1. Priorities
1.1. List priorities and explain how priorities were determined

MACOORA Priorities

Through an extensive series of MACOORA workshops, the user community has identified the priorities for MACOORA-wide regional and sub-regional scales. The specific goals of IOOS are to (1) Improve predictions of climate change weather and their effects; (2) Improve the safety and efficiency of maritime operations; (3) Mitigate the effects of natural hazards more effectively; (4) Improve national and homeland security; (5) Reduce public health risks; (6) Protect and restore healthy coastal ecosystems more effectively; and (7) Enable the sustained use of ocean and coastal resources. Working within these seven goals, MACOORA has initially identified four priority areas where critical information will be provided to users:

(1) Coastal Inundation (helps meet IOOS goals 1, 2, and 3);
(2) Maritime Safety (helps meet IOOS goals 2, 3, and 4);
(3) Ecological Decision Making (helps meet IOOS goals 5, 6, and 7);
(4) Water Quality (helps meet IOOS goals 5, 6, and 7).

These four priority areas are included in MACOORA's short-term goals. MACOORA will, as it matures, broaden its priority areas so that it fully incorporates all of the seven IOOS goals noted above. The two MACOORA operating system (MARCOOS) primary 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.

1.2. Identify products that will serve these priorities. Articulate the beneficial uses of these products.

1.2.1 PRODUCTS (See description in Section 2.1, Observing System, below)

Surface Currents for Maritime Safety

- Statistical Surface Current Forecasts
- Regional Weather Data and Forecasts
- Dynamical Surface Current Forecast Ensemble
- Surface Current Evaluation with Drifters
- Outreach to Rip Current Forecasting Community
- Economic Impacts Assessment

3-D fields for Ecological Decision Support

- Satellite Data Acquisition and Processing
- Regional Sustained Subsurface Glider Operations
- Dynamical 3-D Forecast Ensemble
- Education & Outreach for New Fisheries Support Products
- Economic Impacts Assessment

1.2.2. BENEFITS

Maritime Safety. The initial primary user of the 2-D surface currents will be USCG SAR operations. The benefits include reduced search time, more lives saved, and more time available for law enforcement missions. Specific implementation guidance is provided by Art Allen from the USCG Office of SAR participating as a PI on this proposal. Once MARCOOS surface currents are made available on EDS by ASA, they are available to operational SAR controllers by the same methods used to access other less accurate current fields. NOAA HAZMAT operations have similar decision aids for spill response. USCG is already discussing with NOAA HAZMAT the potential for accessing data from EDS for improved spill response. This will potentially enable any surface current fields in EDS, or in a parallel NOAA system, to be used in the HAZMAT decision aids.

The primary user of the nearshore wave and current product enabled by the 26 CODAR sites in the MA is the NWS Regional WFOs. The benefit will be improved forecasts of rip current probabilities. In the event of a Search, the alongshore current product delivered by MACOORA could be used by the WFOs to assist emergency response personnel in determining the speed and direction of alongshore drift. MARCOOS information is delivered to a central WFO operations center and then distributed by the agency to the users in the field. At present, a prototype nearshore CODAR product is delivered via real-time webpage displays, a process that will be facilitated by the MARCOOS website. The MACOORA User Engagement working group will continue regular visits to WFOs. The MARCOOS SeaGrant liaison will specifically work with SeaGrant using its effective outreach and training capabilities to devise the next generation of nearshore products to assist WFO activities supporting rip current forecasting and response.

Ecological Decision Support. Primary users of MACOORA's 3-D circulation and temperature fields are the recreational, commercial and management fisheries communities. Benefits are improved management of marine living resources, and the economic savings of reduced fuel consumption and search time for fishing operations. Recreational fishing groups have already contributed to the design of satellite SST web pages at the shelf break canyons (Saltwater Fisherman, 2006). The next level of information advocated by fishing community leaders is subsurface temperature data. Unlike theme 1, users in the Fishing communities are distributed and operate independently. Effective information flow to distributed groups will be accomplished through the MARCOOS website, the preferred delivery mechanism by this community. Commercial value-added industry groups (e.g., OceanTemp) already access the existing data and products over the Internet. Again the MACOORA User Engagement group will engage fishing community leaders in MACOORA activities and new developments in MARCOOS. The MARCOOS COSEE liaison will leverage their extensive E&O materials already developed for the fisheries community in other regions and apply them to the MA. User needs assessments and attendance at regional fisheries council meetings will enable MARCOOS webpage products to be tailored and refined in a proven-effective iterative process based on the needs of the fishing community. Fisheries management personnel are considered advanced users of observatory data, requiring access to real time web pages for adaptive sampling, but also to historical datasets for retrospective analyses. Access to the real-time and archived datasets beyond web pages will be facilitated by OPeNDAP server access. Leveraging regional IOOS observatories for the development of potential Fisheries ecosystem observatories is an envisioned synergistic collaboration.

Regional Products Supporting Subregional to Local Needs. Coastal inundation proposals will benefit from MARCOOS regional products through improved boundary conditions for nesting, improved surface forcing, and improved spatial data for assimilation. Access to these advanced products will be facilitated by the DMAC team. OPeNDAP servers provide a common access protocol for data assimilation by all local modelers. Nesting within atmospheric and ocean models is model specific, and is a significant component of each subregional inundation proposal. This will be facilitated by regional model providers and by the DMAC team. Water quality efforts will be facilitated through continuing close interactions with the MACOORA community coordinated by the operations manager. The potential range of interactions include: (1) real-time data web pages for local water quality decision-makers, (2) the NJDEP/EPA proposal to monitor dissolved oxygen with gliders that makes use of the MARCOOS glider technology support and data management, and (3) the Delaware Bay National Water Quality Monitoring Network (NWQMN) Pilot Study that will demonstrate synergistic linkages between IOOS and NWQMN.

1.3. Table of required activities to meet identified product areas, including outreach.

1.3.1. Matrix I: User Themes and Regional Assets

This part of the Matrix shows how the integrated regional assets relate to the four cross cutting regional areas

		Cross Cutting Regional Areas				
		Inundation	**Maritime Safety**	**Ecological Decision Support**	**Water Quality**	**Operational Metrics**
USERS		Local Inundation Product Producers	USCG, NOAA HAZMAT, NOAA NWS Surf Zone Forecasters	Fisheries Groups- Commercial, Recreational, Management, Research	EPA, State Environmental Agencies, County health Agents, & Municipal Governments	
INTEGRATED REGIONAL ASSETS	**NOAA NCEP & WFO Forecasts**	Regional atmospheric & basin scale ocean forecasts	Regional atmospheric & basin scale ocean forecasts	Regional atmospheric & basin scale ocean forecasts	Regional atmospheric & basin scale ocean forecasts	Document forecast improvements through inclusion of weather networks
	High Resolution Weather Networks	Weather Station data to NWS to improve weather forecasts	Gridded real-time near shore Wind fields into the USCG Environmental Data Server (EDS), and then into SAROPS	Gridded real time wind field for estuary and bay response to local winds	Gridded real-time near shore Wind fields to an easy access website for river plumes	Real-time weather network data available for assimilation. Validated gridded fields
	Satellite SST & Ocean Color Imagery	Improved high resolution SST products for atmospheric model boundary conditions	SST to augment SAROPS survival time estimates	SST combined with Ocean Color to determine water mass origins (riverine, coastal, shelf) and for assimilation	SST & Ocean Color Images of river plumes and upwelling	SST product delivered. New combined SST/Ocean Color products automated.
	Mid-Atlantic HF Radar Network	Assimilation &Validation Data for Regional Models	Surface current maps for direct input to SAROPS, initialization of STPS, and	Surface current maps for transport pathways and assimilation	Surface current maps of river plumes from the inner CODAR nests.	Standard practices established with NOAA & implemented. QA/QCed product delivered.

			assimilation in dynamical models			
	Repeat Regional Glider Sections	Surface layer temperature & thickness for heat content and wind driven layer response	Thickness of upper wind-driven layer for dynamical forecast models.	Subsurface distributions of T, S, phytoplankton, and particles	Subsurface T&S data with optics and oxygen	Standard operational Navy practices adapted and implemented. QA/QCed product delivered.
	USCG Surface Drifters	Rapid response deployments before storms to validate storm current forecasts	Spatial statistics of current velocity uncertainties in CODAR, STPS, and ensemble of forecast models	Dynamical forecast model larval transport pathways validation	Forecast Model Transport pathway validation.	Surplus drifters deployed in regions of USCG interest, data distributed, standard comparison statistics calculated

1.3.2. Matrix II: User Themes, Data Dissemination, and Economic Metrics

This part of the Matrix shows how the web page, data management, data dissemination, outreach and education, and economic metrics relate to the cross-cutting regional areas.

	Cross Cutting Regional Areas				
	Inundation	**Maritime Safety**	**Ecological Decision Support**	**Water Quality**	**Operational Metrics**
MARCOOS Webpage	Real-time validation of surface current maps from CODAR & models	MAB current maps. Near shore wind, wave and current product. Real-time validation.	Real time maps of wind fields, SST & ocean color, surface currents, and subsurface fields	Real time maps of Wind fields, SST & color, surface currents, subsurface 3-D fields.	Webpage developed, usage tracked, response to feedback.
Data Management	Opendap server for MAB currents, SST and subsurface T&S profiles for assimilation	Radials to NOAA East Coast server, to Scripps aggregation center, to NDBC archive, to USCG EDS, to SAROPS	SST, CODAR and Glider data on Opendap server for assimilation	Glider data aggregation center combined with Navy Adaptive Sampling Planning Tool	Regional integrated datasets are publicly available according to DMAC standards
Statistical Short Term Prediction System -STPS		STPS running based on CODAR surface current maps and forecast wind fields MAB CODAR current maps to STPS to EDS to AROPS			Statistical model is implemented, automated, and available for inclusion on USCG EDS and MARCOOS Web pages
Dynamical Ocean Forecast Ensemble	Forecast of Offshore Ocean Boundary Conditions	Assimilation of MAB current maps and surface	Assimilation to forecast 3-D temperature	Assimilation of data to produce transport	Data assimilative forecast models are

			layer thicknesses to generate surface current forecasts for EDS	structure	pathway forecasts	implemented and producing timely forecasts that are available via DMAC, EDS, and MARCOOS webpage.
	Outreach & Education	Sharing of best practices with local product providers and users throughout region	Outreach to boating communities, Sharing of best practices from Sea Grant surf zone education programs	Entraining fishing groups in data use & obtaining feedback on data needs	Sharing of best practices & experiences, feedback on data needs.	Successful entrainment of a broad spectrum of users as measured in increased MACOORA membership and public awareness of IOOS activities.
	Economic Impact Metrics	Improved response and resiliency to storms & hurricanes	Search areas reduced, additional lives saved, search costs reduced	Better informed management practices, fisheries bycatch reduced, fuel savings		Improved beach closure statistics. Improved impact assessments to low Dissolved Oxygen.

