MARACOOS SEMI-ANNUAL REPORT: 6/1/2011 – 11/30/2011
NOAA Award Number NA11NOS0120038 (June 2011 – May 2016)

1) PROJECT SUMMARY

The Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS) will implement a partnership-based strategy that supports stakeholder needs for sustained regional ocean observation and forecasting in the Mid-Atlantic Bight from Cape Hatteras to Cape Cod. Over the 5-year project duration, MARACOOS will (1) unite and integrate the organizational activities of MACOORA (established in 2004) and the operational activities of MARCOOS (established in 2007); (2) maintain and expand the existing observing, data management and forecasting subsystems focused on the transition from data-generated to model-generated ensemble ocean forecast products that target multiple users; and (3) expand end-to-end operations across all five regional themes through (a) enhanced education and engagement activities, (b) the leveraging of resources beyond IOOS through expanded Users and Advisory Councils, and (c) the application of NFRA-endorsed metrics to measure and demonstrate success.

2) PROGRESS AND ACCOMPLISHMENTS

MARACOOS has exploited both successes and lessons learned in moving forward toward its 5-year goals. Chief among these goals are the aim to expand from observation to forecasts and the aim to expand the suite of valued information products across the 5 MARACOOS themes. In order to achieve these goals and thereby realize the potential envisioned in the 5-year plan, we see increasing user engagement and expanding leveraging of new and existing partnerships as crucial. Simultaneously, traditional performance metrics are being refined to gauge the spatial coverage and temporal reliability of the MARACOOS observations, and new metrics are being developed to assess the accuracy of these observations and our forecast products. Our milestone schedule is found on page 13, Section E of the MARACOOS proposal. Progress towards milestones and metrics for each of the 5 subsystems are outlined first, followed by highlights of significant meetings and events. In sections A-J, the work accomplished during this reporting period to fulfill those milestones is discussed in greater detail.

Milestones and Metrics:

Management Subsystem. During this reporting period, the MARACOOS entity was formalized, a user/advisory council was formed, bi-weekly board meetings were held (mostly via conference call) and the annual membership meeting is scheduled for Washington, D.C., December 15-16. The bi-weekly operations meetings were held (via phone) included discussions on the Weather Forecast Ensemble Validation, HF-Radar, Gliders, Satellites, DMAC, Ocean Forecasts, Education, and Outreach. This report will complete the bi-annual progress reporting requirement.

Observing Subsystems: a) *Weather Ensemble:* Regular construction of the MARACOOS weather ensemble was begun with 4 initial contributors. The RUWRF atmospheric model was configured for the MAB as the 5th contributor to the ensemble stating during the second 6-month reporting period. b) *Satellites:* There were 0 days of data acquisition gaps for both the L-band and X-band satellite ground stations. c) *HF-Radar*: Continued work on site resiliency and the reinstallation of the Cape May radar at a new Coast Guard location moved operational statistics closer to the metric of 80% spatial coverage 80% of the time (Figure 3). d) *Gliders*: 6 leveraged regional glider transects were completed during the reporting period, totaling 122 days in water and traversing 2459 kilometers of the MARACOOS Region.

DMAC Subsystem: The team completed a significant series of upgrades to the Asset Map, adding 13 new data sets and the capability to view time series of all data displayed on the map.

Modeling Subsystem: The STPS system had a single day of downtime due to Hurricane Irene, for an uptime rate of 99.5%. The NYHOPS system was operational 100% of the reporting period, and has upgraded from 1 to 4 forecasts daily. The HOPS model continued to make weekly nowcasts/forecasts (Wednesdays) during the reporting period.

Education and Outreach Subsystem. The Board conducted a search process over several months to identify and hire an individual to begin a planned, significant enhancement to MARACOOS' connectivity with its partners and the larger user community. A short list was identified and scheduled for interviews in December. A report on the new Stakeholder Liaison and his/her responsibilities will be furnished in the next MARACOOS report.

Meetings Highlights: On August 9, 2011, MARACOOS and colleagues from NERACOOS and SECOORA hosted an IOOS roundtable discussion for Department of Commerce Assistant Secretary for Environmental

Observations and Forecasts, Dr. Kathryn Sullivan, as an introduction to the regional component of U.S. IOOS. Regional Perspectives, including an Overview of MARACOOS, NERACOOS, SECOORA, User Perspectives, and Federal Observatory Partnerships were presented.

A Fisheries Workshop Planning Meeting was held in Providence, R.I. on July 13 -14, 2011. This planning group involved representatives of NOAA Fisheries, the commercial fishers, the Mid-Atlantic Fisheries Council and academic fisheries scientists. As an outgrowth of this planning session, a workshop directed at the commercial and recreational fishing sectors was conducted on September 26, 2011 in Providence, Rhode Island. The overarching goal was to develop an ocean observatory/ fisheries community interactive partnership. The workshop focused on: determining what MARACOOS-derived information products can be supplied regularly to fishermen; complementing what fishermen already know with new MARACOOS-derived information products; engaging the fishing community in the design and conduct of fisheries research projects; and, establishing a process for regularized engagement of fisheries stakeholders with MARACOOS. It was agreed to establish a small working group, comprising 3-5 commercial fishermen and 3-5 scientists.

Event Highlights: There were three significant oceanographic events of interest that occurred during this reporting period. These included a sewage release in the Hudson River, an enormous phytoplankton bloom spanning over 15,000 km^2 in the Mid-Atlantic Bight, and the passage of Hurricane Irene for which MARACOOS acquired satellite, CODAR and glider data sets and produced atmospheric forecasts.

MARACOOS was instrumental in supporting New York and New Jersey authorities as they managed their response to a sewage spill that began on July 20, 2011, when a fire broke out at the North River Wastewater Treatment Plant in New York City. With MARACOOS support, the Stevens Institute of Technology was able to track the sewage plume, which spread mostly through the lower Hudson along Manhattan, the Bronx, and New Jersey; but also in smaller amounts to areas around the ocean beaches of Brooklyn and Staten Island. As a result of the Stevens' water quality modeling efforts, the New York City DEP and the New Jersey DEP were in an informed position to decide which beaches to close and when the closures needed to happen to protect public health. For more information on this event, visit http://maracoos.org/node/166.

