MARACOOS SEMI-ANNUAL REPORT: 12/1/2011 – 5/31/2012
NOAA Award Number NA11NOS0120038 (June 2011 – May 2016)

1) PROJECT SUMMARY

The Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS) is implementing 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 is (1) uniting and integrating the organizational activities of MACOORA (established in 2004) and the operational activities of MARCOOS (established in 2007); (2) maintaining and expanding 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) expanding 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:

<u>Management Subsystem</u>. During this reporting period, bi-weekly board meetings were held (mostly via conference call) and the annual membership meeting was held in Washington, D.C., December 15-16. The bi-weekly operations meetings were held (via phone) which 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 for MARACOOS year 1.

<u>Observing Subsystems:</u> a) Weather Ensemble: The MARACOOS weather ensemble is now regularly run twice daily at 00 and 12UTC. WeatherFlow has added 3 new models to the ensemble including NAM, GFS and CMC as well as a second RAMS domain which brings the total number of models to 8. b) *Satellites:* There were 0 days of data acquisition gaps for both the L-band and X-band satellite ground stations. c) *HF-Radar*: There were 5 new CODAR sites added to the network (4 13Mhz and 1 5MHz) during the reporting period bring the total MARACOOS HF-radar sites to 37. MARACOOS averaged approximately 70% spatial coverage 70% of the time as we move toward the 80/80 goal. d) *Gliders*: Globally MARACOOS deployed 15 gliders for a total of 224 in water days covering 4211km. In the MARACOOS region there were 4 deployments totaling 48 in water days covering 958 km.

<u>DMAC Subsystem:</u> The team completed a significant series of upgrades to the Asset Map, adding 8 new data sets and a prototype asset map specifically for fishermen.

<u>Modeling Subsystem:</u> The STPS system was 100% operational during the reporting period. The NYHOPS system was operational 100% of the reporting period, running four forecasts daily. The HOPS model continued to make weekly nowcasts/forecasts (Wednesdays) during the reporting period and missed 3 forecast weeks during the period which equated to a 90% uptime rate.

<u>Education and Outreach Subsystem.</u> Mr. Peter Moore was hired as the Stakeholder Liaison, reporting to the Executive Director of MARACOOS and overseeing the development and implementation of a stakeholder engagement strategy.

Meetings Highlights: During the reporting period, MARACOOS was engaged in a variety of meetings. Beyond its Annual Meeting in Washington, D.C. in December, MARACOOS was also engaged in the following meetings, hosting several and participating in the all of the meetings: Joint Ocean Commission Initiative (JOCI) Strategic Planning conference (January 2012); ASLO/TOS/AGU Oceans 2012 Conference, Salt Lake City (February 2012); NOAA NCEP Virtual Meeting on Potential Collaboration (March 2012); Consortium on Ocean Leadership and Ocean Observing Committee (March 2012); ICES Working Group on the Northwest Atlantic Regional Seas (March 2012); NOAA NART / MARACOOS Workshop to Develop a Framework for Quantitative Seascape Ecology Supporting Ecosystem Assessment and Management (March 2012); Delaware Sea Grant Strategy Session (March 2012); NOAA Chesapeake Bay Office CBIBS (March 2012); Oceanology International 2012, London (March 2012); NOAA CO-OPS Meeting RE PORTS (April 2012); SECOORA Annual Meeting (May 2012); Harbor Navigation, Safety, and Operations Full Committee Meeting (May 2012); Regional Response Team 3 Meeting (May 2012); Mid-Atlantic Sea Grant Regional Collaboration Meeting (May 2012); MTS Oceans 2012, Korea (May 2012); and a variety of meetings involving the partners of the National Federation of Regional Associations for Coastal and Ocean Observing Systems (NFRA). The annual supplemental report contains more information on these meetings.

Event Highlights: In the Mid-Atlantic region this winter was essentially "winter free" and therefore ocean temperatures in the Mid-Atlantic Bight this past winter and spring were much warmer than normal as viewed by satellite and in situ sensors. Several air temperature records were set throughout the Mid-Atlantic during the first 5 months of 2012.

Figure 1 shows water temperature at the Chesapeake Bay Bridge Tunnel. The BLUE line shows water temperature measurements for this year. The BLACK line is the average for all years. The RED lines are one standard deviation unit below and above the mean. Record high temperatures occurred in January and March, with movement closer to the mean, but still above average, in April and May.

