

**Phased Deployment and Operation of the
Mid-Atlantic Regional Coastal Ocean Observing System (MARCOOS)**

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NOAA Award Number: NA07NOS4730221

Award Period of Performance: October 1, 2007 – March 31, 2008

2) PROJECT SUMMARY: The Middle Atlantic Coastal Ocean Observing Regional Association (MACOORA) is one of eleven Regional Associations (RAs) within the U.S. Integrated Ocean Observing System (IOOS). The MACOORA footprint encompasses 9 states, 66 million people, four major estuaries, one of which is the world's largest, and the world's largest Navy base. MACOORA ports handled cargo worth over \$259 billion in 2005 (over 23% of the total US waterborne commerce) including over \$130 billion at the Port of New York/New Jersey alone. Through MACOORA, the user community has identified the priorities for MACOORA-wide regional and sub-regional scales. The two MACOORA priority themes for the regional components of the Integrated Coastal Ocean Observing System (IOOS) are:

MACOORA Regional Themes

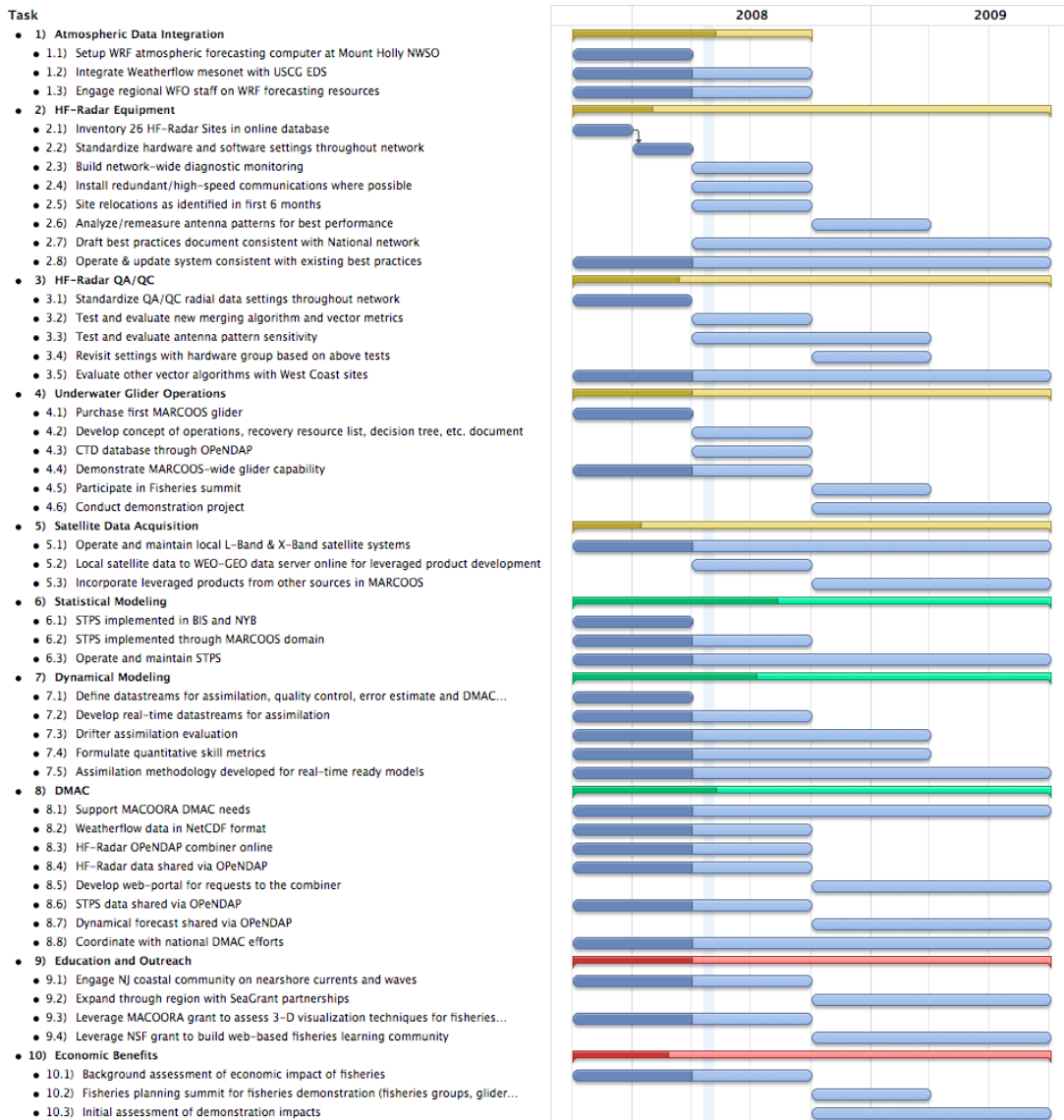
1. Maritime Safety – providing regional surface current maps to improve Search And Rescue and hazardous material spill response, as well as products to improve rip current forecasting.
2. Ecological Decision Support – providing regional 3-D temperature and circulation data and forecasts for the recreational, commercial and fishery management communities.