2. MARCOOS Conceptual Design. Should include brief descriptions, rationale, and the interdependencies of the subsystems.

2.1. Observing system

2.1.1 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.

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 Regional Assets

1. Collaborations with Regional Weather Forecast Offices for NOAA WRF forecasts
2. Privately-operated coastal weather network to resolve mesoscale coastal wind fields
3. Satellite (temp and color) data acquisition systems linked to a national university network

4. Mid-Atlantic HF Radar Consortium operating 26 sites providing currents & nearshore waves
5. Mid-Atlantic Glider Consortium operating a growing fleet providing subsurface hydrography
6. Coast Guard Search and Rescue drifters for validation and assimilation into ocean models
7. Experienced data management team to link the data, models and products
8. Short-term statistical forecast model of surface currents for Search And Rescue.
9. Ensemble of three different ocean forecasting models with different assimilation schemes
10. Experienced coastal observatory web site development and maintenance team
11. Education & Outreach professionals to access education resources and evaluation expertise
12. Existing economic study groups to assess the impact of regional data and model products

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.

2.1.2 PROJECT DESCRIPTION

The ***Mid-Atlantic Regional Coastal Ocean Observing System (MARCOOS)***, the regional observing system of MACOORA, will produce and deliver valued regional data and information products based on regional user priorities as defined by MACOORA, on an operational and sustained basis, guaranteeing data quality and adherence to IOOS standards. As the IOOS RA matures, MARCOOS will transition to an entity under contractual direction from MACOORA, which is now a 501c(3) corporation. During this transition, the overlap between MACOORA Board membership and MARCOOS leadership will facilitate operations as well as data management, EO, and economic impact assessments.

2.1.2.1 GOALS AND OBJECTIVES.

This first implementation phase of MARCOOS will be an end-to-end regional ocean data acquisition, management, modeling and product-generation system in response to region-wide user needs in the thematic areas of ***Maritime Safety*** and ***Ecological Decision-Support***. MARCOOS regional products will support the production of higher-resolution products that are being proposed by MACOORA sub-regional groups in response to the thematic areas of ***Coastal Inundation*** and ***Water Quality***.

MARCOOS will augment existing federal backbone products by leveraging its extensive existing assets. By coordinating, sustaining, and expanding ongoing ocean observing and forecasting activities, regional-scale data and products will be available in real time across the full Mid-Atlantic (MA) region and extending into the Bays and Sounds. The data will be assimilated into 2D statistical and 3D dynamical ocean forecast models, driven by NOAA NCEP standard atmospheric forecasts that include a dedicated NOAA-WRF regional

Seabreezeresolving forecast. Datasets and forecasts will be delivered into operational decision making systems, such as USCG Environmental Data Server (EDS) and Search And Rescue Optimal Planning System (SAROPS), through IOOS-compatible automated data servers for forecasting applications and a MARCOOS website. Outreach activities will extend products to support ongoing NWS rip current forecasting projects and refine products for the fishing community.

Year 1: 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 to 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.

Year 2: The operation of the HF Radar network and STPS statistical forecasts for inclusion in EDS and SAROPS will be sustained. Surface currents from the dynamical forecast models will be evaluated with drifters. Estimates of uncertainties will enable forecast model information to be included in SAROPS. At the $2 M/year funding level in Year 2, the modelers will be able to maintain their ongoing work for SAROPS and progress will be made on the Ecological Decision-Support theme. However, if the funding for Years 2 and 3 is increased to $3.5 M/year, then a MARCOOS glider fleet (distributed at 3 institutions) will be constructed and a bimonthly schedule for region-wide flights (both the northern and southern half) will be established. The glider flight data will be assimilated in the models to produce the 3D fields –an unprecedented spatial product for the Ecological Decision-Support theme.

Year 3: Assuming the $3.5 M/year funding, a 7-glider fleet will be established, allowing MARCOOS to become operational with 3D nowcasting/forecasting that is supported by real-time satellite imagery, CODAR surface currents, and monthly region-wide glider flights. The occasional CG surface drifter deployments will enable the evaluation of model products.

2.1.2.2 BACKGROUND

Maritime Safety**.** The Maritime Safety priority for MACOORA is evidenced by its focus on establishing the region-scale Mid-Atlantic HF Radar network. Measured surface current maps by the Mid-Atlantic HF Radar Consortium (MAHFRC) are recognized (1) by the Coast Guard to improve their Search And Rescue (SAR) activities and (2) by NOAA HazMat to improve emergency response to hazardous spills. Nationally, the Coast Guard receives an average of 13 SAR calls per day, of which 10 are successful rescues. To reduce the lives lost, the critical

USCG need is to optimize SAR operations to minimize Search time. HF Radar information in the gap between the inshore NOAA PORTS and recommended offshore NDBC buoys will allow SAR operations to be optimized. The basic infrastructure for CODAR operations is in place to fill the gap. Another Maritime Safety issue is rip currents, which are the primary cause of ocean drowning and rescue incidents along U.S. coasts. According to the United States Lifesaving Association (USLA), 71% of the total surf zone rescues (12,137 incidents) in 2003 were due to rip currents. As demonstrated by NOAA Sea Grant research and recognized by the NWS, HF Radar provides wave/current information that improves rip current forecasting.

The community, in numerous MACOORA-wide meetings, has concluded that the existing observational infrastructure and resident expertise can be leveraged to produce sustainable products to improve Maritime Safety. Recent statistical comparisons between surface drifter trajectories, those produced by STPS and the pre-SAROPS methodology using climatology or nearest NOAA coastal station data indicate that the STPS/CODAR fields lead to more accurate results. In another recent study, comparisons between Coast Guard drifter-inferred currents and CODAR surface currents indicate *a factor of 2 improvement in uncertainty*, as compared to the existing models in the EDS and available to SAROPS. Thus, the USCG Office for Search And Rescue has concluded that by using CODAR currents (with their estimated uncertainty) in the existing EDS for SAROPS, an additional 50 lives per year will be saved at the national level.

Ecosystem Decision-Support. Commercial and recreational fishing represent a multi-billion dollar industry in the Middle Atlantic (MA). Management of these resources is difficult as many of the species are migratory and poorly sampled using traditional strategies. An integrated regional perspective is required. Timing and migration patterns of living marine resources are strongly influenced by the structure of MA water properties. Unless regional hydrography is mapped on at least monthly time scales, it is difficult to assess the efficacy of fisheries management approaches based on marine protected areas, no fishing areas, marine reserves, and rotating closures. Regional hydrography and circulation from MARCOOS observations and models will facilitate analysis of the movement of water masses and their associated populations. This will assist interpretation of population breeding dynamics and connectivity. For species with mobile adult stages, retention-through-migration can effectively counteract the dispersing effect of physics. Species with less mobile juvenile or adult life stages (e.g. sea scallops) depend on circulation processes to maintain them within their habitat range. For example, scallops, the 2nd highest ex-vessel revenue in the Northeast fishery, contribute $431.5 million annually to the MA domain. MARCOOS modeling will provide spatial patterns of the MA physical ocean to fishery managers for use in their individual-based models of larval dispersal, settlement and recruitment.

Many commercial pelagic species aggregate within or at frontal boundaries between water masses with physical, chemical or biological signatures. These fronts are visible in present web-served satellite products, with MA fishers the majority user of the existing Rutgers observatory web pages (over 12M hits, 660K Pages, & 189K Visits per month). Over the years, the commercial/recreational fishing community has suggested ways to optimize web products. Web-served surface spatial information is also used by NOAA NFMS for adaptive sampling of fisheries in the MA. The second most requested data product is subsurface temperature and salinity fields. Subsurface data is needed because of their relevance to population distributions. For example, bottom temperatures can impact the survival of larval and juvenile shellfish and fish. Long-term changes in the MA are being increasingly implicated in changes in migration patterns of species and shifts in historical fishing areas.

The MARCOOS goal to provide 3D pictures of water masses in near real-time support these user needs. To accomplish this, we will use a multi-platform approach of proven technologies, including satellites, gliders, and data assimilative models to integrate into synoptic fields. Satellites provide maps of surface temperature, chlorophyll a, and a suite of existing ocean color products, such as absorption and backscatter. Satellite information will be fed into objective water mass classification algorithms being developed through NASA. Gliders, operated by the Mid Atlantic Glider Consortium (RU, UMassD, UMaryland, and UNC-CH) will measure the month-to-month changes in the 3-D water property structures over the MA. Gliders will be outfitted to measure temperature, salinity, currents, chlorophyll a fluorescence, particle backscatter, and, while surfaced, waves. Combined satellite and glider data will be assimilated into numerical circulation models (UMD-HOPS, NYHOPS, ROMS), each with different assimilation schemes. Comparisons of this ensemble of 3D realizations will be used with measurements to estimate uncertainties. The model realizations will be used to characterize 3D water mass patterns for Web display.

Supporting Sub-Regional MACOORA Efforts. Several proposals focusing on important subregional issues in the MA are being submitted. This regional MARCOOS will support these efforts by providing the outer boundary forcing and other region-scale information. While the proposed MARCOOS operations do not depend on data and/or information from the sub-regional efforts, their products will be incorporated with MARCOOS information.

***Coastal Inundation*:** The NOAA Storm Surge Leadership Team and a MACOORA Coastal Managers Workshop determined from coastal stakeholder comments that improvements are required in the resolution and accuracy of storm-surge forecasting and improved integration of surge and overland flood models down to the street level. This is a focus of several sub-regional proposals within the MARCOOS domain. The several sub-regional proposals from the MA, which address those inundation issues rely on MARCOOS to provide operational, region-scale open boundary water level, current, temperature and salinity fields.