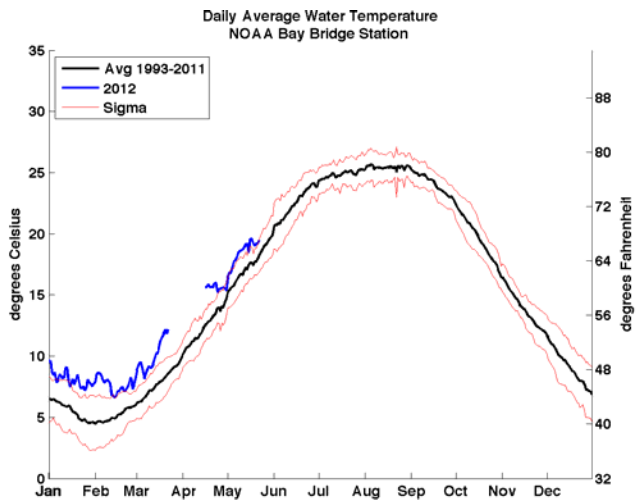

Figure 1. Average temperatures at Chesapeake Bay Bridge for 2012 (black) and the current 2012 temperatures (blue).

During April air temperatures were closer to average but still above normal. This raises the question: Why have we not seen continued record warming in the SST images during spring? The Mid-Atlantic had warm periods in April, but they were combined with periods of reasonably high winds, which to a certain extent had offset the surface warming by mixing cold bottom waters to the surface. Our current hypothesis is that the wind resulted in the entrainment of cold bottom water to the surface, which is why the SST images may not be showing as dramatic an increase in mid-late spring temperatures.

The warming has had impacts on Mid-Atlantic fish. The unusually warm conditions in the winter and spring of 2012 have resulted in water temperatures up to 3°C warmer than the previous 3 years resulting in comparable Atlantic sturgeon catches off the coast of Delaware occurring 3 weeks earlier than past sampling efforts. During sampling events for Atlantic sturgeon we have also documented sand tiger sharks arriving off the coast of Delaware in late-March, a full month earlier than documented in previous seasons.

The U.S. Coast Guard contacted MARACOOS to assist with locating a submerged fishing vessel off the New Jersey Coast during the winter. MARACOOS scientists provided three datasets to the support the USCG search for the sunken vessel: 1) NYHOPS model runs of simulated particle tracking, 2) HF-radar data and 3) Local expertise on bottom circulation. Meredith Austin, Captain USCG stated, "Your efforts and recommendations were critical in vastly improving the value of our search patterns." A thank you letter from the USCG for MARACOOS support is included in the annual supplemental report.

A) Atmospheric Data Integration: WeatherFlow continues to run an operational ensemble, twice a day at 00 and 12 UTC, with varying degrees of success. Logistical hurdles that need to be overcome include re-establishing a robust connection for collecting all the ensemble members, standardizing output of member's GRIB/netCDF files, attracting more members, and maximizing member domains to encompass the entire MARACOOS domain. The following changes have been implemented towards achieving these goals: 1) WeatherFlow has increased its 4 km horizontal resolution Atlantic domain to encompass the entire MARACOOS domain, 2) WeatherFlow has added a second member (model output) using another 4 km grid with the higher resolution sea surface temperature (SST) input dataset provided by the NASA Jet Propulsion Lab. 3) WeatherFlow has added the operational 5 km WRF run by NCEP. Rutgers WRF has altered run time on its model and will be adhering to providing output for the 12 UTC ensemble. 4) The server at the National Weather Service Eastern Region which housed the model output from the local Weather Forecast Offices (Wakefield and Sterling VA, Mt. Holly NJ) was retired. WeatherFlow is in the process of establishing a direct transfer of files from both Virginia offices.

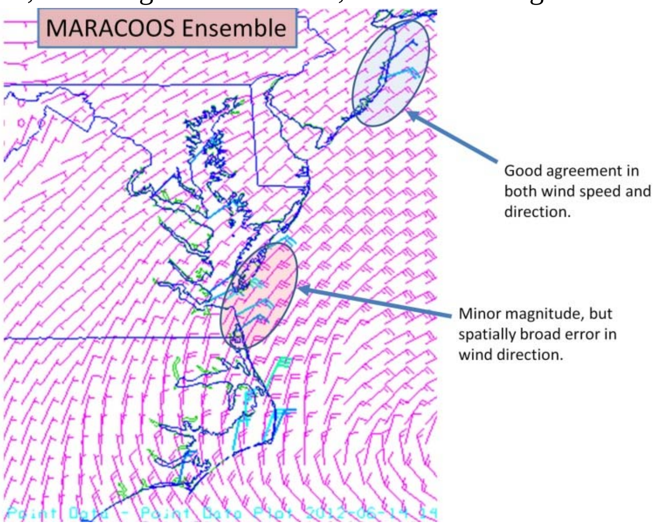

Figure 2. WeatherFlow's new visual verification asset

In addition, three tasks are being implemented in order to access the performance of the ensemble and increase the usage of the resultant products. The original set of output parameters, surface pressure and winds, air temperature, and precipitation constructed to support input into inundation studies, is to be expanded to include radiation products including shortwave, long wave and net radiation. Second, WeatherFlow continues to provide daily statistics on performance of each member, as well as the ensemble itself. Finally, WeatherFlow has built a visual verification asset using IDV (Integrated Data Viewer) in which WeatherFlow (current) and additional public domain data such as NWS, C-MAN, PORTS (coming soon) are overlaid on model output files to yield a qualitative assessment capability (Figure 2). The creation of hourly maps for each model member plus the ensemble itself can be scripted. WeatherFlow will make this resource and the accompanying statistics available to users via the MARACOOS interface.

