MARCOOS SEMI-ANNUAL REPORT: 10/1/2011 – 03/31/2011

NOAA Award Number NA01NOS4730014 (October 2010 – September 2012)

1) PROJECT SUMMARY

The Middle Atlantic Coastal Ocean Observing Regional Association (MACOORA) formed the Mid-Atlantic Regional Coastal Ocean Observing System (MARCOOS) to generate quality controlled and sustained ocean observation and forecast products that fulfill user needs in the 5 user prioritized theme areas of: 1) Maritime Safety, 2) Ecological Decision Support, 3) Water Quality, 4) Coastal Inundation, and 5) Offshore Energy. MARCOOS (a) *collaborates* with NOAA WFOs linking existing regional coastal weather networks to evolving NOAA WRF regional forecasting capabilities – *to provide* an improved ensemble of weather forecasts, (b) *operates* the existing Mid-Atlantic HF Radar Network and leverages Coast Guard drifters that are linked to statistical and dynamical models - *to provide* an ensemble of regional nowcasts and forecasts of 2-D surface currents, and (c) *operates* existing satellite receivers and leverages the Navy investment in a regional glider capability linked to the dynamical models - *to provide* an ensemble of 3-D circulation, temperature and salinity nowcasts and forecasts. The MARCOOS data management team facilitates implementation of an end-to-end system consistent with DMAC standards. Education & Outreach (EO) teams engage additional users and provide frequent and timely feedback, while an economic impact team assesses benefits of MARCOOS information. A management structure that establishes and monitors performance metrics ensures quality.

In 2011, MACOORA and MARCOOS merged to become the Mid Atlantic Regional Association Coastal Ocean Observing System (MARACOOS). This year 4 MARCOOS funding is the last year for MARCOOS, as all future funding will be acquired by MARACOOS.

2) PROGRESS AND ACCOMPLISHMENTS

Year 4 of MARCOOS continued the sustained implementation of the original 10 major categories. This report is being filed for MARCOOS during the no cost extension for year 4. Much of the funding had been expended prior to this reporting period. Please see the MARACOOS year 1 report, to be filed on June 30, 2012, for more information on the full network.

A) Atmospheric Data Integration: There was little funding for WeatherFlow's atmospheric data integration in this period of MARCOOS year 4. Please see the Year 1 MARACOOS report to be submitted on June 30 for progress on the weather ensemble during this reporting period.

B) HF-RADAR Equipment: MARCOOS funding continued to support operations and maintenance of the sites throughout the region operated by North Carolina, Old Dominion, University of Connecticut and University of Rhode Island. MARACOOS now operates 36 sites including standard (25MHz), mid range (13MHz) and long range (5MHz) systems.

C) HF Radar QA/QC: During this period, HF Radar QA/QC research work was performed through the MARACOOS project.

D) Underwater Gliders: SMAST Ocean Observation Laboratory continued to prepare the University of Massachusetts Dartmouth (UMassD) IOOS Slocum G-2 glider, called Blue, for a mission between Massachusetts (MA) and New Jersey (NJ) at the end of March 2012. The engineering diagnostics and the measurements from the SMAST Test Tank test dives during the fall were analyzed as part of an effort to establish the working knowledge and infrastructure necessary for more routine operational deployments of Blue; as described in our previous report.

Blue was deployed for the first time in the ocean off of Martha's Vineyard on 1 April 2012. A several hour in-ocean test of Blue's performance via a 1-kilometer scale triangular mission was successfully conducted. After completing that test run, it headed south toward the OOI Pioneer Array site late on 1 April. By 4 April, when Blue was about 44 km south of its deployment site, it became clear that Blue's compass was compromised and Blue was put into a circular holding pattern, so that tests to diagnose the problem could be conducted. Those tests revealed that on some headings Blue could progress, while on others it could not. Blue was instructed to return to its original deployment site and recovered. Blue will be returned to Teledyne-Webb for diagnosis and repair of its compass (and an oxygen sensor which also had problems). MARACOOS will make an attempt to repeat the MA-NJ glider run as soon as possible to measure a warmer than normal MAB as described next.

Although the intended MA-NJ mission needed to be aborted, Blue was able to able to collect nearly a full suite of data during its 12 day adjusted mission. Technicians are processing the 225km suite of pressure, temperature, conductivity, chlorophyll, and CDOM data. Preliminary comparisons between Blue's April 2012 temperature measurements and comparable ones made during MARACOOS glider runs in Massachusetts waters in April 2010 and 2011 indicates that 2012 ocean waters are warmer by about 1^{o}C.

UMassD presently has approximately $22,000 remaining in the Year 4 Glider budget, which will be used for summer salaries and UMassD boat trips related to the next Blue glider mission - before the September 2012 funding deadline.