***Water Quality*:** The MARCOOS domain that extends across the EPA's designated Virginian Province contains nearly 25% of the US population. It is the most urbanized coastal region in the US, representing 24% of the national economy. Buoyant coastal currents in the MA are fed by many urbanized rivers, which provide anthropogenic inputs into coastal waters. Nutrient and organic matter loadings fuel hypoxia/anoxia, a focus of some sub-regional proposals which will benefit from information on shelf circulation, density structure, waves and sea surface heights.

2.1.2.3 AUDIENCES

Maritime Safety. The major MARCOOS products for Maritime Safety are the 2D surface current fields observed by the HF Radar network and predicted by the statistical and dynamical forecasts. The primary users are the USCG and NOAA HAZMAT. Both require surface current products to be delivered into centralized operation centers and loaded into tactical decision aids. USCG SAR users are the operational controllers that direct deployment of aircraft and vessels using an operational decision aid called SAROPS. SAROPS uses observed or predicted surface wind and surface current fields from the USCG's EDS to predict the trajectories of floating objects. During an actual event, or test, a cluster of a few hundred virtual objects is deployed in surface wind and current fields downloaded from EDS and allowed to drift over time. The cluster disperses based on the uncertainty estimates in the winds and currents. If SAROPS data has lower uncertainties there is lower dispersion in the cluster, a smaller search area, and greater likelihood for success. Coast Guard operational SAR controllers are trained in how to use SAROPS and get data from the EDS. No new training is required once the MARCOOS products are in EDS. NOAA HAZMAT operations have similar decision aids. HAZMAT is collaborating with the USCG to link EDS and HAZMAT oil spill drift models.

Other Maritime Safety products enabled by the HF Radar network are nearshore waves and alongshore currents being developed with SeaGrant. Where available, these products are *already* used by the Mount Holly WFO. The WFOs presently use observed and forecast surface waves to predict the probability of rip currents as low, medium or high. In the event of a nearshore search emergency, the direction of the alongshore drift is then the key unknown. Providing WFO forecasts currents will be a big step forward but will require outreach and training about wave and current products, and their relationship to rip current characteristics.

Ecological Decision-Support. Primary MARCOOS regional products for Ecological Decision Support for Fisheries are 3D temperature and circulation fields. These primary products include both real time data (satellite surface maps and subsurface glider data) and model predictions from the ensemble of data-assimilative forecast models. Users include recreational, commercial and management fishing groups.

Recreational and commercial fishing communities access the data via websites and use it to decide where and when to fish, often accessing the data daily. Fishing groups then use their own knowledge of fish behavior relative to temperatures and fronts, or rely on value added services such as OceanTemp or Jenifer Clark's Gulf Stream that interpret the data available on the websites for a subscription fee. Outreach and training efforts are required to improve webpage displays that are easy for the fishing public to interpret. The fisheries management community is very much aware of the importance of 3D circulation, temperature and salinity fields on fish. Real-time data needs include adaptive sampling for fisheries management and continued analyses of fishery cruise results to relate stock distributions to the environment. Adaptive sampling is facilitated by web access from shore support sites or fisheries vessels using cell phones. Both methods have been used to coordinate fisheries sampling in the MA. An important aspect of adaptive sampling is real-time feedback between vessels at sea and gliders. As recently demonstrated, a regional glider flight from Mass. to NJ broke away from its mission to assist a fisheries vessel by flying repeat sections along the same cross-shelf sampling transect. Fisheries managers are sophisticated users of ocean data and will require little more than background training on access and quality.

Regional Products Supporting Sub-Regional Needs. Local inundation proposals require information on the regional scale of storms that can be enhanced with even higher resolution models. Local inundation models require surface forcing fields, boundary conditions from regional atmospheric/ocean models for nesting, and datasets for assimilation, including surface and subsurface temperature structure to improve estimates of upper ocean heat content, thickness of the wind-driven layer, and current/drifter data for assimilation to improve the surface layer response. Nested models for winds, waves and currents will then be run by the inundation groups to provide local guidance on water levels, wind speeds and wave heights. Water quality at a given location depends both on the advection into or out of the area as well as local processes. Advection in many locations requires knowledge of the regional response to wind and buoyancy driven flows. Real-time surface circulation maps and forecasts provided by MARCOOS will help coastal managers concerned with water quality better understand where the water in their area is coming from, and where it is going.

2.1.2.4 APPROACH

Management Structure. The MARCOOS Co-Directorship will guide the activities of the MARCOOS Product Development, Operations, and Resource Groups (see below). They are responsible for building the MARCOOS capability and evaluating performance, altering procedures if necessary, and responding to the MACOORA Board of Directors. Their primary charge is to ensure organization, communication, production, and accountability of the system. As with MACOORA, day-to-day operations oversight, coordination, and communication are handled by a dedicated manager.

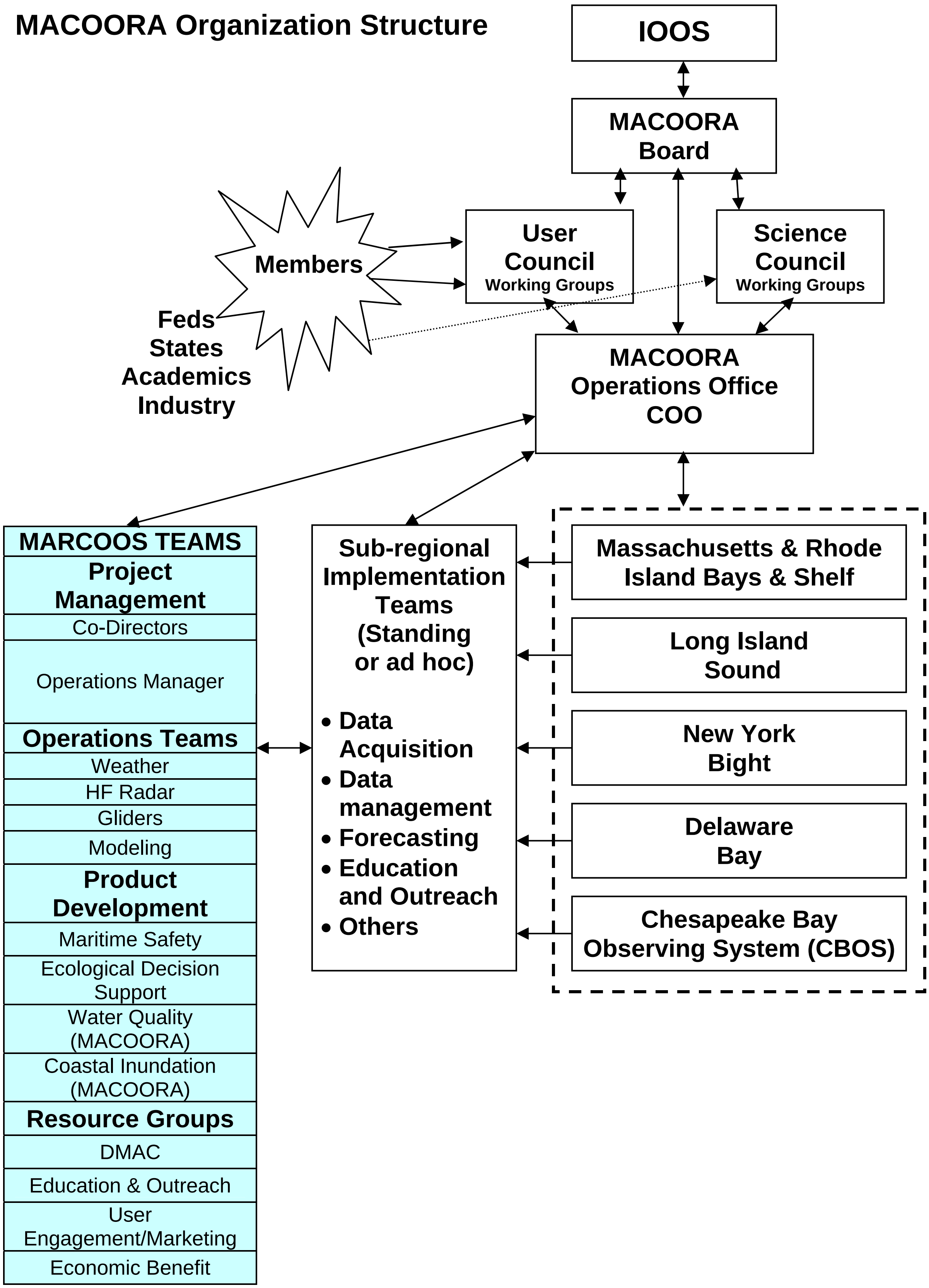
Product Development Team (PD). Early in Year 1, the PD team will work with the different MARCOOS Team Leaders to define the initial suite of MARCOOS Products under the Maritime Safety and Ecosystem Decision-Support themes. Thereafter the PD team, under the leadership of the MARCOOS Product Development Team Leader will work in parallel with the MARCOOS Operations teams, drawing in the Resource Teams as needed, to define MARCOOS products for Year 2 and beyond. Many of these products may be refined versions of Year 1 products based on user feedback.

Operations Teams. The initial suite of MARCOOS products will define (1) operational scenarios for the Weather, CODAR, Glider and Modeling Groups, and (2) how the data/information are integrated operationally (24/7) and quality-controlled to produce the required data/information products. The MARCOOS Operations Manager will work directly with the individual Operations Team Leaders to establish and maintain quality assurance metrics, and to assure that the required information is available in time to produce the products.

Resource Groups. The MARCOOS development of an end-to-end system will require the regular input from its suite of MARCOOS Resource Groups concerning many technical matters as well as the dissemination and evaluation of user response to MARCOOS products. The Resource Group Leaders will be points of contact for MACOORA-wide capabilities in data management, education and outreach, user-engagement and marketing, and economic impact. The Resource Groups parallel those in MACOORA Working Groups, and leverage support from MACOORA.

