## Ocean Observation

# U.S. IOOS Program Update

*by Zdenka Willis, Director, U.S. IOOS Program, NOAA*

As I write this, I am taking some personal ocean observing at my beach house in South Carolina where I spend my days with my family walking the lovely beaches and enjoying the surf. So, for me, the U.S. Integrated Ocean Observing System (IOOS) is personal, which is something I share with everyone involved in IOOS. The passion runs high as we all strive to set up this national effort. As I reflect on the accomplishments since we last reported two years ago, there has been good progress, but additional resources remains elusive.

On March 30, 2009, President Obama signed the Integrated Coastal and Ocean Observation System Act of 2009 ("the Act") into law, authorizing U.S. IOOS and designating NOAA as the lead federal agency. This was followed, on July 19, 2010, by the Administration releasing the Final Recommendations of the Interagency Ocean Policy Task Force, which has as one of its priorities to strength and integrate Federal and non-Federal ocean observing systems into a national system, and integrate that system into international observation efforts.

### At the National Level

Data Management and Communications (DMAC) is the primary mechanism to integrate collected data. The Data Integration Framework (DIF) will finish in September with having integrated seven variables (i.e. ocean currents, temperature, salinity, water level, waves, chlorophyll, and surface winds) at three NOAA data centers and all eleven of the IOOS Regional Coastal Ocean Observing Systems (RCOOS) and will transition to the baseline capability of the IOOS DMAC subsystem. IOOS data integration was used to improve NOAA's operational storm surge model. NOAA's National Weather Service (NWS) forecasters and emergency managers can now call up time series graphs of water levels and winds and display them along with surge information from the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) program. It was first used during the 2009 hurricane season to improve communications to the public on expected inundated areas in advance of a hurricane. In June 2010, IOOS launched the first version of the IOOS Data Catalog to allow users to find the data they want, for the location and time period of interest, from all available IOOS partners without having to know in advance which partners actually operate the observing systems and data servers.

We made progress on implementing the Act. The Integrated Ocean Observing Committee (IOOC) was chartered. Initial steps included hosting a town hall session focused on public-private partnerships at the Oceans '09 conference sponsored by the Marine Technology Society, drafting a public-private use process, beginning to develop certification standards for IOOS' non-federal assets, releasing yet another competitive Federal Funding Opportunity for regional participation in FY11, continuing to focus on the development of a data management and communications system, and pursuing a path forward for establishing a System Advisory Committee.

### Advances in Observing

High Frequency Radars (HFR) operate in 9 of 11 IOOS Regions. A national HFR data delivery system was established at NOAA's National Data Buoy Center (NDBC), The Scripps Institution of Oceanography, and Rutgers University. The United States Coast Guard ingests surface data currents from HFR sites into its SAR operations center for the mid-Atlantic coast which results in decreasing the area of search by up to two thirds over a four-day period. In 2009 the National Surface Current Monitoring Plan was published.

The U.S. Army Corps of Engineers (USACE) and NDBC have long led the nation in wave observation programs, but the observation locations were based on local project or user requirements resulting in a useful but ad hoc network with limited integration. The National Operational Wave Observation Plan addresses this situation by defining a comprehensive wave-observing network for the United States. The plan defines a standard level of wave measurement accuracy, assesses existing measurement locations, adds additional observations in critical

"gap" locations, implements a continuous testing and evaluation program, supports the quality assurance/quality control and data integration and promotes the development of new sensors and measurement techniques.

"New Technology's Historic Underwater Flight Advances Climate Understanding, Education" is how we describe the Atlantic crossing of Scarlet Knight, from April 27, 2009 to December 9, 2009. Scarlet Knight is a Slocum Glider developed in partnership with Teledyne Webb Research Inc. **This effort emulates the partnerships of IOOS bringing together Rutgers University, NOAA, the Office of Naval Research, the National Science Foundation, Puertos Del Estado (Spanish Port Authority), and Teledyne Webb Research Inc.** This mission opens up new frontiers in the ocean, with the ability to accomplish for deep water oceanography what it has already done in continental shelf oceanography. The data collected through this mission was used to benchmark remotely sensed information and the HYCOM model output. As part of an undergraduate class, this mission also provided practical applications for oceanography, computer science, and engineering students. Additional glider operations include efforts in the mid-Atlantic by MACOORA and SECOORA, by SCCOOS to evaluate El Niño conditions, by PacIOOS for integration and model verification, by GLOS to test applicability in freshwater, by NANOOS with the incorporation of acoustic modems to track fish.

