LINKAGES AMONG ACIDIC AND MERCURY DEPOSITION AND CLIMATE CHANGE IN ECOSYSTEMS IN THE ADIRONDACK REGION OF NEW YORK

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Outline

- Background
- Acidic deposition patterns and issues
- Linkages with mercury
- Linkages with climate change
- Linkage with State, regional and U.S programs
- Final thoughts
Lake Classes

- Seepage
- Drainage
- Thin till
- Medium till
- Thick till
- Carbonate
Arbutus Lake – 48.2 ha
Climatic Data
- Solar radiation
- Precipitation
- Temperature

Atmospheric Chemistry
- Carbon dioxide
- Ozone

PnET
- Water balance
- Photosynthesis
- Living biomass
- Litterfall

Net Mineralization

BGC
- Aqueous reactions
- Surface reactions
  - Cation exchange
  - Adsorption
  - Humic binding
  - Aluminum dissolution/precipitation

Uptake

Deep water flow

Weathering

BGC – Surface water
- Aqueous reactions

Wet Deposition

Dry Deposition

Shallow water flow
PATTERNS AND TRENDS IN ACID-BASE STATUS
48 Long Term Monitoring Lakes
1992-2008

Change (ueq/L-yr, umol/L-yr)

<table>
<thead>
<tr>
<th>Substance</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO4</td>
<td>47</td>
</tr>
<tr>
<td>NO3</td>
<td>19</td>
</tr>
<tr>
<td>Ca</td>
<td>39</td>
</tr>
<tr>
<td>ANC</td>
<td>34</td>
</tr>
<tr>
<td>ALIM</td>
<td>35</td>
</tr>
<tr>
<td>HION</td>
<td>28</td>
</tr>
<tr>
<td>SO4 + NO3</td>
<td>46</td>
</tr>
<tr>
<td>CB</td>
<td>29</td>
</tr>
</tbody>
</table>

Min - Mean - Max
Effects of increases in DOC supply: compensating acidification, enhanced metal transport but decreases in bioavailability, and increase attenuation of light and prolonged thermal stratification
Cumulative Frequency Diagram for Ca (cmol$_c$/Kg)
Ca Normalized to C (Oa Horizon)

Cumulative Frequency Diagram for Exch. Al (cmol$_c$/Kg)
Exch. Al Normalized to C (Oa Horizon)
LINKAGES WITH MERCURY DEPOSITION
$y = 6.67x^{-2.40}$

$r^2 = 0.49; P < 0.0001; n = 131$

Sulfate (mg/L) vs. MeHg (ng/L) for Sunday Lake and Arbutus Lake.
LINKAGES WITH CLIMATE CHANGE
AOGCM Temperature Projections

AOGCM
- Hadley (high sensitivity)
- GFDL (mid sensitivity)
- PCM (low sensitivity)

Low $\text{CO}_2 = 550$ ppm
High $\text{CO}_2 = 970$ ppm
at 2100
With CO$_2$ Fertilization
Streamwater DOC

![Streamwater DOC Graph](image)

**DOC (μmol/L)**

1950 2000 2050 2100

- **HadCM3 High CO2**
- **PCM High CO2**
- **GFDL High CO2**
- **Observed**

- **HadCM3 Low CO2**
- **PCM Low CO2**
- **GFDL Low CO2**
Acidification Recovery

Deposition
- Sulfate
- Nitrate
- Acidity

Forests
- Soil
- Calcium
- Sugar Maple
- Red Spruce

Lakes
- Sulfate
- Nitrate
- ANC
- DOC
- Fish

Strongly Recovering
Moderately Recovering
Uncertain
Deteriorating
Mercury Interactions

Deposition

Sulfate  Mercury

Forestsover

Soil Mercury

Lakes

Total Sulfate Mercury  Methyl Mercury  DOC  Fish Mercury

Strongly Recovering

Moderately Recovering

Uncertain

Deteriorating
Climate Interactions

- **Deposition**
  - Soil Nitrate
  - Soil DOC

- **Forests**
  - DOC
  - Nitrate
  - ANC
  - Fish

- **Lakes**
  - Strongly Recovering
  - Moderately Recovering
  - Uncertain
  - Deteriorating

Legend:
- **Strongly Recovering**
- **Moderately Recovering**
- **Uncertain**
- **Deteriorating**
Linkages with State, Regional and Federal Management Programs

- NADP, CASTNet, LTM, TIME
- CLAD/FOCUS/CASAC
- MercNet
- Mercury pollution committee in NYS
- RGGI
Isopleth of ANC - Critical Load

Isopleth of ANC - Target Load (2030)
MercNet—Establishing a Comprehensive National Mercury Monitoring Network

2008 Workshop Report
Final Thoughts

- Continue monitoring, link acidic deposition, mercury and climate change monitoring and modeling
- Link between atmospheric and watershed models
- Better understanding of changes and effects of DOC supply
- Improved understanding and predictions of biological response to climate and chemical change
- Improved dialog between research and management programs