MARCOOS Teams	Team Leaders	MARCOOS Teams	Team Leaders
Project Management		**Product Development**	
Co-Directors	S. Glenn - W. Boicourt	Maritime Safety	M .Bruno
Operations Manager	M. Crowley	Ecological Decision Support	W. Brown
Operations Teams		**Resource Groups**	
Weather	J. Titlow	DMAC	J. O’Donnell
HF Radar	J. Kohut	Education & Outreach	J. McDonnell
Gliders	O. Schofield	User Engagement/Marketing	A. Voros
Modeling	A. Blumberg	Economic Benefit	D. King

Following is the MACOORA Organization Structure, showing its relationship to the MARCOOS Teams:


MACOORA Organization Structure
IOOS
MACOORA Board
User Council
Working Groups
Science Council
Working Groups
Members
Feds
States
Academics
Industry
MACOORA Operations Office COO
MARCOOS TEAMS
Project Management
Co-Directors
Operations Manager
Operations Teams
Weather
HF Radar
Gliders
Modeling
Product Development
Maritime Safety
Ecological Decision Support
Water Quality (MACOORA)
Coastal Inundation (MACOORA)
Resource Groups
DMAC
Education & Outreach
User Engagement/Marketing
Economic Benefit
Sub-regional Implementation Teams (Standing or ad hoc)
• Data Acquisition
• Data management
• Forecasting
• Education and Outreach
• Others
Massachusetts & Rhode Island Bays & Shelf
Long Island Sound
New York Bight
Delaware Bay
Chesapeake Bay Observing System (CBOS)

Responsiveness to User Needs and IOOS Development Plans: Communications with IOOS and users is ensured through the present overlap in MACOORA/MARCOOS membership. Specifically, Scott Glenn, Chair of the MACOORA Product Development working group, works closely with Andrew Voros, Chair of the MACOORA User Engagement working group. Bill Boicourt is a MACOORA representative to the National Federation of Regional Associations (NFRA) - the MACOORA/MARCOOS conduit to IOOS. Jim O'Donnell, as Chair of the MACOORA Data Management working group, will help ensure that DMAC standards are adopted in MARCOOS protocols. The industry experience of Jay Titlow, MACOORA Treasurer, will help ensure that MARCOOS development remains cost effective.

Theme 1: Surface Currents for Maritime Safety. This MARCOOS regional theme will leverage the existing (1) 26-site CODAR-type HF Radar system that is coordinated through an existing network; (2) NOAA East Coast HF Radar Hub at Rutgers for aggregating radial data with a NASA backup site; (3) national HF radar data management facility at Scripps, (4) region-scale weather meso-net; (5) NOAA WFO atmospheric forecasting experience; (6) URI/OPeNDAP radial data server and other expertise for DMAC-compatible data management; (7) STPS system; (8) ensemble of three regional dynamical forecast models (NYHOPS, UMDHOPS, ROMS), with distinctive formulations and assimilation schemes; (9) Coast Guard-donated surface drifters; (10) cost-effective means of deploying the drifters; (11) data, model, and drifter comparison experience necessary to estimate SAROPS-required uncertainties; and (12) ASA Inc. expertise in automated systems that link surface current data and forecasts to Coast Guard EDS for SAROPS. Since at least one USCG Surface Drifter is deployed in every SAR mission, a high Coast Guard priority is to evaluate the improvements in forecasted currents. Thus the data from their one or more drifters will be routinely assimilated into the MARCOOS dynamical models. The protocols developed under this aspect of the project will be transportable nationwide through NFRA, NOAA and USCG activities.

Mid-Atlantic HF Radar Network Operation. Saving lives at sea and on beaches is a national IOOS priority that is supported by Memoranda of Understanding (MOU's) between NOAA and the USCG to collaborate in the establishment of a national HF Radar network. The nation's oldest & largest HF Radar network is in the 26-site MA HF Radar Consortium (MAHFRC) network, which is also distinguished by its nested coverage of important bays and sounds. The MAHFRC network is a testbed for the (1) NOAA HF radar research for bistatic operations, which will improve surface current mapping in complicated coastal regions, (2) USCG for evaluation of new products for SAROPS, and (3) DHS/Counter NarcoTerrorism for development of dual-use vessel tracking capabilities. Best practices developed in the MA can be spread nationwide through the NFRA, NOAA QARTOD, and ROWG. Thus immediate investment in the MAHFRC network represents a great opportunity to demonstrate early regional success and a large step towards a national capability.

We propose the Phase 2 implementation, in which the operational clusters established in the northern, central and southern MA are coordinated for the region by the Rutgers NOAA Data Hub. The establishment of this fully interoperable, operational CODAR-based network is consistent with the 3-Phase implementation plan for the OceanUS Surface Current Mapping Initiative (SCMI). The MARCOOS HF Radar Team Leader will ensure that all sites are operating by standards established at the recent NOAA coordination meeting, and is delivering quality-controlled data consistent with NOAA QARTOD. Year 1 efforts will support existing radar operations in producing hourly surface current maps with fully regional, quality-controlled data . Years 2 and 3 efforts will maintain and sustain Phase 2 regional network operations that deliver surface current maps to the (1) USCG EDS for SAROPS, (2) OPeNDAP servers for distribution to the MARCOOS modeling groups, (3) NOAA national archive, and (4) MARCOOS website for public distribution. Additional Year 2 and 3 funds, will enable the purchase of additional systems to enhance spatial coverage based on USCG needs.

Theme 2: 3-D fields for Ecological Decision Support This MARCOOS regional theme will leverage: (1) an existing satellite data acquisition center linked to the UMaine center for automated backups, (2) an existing Glider Technology Center at Rutgers established by ONR to facilitate the operation of gliders nationwide, (3) the existing 5-Year, $5M DoD MURI investment in data assimilation development using the Mid Atlantic, (4) existing expertise of fisheries management personnel at government and academic labs, (5) OPeNDAP expertise to facilitate the assimilation of data into numerical models, (6) the ORION E&O conceptual design of a data translator that works to turn observatory data and forecasts into user designed products, (7) extensive experience with observatory and model website design, and (8) over a decade of experience on the economic impact of fishing activities. Additionally many of the products in theme 1 will directly serve this effort

2.2. Data management

MARCOOS Data Management Plan

2.2.1. Introduction

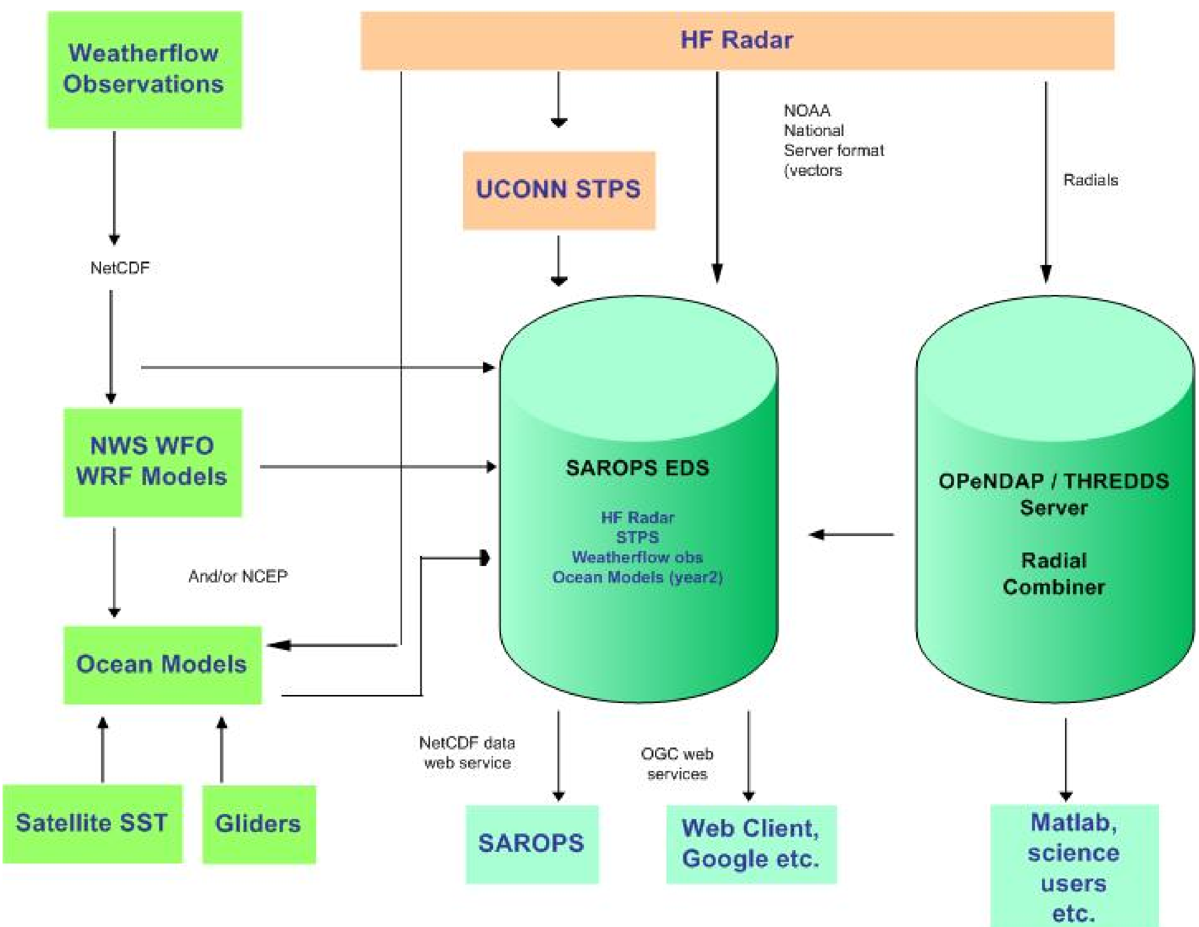
The Mid-Atlantic Regional Coastal Ocean Observing System (MARCOOS) data management approach is aimed at facilitating the flow of raw data and data products between data providers, data users, and data archiving facilities. In order to ensure interoperability with the larger U.S. Integrated Ocean Observing System (IOOS), of which MARCOOS is a component, it is crucial that practices are adopted which are consistent with developing national standards. Preliminary recommendations for IOOS data management practices have been formulated by the IOOS Data Management and Communications (DMAC) committee (Ocean.US, 2006). The MARCOOS DMAC team will work with MARCOOS data providers to ensure that relevant IOOS DMAC guidelines for metadata and data discovery, data transport and access, and archiving are followed to the fullest extent possible. The overarching design is to use open data standards and protocols to facilitate interoperability.