During July and August, a large and dramatic phytoplankton bloom occurred in the Mid-Atlantic Bight. At one point the bloom was almost as large as the state of NJ with a large portion of the area measuring over 15mg/m^3 of chlorophyll-a. Satellite data originally detected the bloom in July which was then sampled by multiple MARACOOS gliders and a REMUS AUV, and tracked by CODAR as the bloom move offshore. For a detailed blog on the bloom event, visit http://maracoos.org/blog_archive.

Hurricane Irene tracked northward along the eastern seaboard on Aug 27-28, passing directly over the MARACOOS HF Radar network and Glider RU16 deployed off the NJ coast. Satellite sea surface temperatures on the continental shelf before the storm on Aug 24 were 25C to 26C were reduced to the 18C -20C range after the storm on Aug 29. Glider RU16 observed the rapid cooling and mixing in the early hours of Aug 28, where the upper mixed layer temperatures drop about 7C from 25 C to 18 C and the thermocline deepens from about 12 m to 30 m. Most of the MARACOOS HF Radar network continued to operate as Irene passed overhead. Strong onshore currents were observed as the hurricane approached that rapidly switched to offshore as the eye passed overhead. Using the current maps to locate the eye, the intense mixing and cooling observed by the glider occurred as the eye was still approaching and the currents where onshore. In the wake of Hurricane Irene, large inertial currents over 50 cm/sec were observed offshore where the water remained stratified. Inshore, where the intense mixing occurred, the inertial wave amplitude remained small. The HF-RADAR observed currents are now being compared to ocean forecast currents. The impact of the cooler MARACOOS SST on the RUWRF hurricane hindcast was to reduce the intensity of the hurricane by 5-10 knots with little impact on track and rain. For a detailed blog on Hurricane Irene visit http://maracoos.org/irene/ or http://maracoos.org/blog_archive.

A) Atmospheric Data Integration: WeatherFlow continues to manage the utilization of atmospheric modeling assets for use in coastal physical process analysis. Four organizations supply operational model output to the MARACOOS model averaged surface wind field product. Appreciable effort is expended to keep each of these modeling assets current. Figure 1 depicts the availability of the four models for November. WeatherFlow made attempts to alert each group of delivery failures and collects, processes, and archives the surface wind field product.

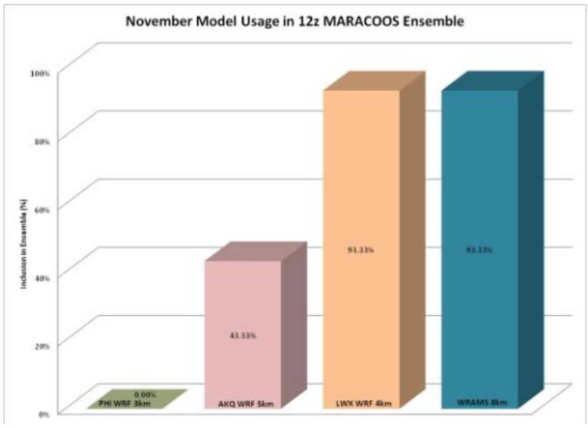

Figure 1. Model availability for November 2011.

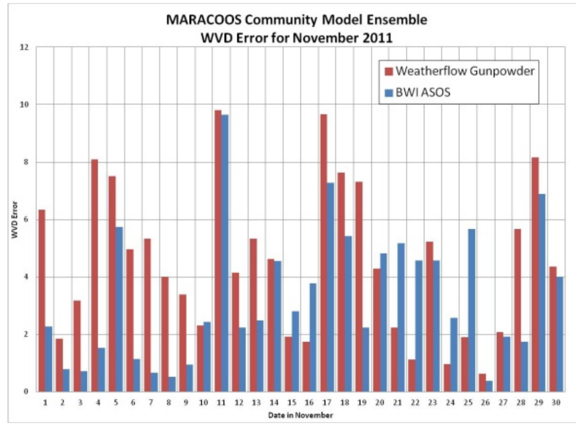

Figure 2. Model ensemble comparisons.

WeatherFlow is tasked with assessing model performance. With the use of their own mesonet data, we are able to provide the needed observations to fully vet model accuracy. WeatherFlow's database contains observations from several sources including the National Weather Service ASOS observing sites and an expansive suite of coastal sites including WeatherFlow sites, federal, state, and private stations. These sites are critical to assessing how well each model is performing in areas of known high meteorological variability. Figure 2 depicts model ensemble performance at two sites: Baltimore Washington International Airport (BWI), and Gunpowder River, a WeatherFlow site located on a Chesapeake Bay tributary. The ensemble exhibited higher error at Gunpowder on 23 of 30 days of November 2011, with 9 of the days having errors more than double that at BWI. The reverse occurred on only 3 days. Since the objective of this effort is to exploit existing atmospheric modeling assets for coastal processes, it is essential that models yield accurate forecasts within the littoral zone. Results like those shown in the comparison below reveal that there is a need to improve atmospheric model parameterizations related to oceanic processes such as latent and sensitive heat exchanges. Additionally, we will introduce dynamic roughness lengths between atmosphere and adjacent water surfaces. MARACOOS is initiating an atmospheric forcing working group whose initial meeting is scheduled for Dec 19th.

B) HF-RADAR Equipment: The HF radars have operated well in the Mid Atlantic for this reporting period. We are now displaying an up to date coverage metric on the daily, weekly and yearly coverage of the network. The link to these performance metrics can be found here http://marine.rutgers.edu/~codaradm/images/stats/. An example of the metric from September 1, 2011 to December 16, 2011 is given in Figure 3. The metric shows that we are nearly at our goal of 80% spatial coverage 80% of the time.

