The Continued Development of the Northeastern Regional Coastal Ocean Observing System

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LONG-TERM GOALS

The overarching intent of this proposal is to continue operation and further the development of the integrated ocean observing system for the Northeast and to expand the user base through consultation and outreach.

OBJECTIVES

At the recommended funding level NERACOOS will achieve the following objectives detailed in the original work plan of the proposal submitted in the fall of 2010. Due to the overlap in the performance periods of the FY2010 and FY2011 IOOS Implementation awards, efforts will be able to maintained at current capacity without the anticipated decrease in activity with level funding. In addition, enhanced capacity will be achieved in nutrient and water quality monitoring especially in Narragansett Bay and wave measurements on Jeffreys Ledge.

1. Coordinated Regional Management
   1.1. NERACOOS office at base capacity.
2. Observing Subsystem
   2.1. Planning for future enhancement and National Synthesis of Regional Build Out Plans
   2.2. The Gulf of Maine buoy array will be maintained at current capacity (6 buoys – UMaine).
   2.3. The Long Island Sound buoy array will be maintained at current capacity (3 buoys – UConn).
   2.4. The Great Bay Coastal Buoy and Coastal Marine Lab will be maintained at current capacity (UNH).
   2.5. The Gulf of Maine HFR array will be maintained at current capacity (3 locations – UMaine).

2.6. HAB monitoring in the Bay of Fundy and MERIS satellite work will be maintained at current capacity (BIO).
2.7. Nutrient work will obtain additional capacity to allow buoy integration at URI and maintain capacity of the AZMP program (URI and BIO).
2.8. Enhanced observing capacity will be achieved with continuing the deployment of Jeffreys Ledge CDIP wave buoy (UNH).
2.9. Enhanced observing capacity will also be obtained with the real-time telemetry Narragansett Bay Fixed-Site Water Quality Monitoring Network (NBFSMN, URI).

3. Data Management and Communications Subsystem
   3.1. DMAC coordination will be maintained at current capacity (GMRI)
4. Modeling and Analysis Subsystem
   4.1. The Northeast Coastal Ocean Forecast System will be maintained at current capacity (UMassD).
   4.2. The WaveWatch III wave model will be maintained at current capacity (BIO).
5. Outreach and Education
   5.1. Current capacity at the NERACOOS office will be maintained.

APPROACH AND WORK PLAN

The work plan is organized by subsystem, asset class, and general priority.

1) Coordinated Regional Management

Governance and organization – The Board of Directors will continue to meet quarterly with an annual meeting in the fall. A similar quarterly meeting schedule for the SPI Team will occur a month before Board meetings, allowing feedback on progress to date.

Management Plan –The NERACOOS Executive Director has overall responsibility to oversee the sustained management, development and operation of the regional observing system for the Northeast. He will coordinate and lead the PI Group consisting of the other investigators named in this proposal. This group will meet monthly via tele/video conference and in person once a year in conjunction with the SPI team annual meeting and will report out to the SPI team quarterly. The NERACOOS office will compile and send semi-annual progress reports to NOAA in the specified format, provide performance metrics, and seek certification by IOOS when appropriate.

Identifying Regional Needs and Priorities – Building on the 2010 regional planning initiative, NERACOOS will annually invite the user base to review strategic priorities and identify omissions. A running list of needs and enhancements will be compiled and reviewed quarterly by the SPI team in order to refine and manage priorities. NERACOOS will enhance its requirements process by contacting end users of all products and services to determine how well they meet end-user needs and how products can be improved. In development of new products, NERACOOS will invite users to participate from end to end.

Information, Product and Service Requirements Process – The SPI team and its working groups bring representatives of stakeholders who need the information, products, and services of NERACOOS together with those who have the capability to deliver them. All working groups, based on input from activities such as the regional planning initiative and communications with its membership, suggest strategic priorities. The SPI team then collates the input and develops the full strategic priorities.

NERACOOS will be creating a product team in fall of 2010 to be charged with development of products determined for which a clear need is identified. The process includes initial scoping of requirements, information gap assessments with suggestions for remedying, technical development, and performance evaluation. The product team will be highly flexible and drawn from individuals funded by NERACOOS as well as interested parties and contractors, and overseen by the outreach and communication specialist.

