CO$_2$ and Lake Superior

Cindy Schafer – GCEP, SURE
Michigan Technological University
Project Description

• Model CO₂ cycle within Lake Superior
  – Use measured gaseous and aqueous CO₂ concentrations

• Quantifying regional impact of Lake Superior on the carbon budget
Importance of CO$_2$ Flux over Lake Superior

- Effects on terrestrial CO$_2$ concentrations
- Source or Sink?
- Seasonal and spatial variability
Factors influencing \( \text{CO}_2 \) concentration over Lake Superior

- On-shore and in-lake diurnal photosynthesis and respiration patterns
- Seasonal variations in photosynthesis and respiration
- Atmospheric stability and fetch
Methods

• Micrometeorological instruments on boat mast 10 meters about the deck
• Other Instruments on deck
• Transect out into lake
  – Stations at 3km, 10km and 20km offshore
• Land Station
  – CO₂ gas analyzer
  – Humidity and temperature sensor
Instruments on Ship

- **From deck**
  - GPS
  - Surface water temperature probe

- **Mast 10m above ship deck**
  - Sonic anemometer
  - CO₂ gas analyzer
  - Fine wire thermocouple
  - RM Young wind monitor
  - Humidity and temperature sensor
  - Gyroscope
Flux Calculations

\[
\text{Flux (mg/m}^2 - s) = \left( [CO_2] - [CO_2]_o \right) \left( \text{mg/m}^3 \right) \times \left[ \frac{\text{mixing height (m)}}{\text{time over lake (s)}} \right]
\]

\[
\text{Mixing Height} = \frac{\left[ \frac{\text{Avg Flux (mg/m}^3)}{\text{time over lake (s)}} \right]}{\left( [CO_2] - [CO_2]_o \right) \left( \text{mg/m}^3 \right)}
\]
Preliminary Results

**CO2 Over Lake Superior**

- Flux [mg/m²-s]
- Distance from Shore (km)
- 26-Aug line

**CO2 Flux and Fetch**

- Flux [mg/m²-s]
- Fetch (km)
- 26-Aug line

**CO2 Concentration**

- CO2 Concentration (ppm)
- Distance from Shore (km)
- 26-Aug line
What’s Next?

• Motion Correct the wind speed data
  – Recalculate fluxes using vertical wind speed
  – Compare with other flux calculations
• Update Regional Model
• Paper
Thanks To:

• Milton, Jeff, Nancy, Alicia, and …. 
• GCEP, DOE, ORAU, ORISE 
• Dr. Perlinger, Dr. Urban, David Tobias and Mark Rowe