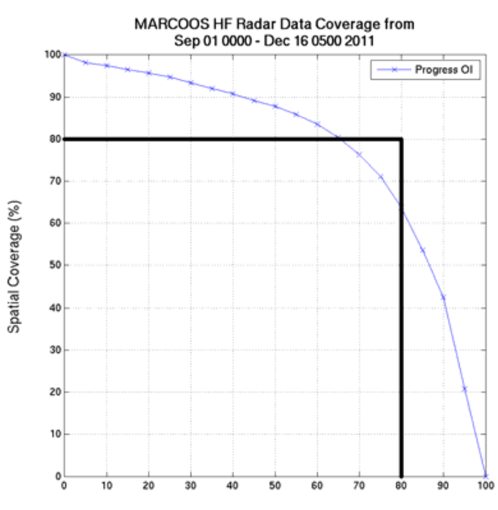

Figure 3: Temporal and spatial coverage of the long range HF radar network in MARACOOS.

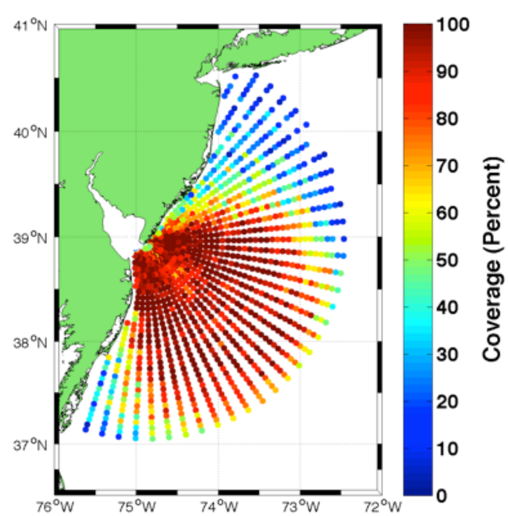

Figure 4. Wildwood long range CODAR radial coverage.

We continue to upgrade equipment as funding allows (e.g. new single transmit/receive antenna at Montauk Point). We reestablished the 5 MHz system at Wildwood, NJ (WILD) that was down for approximately 1 year due to the closure of the US Coast Guard LORAN Support Unit in Wildwood. The site was relocated just south on the Coast Guard Training Center in Cape May, NJ. A radial plot from this site is shown in Figure 4. We also added two 13 MHz systems in Brant Beach and Brigantine NJ that will support the Rutgers project of mapping the spatial resource of wind energy of the coast of New Jersey.

Ocean Power Technologies, a small and medium enterprise based in Pennington, NJ used the surface currents from the long range system to evaluate the performance of their littoral PowerBuoy during its deployment from August to October 2011.

When a CODAR system is installed, a checklist is followed to ensure that the system is installed correctly. That checklist is found here:

http://maracoos.org/sites/macoora/files/downloads/data/SOP_MARCOOS_Long_Range_Radar.pdf

All the sites in the network are standardized based on the operating frequency of the radar. This standardization table is found in Table 1. Once the system is installed it is remotely inspected once a week by the operators checking 10 components of the radar data stream to ensure the data is of the highest quality.

Parameter	5 MHz	13 MHz	25 MHz
Sweep Rate (Hz)	1	2	2
Velocity Resolution (cm/s)	3	4.5	2
CSS Averaging Period (min)	60	15	15
CSS Output Period(min)	30	10	10
Radial Coverage (min)	180	75	75
Radial Output Period (min)	60	60	30

Table 1: Critical parameters in the radial processing stream.

C) HF Radar QA/QC: We focused on the sensitivities of the optimal interpolation (OI) radial combining method. We have Matlab code that calculates a random flight of the virtual drifters using the surface currents from the High Frequency radar. We have experimented with the parameters that are input into the OI algorithm. An example from one of these simulation runs is shown in Figure 5. For these simulations we released 1000 virtual particles and calculated the centroid of the drifters at each time step (green line). The termini of the virtual drifters are shown as the blue dots and the 95th percentile area of the drifters is shown as the gray shaded boxes. Our initial findings indicate that the OI method places the virtual track 30% closer to the actual drifter than unweighted least squares after 24 hours.

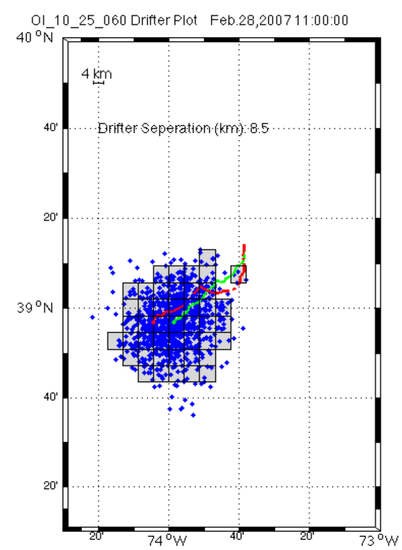

Figure 5: Comparison between SLDMB 43484 (red) and virtual CODAR drifter (green) for a 96 hour trajectory using the optimal interpolation combining method with Sx 10 km and Sy 25 km.

D) Underwater Gliders: During this reporting period, the MARACOOS glider team conducted 6 successful regional glider transects covering both the northern and southern regions of the MARACOOS domain. These domain-scale gliders were in the water for 122 days; traversing 2459 kilometers of the MARACOOS Region. This basic domain-scale surveying effort was supplemented by the ongoing MARACOOS support provided to other programs such as the NJ DEP water quality glider surveys, NOAA fishery technical tests, DoD MURI surveys, and NSF technical tests of experimental MRI gliders. The MARACOOS glider data is being used by several of our University partners' PhD students.

A noteworthy highlight of the MARACOOS glider measurement program was the sampling of the autumnal destratification of the Mid-Atlantic Bight in the Southern region (see Figure 6), which was accompanied by one of the largest MAB phytoplankton blooms we have seen.