B) HF-RADAR Equipment: The HF radar network expanded during this reporting period. A 5 MHz site was added at Hempstead, NY filling the gap between the stations at Sandy Hook, NJ and Moriches, NY. This is the second site added since the MARCOOS Gap Filling Document was submitted to IOOS in 2009. We have also added four 13 MHz systems in the southern half of New Jersey and plan on installing another 13 MHz system at Hempstead, NY adjacent to the new 5 MHz system. That will bring the total number of 13 MHz systems in the NY/NJ bight to eight.

We have decommissioned the 25 MHz systems at Sandy Hook, NJ and Breezy Point, NY. The system at Breezy

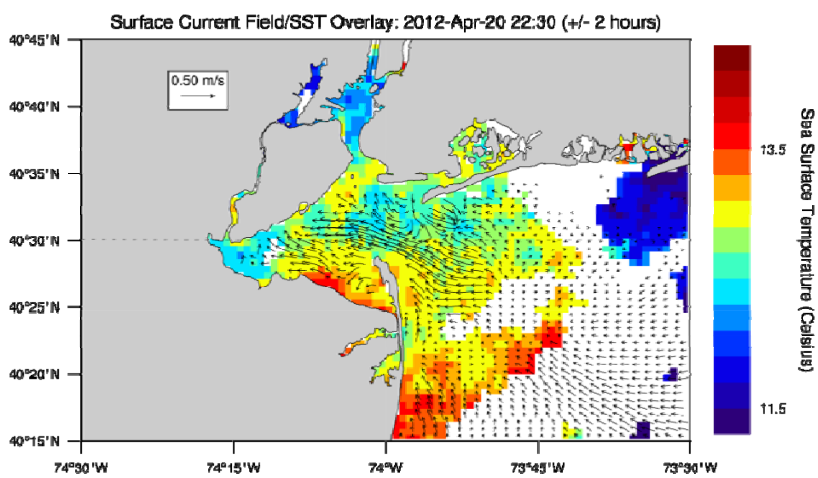

Figure 3: Surface currents overlaid on sea SST for April 20, 2012. The currents in Raritan Bay are provided by two 25 MHz systems and the currents in the NY bight are provided by the 5 MHz network.

Data Availability to National Network
12/1/11 to 5/31/12

Site #	Site Code	Data Coverage
5 MHz Systems		
1	NAUS	77.4
2	NANT	95.6
3	MVCO	93
4	BLCK	72.7
5	MRCH	83.6
6	HOOK	89.3
7	LOVE	83.4
8	BRIG	80
9	WILD	61.3
10	ASSA	90
11	CEDR	80
12	LISL	95
13	DUCK	96
14	HATY	66
	Frequency	**83**
13 MHz Systems		
1	SEAB	93.5
2	BELM	39.2
3	SPRK	93
4	BRNT*	75.1
5	BRMR*	90.2
6	RATH*	84.6
7	WOOD*	75.3
	Frequency	**79**
25 MHz Systems		
1	MISQ	95.3
2	BISL	95.3
3	MNTK	0
4	GCAP	95.1
5	STLI	81.6
6	PORT	NA
7	SILD	NA
8	CMPT	59
9	HLPN	NA
10	VIEW	88
11	CBBT	0
12	CPHN	95
13	SUNS	54
	Frequency	**66**
	Average	**70**

Table 1. Percent of uptime for each CODAR site in the MARACOOS network.

Point was moved to Port Monmouth, NJ to pair with the other 25 MHz system on Staten Island, NY. This allows for the generation of surface currents in Raritan Bay (Figure 3). The system at Sandy Hook is in the process of being configured from a solely 25 MHz system to a 13/25 MHz system and will be installed at Hempstead, NY.

The receive antenna location at Misquamicut, CT needed to be relocated. The winter fencing was destroyed last August by Hurricane Irene which resulted in the dunes being severely eroded during the winter. One of the guide lines for the receive antenna was anchored in the eroded dune which needed to be relocated. A new antenna pattern measurement is now needed.

Since late spring, the Great Captain Island, CT, CODAR has experienced above normal operating temperatures. The transmit and receive chassis temperatures have been within normal operating range but were approximately 10 degrees Celsius above normal as it seems the air conditioning unit is failing. Daily site checks are now being performed to make sure the system isn’t overheating. New air conditioning units have been ordered to replace the current unit.

The Block Island, NY CODAR has recently lost approximately 10W in forward power and subsequently the Bragg peak signal in the cross spectra is very weak effectively reducing the range of the system by 10km. Cleaning the connection at the antenna base temporarily solved this issue but the problem persists. A spare antenna will be installed and new cable termination will be made to try and correct this problem in the latter half of 2012.