Partners of IOOS recently deployed various types of ocean data collection sensors. PacIOOS deployed water quality systems in Guam, Palau, the Marshall Islands, and the Federated States of Micronesia. Two additional buoys will be deployed in Hawaii and the insular Pacific. NANOOS, with the Murdock Foundation, deployed a buoy system off the coast of Newport, OR, which measures meteorological quantities, chlorophyll, turbidity, dissolved oxygen, temperature, salinity, pCO2 and pH. MACOORA deployed the historic Francis Scott Key buoy in the Patapsco River. CaRA worked closely with NWS San Juan Weather Forecast Office (WFO) and deployed a mesonet consisting of eight coastal weather stations (in collaboration with WeatherFlow, Inc.) and two coastal data buoys off the southern and northern coasts of Puerto Rico.

An important component of observing is ensuring that the sensors we use are validated and verified. The Alliance for Coastal Technologies (ACT) is a partnership of research institutions, resource managers, and private sector companies dedicated to fostering the development

and adoption of effective and reliable sensors and sensor platforms for environmental monitoring and the long-term stewardship of coastal ocean resources. In total, ACT has conducted 226 instrument performance tests in the laboratory under a wide range of environmental conditions and different deployment applications. The focus in 2009 was performing validation tests on in situ pCO2 sensors and this will continue in 2010.

### IOOS Model Testbed to Improve Marine Forecasts along Atlantic and Gulf

In 2010, IOOS kicked off a project under the Southeastern Universities Research Association (SURA) to evaluate the readiness of marine forecasts along the Atlantic and Gulf of Mexico coasts and improve them for operational use. This project creates an objective environment to compare the latest models for improved forecasting of chronic issues of high relevance in the Atlantic and Gulf regions such as flooding from storm surge and seasonal depletion of oxygen in shallow waters. They will also explore methods for effectively delivering model results to regional centers, scientists, and managers relying on IOOS. Congress kick-started the grant opportunity with the inclusion of funding to support such a project in last year's Consolidated Appropriations Act.

### Products and Services

Across the IOOS regions, there a number of new products and services and space limitation only allows me to highlight a small sample that support the IOOS themes of Marine Operations, Climate Variability and Change, Ecosystems, Fisheries, and Water Quality, Coastal Hazards, and Coastal and Marine Spatial Planning.

During the Deepwater Horizon crisis, the U.S. IOOS community provided highly valued support to the Federal response and showed that the concept of U.S. IOOS was one that was sound. Highlights of this support include:

- Six HFR, along the Northern Gulf of Mexico and Florida coasts, were used by NOAA to support trajectory modeling.


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- Gliders from MACOORA, SECOORA, GCOOS, and SCCOOS partners and industry partners IRobot and Teledyne Webb Research Inc were flown to collect three-dimensional information of the water column.
- Models from SECOORA and GCOOS partners were used by NOAA for trajectory forecasts.
- Imagery from SECOORA and GCOOS partners were integrated with HFR surface currents and were used USGS, NGA, and NOAA.

An emerging U.S. IOOS partnership centers on the threat of ocean acidification. U.S. IOOS is working with NOAA's Pacific Marine Environmental Laboratory to deploy their MapCO2 sensor on coastal

buoys. Additionally, the U.S. IOOS is teaming up with shellfish growers as they are already experiencing the effects of ocean acidification. A workshop was held in July 2010 and brought together constituents from west coast fisheries industries, scientists, and governmental representatives to address concerns related to the impacts of ocean acidification on the west coast shellfish growers and other fisheries industries.