Prior to destratification, a coastal-trapped, low-salinity current emanating from the Hudson River plume can be seen near the glider launch location. The entire shelf was well stratified until a series of storms augmented by the seasonal convective cooling stirred the water column and destroyed this structure. The storms resuspended particles, as indicated by high optical backscatter. Colored Dissolved Organic Matter (CDOM) also increased. Furthermore, the high seas associated with the strong winds made maneuvering and recovering the glider a challenge. Skill and experience of the glider operators paid off in a recovery at the end of the glider's battery power. This unique glider-measured dataset will enable the analysis of a key Mid-Atlantic ecological event that remains poorly understood.

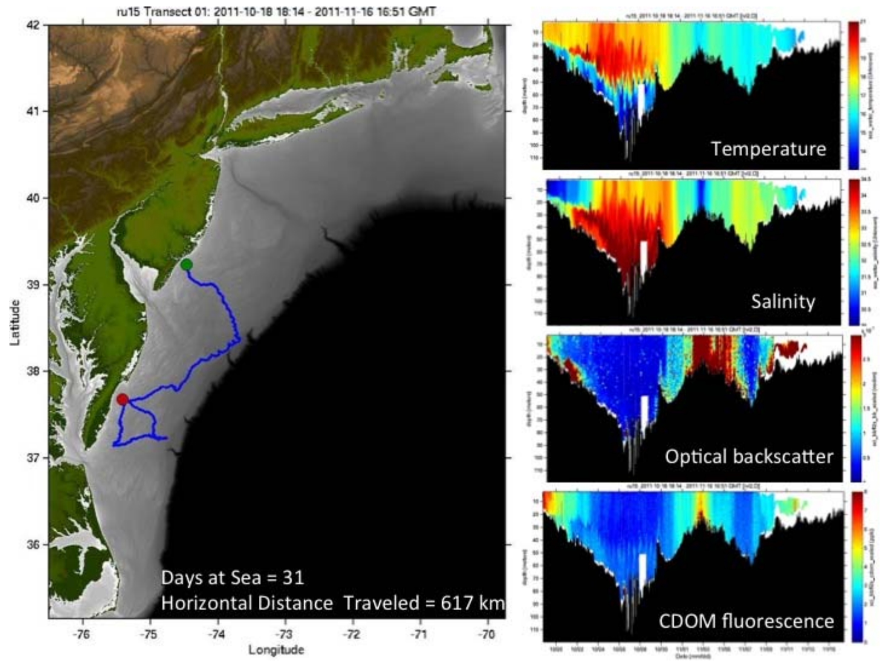

Figure 6. The MARACOOS glider mission conducted in October 2011. The measurements toward the end of this longer-than-normal mission were degraded because of the rapidly decreasing battery power.

E) Satellites: We continue to support expanded satellite coverage from the Gulf of Mexico, to Cuba to Newfoundland. We have been receiving and processing de-clouded sea surface temperatures (SST's) from the Rutgers University L-Band dish and posting the data to a publically-available THREDDS server in a Climate Forecast (CF) netcdf format. Our CF-compliant SST data feed, which began in 2005, is updated in near-real time (http://tds.maracoos.org/thredds/SST.html). This real-time SST data is also visualized via the MARACOOS Asset Map (http://maracoos.org), via Google Earth (http://modata.ceoe.udel.edu/web_kmzs/), and via browser-based mapping services (http://orb.ceoe.udel.edu/public-access).The University of Delaware X-Band dish has been brought online to create real-time CF-compliant ncdf4 ocean color data feed, which is being updated in near-real time (http://tds.maracoos.org/thredds/MODIS.html). This data is processed with Naval Research Labs Advanced Processing System. Our ocean color THREDDS feed includes 39 ocean color-related products, including estimates of the inherent optical properties which are critical for understanding the coastal ocean.

One of our business lines is to develop MARACOOS data products which will to help us understand the distribution and migration of these living resources. In one example, we now use a unique biome analysis of the real-time ocean color data to produce a product that can be used to identify significantly different water masses and biomes are in the MARACOOS region. These MARACOOS biome and water mass products are being used to drive a real-time regional butterfish model, which is presently being tested by commercial fishermen (http://ecologyofcoastaloceanseascapes.blogspot.com). In addition to our butterfish work, we are also starting to model Atlantic Sturgeon, Sand Tiger Sharks and Tiger Sharks using satellite observations. Another related project involves reprocessing of historic ocean color data in order to provide historic trends of ocean color products via the THREDDS catalog in the MARACOOS region. This historic data product development is critical for future development of MARACOOS centric satellite and fisheries products.

Other real-time data/information product feeds include the University of Delaware geostationary satellite dish's cloud information in support of ocean color products (http://udceoe-vis1.ceoe.udel.edu/modis/images/gvar/). We also have developed a near shore ocean color-based salinity model, which is used to produce an experimental real-time product that is being tested by NOAA (http://coastwatch.chesapeakebay.noaa.gov/cb_salinity.html). This ocean salinity product has great potential for improving our understanding both the physics and biology of the MARACOOS region.

Several projects are focused on enhancing satellite data delivery to the MARACOOS community. For example, we will be testing the real-time delivery of satellite data to mobile devices. This work is ongoing and depends on the maintenance of our satellite THREDDS servers (http://marine.rutgers.edu/cool/maracoos/mobile/). We are also working to increase the resolution of our visualizations through Google Earth to 250m.

We support outreach efforts by making our satellite observations available through Google Earth, web-based platforms, and coastal ocean observation labs. For example, we have hosted more than 2600 visitors - ranging from K-12 groups to Federal Senators - At the University of Delaware Ocean Exploration, Remote Sensing and Biogeography Lab (ORBLAB). These groups have learned about the IOOS and MARACOOS data and services.

