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

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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 been 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.

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

<table>
<thead>
<tr>
<th>Process</th>
<th>DOC Concentration</th>
<th>DOC Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVAPORATION</td>
<td>↑</td>
<td>same</td>
</tr>
<tr>
<td>MICROBIAL DEGRADATION</td>
<td>↓</td>
<td>changes</td>
</tr>
<tr>
<td>PHYTOPLANKTON PRODUCTION</td>
<td>↑</td>
<td>changes</td>
</tr>
<tr>
<td>SORPTION TO PARTICLES</td>
<td>↑</td>
<td>changes</td>
</tr>
<tr>
<td>FLOCCULATION</td>
<td>↓</td>
<td>changes</td>
</tr>
<tr>
<td>PHOTOCHEMICAL OXIDATION</td>
<td>↓</td>
<td>changes</td>
</tr>
</tbody>
</table>

Observed Patterns

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

Work in Progress, and future experiments...

- Statistical and Spectral Analysis of ESI-MS Data
- Primary Components Analysis
  - establish correlations among ESI-MS peaks
- Cluster Analysis
  - establish groups of commonly occurring ESI-MS peaks
- Assess correlations with meteorological data

- Major Ion and Trace Element Analyses
  - Evaluate changes and patterns in major ion and trace element composition:
    - Na⁺, K⁺, Ca²⁺, Mg²⁺, SO₄²⁻, Cl⁻, etc.
    - Fe, Mn, Co, Cu, V, etc.
  - Assess relationships with amount and composition of DOC

- Carbon Bioavailability Experiments
  - Measure rates of organic carbon production and consumption by plants and microbes

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
  - Higher abundances, and more unique peaks, predominance 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

Statistical and Spectral Analysis of ESI-MS Data

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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!