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. MARCOOS products will support the two priority regional themes and provide critical regional-scale input to MACOORA's nested subregional efforts on Coastal Inundation and on Water Quality. MARCOOS will accomplish this by coordinating an extensive array of existing observational, data management, and modeling assets to generate and disseminate real-time data, nowcasts and forecasts of the ocean extending from Cape Cod to Cape Hatteras.

MARCOOS will (a) *collaborate* with NOAA WFOs to link existing regional coastal weather networks to evolving NOAA WRF regional forecasting capabilities – *to provide* an improved ensemble of weather forecasts, (b) *operate* the existing Mid-Atlantic HF Radar Network and leveraging 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) *operate* the existing satellite receivers and leverage 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 will facilitate implementation of an end-to-end system consistent with DMAC standards. A management structure that establishes and monitors performance metrics will ensure quality. Education & Outreach (EO) teams will engage additional users and provide frequent and timely feedback, while an economic impact team assesses benefits of MARCOOS information.

Progress and Accomplishments

Milestones:



Year 1 Goal Summary: The focus will be on the observation and forecasting of 2-D surface currents to support Maritime Safety. Priority is given to operating the full regional HF Radar network, and linking the surface currents to Short Term Prediction System (STPS) statistical forecasts, the Coast Guard's Environmental Data Server (EDS), and their SAROPS system. SAROPS-required uncertainty estimates will be determined through evaluation of the HF Radar and STPS surface current system with Coast Guard surface drifters. Three dynamical ocean forecast models will be run in their native domains and forced by nowcast/forecast surface meteorological products from both NOAA NCEP and the NOAA Weather Research & Forecasting (WRF) model (to be set up at the Mount Holly WFO). These NOAA wind fields will be compared with a high

resolution weather meso-net from WeatherFlow Inc. The models will be adapted to assimilate MARCOOS satellite, HF Radar, glider, and drifter data as available. Year 1 MA regional glider flights leveraged from existing ONR assets are partially supported as part of the ongoing DoD MURI program. Efforts will determine which assimilation and wind field forcing best improves surface current forecasts. The first MARCOOS glider will be built. Education efforts will leverage SeaGrant expertise to include HF Radar wave and current nearshore products into NWS rip current forecasting activities, and leverage the Centers for Ocean Science Education Excellence (COSEE) – Mid Atlantic’s expertise to coordinate product development with the recreational, commercial, and fishing management communities.

The detailed task list below focuses on year one tasks. Tasks are organized into two categories, progress and plans. The plans category includes those tasks on schedule for completion by the end of the first year of this project (October 1, 2008).

1. Atmospheric Data Integration & Gridded Diagnostic Product.

Lead: Jay Titlow, Weatherflow.

Working Group Members: Andrew Voros, Al Cope, Scott Glenn

Progress

- The WRF atmospheric forecasting computer was designated, purchased, and installed at the Mount Holly National Weather Service Office. Rutgers WRF forecasting software was installed by Louis Bowers and Al Cope. Initial test forecasts have been run, and the output has been linked to the NOAA AWIPS system.
- Atmospheric data from the Weatherflow mesonet has been placed in the proper formats integrated into the U.S. Coast Guard’s Environmental Data Server (EDS). The weather data is also available to the NWS to provide additional validation data for the WRF model at the critical land-sea interface.
- The 5 National Weather Service offices (Mount Holly, Upton,) in the Mid-Atlantic have been individually contacted. An initial conference call was held to explain the MARCOOS objectives, and begin an inventory of WRF forecasting capabilities at each office. A significant synergy to date was the comparisons of WRF model resolution needs, with 6 km or better required for seabreeze and 4 km or better required for convection.

Plans

- Finish inventory of WRF forecasting activities and configurations at each NWS site in our region.
- Revise Mount Holly WRF forecasting domain for real-time regional forecasts.
- Develop comparison procedures between WRF forecasts and available data including Weatherflow mesonet.
- Continue to provide Weatherflow mesonet data to the NWS and USCG EDS

2. HF Radar Site Operations

Lead: Hugh Roarty, Rutgers.