2) Observing Subsystem - a system of systems with multiple uses

The NERACOOS observing system supports multiple uses of individual assets and includes additional capacity and leveraged activities to provide an integrated regional monitoring program. The initial priorities are to fund the current systems either at existing funding levels (with the resulting loss of capacity over time), or at anticipated levels necessary to maintain the current capacity now and in future years. Subsequent increases in funds will add additional elements detailed below as Enhanced Capacity. All data will be quality controlled, and with nationally recognized standards (e.g., Quartod developed protocols) when applicable.

Planning for future enhancement – Observing systems are designed to measure inherent variability of environmental systems at sufficient temporal and spatial resolution to enhance understanding and remove gaps in knowledge. Future build-out plans for the observing system will first define the knowledge gaps and the measurements needed to address them. The final design will then optimize asset deployment to maximize knowledge return to multiple sectors based in-part on economic return. Balance between financial constraints and optimal design is not trivial and the former are the major obstacles to meeting stakeholder requirements. Technological challenges exist, too, such as sensor availability and adaptability to environmental conditions. An updated Regional Build Out Plan (RBOP) or conceptual design developed in the next year by the SPI Team will refine gap analysis in the current system and provide a basis for system enhancement. Annual updates of the gap analysis are an integral part of the strategic operating plan (SOP) mandated by the ICOOS Act of 2009. NERACOOS working with the National Federation of Regional Associations for Coastal and Ocean Observing (NFRA) will also fund development of a national synthesis of the RBOPs developed by all eleven IOOS regions.

The Gulf of Maine Buoy Array– UMaine Physical Oceanography Group (PhOG) will continue to operate data buoys in the GoM for 2011-2016. PhOG has designed, built and operated the IOOS buoy system in the GoM since 2001. Operations include calibration and sensor preparation, system testing, and mooring operations as well as all data processing and distribution, in IOOS-compatible formats for posting on the NERACOOS website. Deployment and servicing are on a 12-month rotation. Unscheduled servicing will be performed only to deal with failures related to marine safety (wind, waves) or malfunctions that could risk buoy loss.

The Long Island Sound Buoy Array – UConn will maintain, operate and distribute data from 3 buoys that measure wind speed and direction, currents, salinity, conductivity, temperature, pressure, currents, and dissolved oxygen near the surface, bottom and mid-depth supporting hypoxia research whose results are used by both EPA Long Island Sound Study and NY and CT to set nutrient reduction goals. Two buoys will be located in western LIS and the third will be in the Central Sound. All data will be telemetered to shore, and UConn will maintain and operate a data archive and Mapserver-based distribution system that shares the near-real-time observations with the NDBC and the NERACOOS data system. UConn will also continue to acquire monthly water quality survey data from the CTDEP and include it in the freely accessible archive.

The Great Bay Coastal Buoy – UNH will continue operation of the Great Bay Coastal Buoy (initiated in 2005) during ice-free months and the Coastal Marine Lab (CML) will also monitor oxygen and carbon dioxide, and serve as a node for NERACOOS ocean acidification data. With level funding the number of sensors supported will be decreased.

Gulf of Maine HFR array – The UMaine PhOG will continue its CODAR operations at three locations (two at level) in the northeastern GoM, process the data, post them online, and make them available to the national HF RADAR Network Gateway for use by the USCG, and provide them to the Canadian Coast Guard for integration with Canadian Search and Rescue operations. Although PhOG will continue to visit the island installations for servicing, most of the routine operations will be performed via subcontract with CODAR Ocean Systems (the manufacturer) to ensure consistently high data quality.

HAB monitoring – BIO will continue detecting *Alexandrium* using remote sensing data in the pilot area of the outer Bay of Fundy. BIO will perform weekly shipboard sampling over a fixed array of five stations from May to October, and collect, analyze and validate high-resolution ocean color imagery (MERIS) through direct measurements of optical properties in the surface layer. The diatom algorithm of Sathyendranath et al. (2004) will form the basis of a "HABs warning" product that will be validated for the Bay of Fundy before expansion to the rest of the region.