The uptime of all the sites in the MARACOOS network is provided in Table 1. These percentages are consistent with past reporting periods and with the funding level of the network.

C) HF Radar QA/QC: The MARACOOS HF radar operators continue to hold twice monthly conference calls to exchange information and develop new procedures. Over this reporting period we have worked on both radial and total vector quality control of the network. On the radial level, we have drafted a document that outlines improvements we would like to see in the transponder that is used for the antenna pattern measurement (APM) of the SeaSonde. We delivered these recommendations to CODAR on May 11, 2012. Teresa Updyke has authored a document on how to complete an antenna pattern measurement. It includes information on preparation, execution and processing of the antenna pattern. The document was distributed to the operators in the region. She would like to distribute it to the ROWG community this fall. On the total level we continue to evaluate the implementation of the Optimal Interpolation algorithm on the 5, 13, and 25 MHz systems. The MARACOOS HF Radar paper published this spring evaluated OI parameter sensitivities with in situ mooring and drifter data. These results inform the implementation of OI across the National HF radar network. Hugh Roarty has submitted an abstract to the upcoming MTS meeting titled “Automated Quality Control of High Frequency Radar Data”. John Kerfoot and Mike Smith have created a radial database for the sites within the region on the web: http://marine.rutgers.edu/cool/maracoos/codar/radials/.

MARACOOS has also created a web based utility that will allow the operators to add new sites to the network, add and remove sites from the processing stream, and to assign site responsibility and contact information for the operators. It will also allow the operators to reprocess total files if a radial file(s) has been found to contain an error.

D) Underwater Gliders: It has been a productive term for MARACOOS glider operations with three deployments. Two of the glider deployments were conducted by the newest addition to the MARACOOS glider fleet - the University of Massachusetts at Dartmouth's (UMassD) glider named "Blue"; short for blue whale. Blue's first of 2 missions southward across the southern New England Bight (SNEB) (Figure 4) started 1 April 2012; with the second on 31 May 2012. Over both missions, the glider covered 454.4 kilometers over a total of 23 days.

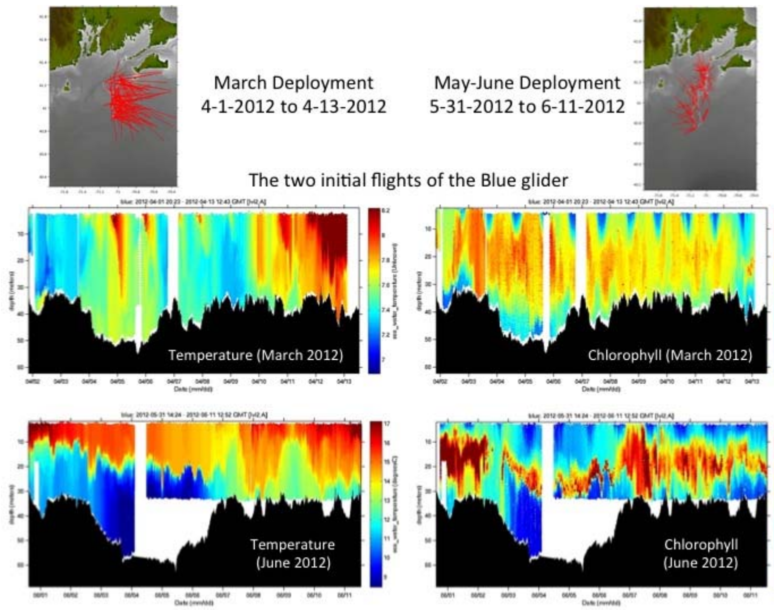

Figure 4. Data collected by MARACOOS glider Blue. Mission trajectories are shown in the uppermost panels. The contoured temperature and chlorophyll fluorescence transects are shown for early April 2012 in the upper data panels; and for early June 2012 in the lower data panels.

The early April SNEB mission data (Figure 4) showed the onset of a phytoplankton bloom (with values peaking at close to 2.5 mg/m^3) in an ocean environment with very weak density stratification. Another set of MARACOOS cross-shelf glider measurements from the same early April time off of New Jersey also indicated the apparent onset of the spring bloom in a similarly weak stratification environment.

The end-of-May Blue deployment documented the much stronger vertical stratification, which defines the inshore limits of the Cold Pool in the northeastern MARACOOS domain in early June; accompanied by chlorophyll concentrations which exceeded 4 mg/m^3. The next phase for MARACOOS is to expand the glider fleet coverage in the southwestern MARACOOS domain. Toward that end, University of Maryland has been conducting preparatory work and mission planning for a combined Glider/AUV operation.

E) Satellites: MARACOOS continues 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. The MARACOOS 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://assets.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 netCDF4 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. The degradation of the MODIS-Aqua sensor has hampered our ability to post quality data to the community. However, we are now implementing the latest updates and workflows from NASA to correct, and re-process the MODIS-Aqua mission for the Mid-Atlantic region.