**The Alaska Ocean Observing System (AOOS) and the Oil Spill Recovery Institute (OSRI) conducted an ocean observing system field experiment in Prince William Sound (PWS) in the summer of 2009 to evaluate the utility of the sensor arrays and the accuracy of model forecasts.**

During the field experiment, drifting buoys, CTD casts and AUV and glider transects were made to collect water column profiles. An HFR array was deployed to map surface currents in the central basin. All of the data collected was made available through the AOOS data management system to develop numerical models for forecasting weather, waves, and ocean conditions.

GLOS developed models that display real-time and forecasted waterway data in the corridors between Lake Huron and Lake Erie in southeast Michigan. These models have the potential to protect water quality and drinking water supplies for millions of people by directly supporting decision-making related to drinking water intakes and pollution/spill response.

The models also improve the responsiveness of search and rescue operations. MACOORA is developing "ecosystem-based fishery management" and "spatial marine planning" by producing two new real-time datasets for assimilation by the three dynamic models and established a pair of regional glider lines that zigzag north to south across the mid-Atlantic Byte.

Within SECOORA, they are working within the state of South Carolina to improve beach swimming advisories and shellfish bed closure forecasts due to elevated levels of bacterial contamination.

Standard sampling protocols require the 24-hour incubation of water samples before results are available therefore better predictive capabilities will enhance the utility of an existing monitoring program and to reduce the impact of unneeded closures (false positives) and failures to close when needed (false negatives). Collaboration between the University of South Carolina, the University of Maryland, the South Carolina Department of Health and Environmental Control (SCDHEC), and the Raytheon Corporation developed a decision support tool to address this need.

In California, SCCOOS and CeNCOOS work with the local WFO to provide accurate "bar" forecasts. SCCOOS, in conjunction with its sister program, Coastal Data Information Program (CDIP), operates a number of wave buoys along the coast as well as a wave model. Data from the wave buoys are being used for weather forecasts. For example, a wave buoy placed on the San Francisco Bar at the entrance of San Francisco Bay provides wave data for the NWS forecasts, thereby resulting in a 75% decrease of rescue incidents as reported by the USCG. By incorporating three-day waves forecasts, the IOOS regions are able to send automated messages to the NWS offices and city officials when the model predicts that the threshold levels are to be exceeded.

PacIOOS publishes beach safety conditions for ten beaches in the Hawaii Islands. This website was established through cooperation amongst the Hawaii Lifeguard Association, City & County of Honolulu, County of Maui, Hawaii Department of Health, Hawaii Tourism Authority, and the University of Hawaii School of Ocean and Earth Science and Technology as a non-profit venture. The website provides wave and beach hazard information that is updated every ten minutes based on forecasts by the NWS. Additionally, other factors such as beach closures, road closures, stinging jellyfish, shark sightings, and other events are posted on the site when available.

NERACOOS released a new Model Forecast / Observation Viewer to permit comparing model forecasts against actual observation for both wave height and water levels. The models include both Wave Watch Three and FVCOM. FVCOM has both a Northeast Atlantic domain and a smaller Massachusetts Bay domain. The NERACOOS Map and Model Viewer was designed to permit rapid browsing of the output of several models running in the Northeast region.

This tool was developed using a product called Mapserver and integrates model output layers made available by the provider via a standard webservice know as Web Mapping Service (WMS).

## Conclusion

U.S. IOOS is a team sport where contributions come from all seventeen federal agencies. Further, there are a number of other programs that are also working to provide information on the coastal environment as both contributors to IOOS and users of IOOS. The Integrated Ocean Observing System (IOOS) is working with other

federal initiatives such as the National Science Foundation's Ocean Observatories Initiative (OOI) and the National Water Quality Monitoring Network (NWQMN) for U.S. coastal waters and their tributaries, to enable the United States to make more effective use of existing resources, new knowledge, and advances in technology.

The challenge facing all of us in the ocean observing business is the ability to sustain these observations and continue coordinating each of these efforts.

The recent release of the National Ocean Policy and structure to support the holistic focus on ocean observing along our Oceans, Coasts and Great Lakes, gives me hope that we will be able to realize the potential of a fully functioning US IOOS.





## *About the Author*

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