Working Group: Mid-Atlantic HF Radar Consortium (MAHFRC)

Progress:

The general objective was to standardize the operation of all existing HF Radar sites in the Mid-Atlantic during the first 6 months. Specific activities include

- An operator working group was formed. Conference calls are held every two weeks. Responsibilities for site maintenance were set.
- The 26 existing sites in the region were inventoried and an online database of hardware and software was developed.
- Based on the inventory, software versions were standardized throughout the network.
- Computer scripts to monitor site settings were developed and a network-wide diagnostic monitoring website was developed and installed.
- All operating HF radar sites in the Mid-Atlantic were set up to report their data to the National Network Server at Rutgers.
- HF Radar operations were sustained at a rate consistent with Phase 2 of the MAHFRC's 3-Phase implementation plan. Phase 2 includes 3 HF Radar technicians spread across the northern, central and southern sections of the Mid-Atlantic. Phase 3 provides technical support at the SCMI recommended rate of 2 technicians for every 5 sites to approach a 24/7 response capability.
- A 1-week duration advanced CODAR training class was held at Rutgers for all members of the Mid-Atlantic Bight HF Radar Consortium contributing to MARCOOS.

Plans:

Overall goal for next increment is to increase reliability of radar sites and gap fill with new sites as they come available.

- Install redundant/high speed communications at problem sites.
- Relocate sites with complicated beam patterns or other interference (ex, Tuckerton). Install new sites as available (ex. Fire Island).
- Draft a best practices document consistent with the National HF Radar network

3. HF Radar Data QA/QC

Leads: Josh Kohut & Dave Ullman

Progress

- Standardize present QA/QC settings throughout network
- A guidance document describing the QA/QC recommendations as of March 31, 2008, was developed.

- Radial currents collected from the full network were merged to produce a total vector map in real time on the existing Mid-Atlantic Bight grids.
- A new merging algorithm using the community HF Radar toolkit was developed
- A new computer was purchased as a mirror site to the National HF Radar east coast server for the development and testing of new merging algorithms.
- Merged total vector data files were delivered to the Rutgers Opendap server and made available via ftp for the Short Term Prediction System (STPS).

Plans

- Test and Evaluate New Merging algorithm
- Test and Evaluate Antenna Pattern Sensitivity
- Revisit settings based on above tests
- Provide quality controlled merged data files on the National HF Radar grids.

4. Autonomous Underwater Glider Operations

Lead: Oscar Schofield.

Working Group: Wendell Brown, Bill Boicourt, Josh Kohut

Progress

- Purchase first MARCOOS glider.
- Continue northern line mission with MURI leveraging, 8 Missions completed to date.
- MARCOOS Southern Glider Lines, 2 Missions completed to date.
- Draft concept of operations document assembled by glider working group.
- Meeting held with modeling group to refine data needs for flight planning.
- 1-week duration advanced glider training course held at Rutgers for MARCOOS glider technicians. Successful class is now being repeated for the Navy, with attendance from NAVO and NATO.

Plans

- Formalize Develop concept of operations document
- CTD database through OPeNDAP
- Develop an operations resource list
- Develop an operations decision tree

5. Satellite Data Acquisition

Lead: Matt Oliver

Working group: Oscar Schofield.

Progress

- Satellite data acquisition maintained.
- WEO-GEO data server purchased.
- Decoded and filtered SST product for model assimilation developed and delivered to modelers for assimilation tests.
- Merged SST and Ocean Color water mass product developed

Plans

- Re-formatting APS processed MODIS imagery
- Real-time Images on WEO-GEO and OPeNDAP

6. Short Term Prediction System

Lead: Jim O'Donnell

Progress

- STPS initially implemented in Block Island Sound and the New York Bight on existing grids.
- MAB Total Vector Files are retrieved hourly via ftp from Rutgers server
- Hourly 24hr predictions from current time are made using STPS
- STPS results are stored in SQL database and integrated into GIS web based interface viewable at <http://lisicos.uconn.edu>
- STPS results saved in NetCDF format for accessibility through DODS requests to OpenDAP server <http://nopp.dms.uconn.edu:8080/thredds/catalog.html>

Plans

- STPS implemented for the full MARCOOS domain covered by HF Radar with results on the National HF Radar grid.
- Full forecast domain available via Opendap
- Full STPS domain in the EDS and available for the research SAROPS testing.

7. Dynamic Models

Leads: Avijit Gongopadhyay (HOPS), Alan Blumberg (ECOMSED), John Wilkin (ROMS)

Progress

All three dynamical forecast models are running in their native domains and are now adding assimilation capabilities for the different MARCOOS data sets. Data rich test cases from the past have been identified. Specific progress on each model is listed below.