Nutrient work –URI will facilitate continuous, in-situ, spatial and time-series measurements of nutrient concentration by deploying commercially available sensors at key regional locations and time periods. URI has a long-term goal of obtaining and analyzing in situ, time-series measurements of nutrient concentrations by deploying commercially available sensors. The URI nutrient sensing team will oversee analytical calibration, operation, deployment and data processing and products for in situ nutrient sensors deployed on moorings and other regional observation platforms. Five different types of commercial nutrient sensors are presently available (11 units total) for the project. The nutrient sensing facility team will co-deploy nutrient sensors along with other water quality sensors on multiple sampling platforms and locations determined by the SPI team within the NERACOOS region.

The ongoing AZMP regular, semi-annual sampling of nutrients and hydrographic properties will be continued for a section across the Northeast Channel. Processing of data will take place at BIO, and results will be made available online through the BIO hydrographic database.

Jeffreys Ledge wave buoy – Since 2008, UNH has operated a buoy in the GoM on Jeffrey's Ledge supplying near-real-time ocean wave and sea surface temperature data every 30 minutes for 23 of the last 24 months. The buoy is integrated into the Scripps CDIP, NOAA NDBC, and NERACOOS web-based data servers and is used by the Gray, ME, WFO for setting the SST boundary condition at the southern end of their region. The data are regularly accessed by NWS forecasters, recreational and commercial fishermen and whale-watch vessels. This effort complements the other CDIP buoy operated by the US Army Corps of Engineers (USACE) off Block Island that is also already integrated into NERACOOS and contributes to the National Wave Plan.

Narragansett Bay real-time telemetry – The Narragansett Bay fixed-site water quality monitoring network (NB-FSMN) presently consists of 13 estuarine locations capable of continuously monitoring water quality conditions with respect to hypoxia. RI Department of Environmental Management (RI DEM) coordinates the network and uses the data to support the assessment water quality conditions. Recent assessments (Codiga et al. 2009) indicate about one-third of the Bay waters (RI only) experience periodic hypoxia associated with excessive nutrient loadings. To address it, wastewater treatment facilities discharging to the upper Bay and its tributaries are in varying stages of implementing upgrades. Monitoring the bay over the next five to seven years is critical to measuring the responses of the bay ecosystem. The project will provide real-time transmission via the NERACOOS website through IOOS standards and expand the distribution of data by linking quality-assured data to NERACOOS annually.

3) Data Management and Communications Subsystem

DMAC coordination –Previously NERACOOS and its partners have implemented various components of a regional DMAC system; now we will leverage those past components and existing capacity and upgrade the existing DMAC system to bring it into full compliance IOOS for certification.

At base funding, the GMRI will continue to operate and maintain the core NERACOOS DMAC capacity, which includes maintenance and operations of a secure, robust, 24/7 web presence (www.neracos.org) and data management infrastructure, integration of data from regional providers, coordination and support of regional DMAC efforts and participation in national IOOS DMAC activities. Base funding will only support an incremental adoption of IOOS recommended DMAC guidance as described below.

There is a critical need to better integrate, coordinate, and modernize the entire NERACOOS DMAC system. At the maintenance funding level the DMAC lead will initiate a planning process to develop a long term DMAC implementation plan that will be developed in years 1-2 and implemented in years 2-5. The implementation plan will describe how NERACOOS will deploy the information system components (including infrastructure and relevant personnel) for full life-cycle management of observations from collection to product creation to public delivery, system documentation, and archiving. Maintenance funding will also support the full and timely adoption and maintenance of standards and services described below.

Observations **–**The NEARCOOS DMAC team will ensure that all NERACOOS partner observations are delivered through an OGC compliant SOS service including to NDBC and will provide support to implement and improve these services. The DMAC team will develop monitoring and notification tools for the observing data streams that will allow NERACOOS to monitor and document observing system performance.

Gridded Data –The DMAC team will continue implementation of CF compliant OpenDAP and THREDDS data servers. They will support regional modelers and product developers by providing a standards based, interoperable framework to develop model comparison and validation products, comparison toolkits, and model nesting providing a Regional Model Interoperability System. It will also support delivery and integration of new models as they become available.