E) Satellites: During this period, Satellite product development was performed through the MARACOOS project.

F) Short Term Prediction System (STPS): To provide operational surface current forecasts the University of Connecticut continued operation of Mid-Atlantic STPS. The core processing for this product was moved to a cluster dedicated to running the STPS. An alert and status update of the STPS product and server has been setup to help provide maximum uptime and reliability of the system. This alert and status update system performs hourly checks of the data and server status. Status emails are sent to the operator(s) twice daily and upon discovering a problem an email will be sent out immediately.

The backup server that was located at Columbia University had to be shut down due to Andrew Voros' departure. UConn made arrangements to operate the system at the ASA site and will install it in the coming month.

UConn maintained a bottom mounted ADCP near the WLIS buoy in western LIS to assess the effect of wind and waves on the difference between the near surface ADCP bin and the CODAR radial current estimate in the bin above it. Graduate student Yongmi Shin has found that the difference is consistent with a 5 cm/s uncertainty in the CODAR estimate during low wind stress (<0.06 Pascals) periods. At higher stresses the shear appears to be linearly related to the across Sound wind stress (See Figure 1b), however, the along Sound shear in only linearly dependent on the stress for positive (eastward) values. We are now assessing the physical processes that can explain this behavior.

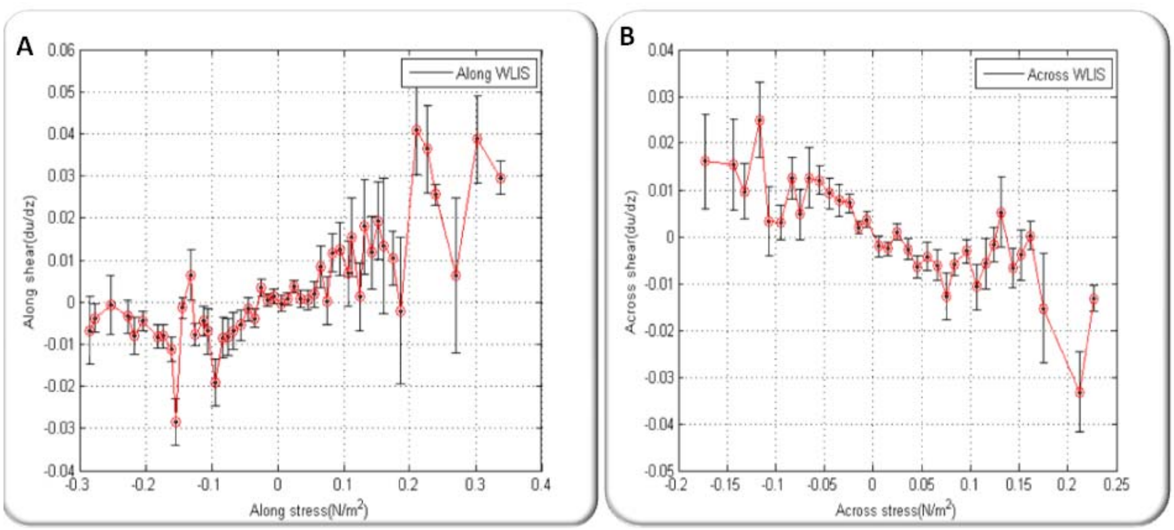

Figure 1. Comparison of (a) the along Sound wind stress and near surface along Sound shear and, (b) the across Sound wind stress and near surface across Sound shear.

G) Dynamic Models: During this period, development of the dynamic models was funded by the MARACOOS project.

H) DMAC: The DMAC team has been focused on the integration of MARCOOS data sets in a new "asset map" that leverages IOOS data standards – TDS/OPeNDAP, WMS, and SOS. This work is being performed with both MARACOOS and MARCOOS year 4 funds. Work on the asset map has continued with inclusion of additional data sets and functions in three major areas.

<u>1) Point observation</u> data is now integrated from:

- NOAA National Data Buoy Center (NDBC) using SOS data protocols

- NOAA Center for Operational Oceanographic Products (CO-OPS) using SOS data protocols
- Hudson River Environmental Conditions Observing System (HRECOS)
- Water quality data from the Maryland Department of Natural Resources
- National Estuarine Research Reserve System (NERRS) using SOAP protocols
- USGS water quality and flow data using WaterML standards
- Drifter tracks from NOAA's Northeast Fisheries Science Center
- Glider data from Rutgers University using JSON data feeds
- Ship and other observation data from Meteorological Assimilation Data Ingest System (MADIS)

<u>2) Spatial data</u> are available from:

- High Frequency Radar using OpenDAP and WMS for data access from the Rutgers server and the National Server at Scripps.
- Satellite-derived water temperature information. This is available in near real-time and the user can select a variety of daily average composites – this data is processed at the University of Delaware and hosted on the Amazon Cloud.