HOPS

- Testing initialization and assimilation schemes.
- ONR Shallow Water 2006 test case.
- Uses historical feature models (for GSMR and GOMGB) adjusted by new data.
- SST, HF Radar, Glider and Drifter data are being used for assimilation.
- Offshore Focus, e.g., Shelf Slope Front.

ECOMSED

- Existing Real-time system.
- Extensive Evaluation for Sea level and currents in the harbor and nearshore
- Ensemble Data Assimilation
- Nudging Scheme
- HF Radar Data can now be assimilated.
- Offshore Validation by gliders.

- Meteorological Sensitivity

ROMS

- Several Nested grids
- 5 km Assimilation Grid
- 1 km forecast grid.
- 4D Variational Assimilation.
- Present Datasets - SST, HF Radar, Glider, Moored T&S
- Future – Altimetry, Optics and Ocean Color
- Glider sampling design via Representers

Plans

All dynamical forecast modelers will continue model configuration and assimilation scheme testing as we approach a real-time data assimilative forecast system. Running actual forecasts postponed to year 2 base on the reduction in funds.

8. DMAC

Lead: Eoin Howlett

Working Group: Dan Holloway, Dave Ullman.

Progress

A MACOORA-wide DMAC plan is under development. Initial implementation is to enable end-to-end data sharing for Search And Rescue.

- Weatherflow data in NetCDF format
- HF Radar data shared via OPeNDAP
- Weatherflow winds and HF Radar data are now integrated into the Environmental Data Server (EDS) and accessible through the research version of SAROPS. These datasets have begun the year long trial in preparation for being part of the operational SAROPS.
- New glider data format defined to ease assimilation into models.
- Process to make STPS available over standard Opendap servers has been initiated.

Plans

- HF radar OPeNDAP combiner online
- STPS data shared via OPeNDAP
- Glider data available in new format searchable by time period rather than by individual gliders.

9: Education/Outreach

Leads: Tom Herrington, Janice McDonnell

Progress

- Complete SeaGrant deployment of ADCP wave sensors to validate new nearshore CODAR wave and current product.
- Plan developed to determine best way to visualize 3-D fields to targeted fishery audiences, additional funding acquired through MACOORA, target tuna club identified.

Plans

- Leverage MACOORA grant to determine best way to visualize 3-D fields to targeted fishery audiences
- Engage NJ coastal community on nearshore currents and waves for improved rip current forecasts through SeaGrant Partnerships.

10: Economic benefits

Leads: Tony McDonald, Dennis King.

Progress

- Initial economic impact of fisheries, recreational and commercial, determined for the northeast and Middle Atlantic states.

Plans

- Form an advisory group made up of fisheries managers to work with MARCOOS modelers and the glider team to define the important times to focus the funding-limited number of glider flights.

Issues

No issues to report. All tasks are on or ahead of schedule.

Key Personnel

No significant changes in key personnel. Minor adjustments include:

Dr. Matt Oliver, lead for the Satellite Remote Sensing component of MARCOOS, has moved from a post-doctoral position at Rutgers to a tenure-track faculty position at the University of Delaware. Dr. Oliver will remain the lead for the Satellite Remote Sensing component.

Dr. Josh Kohut has moved from his position as Director of the Rutgers Coastal Ocean Observation Lab to start a tenure track faculty position at Rutgers. Dr. Kohut will move from HF Radar Regional Coordinator for MARCOOS to Project Coordinator for MARCOOS.

Dr. Hugh Roarty has taken on the task of Director for the Rutgers Coastal Ocean Observation Lab. As a result of this move, Dr. Roarty is now the HF Radar Regional Coordinator for MARCOOS.

Eoin Howlett's role as MARCOOS DMAC lead has expanded with his recent appointment by the MACOORA Board as the DMAC lead for all of MACOORA.

Budget Analysis

Spending on this grant is on schedule in all areas for both Rutgers University and all subcontracts. There are no issues currently in regards to spending for this project.

Salary support is on track and will continue through the summer supporting both staff and key personnel.

All major purchases have been made which in turn support the underwater gliders, HF Radar network and our satellites as outlined above.

MARCOOS related travel has been a great success in developing this network and disseminating the collected data amongst the group and to others and will continue for year one.

All subcontracts have been awarded year one funds and continue to provide positive feedback on all accomplishments and feel there is no cause for concern on spending at this time.

All spending directly correlates with the timeline established and we were able to reach our projected milestones.