In this document, we do not lay out the IOOS DMAC guidelines in detail, as this has been done elsewhere (Ocean.US, 2006). Rather we will present a recommended general data management approach followed by a more detailed focus on the specifics of key MARCOOS data products that will be produced and on the needs of the end users of these products. Data streams to be produced during the initial developmental phase of MARCOOS include surface currents from HF radar, satellite-derived sea surface temperature (SST) and ocean color, hydrographic profiles from autonomous gliders, surface drifter trajectories, meteorological observations, and output from meteorological and oceanographic statistical and dynamical models of the region. User groups include the U.S. Coast Guard’s Office of Search and Rescue, MARCOOS modelers (who will both assimilate observational data products and produce model output products), local fishermen, federal and state agencies, scientists, and the public at large.

2.2.2. General Approach

The general approach is to leverage existing infrastructure and data standards that are being used as they already adopt open standards and allow access from a variety of scientific users. Use of the existing data products generally requires some experience with tools such as Matlab, NCO (NetCDF Operators), or other tools widely used in the scientific community to access observational and model data. This project plan will layer a suite of web services on top of existing data products and new data so that the data is available to a wide spectrum of users, including the public via web applications, and other tools such as Google Earth and ArcGIS.

In general, we recommend that data is made available via OPeNDAP/THREDDS, although we do not expect that all data has to use this route. Access to data via web services such as the standards from the Open Geospatial Consortium (OGC) will also allow the system to readily integrate data, and other basic services such as simple FTP access to data in described formats are acceptable.



Schematic of data components

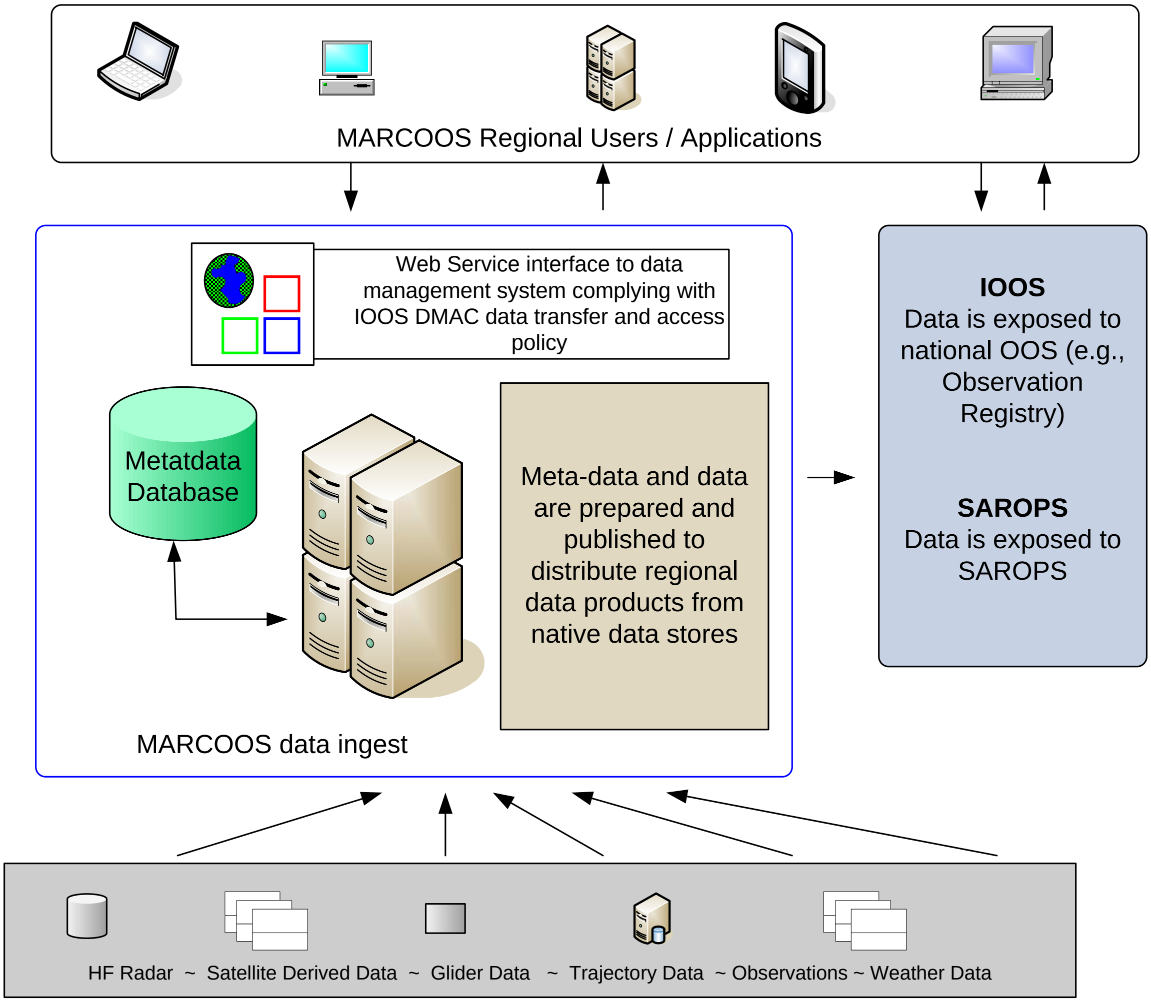
Data Storage. A distributed model of data storage will be utilized, whereby raw data and data products reside either at the location of the data observation sub-system or as close to the sub-system as possible in circumstances where proxies may exist. These data will remain stored as the provider makes these available. Some MARCOOS data products, for example satellite-derived products, are currently stored in community-defined, standardized storage representations that facilitate effective data discovery, transfer, and use. To the extent that these existing strategies are effective and in conformance with the IOOS guidelines, they will be continued without major changes. Other data sets are relatively new (e.g. glider data and HF radar currents), and standard representations, naming conventions and transfer protocols are either non-existent or in development. A primary task of the MARCOOS DMAC team will be to work with the providers of these products and with the wider IOOS community to arrive at solutions that will succeed both locally and when scaled up to the national level.

Metadata. Sufficient metadata must be provided for all MARCOOS data products. Metadata provides information on the basic characteristics of the product that are necessary for its effective use and for the discovery of the data product by the wider community. Metadata for MARCOOS data products will be compliant with standards promulgated by the Federal Geographic Data Committee (FGDC). A metadata database will also be established that will allow the representation of meta information in additional formats to comply with various accepted cataloging services. In addition to providing access to metadata through the MARCOOS web page and data access services, metadata will also be sent to national metadata archives such as the Geospatial One-Stop (GOS; http://gos2.geodata.gov/wps/portal/gos).

The Metadata database will maintain a series of rules that apply to each of the registered data sources. These rules will include access, acquisition and aggregation information to allow the central processor to effectively query, process and deliver the data to users. A data portal will be established that will allow end users to quickly assess available data sources, visualize them and ultimately incorporate the data into decision making tools or scenarios.

Data Transport and Access. The potentially wide spectrum of MARCOOS data product consumers necessitates the use of a variety of data access protocols. Access to MARCOOS data and generated products will be available using a number of access protocols, ranging from representational state transfer (REST) protocols like OPeNDAP and simple FTP file access, to GIS-enabled access as specified thru the OGC WxS suite of interfaces, and to specialized web service interfaces to meet specific product access requirements that might arise. The MARCOOS data management system can be envisioned as a semi-transparent, extensible layer residing between the data provider and consumer that will facilitate the discovery of, and access to the data and products available from the observing system components. The range of operations that will be required include publishing content metadata to support data and product discovery, inventory search and traversal, data aggregation whenever possible, subsetting operations both indexed and geo-spatially specified, format conversion or direct import using access-enabled applications, and simple visualization, display and access through a web server or portal. The data management approach is to incrementally deploy services, using the suite of access protocols available or customized web services, to meet the anticipated range of operations necessary as the RCOOS data providers' and consumers' operational requirements evolve.

A potential use case is, for example, the request of a sub-set of data from the data management system based on parameter, spatial and temporal extents and a requested data format. The data management system will access the data at the data provider's data store based on a registered format that the provider has supplied. Subsequently the data management system will apply any necessary data transformations necessary to meet the needs of the requestor's desired data format. The data will then be returned to the user/client application in the specified format. Where appropriate, the data provider's servers will provide the ability to provide subsets, spatially and/or temporally, of the distributed data archives.



Data Transport and Access Architecture

A variety of services such as WMS (Web Map Service), WFS (Web Feature Service), WCS (Web Coverage Service), and SOS (Sensor Observation Service) will allow a wide variety of client applications to consume the data. In addition, the SAROPS EDS provides NetCDF data services so that a majority of the data will be available in NetCDF CF 1.0 compliant format.

Data Archiving. Initially, we envision that necessary archiving will be performed locally by backing up data either to redundant online locations (hard drives) or to media such as CDs or DVDs. The data management system will provide automated processes that can continuously monitor data providers for new data and deliver these new data to regional data centers for archiving. Additionally, the data management system will expose all data available in the region to national Archive centers as they come on-line. As the project progresses, and as IOOS development proceeds, it is likely that existing NOAA data archives such as the National

Oceanographic Data Center (NODC) will begin receiving data from regional systems such as MARCOOS.

Quality Assurance/Quality Control. Quality assurance/quality control (QA/QC) falls outside the scope of the IOOS DMAC recommendations (Ocean.US, 2006). In most cases, responsibility for QA/QC rests with the data providers although the data users need to be aware of any data quality measures provided and how these can be applied. There are a range of possible QA/AC methodologies: (a). the removal of unreliable values from the data set prior to posting to the internet, (b). provision of a data quality parameter for each data value and a recommended threshold for use in screening the data, or (c). at a minimum, the provision of a single uncertainty value to be applied to all of the data. All of these approaches will be supported by the data management system. Standards for communicating the level of QA/QC will be incorporated into the data sources meta-data record.

IT Security. Standard protocols for IT Security will be met when implementing the data management system and its application software. These include server isolation, redundancy, firewall implementation, etc. Due to the requirement for deploying such a system on the internet, some features of the system must remain exposed. Fortunately, the consideration of a Services Oriented Architecture (SOA) allows for a great deal of component isolation within the data management system itself. Additionally, as data providers agree to provide data from their sub-systems, guidance will be provided on extending the security protocols further along the data chain.

