
Great Lakes
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Why Consider Carbon in the Great Lakes?

- Due to size, they are sensitive to climate change and land use change. Useful as sentinels.

- Easier to close C and nutrient budgets.

- May be important in regional C budgets (evidence for role of GLB in missing C sink.

- The lakes are dimictic. pCO_2 is re-set to equilibration each year.

- No salt, no sharks, no oil.

Key Questions:

- What is the net C flux for each of these systems, and for the region as a whole? This includes air-water exchange as well as other gain and loss processes.

- This is a challenge, because the region is diverse. Each lake is biologically, physically and biogeochemically unique.

- P loads have been reasonably well established for most of the lakes, and these may be useful in establishing preliminary allochthonous C load estimates (with assumptions of C:P ratios).

- There are big data gaps for winter months.

Overview of existing or imminent projects:

- Galen McKinley modeling in Superior, supported by data collection from Jay Austin and others.

- Great Lakes Observing System (GLOS, which is a component of IOOS) is in the process of setting up monitoring buoys on all of the Great Lakes. Some of these will have sensors related to carbon flux (pCO_2, Chl *a*, CDOM).

- pCO_2 measurements being made by a number of researchers on Superior and Michigan.

- EPA now monitors lake with a Triaxus monitoring device, which measures horizontal and vertical distribution of phytoplankton (pigment-specific), seston, others.

Existing Data and Models

- There are a number of existing or pending models addressing applied issues on the Great Lakes, such as nuisance algal blooms (lower Great Lakes), fish production (Michigan, Huron), anoxia (Lake Erie), and contaminant transfer (several lakes).

- Under oversight from NOAA and EPA, there is a current initiative to set up a Model Working Group, using Lake Michigan as a pilot.

- There are probably enough data to construct preliminary C budgets for Lake Superior and Lake Michigan.

Needs:

- Great Lakes data synthesis effort.
- Organize a Great Lakes carbon synthesis workshop.
- Consider measurements of stable and radioactive C in various pools.
- Request EPA and Environment Canada to include carbon pool measurements in their routine monitoring of the Great Lakes.
- There has been a lot of physical modeling, but there is a need for further development of biogeochemical models.
- Need to link lake models to watershed models.

- Virtually no data for organic carbon exchange between lakes and the atmosphere.

- More measurements of pools and fluxes in winter are needed. This includes in-lake and in tributaries.

- Better remote sensing algorithms.

- Need to link Great Lakes carbon dynamics to those of the St. Lawrence.

- Much of the above requires international cooperation and collaboration with Canada.

Progress Since 2008 NACM Report

- pCO_2 in Lake Superior and Lake Michigan.
- Modeling has advanced, especially for Lake Superior.
- Establishment of GLOS buoys.
- Mooring array in Lake Superior.
- Lake Superior carbon budget is closer to being balanced.