Archival – Ensuring archival of NERACOOS data in perpetuity is a critical aspect of the DMAC system. The NERACOOS observations database and web servers are hosted at a managed hosting service. The database is backed up daily. Regional providers perform local archival. To ensure true long term archival, the DMAC team will work with NOAA's NODC to identify and implement a process for delivering NERACOOS information to the NODC archive. THREDDS and other DMAC data servers will facilitate this effort and allow automated archiving of historical data.

Metadata –The IOOS Catalog effort has been focused on harvesting necessary metadata directly from TDS, WMS, WCS and SOS services. Therefore, the NERACOOS DMAC team will ensure that sufficient metadata are returned by the standard service responses in order to generate ISO 19115-2/19 records for all NERACOOS services. The ISO records will be available to web search engines that will facilitate more effective discovery and use of NERACOOS data. Extensive Global Change Master Directory (GCMD) metadata records already exist for the NeCODP members so tools will be developed to convert these existing records to be ISO19115 compliant.

Standards definition – Significant progress has been made by the National IOOS DMAC effort on identifying and recommending standards to support data interoperability. However, some standards are still in development. NERACOOS will continue to actively participate in national and regional working groups to evaluate, test and enhance the existing standards. Additionally, we will continue to participate in efforts to advance DMAC efforts.

DMAC team – NERACOOS DMAC efforts will be led by the ocean data products program at GMRI. All NERACOOS observing and modeling partners will participate to ensure regional integration. The NERACOOS DMAC work has recently integrated with the work of NeCODP, which led a regional approach to improve the discoverability, accessibility and interoperability of ocean and coastal data sets that reside in various state and federal agencies, academic institutions and nonprofit organizations. This collaboration will provide a wide range of non-IOOS funded routine observations collected in the region, providing a broad spatial and temporal context for interpreting data and feeding assimilative models.

4) Modeling and Analysis Subsystem

The Northeast Coastal Ocean Forecast System – UMassD will maintain and operate NECOFS during the five year period. After the Scituate IFS is tested and operational, it will be used to build the Saco IFS. The IFS will then be expanded for the northeast regional domain. Desired outcomes include 1) 3-day prediction of water surface elevation, temperature, salinity, currents and surface waves, 2) warning of coastal flooding and 3) accurate coastal inundation statistics to enable rationale planning. The current NECOFS hindcast archive 1995-2010 will also be extended to 2016 for use in scientific studies, engineering applications, and federal and state planning efforts (CMSP).

WaveWatch3 – The BIO wave model will be supported for delivery of surface wave forecasts to the region in near-real-time, and to contribute to operational products such as the spill-over algorithm used by the NWS. There are two primary tasks involved in this work: 1) continuous error-checking and resolution of operational difficulties in maintaining smooth and consistent operation, and 2) implementation of a new version of the operational model, WaveWatch, featuring flexible, two-way nesting of the computational grid providing reduced computation time is and enhanced accuracy.

Operation of the surface current forecasting algorithm for the national grid – UCONN will continue to operate a computer system to automatically retrieve data from the National HF RADAR database hourly for the national grid, compute the STPS forecasts for 24 hours and share the results with the USCG's EDS. To make the system more resilient, in the first year we will purchase and install backup computers at an offsite location to allow the forecasting calculations for the National Grid to be completed when there is a power or data flow disruption at the Avery Point Campus. A review of the errors in forecasts for a 30 day period will be conducted for each area in which the STPS is implemented to ensure that forecasts are consistent with observations.

5) Outreach and Education

One of the recommendations from the regional planning initiative was a regional Coordinated Outreach and Communication Strategy that could leverage partner's strengths and increase impact with common messaging. The NERACOOS outreach and communication specialist will work with the 13 regional partner organizations on developing this strategy.