2.2.3 Data Product Specifics

The data management system implementation will be configured in a component, service based fashion. As a result an array of services will be aligned to access, retrieve, and transform data to meet the needs of the region's users. The service architecture will allow for easy scaling as new products are incorporated into the region's needs based array. The following data products are currently of specific interest in the MARCOOS region. As a result, some detail is provided on each product type.

HF Radar Currents

The data management plan for HF radar derived surface current fields will include standardized naming and cataloging. Additionally, the plan will recommend a solution that includes the OPeNDAP HF radar combiner/server (Holloway and Ullman, 2005). As a result, data will be made available in several formats from the source. The combiner/ server will be implemented to run on a regular basis to produce vector maps to be archived in a standardized format (ex. NetCDF). The OPeNDAP combiner will also provide the capability to request current vectors within a user-specified time period, spatial region, and grid. Additionally, the radial server that the combiner/server will access will be exposed to make available the raw radial velocities to those users who wish to access data in this fashion. The raw data will also be available for transfer to a localized archiving node.

An existing link to the STPS (Short Term Predictive System) that sits on top of the HF Radar data and provides predictions has been developed in a previous project and these predictions will be available in NetCDF and through other services such as WMS.

Satellite-derived Products

Data management for Satellite-derived products will focus on provision of raw data files (HDF), as well as a mechanism for aggregating the native files at the provider level. Implementing a high-level, standardized naming convention that will allow the data sources to be revealed to a wide audience through registries will also be a focus for this type of data product. Observation products that include a coverage rather than a location are atypical and sources such as the OGC Geography Mark-up Language (GML) standard will be consulted when establishing MARCOOS conventions.

Glider Hydrography

The management plan for glider hydrography data will be established beginning with the development of a standard for naming and storage conventions that will allow for intelligent data sorting and aggregation. Raw data files will be made accessible for post-processing at the provider and access and transport levels. Existing work has been done at Rutgers to provide processed data via OPeNDAP to the modeling team and this will be used to distribute the processed data via other web services.

Surface Drifter Trajectories

The SAROPS EDS currently manages all of the United States Coast Guard SLDMB (Self Locating Data Marker Buoy) and this data is available via a web service that returns ESRI SHP files that are created based on the region and time of the request. There are plans to move this data to NOAA so the data will also be available via other services including the OGC map services.

Statistical and Dynamical Model Output

Statistical and Dynamic Model Output will be stored in various raw file output types, depending primarily on the accepted standard for the community that uses the data. For example CF compliant NetCDF data would be a standard for ocean current model output, while GRIB (1 or 2) would be an acceptable format for meteorological model output. Providers of these data output will receive guidance on best-case storage conventions to allow for efficient querying and retrieval of data. These data formats allow access to the data via OPeNDAP (and GDS), as well as other web services.

Weatherflow Observation Data

Weatherflow collect, manage and process a wide variety of meteorological observations, from their stations as well as from NOAA stations. This data is now being converted to NetCDF and can be made available with OPeNDAP and through a number of web services.

2.2.4 References

Holloway, D. and D. Ullman, 2005. Seamless access to surface current vectors from the IOOS HF radar backbone, *OCEANS 2005, Proceedings MTS/IEEE,* 1: 949-952, doi: 10.1109/OCEANS.2005.1639877.

Ocean.US IOOS DMAC Steering Team, 2006. Guide for IOOS Data Providers, Version 1.0. (http://dmac.ocean.us/dacsc/guidance02.jsp)

Federal Geographic Data Committee, Content Standard for Digital Geospatial Metadata Version 2 – June 1998, FGDC-STD-001-1998.

Hankin, S. and the DMAC Steering Committee, 2005, Data Management and Communications Plan for Research and Operational Integrated Ocean Observing Systems: I. Interoperable Data Discovery, Access, and Archive, Ocean.US, Arlington, VA 304 pp. http://dac.ocean.us/dacsc/imp_plan.jsp

Northrop Grumman Corporation, 11-May-2005, System Design Report (SDR) For IOOS Initial Capabilities Demonstration System, 1.0.

Open Geospatial Consortium, OpenGIS® web services architecture description, November 17, 2005.

Open Geospatial Consortium, Web Feature Service Implementation Specification, May 3, 2005.

Open Geospatial Consortium, OGC Web Map Service Interface, January 20, 2004.

2.3. Modeling/analysis/product development.

Surface Currents for Maritime Safety

Statistical Surface Current Forecasts. During Year 1, the coverage of the University of Connecticut's Short Term Prediction System (STPS) (Ullman et al., 2003; O'Donnell et al., 2005) will be expanded to the regional scale of the MAHFRC network and then implemented to produce short-term statistical forecasts of surface currents on a sustainable basis. These STPS forecast protocols have been incorporated into USCG planning tools and successfully tested through comparison of predicted and drifter surface currents measurements (under a USCG R&D center funded project). During Years 2 and 3, the sustained STPS forecasts will become a permanent MA regional resource for USCG SAR controllers through EDS and SAROPS.

Regional Weather Data and Forecasts. WeatherFlow Inc. owns, operates, and maintains a national coastal mesonet, including 101 measurement sites in the MACOORA region (MA 30, RI 9, CT 4, NY 9, NJ 5, DE 2, MD 16, VA 26). The sites collect and report in real-time data for air temperature, barometric pressure, and wind speed/direction, and at some sites water temperature. Two thirds of the sites are located at the land/water interface (piers, marinas, etc.), and the other 1/3 located on the water; typically on stationary navigational aids. Existing subscription users number in the thousands. The WeatherFlow Inc regional surface wind network will become a MARCOOS data stream that will be available to USCG SAR and to the NOAA Mount Holly WFO for forecast model validation and potential assimilation. For MARCOOS, the NOAA Mount Holly WFO will provide operational NOAA WRF atmospheric forecasts for the MARCOOS region and data in standard GRIB file formats on a not-to-interfere basis. The WRF forecast domain will extend from Cape Cod to Cape Hatteras and westward across the operational area for Mount Holly into central PA. The WRF 6 km grid is capable of resolving the seabreeze that can be missing from larger scale forecasts. This will add a locally run regional NOAA model to the ensemble of NCEP wind products available to MARCOOS.

Dynamical Surface Current Forecast Ensemble
a. NYHOPS. The New York Harbor Observation and Prediction System, NYHOPS, has been operational since the beginning of 2004. The established system provides a 48hr hydrodynamic forecast of sea level, salinity, temperature and 3D currents through an internet interface to the

general public at www.stevens.edu/maritimeforecast. The user base of NYHOPS ranges from ONR, NJ Department of Transportation, and FEMA personnel to recreational boaters in the New York/New Jersey Harbor Estuary. A high-resolution curvilinear model grid encompasses the entire Hudson-Raritan (New York/New Jersey Harbor) Estuary, the Long Island Sound, and the New Jersey and Long Island coastal ocean to the shelf break. The horizontal resolution of the grid ranges from an average of approximately 7.5km at the open ocean boundary to less than 50m in several parts of the NY/NJ Harbor Estuary. The present vertical resolution of the grid is 10 sigma layers. For data assimilation the model uses a nudging scheme and has also successfully tested Local Ensemble Transform Kalman Filtering (LETKF).

***b. HOPS*.** The SMAST adaptation of the Harvard Ocean Prediction System (HOPS) data assimilation models have been successfully used operationally to produce weekly nowcasts and forecasts of water properties and currents for more than a year (Brown et al., 2007a; 2007b). The nested suite of HOPS models, which telescope to a resolution of 5km, use data assimilation and specified spatial distributions of tidal currents and tidal mixing (Robinson et al., 2001). The existing SMAST/HOPS application spans the Gulf of Maine region from Nova Scotia to Block Island Sound (see http://www.smast.umassd.edu/OCEANOL/reports.php). As part of this project the domain will be expanded to include the entire MARCOOS footprint. For data assimilation SMAST/HOPS employs a Feature-Oriented Regional Model System (FORMS, Gangopadhyay and Robinson, 2002; Gangopadhyay et al., 2003) to incorporate available data. FORMS-derived fields are melded with climatology to produce synoptic three-dimensional fields of temperature, salinity, density, dynamic height, and corresponding baroclinic geostrophic velocity fields.

***c. ROMS*.** The Rutgers Coastal Ocean Modeling and Prediction group uses the Regional Ocean Modeling System (ROMS) (http://myroms.org) for a hierarchy of simulation and prediction systems in the MA and greater North American east coast shelf. At the largest scale, ROMS (plus a nitrogen/carbon cycle ecosystem model) is implemented for a Northeast North American (NENA) domain (Grand Banks to Gulf of Mexico). Also, ROMS has been implemented at a smaller spatial scope through the MA. Data assimilation has incorporated glider, XBT, satellite and CODAR data by the Incremental Strong constraint 4-Dimensional Variational (IS4DVar) method. Bridging scales between these high resolution shelf models and NENA is funded by the MA-wide ONR MURI model being developed to simulate circulation and bio-optical properties of MA shelf waters. Our approach will be to implement the ROMS-MURI model operationally using 4DVar to incorporate MARCOOS observations.

The primary MARCOOS Modeling team task for Year1 is to test the individual data assimilation schemes of the respective 3 dynamical models (in their present domain) with MARCOOS data sets, concentrating on improving the surface current forecasts for SAR. In Year 2, the models will expand to the full regional MARCOOS domain, and evaluated with the participation of MARCOOS partners and users. The evaluators will critique model outputs that they receive via a prototype OpenDAP interface that is patterned initially on NOMADS (NOAA Operational Model Archive Distribution System), conforms to standards recommended by IOOS/DMAC, and is coordinated with the MARCOOS portal to observational data sets. In Year 3, the different data assimilation models will be validated using MARCOOS data sets in an effort to assess how well each is providing useful data/information to users. During Year 3, the MARCOOS Modeling team will assimilate USCG drifter velocities into each model. This assures that the observations of deployed drifters during SAR cases would be optimally integrated into the numerical models. Therefore those models would have highest confidence at the locations of the drifters, and consequently at the location of the SAR cases.

