The Lake Tahoe Atmospheric Deposition Study (LTADS)

Joint ARB & SWRCB Workshop on Atmospheric Deposition and Water Quality
February 9, 2006
Presentation Outline

- Background
- Objectives & Study Design
- Results
The Problem: Declining Lake Clarity

LAKE TAHOE
Annual Average Secchi Depth ± 1 s.d.

Meters

Feet

r = 0.89
n = 36
p < .001
Stakeholders & Study Participants

- Air Resources Board
- Tahoe Regional Planning Agency (TRPA)
- Lahontan Regional Water Quality Control Board
- Nevada Division of Environmental Protection
- U.S. EPA
- U.S.D.A. Forest Service
- DRI, TRG, UC Davis, UC Berkeley, UC Riverside

Cost = ~ $2.3 million
LTADS Objectives & Study Design
LTADS Objectives

- Dry deposition of nitrogen, phosphorus and particles
- Source attribution and source categories
- Investigate transport of air pollutants to the basin
- Ozone levels and effect on forest health
Deposition Rate = Concentration $\times V_d$

- **Field Study Measurements** (Nov 2002 - Dec 2003)
  - Air Quality $\rightarrow$ Concentrations
  - Meteorology $\rightarrow$ Site specific, seasonal, hourly $V_d$

- Inferential Source Information
- Improve the Emissions Inventory
- Peer Review
Peer Reviewers

• Professor Thomas Cahill, UC Davis
• Professor Keith Stolzenbach, UC Los Angeles
• Professor Gail Tonnesen, UC Riverside
• Professor Akula Venkatram, UC Riverside
• Professor Anthony Wexler, UC Davis
Primary Instruments

- **winds aloft**
  - RWP/RASS also provides temperature aloft

- **TSP**
  - and PM species
  - on buoys & piers

- **TSP, PM10, & PM2.5**
  - & PM species, and
  - NH₃ & HNO₃
  - at land sites

**Mini-Sodar**

**Mini-Volume Sampler**

**Two-Week Sampler**
Typical Air Flow Patterns

Day

Night

W vertical cross section E
LTADS Diurnal Air Flow, Winter 2003
SLT - Sandy Way         LF - Coast Guard

CALM        OFFSHORE        ONSHORE        SIDESHORE

Number of Days

noon
LTADS Monitoring Network

- AQ – gas & PM
- AQ - PM
- AQ – single gas
- Deposition
- On-Lake
- Meteorology aloft

Locations:
- Big Hill
- Lake Forest
- Thunderbird Lodge
- SLT-Sandy Way
Sites in South Lake Tahoe
Results
**LTADS Deposition Estimates**  
metric tons to the Lake’s surface/year

<table>
<thead>
<tr>
<th></th>
<th>LTADS Dry</th>
<th>LTADS Dry + Wet</th>
<th>Jassby (1994)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nitrogen</strong></td>
<td>110</td>
<td>180</td>
<td>234</td>
</tr>
<tr>
<td></td>
<td>(68 – 150)</td>
<td>(94 – 300)</td>
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<tr>
<td><strong>Phosphorus</strong></td>
<td>2.2</td>
<td>6.4</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(0.6 – 3.6)</td>
<td>(1.8 – 15)</td>
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<tr>
<td><strong>PM</strong></td>
<td>590</td>
<td>1500</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td>(270 – 1100)</td>
<td>(650 – 3100)</td>
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</tr>
</tbody>
</table>
On-Lake Experiment
July 9 -10, 2003

- Vehicle exhaust and wood smoke near population centers in evening
- Drainage flushes shore zone overnight
- Vehicle exhaust precedes smoke in morning
- Effect confined to near-shore
Transport Estimate

- $\text{NO}_x$ - transport is unlikely
- Coarse PM - largely local sources
- Fine PM - local sources and possibly a regional background including transport of phosphorus from Asian soil
Emission Inventory Improvement

• Source Sampling
  – Prescribed Fires
  – Neighborhood Wood Smoke
  – Paved/Unpaved Road Dust
  – Sanding/de-icing
  – Motor Vehicles

• Activity Characterization
  – Prescribed & Wild Fires
  – Wood Burning
  – Sanding/de-icing
  – Motor Vehicles
Summary

- LTADS is the most comprehensive study of atmospheric deposition on Lake Tahoe to date
- Atmospheric deposition appears to be a significant source of nitrogen to the Lake
- Local sources of nitrogen & coarse PM are important
Acknowledgements

• ARB’s Monitoring & Laboratory Division
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• UC Berkeley, UC Davis, UC Riverside, DRI, NOAA
• Peer Reviewers
Thank you