F) DMAC: The MARACOOS DMAC team does not cache or convert the data. Rather MARACOOS data (in its “native” form) is accessed by users on an array of distributed servers within the MARACOOS group, in the Amazon Cloud, and the U.S Coast Guard EDS using IOOS-recommended data standards such as the THREDDS Data Server(TDS)/OPeNDAP, WMS, SOS, and WFS.

In a large MARACOOS DMAC team effort during the reporting period, we have completed the integration of a wide variety of data sets into the MARACOOS Asset Map (Figure 7 & http://assets.maracoos.org/); including data and data products from 1) UDEL satellites [served from a TDS hosted on the Amazon Cloud]. Data which is accessible for download and on-the fly changes such as selecting different composite analyses ; 2) USGS stations via USGS web services; 3) NERRS stations via NERRS web services [SOAP]; 4) NDBC stations [SOS]); 5) CO-OPS stations [SOS] and tide forecasts; 6) WeatherFlow stations [SOS];7) MADIS ships; 8) MARACOOS gliders; 9) HF Radar; 10) STPS predictive system [derived from HF Radar]; 11) ROMS Espresso [Rutgers]; 12) NYHOPS [Stevens]; and 13) other Federal models such as HYCOM, NCOM, and WWIII. Also a new 40-variable MODIS dataset from UDEL (Matt Oliver) was added to the MARACOOS TDS server: http://tds.maracoos.org/thredds/MODIS.html

The MARACOOS DMAC system - leveraging the IOOS Model Testbed - provides added tools which enable users to do model-model comparisons. Model-to-observations comparison tools will be added next year. In another advance, users are now able to customize the MARACOOS Asset Map data layer appearances. Users are now able to extract time series from model and most observation layers.

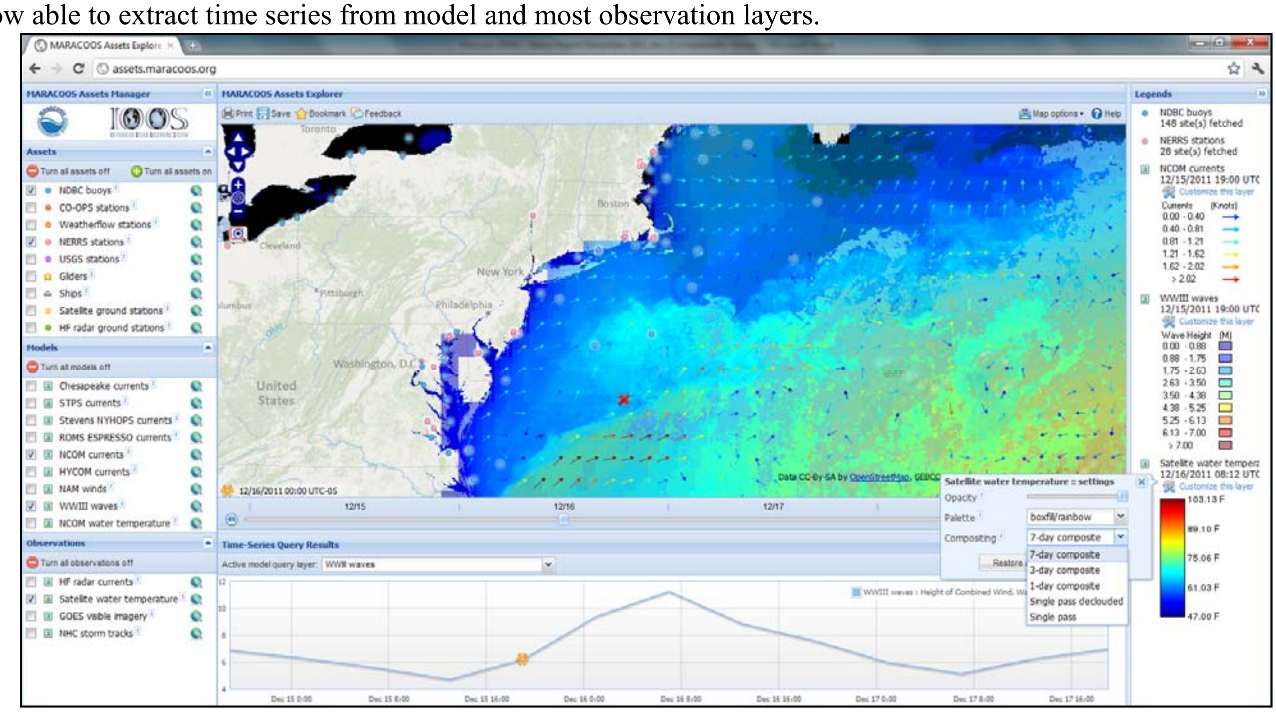

Figure 7. The updated MARACOOS interactive Asset and data query map.

The MARACOOS Asset Map is being used now as a template for custom outreach programs. The first example of this approach is a new Asset Map-related product; defined at the recent MARACOOS fisheries data product development meeting in Providence this past September. The team is also building a version of the Asset

Map that will focus solely on gilder data management as a prototype for national and international glider management.

In another recent development MARACOOS DMAC team member Kyle Wilcox became part of 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. This is a monthly telecom commitment and focuses mainly on user level functionality rather than technical decisions. 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. The group is meeting at the beginning of February to finalize the recommendations and more to implementation across the regions.

G) Short Term Prediction System (STPS): The STPS system has continued in routine operation generating 24 hour forecasts on the 6km grid every hour during the contract period. The backup prediction center that had been housed at Columbia University had to be taken out of service as a consequence of staff relocation at that institution. We have made arrangements with the Applied Science Associates to house the server in their facility in Narragansett, RI. This will provide a secure and reliable alternative generation site should power or communications be lost to the Univ. of Conn site.

In addition, we have engaged in the MARACOOS model evaluation activity by comparing drifter data to the STPS forecasts. A key problem with the comparison is the lack of simultaneous, quality controlled drifter data within in range of high quality the HF radar data and so only limited comparisons are available but the results are not inconsistent with the expectations. We are now updating the evaluation with a better quality dataset, however, a large scale drifter deployment should be supported to fully evaluate the system in the whole domain.

