Transitioning to Operations NOAA-Supported Statistical Hypoxia Models and Forecasts in the Gulf of Mexico and Chesapeake Bay

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Award Number: NA12OAR4320071
Award Total: $200,000
Source of Funding: NCCOS support to CILER
Project Duration: September 1, 2015 to August 31, 2017

Introduction/Narrative

The Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA) mandates the development of scientific tools for managers addressing hypoxia in coastal systems. In response, NOAA has supported development of scenario forecast models in many U.S. coastal regions with serious hypoxia problems with the most mature of these efforts being focused in the northern Gulf of Mexico and the Chesapeake Bay. In both regions, statistical models are being used to inform regional management entities of progress toward hypoxia reduction goals. They also play a crucial role in raising public and stakeholder awareness of the hypoxia problems and the actions needed to address them which is an essential element of a successful management plan. For the Northern Gulf of Mexico, these statistical models are the primary management tool to set nutrient loading targets to reach the interagency Hypoxia Task Force goal to reduce the size of the hypoxic zone to 5,000 square kilometers.

The suite of forecast models currently used to produce the annual Gulf of Mexico dead zone forecast and to support long-term management decisions of the Gulf Hypoxia Task Force, as well as development of statistical models for the Chesapeake Bay, have been the product of competitive research funding from NOAA's National Centers for Coastal Ocean Science. Finalizing the transition to NOAA of the models developed, providing training on their operation, and simultaneously ensuring that the forecast outputs are produced during the period of transition, is a critical next step. In addition to support for regional interagency management efforts, the production of the forecasts and press releases are: 1) deliverables of the National Ocean Policy Implementation Plan for the Water Objective, 2) a FY15 Milestone for the Coastal Intelligence Priority of the NOS Roadmap, 3) Actions in the NOAA Ecological Forecast Roadmap Action Plan, and 4) an NCCOS FY15 milestone.

Specific Aims/Milestones:

The purpose of the requested work is to develop and implement a transition to "sustained operations" an ensemble-based, statistical modeling framework for hypoxia forecasting and assessment in the Gulf of Mexico and Chesapeake Bay capable of addressing NOAA's responsibilities to the Gulf Hypoxia Task Force and regional management entities. The developed system will provide a template for application and extrapolation to other regions (e.g., Great Lakes), applications (e.g., living resources impacts, watershed linkages), and capabilities (e.g., coupled modeling platforms, scenario-based management questions). As part of these transition efforts, NOAA's ongoing commitments for the production of the annual dead zone forecast will be maintained as well as the capability to address Task Force management questions as they arise. These are all goals of NOAA's Ecological Forecasting Roadmap initiative and in-kind NOAA/NCCOS support will be provided during the project to ensure operational needs are fully identified and NCCOS staff are adequately trained for effective and timely transition to NOAA operations. The 3 main focal areas of activity are outlined below.

Activity Area 1: Produce the annual dead zone forecasts for the Gulf of Mexico hypoxic zone size (area and volume) and Chesapeake Bay (anoxic and hypoxic zone volume) in coordination with NOAA.

- Utilizing existing ensemble forecast approaches with associated errors, uncertainty and defined confidence intervals, provide integrated hypoxic zone size predictions for the Gulf of Mexico and Chesapeake Bay. The ensemble prediction should be accompanied with supporting documentation describing the models and assumptions.

- Coordinate with NOAA staff on the development of the NOAA hypoxic zone press releases and maintain supporting documentation of the individual model forecasts on webpages that will be linked to the NOAA press release.

- Produce annual synthesis reports for the Gulf of Mexico and Chesapeake Bay forecasts, reviewing the accuracy of the forecasts and possible factors contributing to the observed size of the hypoxic/anoxic zone for that year and any deviations from the predicted size.

Activity Area 2: Provide technical assistance in coordination with NOAA staff for Gulf of Mexico hypoxia related questions from the Gulf Hypoxia Task Force which are amenable to or can be aided by statistical modeling approaches.

- With recently-updated models, reevaluate the nitrogen and phosphorus reductions necessary to achieve mitigation goals and management targets of the Gulf Hypoxia Task Force Action Plan as part of reassessment and adaptive management cycles.

