Thermal Structure Monitoring and Related Studies

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Overview

Observationally, perhaps the biggest gap in our knowledge of the physical environment in the Great Lakes is in being able to provide a detailed description of the annual evolution of the three-dimensional temperature field and its year-to- year variability. This information impacts the annual evolution of the entire biological community, all the way from the lower food web, including phytoplankton and zooplankton, on up to fish. Some information on surface temperature is available from satellite surface temperature maps and from NDBC buoys during the shipping season, but it is not possible to infer the details of the vertical thermal structure from surface temperature alone. Therefore, baseline measurements of the detailed horizontal and vertical distribution of water temperature data with high resolution in time and space are critically needed to assess inter-annual variability of the thermal structure of the Great Lakes, to test three-dimensional model parameterization, to understand vertical mixing processes, and to aid in interpreting biological and other environmental data. In addition to making new observations it is equally important to study historical data sources such as coastal temperature and NDBC buoy data to see what insights they can provide into system behavior and whether or not any trends are evident.

Proposed Work

The mid-lake mooring (Lake Michigan) will be pulled in the spring of 2009 and the mooring replaced with fresh temperature/data loggers and new hardware as well. The USCG has been placing temperature sensors on the NDBC 45007 buoy as well for GLERL, and new instruments will be provided to them as well.

All of the new data will be edited and archived for use in climatology studies of the thermal structure of Lake Michigan.

Accomplishments

- The mid-lake thermistor mooring was successfully retrieved. All 11 thermistors recorded data throughout the deployment period.
- A new mid-lake mooring was deployed containing 11 temperature data loggers.
- The NDBC in conjunction with the USCG has begun hanging thermistors for us on buoy 45007 at 3 and 6m below the surface on both their summer and winter moorings.
- Completed a temperature database for the main subsurface moorings for the years 1990 through 2008.

Scientific Rationale

The mid-lake thermistor structure monitoring addresses several needs for developing ecosystem forecasting tools. Knowledge of the water temperature climatology serves as a primary forecasting tool and is the basis upon which successful model development is gauged. With the continued development of a long-term data set describing the annual temperature cycle, and accompanying meteorological conditions, it will enhance both our climate and ecosystem forecasting capabilities. This will enable regional and national resource managers to better plan for the impact of climate extremes, variability, and change on the Great Lakes ecosystem. As we enter times of increasing interannual variability in the Great Lakes thermal cycle, it becomes ever more essential to today's climate and ecosystem forecasting research that long-term climate records are maintained with minimal interruption and further enhanced by application of new measurement technologies and new data analysis techniques.

Governmental/Societal Relevance

The temperature data gathered by this project represents the longest continuing set of observations on the offshore thermal structure anywhere in the Great Lakes.

Relevance to Ecosystem Forecasting

The National Academy of Sciences, the President's Committee of Advisors on Science and Technology, and the National Science Board all call for improvements in the capability of ecosystem forecasts. There is a need to improve the understanding of how environmental drivers change community structure and ecosystem function. More research is critical to understand patterns of ecosystem resilience at a variety of temporal and spatial interaction scales.

The potential major benefits of ecosystem forecasts are:

1. Improving decisions to sustain ecosystem productivity and lessening the impacts from extreme natural events and human activities.
2. Bringing scientists and resource managers together to solve resource management problems.
3. Focusing scientific research and monitoring priorities to reduce uncertainties in ecological forecasts
4. To forecast recovery rates to increase effectiveness of ecosystem restoration projects.

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