The data quality of the stand range HF radar systems in Long Island Sound have been evaluated using observations from bottom mounted acoustic Doppler current profilers (ADCPs). By comparing the ADCP projected in the direction of the RADAR radial direction at several sites we have detected high errors during the flood phase of the tide. This mainly affects the radials obtained at STLI in the direction to the north. We have contacted CODAR and are getting help to resolve this issue.

We also evaluated the performance of the HF Radar derived significant wave height products which we have been sharing via the LISICOS.UConn.edu site. Figure 8 shows a comparison between the BLCK standard range radar estimates and those of the wave buoy deployed in 2010 to the southeast of Block Island. The correlation in the 15 minute samples is 0.7 and increases when longer term averages are compared. Other sites did not appear to perform as well and we are attempting to understand the difference in the effectiveness of the systems.

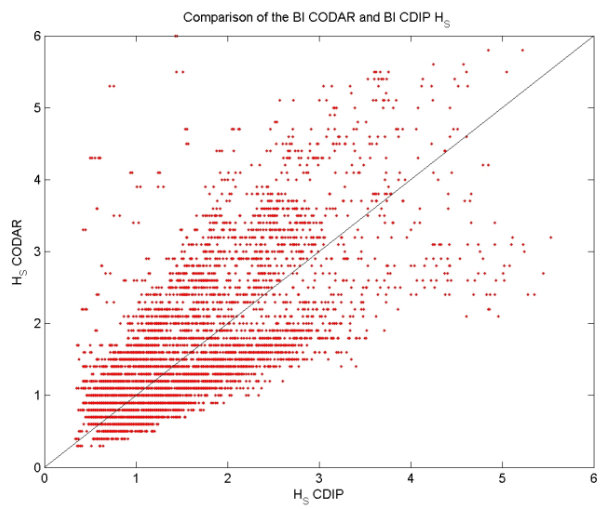

Figure 8. Comparison of significant wave height estimated by HF radar at BLCK and that measured by a wave buoy.

H) Dynamic Models: To increase confidence in the New York Harbor Observing and Prediction System's (NYHOPS) ocean circulation predictions in continental shelf waters New York and New Jersey, a detailed validation exercise was carried out using HF radar and Lagrangian drifter-derived surface currents from three drifters obtained between March and October 2010. During that period, the mean RMS differences of both the east-west and north-south currents between NYHOPS and HF radar were approximately 15 cm s-1. Surface currents derived independently from drifters along their trajectories showed that NYHOPS and HF radar yielded similarly accurate results. RMS errors when compared to currents derived along the trajectory of the three drifters were approximately 10 cm s-1. Overall, the analysis suggests that NYHOPS and HF radar have similar skill in estimating the currents over the continental shelf waters of the Middle Atlantic Bight.

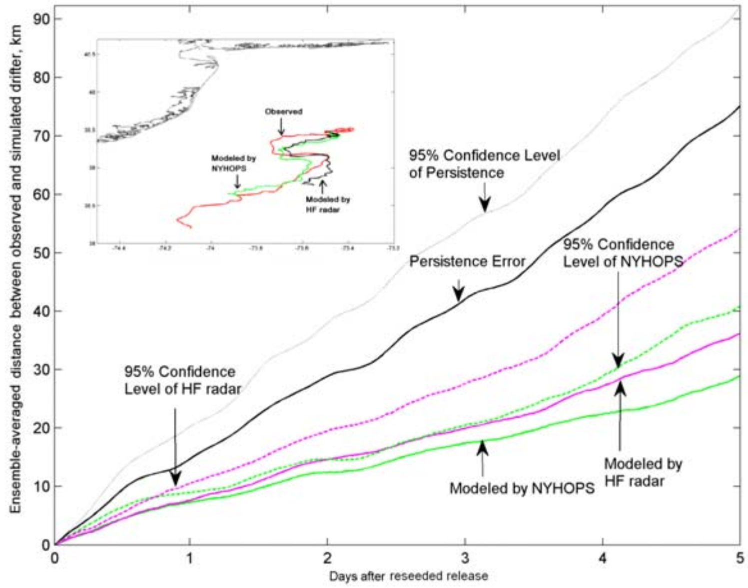

Figure 9. Ensemble-averaged Persistence Error (black solid line) and separation distance between the drifter and numerical drifters based on NYHOPS (green solid line) and HF radar (pink solid line) surface currents. 95% upper confidence levels for the Persistence Error (dotted black line) and the separation distance of NYHOPS (dotted pink line) and HF radar (dotted green line) are also shown, from the "reseeding" experiments described in the text. Insert shows the observed drifter trajectory (red) and the respective drifter trajectories simulated using surface currents from NYHOPS (green) and HF radar (black) over that drifter's complete deployment record.

An ensemble-based set of particle tracking simulations using one drifter which was tracked in the water for 11 days showed that the mean separation generally increases with time in a linear fashion Figure 9). The separation distance is not dominated by high frequency or short spatial scale wavelengths suggesting that both the NYHOPS and HF radar currents are representing tidal and inertial time scales correctly and resolving some of the smaller scale eddies. The growing separation distance is dominated by errors in the mean flow causing the drifters to slowly diverge from their observed positions. The separation distance for both HF radar and NYHOPS stays below 30 km after 5 days and the two technologies have similar tracking skill at the 95% level. For comparison, the ensemble-mean distance of a drifter from its initial release location (persistence assumption) is estimated to be greater than 70 km in 5 days.