Surface Current Evaluation with Drifters. Surface currents from CODAR, STPS, and the dynamical models will be routinely compared to USCG operational version of the Coastal Ocean Dynamics Experiment (CODE) drifter (Davis, 1985, Allen 1996). In Year 1, the evaluation will focus on CODAR and STPS surface currents using 18 drifters deployed over the past year. During Years 2 and 3 the evaluation of operational dynamical model surface currents will be added to the mix. These evaluations will use the Ullman et al. (2006) method to incorporate these fields into the SAROPS.

Outreach to Rip Current Forecasting Community. Tom Herrington (NJ Sea Grant Coastal Processes Specialist) will use nearshore HF radar currents and waves in the development of education and outreach (E&O) products for rip current identification and public safety decision-making. This set of tasks leverages an existing NJ Sea Grant project. These products will be demonstrated at two regional workshops for NOAA WFOs, local lifeguard associations, public officials and coastal OEM personnel who will also be trained in their use. Participant feedback will be used to improve ways to present and disseminate the information to coastal officials and lifeguards. If Year 2 and 3 additional funds are available, results will be used to produce E&O material for lifeguards, local officials and the general public.

Economic Impacts. The evaluation of economic impacts and benefits of MARCOOS data and information products is an integral part of the MARCOOS development and implementation. The baseline effort will leverage existing Education and Outreach (E&O) activities in assessing (1) the potential usefulness of MARCOOS information products to likely users, (2) various methods of transmitting information to users, and (3) various pathways by which the information generates value for users. This effort will require outreach to determine what users want and can use, and a coordinated conversation involving program and data managers to determine what new products can be supplied. An analysis will also be undertaken to identify efficiencies and additional benefits from regional integrated implementation. The economic impact effort will quantify and monetize benefits wherever possible. The most obvious pathways of economic benefits from MARCOOS-generated information involve improved at-sea operating and searching efficiencies and vessel safety related to fishing, shipping, and search and rescue. The analysis will require developing a comprehensive list of potential users of the information and products, screening out those who are not likely to benefit significantly, and focusing on the rest to determine the ways that likely users need to receive information for it to be most useful. These users will be actively engaged in the effort to quantify the value of the information to them. Based on this initial economic analyses and feedback provided by the user groups and MARCOOA theme team for Maritime Safety, a pilot project will be implemented in years 2 and 3 if additional funds are available. This will be aimed at standardizing information delivery methods/products and improving survey protocols/methodologies for quantifying economic benefits from enabling marine safety.

3-D fields for Ecological Decision Support

Satellite Data Acquisition and Processing. The satellite data will be collected with existing L-band and X-Band receive stations at Rutgers. For over a decade these systems have seamlessly provided data for the eastern seaboard. To ensure data availability, there is an automated backup system already operating in collaboration with the University of Maine. Rutgers has delivered satellite imagery in real-time to many users in the Northeast (70% from general public judged by web domain name). This component of MARCOOS includes real-time satellite data from the international constellation of satellites accessed through the MARCOOS data management system for distribution in near real-time. Through all three years of the program the regional satellite sea surface temperature and water mass products will be sustained and made available to the modeling partners for assimilation, the outreach patterns for targeted products, and the general public through the MARCOOS website. Products will be adjusted, as needed, based on user feedback.

Regional Sustained Subsurface Glider Operations. Gliders provide sustained subsurface data and are cost effective compared to ship operations (Schofield et al. 2007). Rutgers has flown gliders 28,418 kilometers underwater since October 2003 which represents 229,740 vertical casts of data. The Webb Slocum glider network is capable of observing the seasonal subsurface regional dynamics for the entire MAB domain. Mid-Atlantic Glider Consortium (RU, UMass-Dartmouth, UMaryland, UNC-Chapel Hill) will conduct monthly interstate surveys of the MA. As with the CODAR network, the Glider network is internally interoperable because Slocum gliders are the only coastal gliders. Through ONR, systems to provide interoperability with Navy ships and aircraft have been developed. This proposal will examine interoperability opportunities with ARGO drifters, including the sharing of QA/QC and formatting software. Each glider will be outfitted to measure temperature, salinity, depth averaged & surface currents, chlorophyll a fluorescence, and particle backscatter. Additionally, gliders will be outfitted with wave sensors in order to provide offshore wave estimates to complement NDBC buoys. The region will be split into two sub-regions that will each be patrolled by southward flying gliders. The proposed MARCOOS glider effort will benefit from logistical and technical expertise emerging from existing projects, including the ONR Glider Technical Center at Rutgers University and the DoD MURI project. Investments by the Navy in the MA glider infrastructure (approximately $10M) enable MARCOOS to propose a sustained glider presence at a reasonable cost. The ONR Glider Center also provides the infrastructure for glider repair and preparation which allows the funds requested here to be dedicated to deployment/recovery, data-synthesis and distribution. These data will be incorporated in the MARCOOS DMAC system for easy distribution among project partners and for producing real-time visualizations posted to the MARCOOS website. DoD support provides most of the resources for initial glider flights in year 1 while the technical support pool in MA, MD & NC is spinning up. The MARCOOS glider purchased in year 1 will be added to this regional glider effort. Gliders will patrol the waters of the MA through years 2 and 3. If additional support is available in years 2 and 3, funding would be directed toward the purchase of three MARCOOS gliders in each year. These vehicles would go directly into the rotation, increasing the coverage along the northern and southern glider lines providing IOOS its first dedicated regional Glider fleet.

Dynamical 3-D Forecast Ensemble. The Modeling Team tasks under Theme 2 are closely integrated with those outlined for Theme 1. NYHOPS, SMAST/HOPS and ROMS are all 3-dimensional models that assimilate both remotely sensed surface and *in situ* subsurface observations. The methods used make no fundamental distinction between assimilating & forecasting surface currents versus subsurface temperature, salinity and velocity. Rather, these factors are closely entwined because surface currents are determined by direct meteorological forcing, tides and subsurface density patterns (through geostrophic dynamics), and surface momentum fluxes impact the 3-dimensional circulation. Multivariate objective mapping, Kalman filter and 4DVar assimilation methods all exploit correlations between ocean state variables so that surface and subsurface observations of differing quantities immediately project onto all model variables. Through close collaboration to establish common portals and protocols for input data access, model output dissemination, and skill assessment related to user requirements, the Modeling Team will work toward sustained fully 3-D assimilation and forecasting by Year 3.

Education & Outreach for New Fisheries Support Products. We will apply an instructional systems design (ISD) approach (Gagne, 1987) that employs an iterative process including front-end (assessment of audience needs), formative (pilot testing of data products), and summative evaluation (assessing impact of our products). In years 2, we will conduct front end assessment through consulting with project PIs, conducting surveys and convening focus groups to collect relevant data from our target audiences. For example, we propose to conduct focus groups at Atlantic States Marine Fisheries Commission (ASMFC) annual meeting to 1) receive formative feedback on the data products and 2) collect feedback on what additional products or services fishery managers might want from the MARCOOS program. In year 3, we will formatively assess prototype data products (e.g. on-line tutorials and training materials through the NERR's Coastal Training Program (CTP). These efforts will be co-managed/funded by the proposed COSEE-NOW and anticipated funds from MACOORA. Our intended educational outcomes include: 1) MARCOOS partners will be able to develop relevant and useful 3D temperature products for our target audiences and 2) our target audiences (including fishery managers, recreational, and commercial fisher people) will assist in development and utilization of real time ocean data products.

Economic Impacts. An important benefit pathway related to theme 2 of this effort is associated with how the observation information improves understanding of ocean ecosystems and how researchers and resource managers can use this information to better interpret observed changes in ecosystem conditions and fishery statistics. These benefits, for example, include resource managers being better able to distinguish changes in abundance of ocean species from changes in sea-states that affect their availability or catchability. Again we will work with users to quantify the value of the information to them, and if funding permits, engage in a similar pilot study. In addition, this may include surveys of user satisfaction and system integration.

3. Rough estimate of costs (order $x million)

3.1 Funding the Existing Capacity in the Mid-Atlantic (Annual Cost)

PORTS (5 x $200 K)	$1 M
NDBC (New Buoys, Amb, Ches)	$1 M
WRF @ WFO's (5 x $200 K)	$1 M
MA & RI Bays & Shelf Subregion	$2 M
Long Island Sound Subregion	$2 M
NY Bight & Harbor Subregion	$2 M
Delaware Bay Subregion	$2 M
Chesapeake Bay Subregion	$2 M
Mid-Atlantic Region Observations	$4 M
Data Management	$1 M
Education & Outreach	$1 M
Economic Impact	$1 M
Total	**$20 M**

3.2 MARCOOS Budget (FY08-FY10)

Task	**Lead PI (Institution)**	**FY 2008**	**FY 2009**	**FY 2010**
Regional Observations				
1) Atmospheric Data Integration & Gridded Diagnostic product	J. Titlow (WeatherFlow)	$90 K	$150 K	$150 K
2) Mid-Atlantic CODAR Network for Current Mapping (MAHFRC Phase 2)				
Operational Support (100K/person + 10K travel)				
Co-Northern Site Technician	W. Brown (UMass)	$50 K	$55 K	$55 K
Co-Northern Site Technician	J. O'Donnell (UConn)	$50 K	$55 K	$55 K
Central Site Technician	J. Kohut (Rutgers)	$100 K	$110 K	$110 K
Southern Site Technician	L. Atkinson (ODU)	$100 K	$110 K	$110 K
Site Support – $10 K/site				
UMass (1 Northern)		$10 K	$10 K	$10 K
URI (3 Northern)		$30 K	$30 K	$30 K
UConn (2 Northern)		$20 K	$20 K	$20 K
Stevens (1 Central)		$10 K	$10 K	$10 K
Rutgers (7 Central, 3 Northern)		$100 K	$100 K	$100 K
UDelaware (2 Southern)		$20 K	$20 K	$20 K
CIT (Year 1: 5, Year 2-3: 7 Southern)			$70 K	$70 K
U North Carolina (2 Southern)		$20 K	$20 K	$20 K
New Sites (Year 2: 1, Year 3: 2)			$10 K	$20 K
New Site Installation			$10 K	$10 K
Equipment Replacement & Repairs		$20 K	$50 K	$40 K
Regional Codar Network Coordination				
Regional Coordinator	J. Kohut (Rutgers)	$35 K	$35 K	$35 K
Technician Training		$20 K	$25 K	$25 K
Travel		$10 K	$10 K	$10 K
Ship Time			$30 K	$30 K
New Codar Systems to fill in coverage gaps			$120 K	$120 K
3) Mid-Atlantic Regional Along-shelf Glider Lines for 3D T&S fields				
Northern Operations	W. Brown (UMass)	$90 K	$200 K	$200 K
Central Operations	O. Schofield (Rutgers)	$90 K	$200 K	$200 K
Southern Operations	B. Boicourt (UMaryland)	$90 K	$200 K	$200 K
Purchase 3 new Gliders per year to dedicate to MARCOOS activities			$300 K	$300 K
4) Acquisition and Processing of Satellite Data for assimilation into ocean forecasts	M. Oliver (Rutgers)	$45 K	$50 K	$50 K