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 that are in the MARACOOS region. These MARACOOS biome and water mass products are being used to drive a real-time regional butterfish model, which was tested by commercial fishermen (http://ecologyofcoastaloceanseascapes.blogspot.com). The results of this experiment are now being evaluated. In addition to our butterfish work, we are also starting to model Atlantic Sturgeon, Sand Tiger Sharks and Tiger Sharks using satellite observations 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. MARACOOS satellite data was also used to guide a MARACOOS glider mounted with a hydrophone to detect Atlantic sturgeon in the Delaware River plume. The integration of satellite, AUV and fisheries technologies hold promise for integrated ecosystem assessments. Because MARACOOS is providing real-time products that have been assimilated by fishermen for testing, members of the satellite team have been invited to join the ecosystems sub-team of the NOAA Northeast Regional Team to evaluate ecosystem visualizations.

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://udceoevis1.ceoe.udel.edu/modis/images/gvar/). A near shore ocean color-based salinity model was developed, 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, however, its implementation is dependent on the correction of the MODIS-Aqua data. Several projects are focused on enhancing satellite data delivery to the MARACOOS community. For example, real-time delivery of satellite data to mobile devices will be tested. This work is ongoing and depends on the maintenance of the MARACOOS satellite THREDDS servers (http://marine.rutgers.edu/cool/maracoos/mobile/). MARACOOS is also working to increase the resolution of our visualizations through Google Earth to 250m.

F) Short Term Prediction System (STPS): The short term prediction system has been in operation throughout this reporting period. The University of Connecticut system acquires vectors for the middle Atlantic Bight area every hour from the MARACOOS data center, and creates a 24 hour forecast. A system operated by Applied Science Associates then fetches the predictions and puts them into the US Coast Guard's Environmental Data Service (EDS) which makes the data available to their Search and Rescue Coordinators. During the current period the use of the NOAA National HF radar data center as a source of the observations was successfully tested.

Surface currents along the mid-Atlantic Bight and New England shelf predicted by STPS from the HF radar network were compared with current data derived from drifter tracks to assess the forecast skill of STPS. Earlier work had characterized the errors in trajectories forecasts using velocity data as a surrogate for the forecast. This established the data limitations. To evaluate the impact of the model approach of the forecast errors required the calculation must be repeated with the STPS.

Drifter track data were used from drifters deployed in the summer of 2009 that were in the area of STPS coverage for a substantial amount of time (>30 days). Of 19 drifters deployed during this period, only three tracks were found (see Table 2) suitable for analysis, the remaining drifters were not in the footprint of the HF radar data. We recomputed the surface current vectors for the time interval drifters data that was available from radials using the OI combiner approach to optimize and evaluate its performance. We then recomputed the STPS forecast on the 6 km grid and interpolated velocities to those positions and used these to predict the trajectory of drifters and the auto-covariance of errors in the velocity.

The covariance functions are now being compared to those using the data alone and the implications for the trajectory predictions will be assessed.

Table 2. Drifters used for comparison with STPS Predictions.

NOAA NEFSC Buoy ID	Drifter Start	Drifter End	Duration (days)
96101	06/04/2009 13:59	09/07/2009 12:12	95
96011	06/26/2009 15:44	07/26/2009 16:30	30
97115	07/09/2009 16:00	10/11/2009 23:30	80 (in coverage)

G) Dynamic Models: The MARACOOS ocean modeling team held a joint science and planning meeting on May 16 at Stevens Institute of Technology. This was a review of progress on algorithms and configuration of the respective individual modeling efforts, but was principally an opportunity to formulate strategies for formally integrating the systems within the timeline of the project. Two approaches are being pursued: (1) Hierarchical modeling - whereby output from an "inner domain" model (e.g. NYHOPS) is interpreted as data for assimilation by an "outer domain" model (e.g. ESPRESSO), thereby passing the information content of estuarine dynamics more highly resolved by the inner domain to the outer. Conversely, the outer domain ESPRESSO will provide open boundary conditions to NYHOPS improving upon the climatology presently used. The cyberinfrastructure tools developed by MARACOOS DMAC greatly facilitate introduction of these new data streams to the respective models. (2) Multi-model ensemble analysis - steps toward producing a multi-model ensemble forecast have been taken by identifying an independent 2-year data set comprising 16 glider missions and 4 NMFS ECOMON cruises (Figure 5) that span the entire MAB shelf region. These data are anticipated to be sufficient for training a system that derives an objective set of weights for combining the 3 MARACOOS models with other IOOS real-time modeling systems in the region. Skill assessments that contrast individual model skill against these 20 data sets have been completed. These indicate no single model has consistently superior skill, and therefore procedures for adapting the optimal weights regionally, or seasonally, need to be derived. This will be a collective effort by the modeling groups to commence this year.