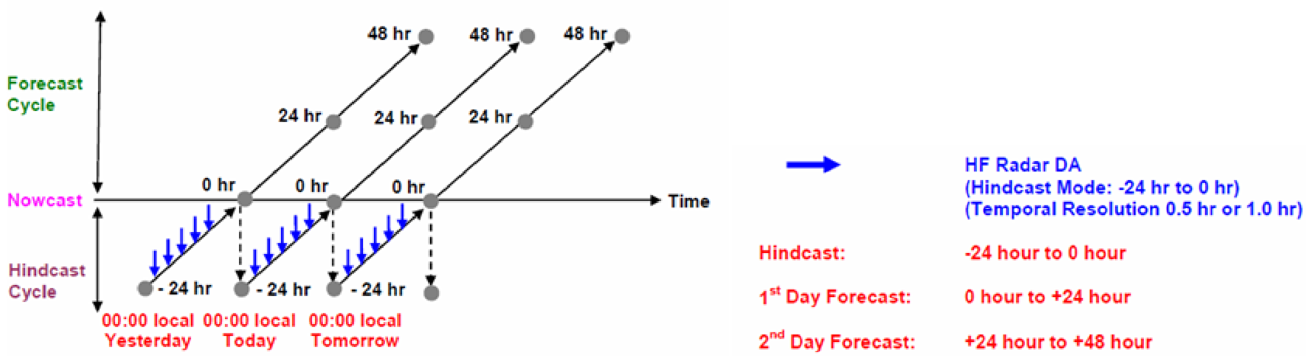

Figure 10. Schematic of the assimilation methodology in the New York Harbor Observation and Predication System.

The HF radar data is now assimilated into the NYHOPS's (www.stevens.edu/maritimeforecast/) hindcast (-24hr to 0 hr) setting the stage for a better forecast out to 48hr. The assimilation schematic is shown in Figure 10. The drifter simulations show improvement from the use of the assimilation methodology over the use of either the NYHOPS or HF radar currents alone.

The MARCOOS/HOPS Real-Time Forecast System has been operational since March 9, 2009. It has been described in detail and validated by Schmidt and Gangopadhyay for MARCOOS implementation. The model simulates the non- tidal dynamics of the WNA and GOMGB, forced by atmospheric fields (surface momentum flux, surface heat flux, surface water flux and shortwave radiation) from the Global Forecast System (GFS) at 1/2 degree resolution, which provides 7-day forecast fields. The horizontal structure of the model domain consists of 131 by 83 grid points with 15-km resolution, extending from Cape Hatteras to Grand Banks (30.5°N to 47.93°N in the meridional and from 80.54° W to 54.23° W in the zonal direction). There are 16 double-sigma vertical levels. Horizontal subgridscale processes are parameterized using a set of scale-selective Shapiro filters: 4-1-1 (fourth order, one time, every time step) for velocity and tracers, a 2-2-1 for vorticity and 2-1-1 for stream function. The time step used in all runs was 225 seconds.

The forecast system is presently assimilating blended SST (5-day composite) data from NOAA CoastWatch. The 5-day long forecasts are issued generally by Wednesday morning; Monday zero-hour is a typical model initialization state, with SST assimilation carried out on Monday afternoon and Tuesday noontime. Real-time Glider data is being assimilated as and when available. The forecast fields (Temperature, Salinity, Currents and Divergence) are available at www.smast.umassd.edu/modeling/RTF/ for different levels at 6-hourly intervals for the full domain, for a zoom domain for Mid-Atlantic Shelf, and for another zoom region for the Gulf of Maine. The CF-compliant model forecast data are available from the THREDDS server http://aqua.smast.umassd.edu:8080/catalog.hml.

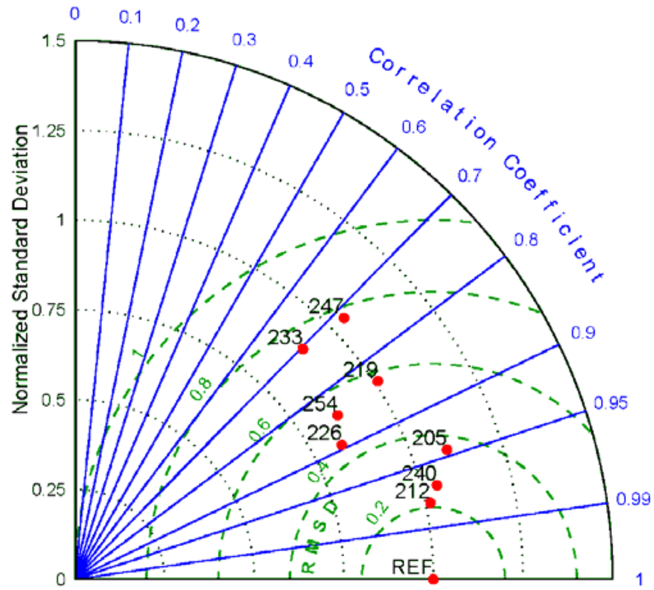

Figure 11. The normalized Taylor Diagram showing the model skill for seven-day forecasting of the Gulf Stream axis (the 15°C isotherm at 200 m) during the eight weekly runs denoted by their starting year days (212 - 254).