NERACOOS will continue to work together with NEOSEC in promoting ocean literacy through collaboration, implementation of ocean observing educational capacity, continued co-sponsorship of the Ocean Literacy Summits, and create joint communication and outreach strategies in 2012. NERACOOS and NEOSEC partners will continue to submit applications for mutually beneficial funding opportunities. The EO section of the NERACOOS website will host resources for ocean observing, aligned with ocean literacy principles, and include key data sets, links, and lesson plans. Further, NERACOOS will work with COSEE-Ocean Systems (OS) to connect observing system science with educators. COSEE-OS will employ its proven communication techniques and online tools, to help NERACOOS work effectively with educators in NEOSEC. Through workshops tailored specifically to the needs of NERACOOS scientists and NEOSEC educators, COSEE-OS will help ensure that scientific data and content can reach broad audiences in an efficient manner. An annual

environmental assessment will also provide a regional synopsis for managers, educators, and the public.
NERACOOS will continue coordinating with national efforts by continuing its participation with the NFRA Education and Outreach Committee (EOC) which includes representatives from all 11 RAs, IOOS, COSEE NOW, and ACT through regular conference calls and in-person meetings.
NERACOOS will continue to participate in mutual projects with the EOC, including developing common products and services utilizing COSEE NOW online infrastructure; developing and implementing a standardized evaluation process; and creating a plan to communicate information about technologies and data being used during oil spills.

WORK COMPLETED

U.S. IOOS regional awards were finalized by NOAA in late August 2011, so work on this award is just beginning. All aspects of the work are being sustained with funds awarded in previous cooperative agreements with NOAA.

Drs. Holly Price and Leslie Rosenfeld were selected as the contractors to support the national synthesis of the regional build out plans from a pool of applicants who responded to a request for proposals issued by NFRA. The selection was made by the build out plan steering committee which included members of the IOOS program office and IOOS regions. Five tasks identified included; 1) assist the Steering Committee and RAs with completion of initial drafts of build out plans, 2) initial high-level review of submitted plans, 3) synthesis of Regional Plans for November Workshop, 4) finalize the synthesis, and 5) prepare synthesis, gaps identification and Executive Summary. To date aspects of tasks 1 to 3 have been worked on and completed. A National Synthesis workshop was held in Portland, ME on November 16 and 17 with representation from all eleven IOOS regional associations, the IOOS Program Office and the Interagency Committee on Ocean Observing (IOOC). Work continues on the synthesis which will be concluded before the end of the first quarter in 2012.

RESULTS

No significant results were achieved to date during 2011 with funds from NOPP.

IMPACT AND APPLICATIONS

National Security

The observing systems in the NERACOOS region provide critical information to mariners on ocean conditions including the U.S. Navy and Coast Guard.

Economic Development

The observing systems in the NERACOOS region provide critical information to mariners on ocean conditions including commercial shipping operations and harbor pilots, essential components of the nation's economy.

Quality of Life

The observing systems in the NERACOOS region provide critical information to those who manage the regions coastal waters including those responsible for Harmful Algal Blooms research, alerts, warnings, and closures.

Science Education and Communication

NERACOOS works closely with NEOSEC and COSEE-OS to promote science education and communication with diverse audiences.

TRANSITIONS

Most activities of NERACOOS are being used by others as IOOS is an end-user driven system to deliver information to those who use and manage the coasts and ocean in the northeast U.S. and Canadian Maritime Provinces of New Brunswick and Nova Scotia. As such, many NERACOOS products and services are incorporated into programs throughout the operational spectrum. For example, the buoys of the Gulf of Maine array have a data return in excess of 90% which is comparable or exceeding the returns of the operational National Data Buoy Center observations in the region. These are routinely used by the National Weather Service's Weather Forecast Offices in the region.

National Security

See comment in the impact section above.

Economic Development

See comment in the impact section above.

Quality of Life

See comment in the impact section above.

Science Education and Communication

See comment in the impact section above. An example would be the "Earth as a System is Essential" (EaSiE) project of the Maine Mathematics and Science Alliance (MMSA) which incorporates NERACOOS information into classroom lesson series.

RELATED PROJECTS

The Northeast Ocean Data Portal (www.northeastoceandata.org)
The Northeast Coastal and Ocean Data Partnership (www.necodp.org)
Earth as a System is Essential (http://www.easie-mmsa.org/)
Families by the Seaside (http://www.neosec.org/projects/families-by-the-seaside)
NSF OOI Pioneers Array (www.oceanobservatories.org)
National Federation of Regional Associations for Coastal and Ocean Observing (www.usnfra.org)

U.S. IOOS Super-Regional Modeling Testbed (http://testbed.sura.org/)

OUTREACH MATERIALS

There are too many materials to include in this report. See http://www.youtube.com/watch?v=vQt2vnPLje8