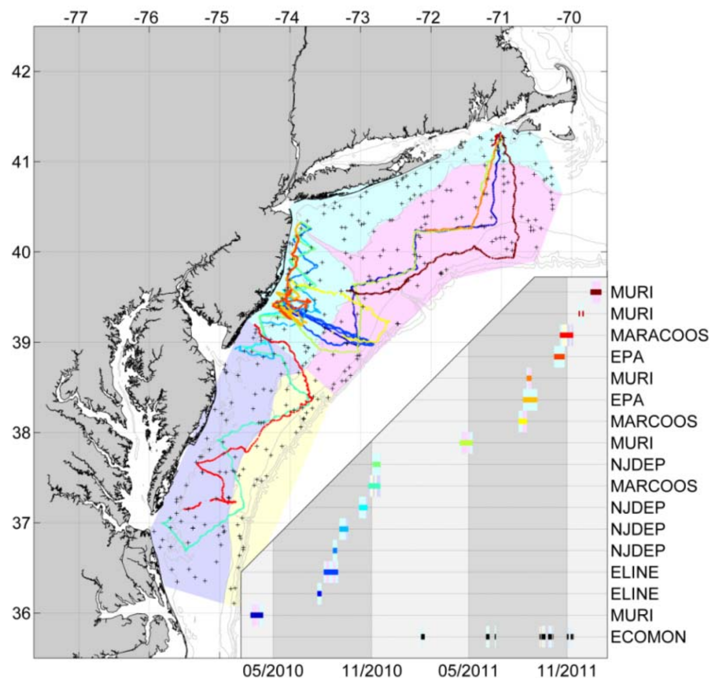

Figure 5. Two year glider missions in the MARACOOS region.

A nudging or Newtonian damping scheme was developed to assimilate a controlled subset of HF radar surface currents in the Middle Atlantic Bight (MAB) into the New York Harbor Observation and Prediction System (NYHOPS). The effectiveness of data assimilation (DA) was evaluated by various methods, including tidal and tidal-residual comparisons to independent datasets (ADCP data and USCG drifter-derived currents), and comparisons of Lagrangian particle-tracking simulations to USCG drifter tracks in 2010 and 2011. Without data assimilation, NYHOPS and HF radar yielded similar root-means-square-differences (RMSD, both around 18cm/s) when compared to surface currents derived independently from drifters along their trajectories. The comparison of tidal ellipses from NYHOPS and HF radar against current meter observations showed both NYHOPS and HF radar perform well and had similar skill in tidal currents estimation. The impact of DA on NYHOPS' ability in capturing total surface current during hindcast (-24 to 0 h) and forecast (0 to 24 h) was analyzed quantitatively. The RMSD of east-west and north-south component of surface current between NYHOPS hindcast and HF radar showed a decrease of 3 cm/s. When HF Radar data are screened through rudimentary quality control before DA, surface currents derived from NYHOPS hindcast after DA show an average 8% improvement when compared with drifter-derived surface currents. The already good tidal performance of NYHOPS after DA also shows slight further improvement. The comparison for NYHOPS forecast surface currents also show an averaged 5% improvement after DA of quality controlled HF-radar totals. Ensemble-based sets of particle tracking simulations for all the drifters show an improvement for NYHOPS hindcast (7%) and forecast (4%) after DA. Next step should be to test DA operationally to QA/QC automated online performance with a goal to carry over the mentioned forecasting skill increases to NOAA Hazmat and USCG SAR missions in the NYHOPS region.

The MARACOOS implementation of the Harvard Ocean Prediction System (HOPS) at SMAST (SMAST-HOPS) has been described in detail and validated against satellite Gulf Stream paths and available drifter data for the Shallow Water 2006 period (July-September). Glider data assimilation was also validated for 4 short-term forecasts of varying lengths during the first two weeks of November 2009 in an ensemble mode with other forecasts to guide glider control. A number of sensitivity experiments were carried out by varying the Feature Model parameters such as the stream width, the stream transport and the strength of the southern recirculation gyre to better capture the Ring formation with faster wave-growth.

