Biogeochemical Processes in Tempe Town Lake: trends and patterns in the amount and composition of dissolved organic carbon

Hilairy Hartnett[1,2], Megan Kelly[2,4], Kathryn Mayer[2], and Hilary Waterman[3,4]

[1] School of Earth and Space Exploration, [2] Department of Chemistry & Biochemistry, [3] Department of Chemical Engineering, [4] Barrett Honors College

Abstract

Tempe Town Lake is an isolated segment of the Salt R. channel in Tempe, AZ was primarily designed as an urban recreation site, but also serves as a flood control mechanism. We have being studying the lake since Jan. 2005. Our data suggest the biogeochemical cycling of organic carbon in the lake varies over seasonal as well as annual and interannual time-scales. Changes in the amount and composition of organic carbon in the lake may reveal information about the sources of organic matter to the lake, and the biogeochemical reactivity of that carbon.

Study Site

Typically, very little water flows into or out of the lake. Summer-time evaporative losses are "made up" from additions of canal water and seepage recharge wells. However, in winter 2005, dam releases on the Verde River resulted in high flow conditions.

Daily water sampling occurred from Jan – Oct 2005. Since that time, water samples have been collected approximately monthly, and in each summer during (or soon after) the onset of the southwest monsoon

Central Arizona has experienced long-term drought during the study period.

Southwest Monsoon Characteristics*

year	start date	end date	# rainfall events	total monsoon rainfall (in)
2005	18 July	11 Sept	8	1.53
2006	02 July	14 Sept	11	3.33
2007	19 July	11 Sept	6	0.74

*determined using NWS dew point criteria; data from NWS and the Maricopa County Flood Control District

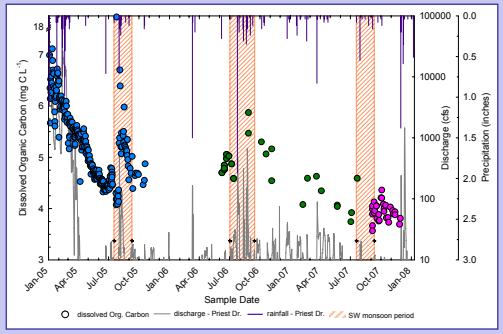
Methods

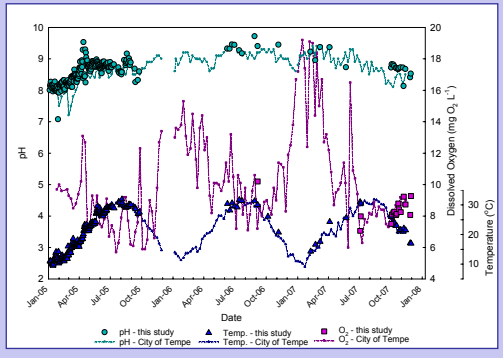
- Temperature, Conductivity, and pH measured in the field
- Water archived for nutrients, major ions, trace elements
- DOC/TN concentration: high-temp. catalytic oxidation
- DOC composition: electrospray ionization mass spectrometry

Potential effects of biogeochemical processes on organic matter concentration and composition

	DOC Concentration	DOC Composition
EVAPORATION	↑	same
MICROBIAL DEGRADATION	↓	changes
PHYTOPLANKTON PRODUCTION	↑	changes
SORPTION TO PARTICLES, FLOCCULATION	↓	changes
PHOTOCHEMICAL OXIDATION	↓	changes

Dissolved Organic Carbon & Water Chemistry

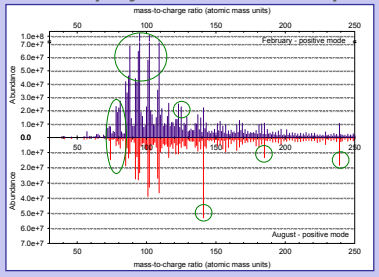


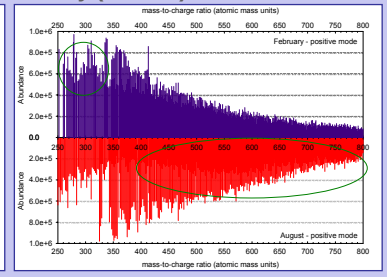


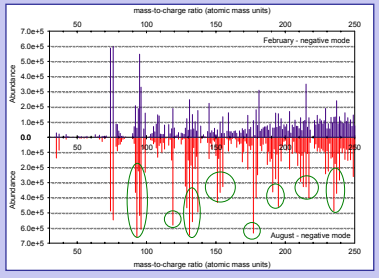
Observed Patterns

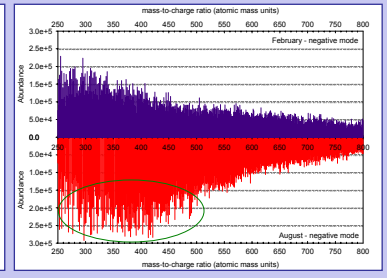
- DOC is generally high, but was highest during the 2005 storms. It decreases through late winter/spring and fall.
- In 2005, 2006 and possibly 2007 DOC concentrations increased significantly after monsoon rain events
- Interannual variability is fairly high, seasonal variations are large

Electrospray Ionization Mass Spectrometry (ESI-MS)









Seasonal Distribution of ESI Peaks

ESI-MS provides a "fingerprint" of the molecules present. Positive mode = bases, Negative mode = acids

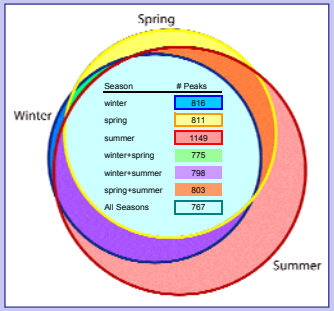
February 2005 (DOC = 5.5 mg/L)

- More unique, low-molecular weight peaks in POS mode

August 2005 (DOC = 4.6 mg/L

- higher abundances, and more unique peaks, predominence of high-molecular weight peaks, especially noted in NEG mode

Samples from the winter storm periods, the evaporative periods, and the post-monsoon periods exhibit differences in the distribution, number and abundance of organic compounds



Work in Progress, and future experiments….

Statistical and Spectral Analysis of ESI-MS Data

Principal Components Analysis

- establish correlations among ESI-MS peaks

Cluster Analysis

- establish groups of commonly occurring ESI-MS peaks

Assess correlations with meteorological data

(this work is M. Kelly's Honors Thesis Project)

Major Ion and Trace Element Analyses

Evaluate changes and patterns in major ion and trace element composition:

- Na^+, K^+, Ca^{++}, Mg^{++}, $SO_4^=$, Cl^-, etc.
- Fe, Mn, Co, Cu, V, etc.

Assess relationships with amount and composition of DOC

(this work is H. Waterman's independent research project)

Carbon Bioavailability Experiments

Measure rates of organic carbon production and consumption by plants and microbes!

Compound Identification Studies

Figure out what all these compounds are, and where they come from!

(We're looking for people to work on these projects !!)

Acknowledgements: *Many thanks to K. Alexander for 11th-hour sample analyses!!* **Questions or further information:** Hilairy Hartnett, phone: 480-965-5593, email: h.hartnett@asu.edu