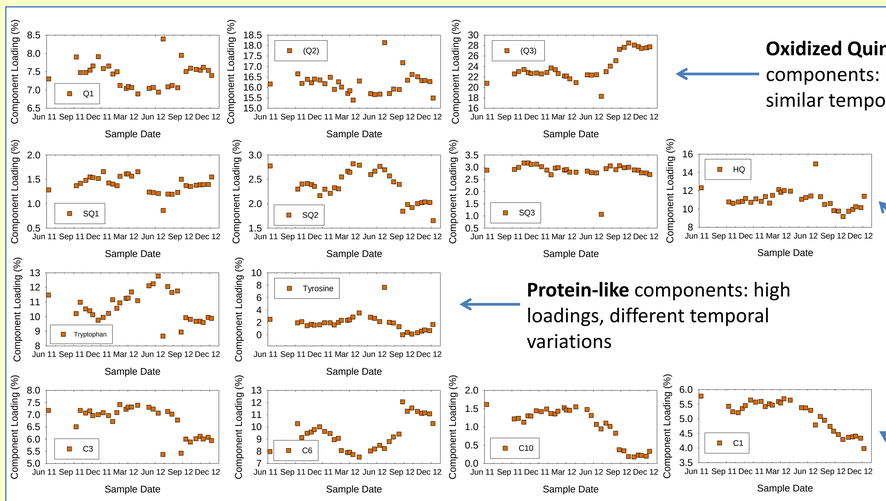
Fluorescence Spectroscopy Excitation Emission Matrices (EEMs)



Fluorescence Indices (related to the 'character' of the organic carbon)



PARAFAC Components (a linear combination model of known fluorophores, Cory & McKnight, 2005)



Oxidized Quinone-like components: high loadings, similar temporal variations

Reduced Quinone-like components: lower loadings, several temporal patterns

Protein-like components: high loadings, different temporal variations

Other components: several temporal patterns

The 13 components show a variety of temporal patterns – changes in fluorophore distribution are not generally correlated with changes in bulk DOC

Summary

- **From June 2011 though July 2012, bulk DOC in the lake decreased by ~45%. This was predominantly a dry, evaporative period.**
- **Individual fluorescent components exhibit temporal patterns different from those of the bulk DOC (PARAFAC)**
- **TTL carbon appears predominantly microbial in origin over the entire study period (FI)**
- **TTL carbon is highly oxidized (Q1-3, RI) and fairly degraded (Freshness)**
- **We plan similar analyses using samples collected during future high-flow and monsoon seasons to assess allochthonous organic carbon in TTL.**

Many thanks to CAP-LTER for their long-term support! Questions or further information? Contact H. Hartnett, h.hartnett@asu.edu