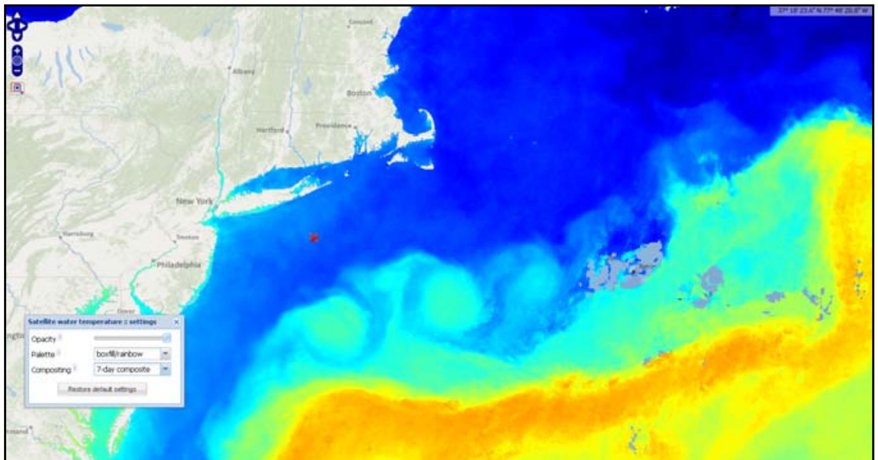

Figure 2. An example of SST spatial data collected and processed by MARACOOS and displayed on the Asset Map.

<u>3) Model Data</u> are available from:

- Short term predictive system (STPS) derived from HF Radar operated by the University of Connecticut
- New York Harbor Observing and Prediction System (NYHOPS) - High resolution hydrodynamic model results for New York harbor and surrounding area operated by the Stevens Institute of Technology
- Mid Atlantic model using the ROMS model operated at Rutgers University

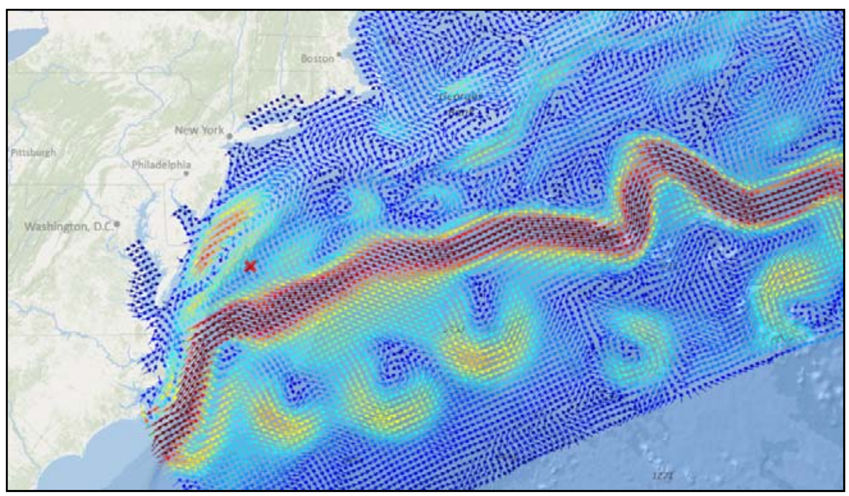

Figure 3. HOPS forecast of surface currents.

- The Harvard Ocean Prediction System (HOPS) operated at the University of Massachusetts at Dartmouth
- Federally operated models such as the U.S Navy's Coastal Ocean Model (NCOM), NOAA's North Atlantic HYCOM model, NOAA's Wave Watch III model
- Federally operated meteorological models such as NOAA's North American Mesoscale Model (NAM)

In order to explore how MARACOOS data can be used in Ocean planning; monthly average sea surface temperature data has been created in a GIS format for use by the ocean planning community.

The DMAC team is now working with outreach team to provide a "Fisherman Ocean Portal" ; a site focused on meeting the needs of the fishing community with data such as bottom temperature and collaboration tools so users can share information by adding data to the web site. This site is being customized to offer science data in a user friendly way to address the needs of the non-science community.

Eoin Howlett has been active with the IOOC DMAC and Kyle Wilcox continues to participate with the THREDDS Steering Team (TST) representing MARACOOS and IOOS. The TST was assembled to provide guidance to UNIDATA on the overall direction of the Common Data Model (CDM) and THREDDS Data Server (TDS). Kyle has also been involved in the IOOS" SOS Reference Implementation Working Group" to develop SWE Common 2.0 encoding standards for all of the CF compliant discrete sampling geometries.

I) Education and Outreach: During this period, education and outreach work was funded by the MARACOOS project.