- Provide responses to the Gulf Hypoxia Task Force related to ad hoc questions. For example, is the Gulf of Mexico becoming more sensitive to nutrient loading, how long will it take the system to respond to nutrient load reductions in the watershed, what will be the expected response of the hypoxic zone to interim load reduction milestone targets.

- Document the methodology for calculating the measured hypoxic zone areal extent and volume from monitoring observations. This methodology will provide a needed operational foundation for a robust and standardized procedure for documenting and measuring the annual size of the dead zone. This is a key variable for developing, validating and updating the models and is also the only measure used by the Gulf Hypoxia Task Force to assess progress toward its primary goal.

Activity Area 3: In coordination with NOAA staff, develop the requirements and conduct the training required for NOAA to maintain an operational scenario forecasting capability to address the management and public information needs related to hypoxia in the Gulf of Mexico and Chesapeake Bay, with expandability to other systems around the U.S. experiencing hypoxia. At the completion of the project, the requirements should be capable of addressing activity areas 1 and 2 from above.

- Organize and conduct training of NOAA staff on the use and long-term operations of the hypoxia forecast models within NOAA.

- In-kind support will be provided to NOAA staff in the development of a transition plan for an operational scenario forecasting capability to address issues related to hypoxia in the Gulf of Mexico and Chesapeake Bay which fully defines the requirements, components,

dependencies and costs associated with transitioning the systems to operational frameworks (see core components below).

- Transfer all necessary models and associated tools and documentation to NOAA.

Core Components of Operational Hypoxia Forecast System

- Models: Hypoxia forecast models. Models should be well documented and published in the peer-reviewed scientific literature and have a proven track record for being able to predict hypoxic zone size for a given set of conditions. Process to update models with new observational data.

- Personnel: Hypoxia modeling content expert to run the forecast models, interpret results, upgrade and troubleshoot model components, develop appropriate synthesis reports and communicate results to outreach personnel.

- Infrastructure: Desktop computing capability to run forecasts and to develop model uncertainty estimates for both individual models and for ensemble forecast products. Computing capacity to graphically display and synthesize model forecast products.

- Monitoring: For the Gulf of Mexico, annual ship-board mid-summer hypoxic zone survey conducted in July during the expected maximum annual extent of the hypoxic zone in the Gulf of Mexico. This is the absolute minimum annual observational effort to validate the model forecast and to serve as the key metric to measure success toward achieving the Gulf of Mexico Hypoxia Task Force Action Plan goals. Spring river loads of nitrogen (and perhaps phosphorus) from USGS monitoring and/or from NWS river forecasting models is also a requirement. In the Chesapeake Bay, EPA Chesapeake Bay Program and MD DNR will deliver monitoring data on hypoxic and anoxic volume at various seasonal intervals to inform the summer hypoxia review and press release.

- Data Management and Visualization: Staffing, protocols, computing power, storage capacity and web capabilities to quality assure, archive and distribute observational data, model output and associated data products such as model uncertainty analysis and model validation data (e.g., processed cruise survey data). Data analysis products such as the interpolation of the annual hypoxic zone area and volume are also needed along with the capacity to conduct additional analyses and develop synthesis reports as needed.

Outputs

- Continued production and improvement of the annual hypoxic zone forecasts in the Gulf of Mexico and Chesapeake Bay and the creation of integration, ensemble based forecast products.

- Continued capability for NOAA to provide essential model-based informational products to assist in Task Force assessments, Action Plan goals, and Chesapeake Bay management interests.

- Transition plan document for operational scenario-based hypoxia forecasting in the Gulf of Mexico and Chesapeake Bay including options for NOAA to assume all responsibilities.
- Transition to NOAA the scenario-based hypoxia forecasting models with potential applicability to other types of scenario forecasts currently being developed in NOAA.

Outcomes

- A long-term, sustained operational capacity in NOAA to respond to Gulf Hypoxia Task Force and HABHRCA related needs for hypoxia.
- The first successful transition to operations and adoption within NOAA for an operational, scenario-based ecological forecasting application.
- The creation of a core scenario forecasting modeling capability within NOAA (personnel, models, infrastructure) from which to add additional capabilities (living resources, etc.)
- A scenario-forecasting based template from which to apply toward other NOAA ecological forecasting applications.