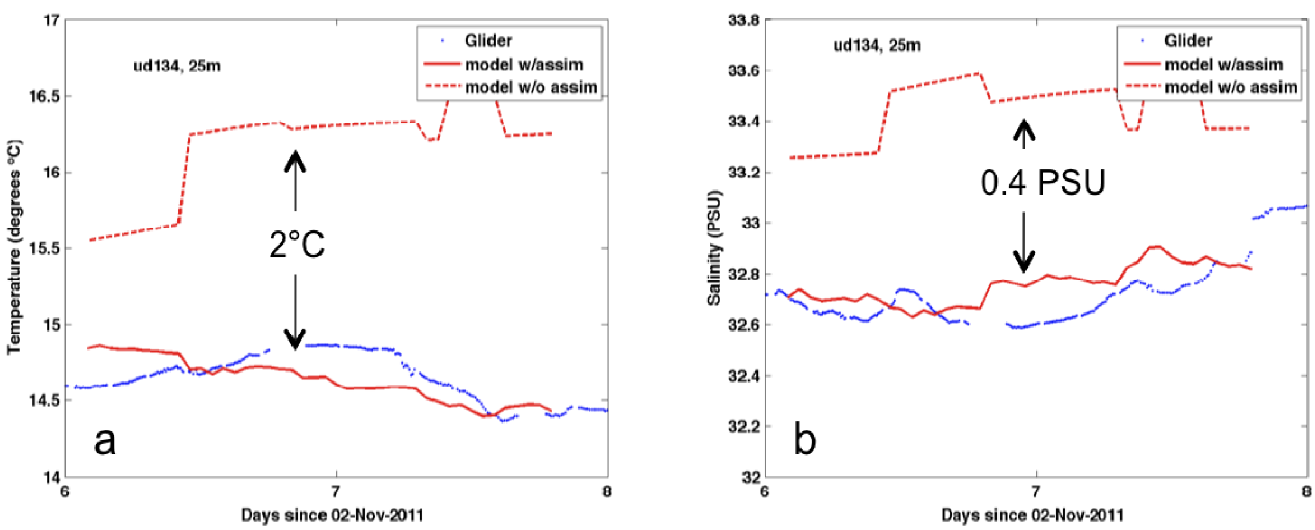

Figure 12. Independent Glider (UD134) data at 25-m for (a) temperature and (b) salinity, compared to the SMAST-HOPS 02 Nov 2009 runs. Only RU05, RU21 and RU23 data were assimilated (UD134 was not) during the first week. Glider data are shown in blue; the model run with glider assimilation is shown with a red solid line; and the model run with no glider assimilation is shown with a dashed red line. Note the difference between assimilation and non-assimilation runs for temperature is about 2°C; while that for salinity is about 0.4 psu.

The MARACOOS implementation of the Harvard Ocean Prediction System (HOPS) at SMAST (SMAST-HOPS) has been validated for the Shallow Water 2006 period (July-September). Eight weekly forecasts were compared against satellite GS paths and available SW06 drifter data. The validation is presented by Taylor diagrams, which provide a statistical summary of how well model simulation and observation patterns match each other in terms of their correlation coefficient (R), their root-mean-square difference (E), and the ratio of their standard deviations (σ) (Figure 11). For six out of eight weeks, the forecast skills were higher than that of the persistence. The model also shows reasonable skill in simulating drifter trajectories, especially over the first three days of simulation. Furthermore, an example of Glider data assimilation is presented in Figure 12. Comparison of assimilated prediction against an independent glider data shows that the model (after assimilation) has reasonable skill for temperature and salinity prediction at least on the order of a week in the mid-Atlantic Bight region.

I) Education and Outreach: The transition from MARCOOS to MARACOOS has resulted in a new and more focused set of activities for our Education & Outreach Subsystem. The MARCOOS E&O Team focused almost exclusively on outreach to the fishing, beach and state CMSP communities. The MARACOOS E&O Team will now include a new yet-to-be-selected Stakeholder Liaison that will bring fulltime attention on outreach to MARACOOS end users. While the Stakeholder Liaison is expected to represent MARACOOS in all 5 of its main user communities, there will be a special effort to outreach to the multifaceted fishing community. This focus will leverage recent successes of the MARACOOS fisheries workshops and fisheries product development. For its part, the MARACOOS Education Team has determined, based on discussions with membership, that the greatest near-term educational need is in workforce development at the undergraduate level. Specifically, we plan to leverage the ongoing development of NSF OOI Education and Public Engagement (EPE) tools in bringing MARACOOS concepts, data and models into the undergraduate classrooms of member universities. Thus already, we have begun to plan a spring workshop for undergraduate teachers. The workshop will focus on the development of classroom applications using the springtime MARACOOS activities as guidance. These applications will then be used in the classroom during the fall peak in MARACOOS activity.

J) Economic Benefits: MARACOOS solicited the Mid-Atlantic Regional Council on the Oceans (MARCO) for participation on MARACOOS Board and participated in MARCO Management Board calls to discuss regional ocean planning and incorporated MARACOOS collaboration into 2012-2013 work-plan for development of MARCO Mid-Atlantic Mapping and Planning Portal.

3) SCOPE OF FUTURE WORK

There are currently no planned changes to the MARACOOS scope of work or milestones for year 1, nor do we foresee any issues that may hamper future progress toward goals stated in the proposal.

4) LEADERSHIP PERSONEL AND ORGANIZATIONAL STRUCTURE

MARACOOS completed its search for the Executive Director position that was vacated on May 1, by selecting Dr. Gerhard Kuska from a pool of candidates. Kuska officially began his duties on October 1, 2011. He will maintain an office at MARACOOS' offices at the University of Delaware.

5) BUDGET ANALYSIS

The MARACOOS account was created at Rutgers on September 15, 2011 when funding arrived from NOAA. The total budget for this 1 year contract was 2,082,235. Subcontracts for the eleven subs were issued between October 4 and 14, 2011. Figure 13 highlights the current balance remaining for the lead and all subcontracts as of November 30, 2011.

#	Distribution	Year 1	Remaining Balance
LEAD	Rutgers University	$ 575,325	$ 468,528
1	Applied Science	$ 156,145	$ 156,145
2	Center for Innovatice Technolog	$ 44,458	$ 44,458
3	Old Dominion University	$ 98,795	$ 98,795
4	Stevens Institute of Technology	$ 95,857	$ 95,857
5	University of Connecticut	$ 145,254	$ 145,254
6,7	University of Delaware (2)	$ 519,926	$ 519,926
8	University of Maryland	$ 88,915	$ 88,915
9	University of Massachusetts	$ 225,278	$ 225,278
10	University of North Carolina	$ 17,783	$ 17,783
11	University of Rhode Island	$ 26,668	$ 26,668
12	Weatherflow	$ 87,831	$ 80,512
	TOTAL AWARD	$ 2,082,235	$ 1,968,119

Figure 13. MARACOOS budget distribution with total and remaining budget listed for all parties.