J) Economic Benefits: During this six-month period, several MARACOOS members assisted with an update of the 2010 UMCES Technical Report, "The Role of Ocean Observing Systems in Fisheries Management" and attempted to document the actual or potential economic benefits of the direct use of MARACOOS observations by commercial fishermen. As described in our 2010 report and other MARACOOS reports we have produced, this work examines the "value of information" of MARACOOS observations and resulting work products.

Discussions with researchers suggest that the value of these observations is increasing, particularly in light of warming in the mid-Atlantic this past winter and spring; of indications that certain fish migration patterns may be changing in ways that have an economic impact on fisheries; and, with regard to the potential for MARACOOS observations to help avoid "by-catch" problems associated with protected species, such as butterfish and the listing of Atlantic sturgeon as an endangered species this month.

An important framework included in our value-of-information research to date has been the "Ocean Data Value Chain," an adaptation of "business intelligence value chains" described in the 2008 IOOS Business Case (NOAA 2008). This concept describes the value provided by the chain of information from data providers to intermediary users to decision-makers to end-users, for example, commercial and/or recreational fishermen. MARACOOS data thus far has provided value primarily to other researchers and to a lesser extent to intermediary users. In recent months, however, workshops and other outreach by MARACOOS to the commercial fishing industry have produced feedback suggesting that in the very near future these observations are likely to generate economic benefits for end users. The University of Maryland research team is currently producing a paper to describe how these benefits might accrue to end users.

On 7 March 2012, Bill Boicourt represented MARACOOS and IOOS in an invited presentation to the Consortium of Ocean Leadership's Ocean Policy Forum at the U.S. Capitol. The Forum was designed to inform the Congress on pressing issues concerning the ocean and to hear back from Senators and Representatives as to their perspectives. Boicourt's talk focused on the need for monitoring the ocean, especially the coastal ocean, to support their restoration and protection. A main point was the economic need to take advantage of the multi-purpose approach as espoused by IOOS to justify the necessary costs of delivering information to a broad range of audiences for a broad range of purposes.

K) Statistics: New Regional Products: In addition to the standard asset map, a global glider asset map was created which is being used by IOOS. **Deployed Assets:** Multiple MARCOOS gliders were deployed and recovered, and 6 new CODAR systems were installed. **Assets Removed:** None **Assets Maintained:** 4 Satellite Ground Stations, 36 CODAR sites, over 100 Weather Stations and 2 Glider flights every 6 months. Over 100 weather sites contributed data to AWIPS and EDS. Real-time forecasts were produced by 1 statistical and 3 dynamical models. **Papers published:** See http://maracoos.org/papers. **Presentations**: Over 40 presentations were made (http://maracoos.org/presentations). **Data Management:** The asset map was upgraded http://assets.maracoos.org.

3) SCOPE OF FUTURE WORK

MARCOOS Year 4 is now over, and we are in the no-cost extension year. Most operations have been transferred to the MARACOOS project. The main purpose of the MARCOOS Year 4 no-cost extension was to cover the fall glider deployment and a spring deployment of a new UMass glider.

4) LEADERSHIP PERSONELL AND ORGANIZATIONAL STRUCTURE

MARACOOS added stakeholder liaison, Peter Moore, during the reporting period. Peter has extensive experience in fisheries and working with the commercial fishing industry in the northeast U.S.

5) BUDGET ANALYSIS

The Year 4 MARCOOS budget includes Rutgers $606,000 plus $1,190,000 in subawards for a total of $1,796,000. This budget analysis covers the first year of funding plus the first six months of the 1 year extension for the Mid Atlantic Regional Coastal Ocean Observing System grant NA01NOS4730014. The remaining balance shown is based on invoices to date, not necessarily what has been spent to date as billing from subcontractors can lag.

	Institution	Budget	Balance
	LEAD: Rutgers University	$606,000	$ -
1	Applied Science	$207,000	$ 35.65
2	Center for Innovative Technology	$45,000	$ -
3	Monmouth University	$25,000	$ 10,849.87
4	Old Dominion University	$100,000	$ 11,856.42
5	Stevens Institute of Technology	$114,000	$ -
6	University of Connecticut	$148,000	$ 37,557.40
7, 8	University of Delaware (2)	$72,000	$ 55.42
9	University of Massachusetts	$229,000	$ 22,039.01
10	University of North Carolina	$18,000	$ 3,463.16
11	University of Rhode Island	$27,000	$ 20,719.68
12	Weatherflow	$90,000	$ -
13,14	University of Maryland (2)	$115,000	$ 19,755.07
	TOTAL AWARDED	**$1,796,000**	**$ 126,331.68**

The base IOOS regional funding was $1,700,000. Additional NOAA funds included $10,000 to cover expenses for the RU27 glider exhibit at the Smithsonian, and $86,000 to support validation of the OI algorithm for the National HF-RADAR Network.