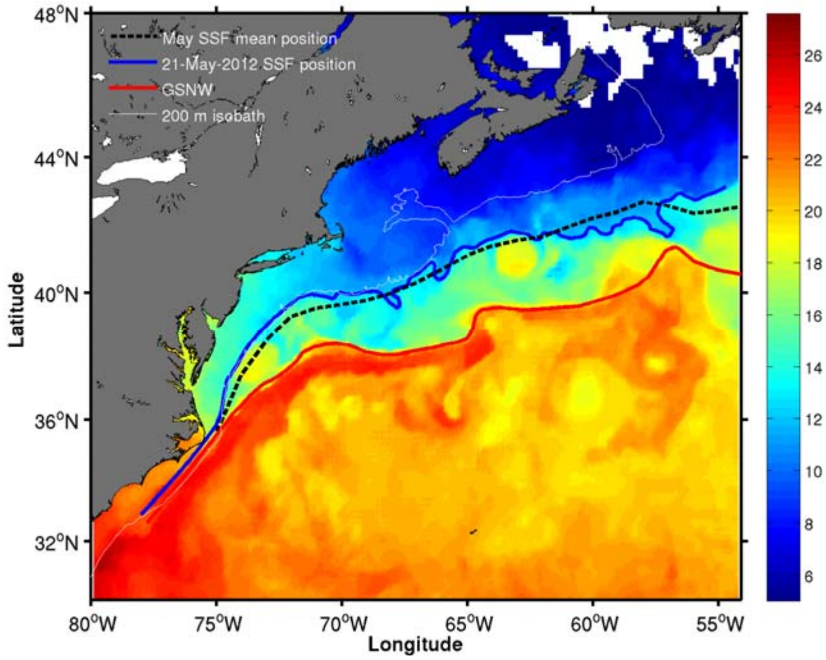

Figure 6. An example of the subjectively determined paths of the Gulf Stream north wall (red-solid) and of the SSF (blue-solid) is shown for the weekly initialization on 21 May, 2012. These trajectories are then used to place the synoptic FM temperature/salinity profiles across the fronts. The black (dashed) line represents the mean SSF path from Drinkwater that was used in the first implementation of the operational system (www.smast.umassd.edu/modeling).

Given the importance of understanding the variability of the Shelf Slope Front (SSF) and the imminent availability of multiple data streams from the Pioneer Array for next three years, a new procedure for synoptic identification of the SSF path (Figure 6) has been implemented. This will help monitoring the SSF on a weekly basis and study its impact on the ecosystem in the MAB. The synoptic SSF detection is based on a combined (objective and subjective) procedure that uses both SST imagery and Jenifer Clark's analyses. The SST is first filtered using a hybrid median filter to preserve the edges and then subjected to an edge detection algorithm that consist of a combination of a Laplacian and a second-derivative in the gradient direction. This procedure gives a set of edges that are then subjectively compared by the analyst with Jenifer Clark's SSF analysis and against the mean monthly SSF. The final outcome is a more dynamic realization of the SSF's evolution for operational forecasting.

H) DMAC: The DMAC team continues to work on maturing the asset map and adding data sources. The data management approach underlying the Asset Map includes:

- Where possible, data is served and integrated using open, interoperable data standards recommended by IOOS
- Where possible, the data providers manage, host and serve their particular data and the Asset Map integrates data "on the fly" from this distributed network of data servers
- The Asset Map provides preview capabilities so users can see recent, present, and future conditions in a single map and view time series data at discrete points. Scientists and "power users" are provided links to the data servers so they can download data for further analysis with tools such as Matlab and ArcGIS.
- The system takes advantage of a combination of OpenSource technologies and standards
- Use of "cloud computing" for data storage and delivery
- The system leverages the power of the federal data centers to access data using open standards
- The system is extensible to add new data sources from other data providers

The Asset map has added data from:

- 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)

The DMAC team is now working with the stakeholder liaison to provide a "Fisherman Ocean Portal" (Figure 7); 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.

