Enhancing Coastal and Ocean Observing and Innovation

Image: Harmful algal blooms; Lake Erie; HABs; Source

Observations of Great Lakes Multiple Stressors

A Lake Erie Testbed Approach

OVERVIEW

Threats to Great Lakes' ecosystems come from multiple sources including excess nutrients, harmful algal blooms, hypoxia, high water levels, and invasive species. Understanding the ecosystem complexity in toto is necessary to develop advanced modeling and forecasting techniques. Accurate determination of the impacts the Great Lakes suffer from these stressors requires a year-round observing system that addresses the need to simultaneously observe the interactions of these multiple stressors at relevant spatial and temporal resolution along with a data management and delivery system.

OPPORTUNITY

A Lake Erie test bed (a platform for conducting rigorous, transparent, and replicable testing of scientific theories, computational tools, and new technologies) focused on understanding the ecosystem stressors will provide a focused forum for improving the coordination of current efforts between the Oceanic and Atmospheric Research (OAR) and Integrated Ocean Observing System (IOOS); optimizing, formalizing, and systematizing collaborative processes; improving workflows; and coordinating work plans. Given the ongoing, collaborative observational efforts across Lake Erie, this lake is an ideal test bed for applying lessons learned to the other Great Lakes. A further overview of the Lake Erie Testbed Proposal can be found here.

NEXT

HARMFUL ALGAL BLOOMS (HABS). HABs in the Great Lakes result from numerous cyanobacteria species and can threaten human and ecosystem health, damaging local economies, and impact drinking water supplies. NOAA's operational forecast systems are currently focused on western Lake Erie and include a seasonal outlook and an operational HAB forecast. OAR and IOOS' combination of forecast and observational tools and data integration provides the awareness that was lacking when HAB toxins shut down the Toledo water intake in 2014. Advanced warning of changing lake conditions is available to drinking water managers and the public that provides for planning drinking water treatment as well as coastal recreational activities. Future Lake Erie testbed research and observations need to focus on the detection and forecasting of HAB toxin concentrations.

HABS: Lake Erie Testbed Priorities

- Provide hyperspectral HAB imagery for use in experimental HAB forecasts obtained from crewed and uncrewed airborne systems.
- Integrate the Monterey Bay Aquarium Research Institute (MBARI) 3G system into an autonomous surface vessel (ASV) to create a shallow water HAB toxin mapping system with initial testing in Summer 2021.
- Leverage the combination of sensors, systems, autonomous platforms, and real-time data collection, management, and distribution to:
  - Improve the understanding of cynaoHABs;
  - Enhance early warning services;
  - Contribute to the development of technology that can be used in other IOOS regional associations focused on HABs.
- Bridge the funding gaps for these projects that are in various stages of transition to operations.

HYPOXIA/ANOXIA. Persistent and episodic hypoxia and anoxia events result in very low dissolved oxygen (DO) and impacts Great Lakes ecosystems and drinking water in the United States and Canada, particularly in Lake Erie, which contains one of the largest hypoxic zones in the United States.

In 2015, a real-time hypoxia observing system developed by the Great Lakes Environmental Research Laboratory (GLERL) was operationalized by the Great Lakes Observing System (GLOS) in partnership with the Cleveland Water Department (CWD). GLERL has now developed an experimental hypoxia forecast system that is a candidate for transition to operations for use by the CWD and other water treatment managers. The forecast model development and validation is aided by moorings supported by GLOS, Cooperative Institute for Great Lakes Research (CIGLR) partner Limnotech, and the CWD. While the GLERL experimental forecast system is effective in providing hypoxia forecast information to drinking water intake managers, gaps in observational coverage remain that limit the system's effectiveness.

Hypoxia/Anoxia: Lake Erie Testbed Priorities

- Procure stable GLERL and CIGLR funding for continued deployment of the real-time and moored observational network.
- Fill in observations gaps with Slocum glider-based DO observations deployed by CIGLR partners.
- Evolve the GLOS Early Warning System to include hypoxic events and better leverage real-time observations.
- Develop a severity metric based on hypoxia duration and extent.

WINTER ECOLOGY AND ICE OBSERVATIONS. Great Lakes winter observations are limited relative to the other seasons due to the challenges of ice cover. This has resulted in clear observational and knowledge gaps because some Great Lakes biological processes are known to accelerate during the winter months. As a result, modeling and forecasting research and development lack the data required to validate processes during critical, annual thermal cycle transition times when data collection platforms (e.g., buoys, autonomous vehicles, and research vessels) are precluded from safe or efficient operation. While the remote sensing capabilities of the Great Lakes CoastWatch node at GLERL provide information about winter ice extent and ice type that are vital to commercial shipping and United States Coast Guard ice-breaking operations, winter observations in the Great Lakes need improvement.

Winter Ecology and Ice Observations: Lake Erie Testbed Priorities

- Deploy and leverage offshore cabled systems for year-round observations.
  - Deploy a second Western Lake Erie cabled system in 2021.
  - Leverage the Western Lake Erie cabled systems to generate year round observations, including baseline water quality measurements; and wave, current, and ice thickness observations using acoustic Doppler current profilers.
- Advance the operation and deployment of Under-Ice Autonomous Underwater Vehicles (AUV).
  - Advance the operation of under-ice AUVs, including an AUV docking station with power and data transfer provided by short cabled systems.
  - Advance deployments of uncrewed air systems (UAS) capable of ice albedo observations for ice forecast development and for ice classification.
- Leverage year-round observations to advance understanding of the impact of ice cover on HABs and winter phytoplankton production under ice.
- Leverage data integration and development of products and services to maximize the usability and access of year-round observations data.
- Bridge the funding gaps for these projects that are in various stages of transition to operations.

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