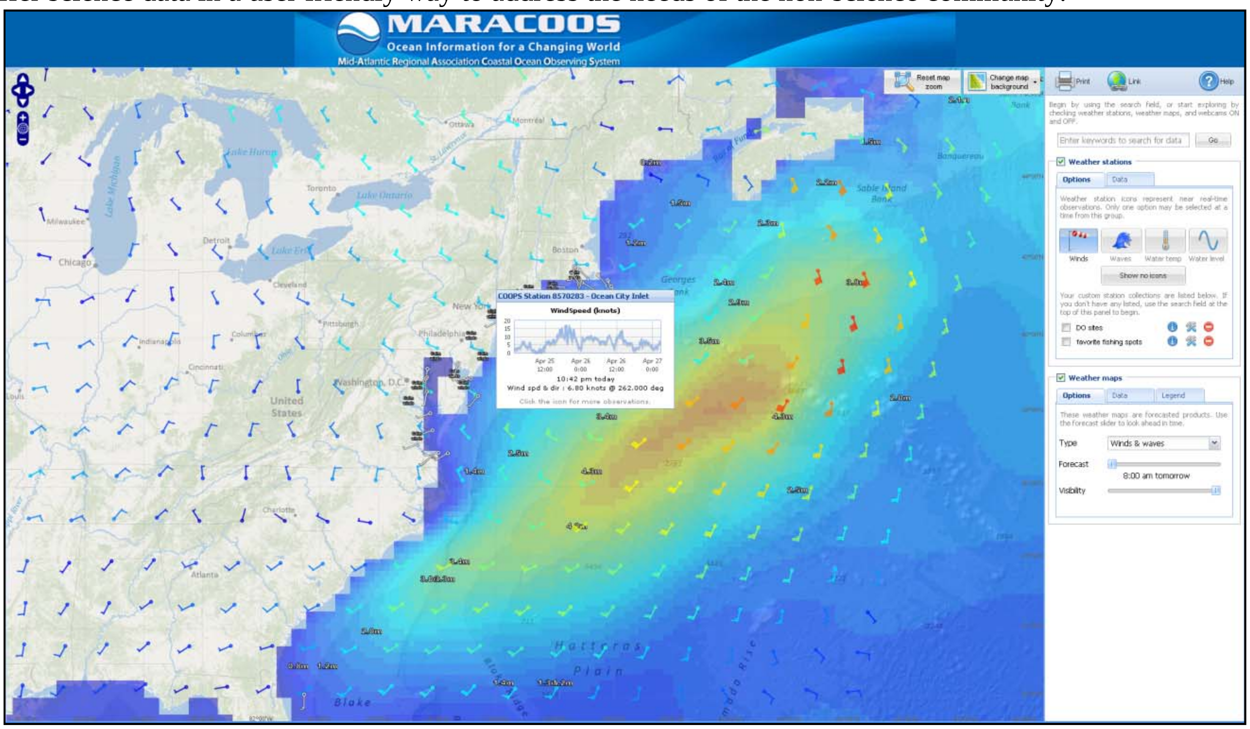

Figure 7. The updated MARACOOS Fishermen Ocean Portal interactive Asset and data query map.

I) Education and Outreach: The MARACOOS Education Team continues to participate in the NFRA Education and Outreach conference calls that have become increasingly focused on congressional outreach. In parallel, MARACOOS has continued its historical emphasis on supporting science educational needs with an increasing focus on workforce development at the undergraduate level. This undergraduate education focus is enabling the team to leverage support from NSF COSEE-NOW, NSF OOI EPE IO, and the DHS CSR to bring ocean observatory data and models into the classroom. The most significant event of the reporting period is the education design workshop held in Seattle at the University of Washington to provide feedback on the education tools currently being developed by the NSF OOI EPE for ocean observatory data. The workshop of OOI-engaged geophysical scientists, undergraduate educators and learning scientists provided initial feedback as a precursor to an east coast workshop of IOOS-engaged scientists planned for July of 2012. Early feedback has validated the EPE approach for simple data visualization tools that can be used by teachers and students, the importance of integrating the tools, and the ability to collaborate between universities.

Mr. Peter Moore was hired as the Stakeholder Liaison, reporting to the Executive Director of MARACOOS and overseeing the development and implementation of a stakeholder engagement strategy. The Stakeholder Liaison oversees the User Council and the sub-groups under the User Council. Currently there is a Fishery Working Group and discussions to create an Offshore Wind Energy Group along the eastern seaboard together with NERACOOS and SECOORA. Other working groups focused on the other thematic areas are being discussed. Further, a stakeholder engagement strategy is under development to support product development, including through collaboration with the Sea Grant outreach network.

J) Economic Benefits: As principal investigator for the NOAA Regional Ocean Partnership Program's Mid-Atlantic Mapping and Planning Portal project, Tony MacDonald continued work with the Mid-Atlantic Regional Council on the Ocean (MARCO) Management Board to identity opportunities for development of MARACOOS derived ocean observation products into regional CMSP efforts. Portal project co-PI Jay Odell from The Nature Conservancy has joined the MARACOOS Board. Mr. MacDonald also worked with MARACOOS Executive Director Gerhard Kuska to plan and moderate the MARACOOS Congressional Staff Information Briefing in Washington, DC on June 25, 2012.

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 PERSONELL AND ORGANIZATIONAL STRUCTURE

During this reporting period Mr. Peter Moore was hired as the first Stakeholder Liaison for MARACOOS.

5) BUDGET ANALYSIS

The MARACOOS account was created at Rutgers on September 15, 2011. 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 8 highlights the current balance remaining for the lead and all subcontracts as of May 31, 2012. Note that many of the subcontractors billing lags several months, so the next report will include more complete financial data.

#	Distribution	Year 5	Remaining Balance
LEAD	Rutgers University	$ 575,325	$ 97,285
1	Applied Science	$ 156,145	$ 76,947
2	Center for Innovatice Technolog	$ 44,458	$ 29,104
3	Old Dominion University	$ 98,795	$ 86,795
4	Stevens Institute of Technology	$ 95,857	$ 4,781
5	University of Connecticut	$ 145,254	$ 83,033
6,7	University of Delaware (2)	$ 519,926	$ 316,961
8	University of Maryland	$ 88,915	$ 17,488
9	University of Massachusetts	$ 225,278	$ 85,076
10	University of North Carolina	$ 17,783	$ 16,646
11	University of Rhode Island	$ 26,668	$ 15,018
12	Weatherflow	$ 87,831	$ 41,622
	TOTAL AWARD	$ 2,082,235	$ 870,756

Figure 8. MARACOOS budget distribution with total and remaining budget listed for all parties.