Regional Ocean Forecasting				
1) Statistical Ocean Models Short Term Prediction System STPS	J. O'Donnell (UConn)	$80 K	$100 K	$100 K
2) Dynamical Ocean Models NYHOPS (Stevens) ROMS (Rutgers) HOPS (UMass)	 A. Blumberg (Stevens) J. Wilkin (Rutgers) A. Gangopadhyay (UMass)	 $80 K $80 K $80 K	 $200 K $200 K $200 K	 $200 K $200 K $200 K
Management				
Data Management DMAC, OPeNDAP, & Environmental Data Server	D. Holloway (OPeNDAP) E. Howlett (ASA) D. Ullman (URI)	$160 K	$350 K	$350 K
Outreach, Education, Evaluation, and Economic Impact Studies	T. Herrington (SeaGrant) J. McDonnell (Rutgers) D. King (UMaryland) A. MacDonald (Monmouth)	$25 K $25 K $25 K $25 K	$75 K $75 K $75 K $75 K	$75 K $75 K $75 K $75 K
MARCOOS Webpage Communication & Data Displays	J. McDonnell (Rutgers)	$40 K	$50 K	$50 K
Program Management Operations/Financial Managers	S. Glenn (Rutgers)	$80 K	$100 K	$100 K
Total		**$1.7 M**	**$3.5 M**	**$3.5M**

3.3 MARCOOS Budget Overview (FY08-FY10)

IOOS is a federally led, NOAA-managed partnership. Federal agency partners include NOAA, NSF, Navy, NASA, EPA, USGS, MMS, & USACE. When examining where IOOS is today, NOAA found that of eight categories, three require substantial effort and focus to meet objectives (IOOS 101, D. Zilkoski, 2006). These three categories are to integrate and densify observations, to build interdisciplinary modeling capability, and to establish DMAC. The approach adopted by MARCOOS will contribute to regional and national efforts to build IOOS by leveraging investments from nearly all of the IOOS federal agencies in the Mid-Atlantic region, and by focusing implementation efforts on the three categories in greatest need - observations, modeling and data management.

The Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA) is a 501c(3) corporation and is the guiding body of Mid-Atlantic Regional Coastal Ocean Observing System (MARCOOS). While MACOORA has established a draft business plan, it does not yet have in place the personnel and infrastructure to administer contract funds. To facilitate the development of this RCOOS as the IOOS RAs are brought on line, Rutgers University will administer these MARCOOS project funds. Rutgers has agreed to waive indirect costs for establishing the 14 MARCOOS subcontracts, *a cost savings of over $191,000 to this proposal*.

The MARCOOS Budget Overview is presented in Table 1. The FY2008 budget has been adjusted for a base level funding of $1.7 M/year for Year 1. If funding for Years 2 & 3 remains at the base level of $2 M/year, the same distribution shown in FY2008 will be carried through to FY2009 & FY2010. If funding for Years 2 & 3 is increased to the level of $3.5 M/year based on the Mary Culver email announcement, the distributions shown in Table 1 for FY2009 and FY2010 will be used.

The MARCOOS budget overview provides the overall cost breakdowns to provide observational data products for Weather, HF Radar, Satellite and Glider components of the observing system. The USCG Drifter component incurs no charges, since we will use drifters deployed in actual SAR cases, or drifters that have reached the end of their two year shelf life for operational SAR and therefore must be discarded.

The Weather component leverages WeatherFlow's extensive existing regional network of 101 stations, and the emerging capabilities and interests of regional Weather Forecast Offices to run their own versions of the NOAA Weather Research & Forecast (WRF) atmospheric model. Weatherflow will use $90 K the first year and $150 K per year for Years 2 & 3 of base support to bring their datasets into the MARCOOS framework for use in validation of and eventually assimilation into the regional NOAA models, and for input to USCG Environmental Data Server for SAROPS. NOAA Mount Holly will perform the WRF forecasts at no charge so long as it continues to fit with their normal forecast schedule. Mount Holly typically runs their WRF forecast for 24 hours. To increase the duration of this forecast to at least 48 hours so that it is useful for subregional inundation proposals and for regional ocean forecasts, Rutgers will purchase a faster computer for Mount Holly out of their supplies budget. If the funding level is increased, WeatherFlow will receive an additional $50 K per year to support gap filling of wind fields in regions were additional resolution is required.

The Mid Atlantic HF Radar Consortium (MAHFRC) submitted a 3-Phase implementation plan to MACOORA for a region-wide network in 2006. The network is currently at the Phase 1 level of operation, based on voluntary participation in the supply of radial data to the NOAA East Coast Data Hub at Rutgers. It takes advantage of an estimated $10 M infrastructure investment by NOAA, ONR, NOPP, NSF, DHS, DoD Counter NarcoTerrorism to fund individual HF radar sites around the region. Phase 3 is consistent with the support level recommendations of the OceanUS Surface Current Mapping Initiative (Paduan et al., 2005). An intermediate Phase 2 level is proposed here, where each HF Radar site is provided $10 K in operating fund per year for power, communications and backups, 3 rapid response technicians are distributed around the region (north, central and south), and a regional coordinator located at the NOAA East Coast Hub coordinates activities and ensures the quality controlled surface current product is produced in a timely manner. Total Phase 2 operational costs are $595 K per year and are included in the base level of funding. If additional funding is received in years 2 & 3 an additional $200 K per year will be added for gap filling based on USCG priorities for SAROPS.

The proposed satellite component leverages a significant NSF investment in acquisition infrastructure, and NRL and NASA investments in data processing. The satellite acquisition system is the most operational of all MARCOOS observing technologies, and requires minimum level of funding, $45 K the first year and $50 K per year for Years 2 & 3, to pay for licenses, operations, maintenance and product preparation.

The autonomous underwater glider component leverages a significant Navy investment in autonomous undersea technologies. ONR has formed a national Glider Consortium for the rapid advancement of glider technologies. Rutgers is the Slocum Glider Technology Center, where existing expertise in the operation, maintenance and use of shallow water Slocum gliders is maintained. The Mid Atlantic is used as a testbed for Slocum glider development. With the highest concentration of gliders and glider operators in the world located in the Mid Atlantic, and following the successful HF Radar model, we have formed the Mid-Atlantic Glider Interoperability Consortium to transition the operational use of gliders across the region. We propose to fund this effort at the base level of $90 K the first year and $100 K per year for Years 2 & 3 for UMass, Rutgers and UMaryland. Based on extensive ONR experience in the Mid-Atlantic, $300 K is the approximate cost of 1 glider year of data. This typically consists of twelve approximately 30-day duration flights, assuming gliders are available. Initially we will rely on gliders from the existing MA fleet (RU-6, UNC-1, ONR-10), and propose to purchase the first MARCOOS glider out of the RU base funding for year 1. We will operate at this base level for 3 years if no additional funding is available. If there is an increase to the higher $3.5 M level, operational support will be increased to $200 K/year at each glider operations center (UMass, RU, and UMaryland), and we will beginning building the MARCOOS fleet at the rate of 3 gliders per year ($300 K/year) split between the three centers. The Glider component will leverage an existing 5-year $5M DoD MURI described below for Mid-Atlantic Glider operations already begun with the recently completed Massachusetts to New Jersey flight in March of 2007.

MARCOOS has a range of forecast models already operating in the Mid Atlantic. The UConn Short-Term Prediction System (STPS) statistical model was developed with USCG funds and has already been evaluated with USCG drifters as a tool to improve SAR efforts. The Mid-Atlantic also has 3 dynamical models running with different footprints. The New York Harbor Ocean Prediction System (NYHOPS) is the most operational, already running continuously since 2004, and covers the Cape Cod to Cape May region offshore. The UMass Dartmouth SMAST version of the Harvard Ocean Prediction System (HOPS) runs with a nested domain that covers the northern part of the Mid-Atlantic region. The Regional Ocean Modeling System (ROMS) is now running in the domain that covers the full Mid-Atlantic for the DoD MURI program to develop advanced data assimilation schemes using the Mid Atlantic as its tesbed. Development and testing costs for all 4 models are heavily leveraged. Four modeling groups are supported at the base level of $80 K the first year and $100 K per year for Years 2 & 3 with the primary task of producing the 2D surface currents for inclusion in the USCG Environmental Data Server for SAROPS. If additional funding is available for years 2 & 3, an additional $100 K per year is designated for each of the three 3D dynamical forecast models to produce data assimilative 3D forecasts for Fisheries applications.

Data management will leverage existing collocated experience in Rhode Island to form the MARCOOS DMAC team. Applied Science Associates, OPeNDAP, and URI will server as the data management team for MARCOOS. All three are all located near each other by URI in Narragansett. MARCOOS will leverage their existing experience and other proposed efforts, including the OPeNDAP proposal to extend their link to include GIS systems used by water quality and inundation decision makers throughout the region. MACOORA sees DMAC activities as part of its overall business plan. MARCOOS will enhance the envisioned MACOORA DMAC plans for the specific needs of this proposal. A total of $160 K is dedicated at the base level of support for the first year and $200 K per year for Years 2 & 3. If additional funding is available, $150K will be added to the total DMAC budget in years 2 & 3. Thus 10% of the total funds are allocated to DMAC enhancements above MACOORA’s envisioned base level.

Education and Outreach will also leverage existing assets within the region. Extensive

E&O programs are ongoing at NOAA NERRS and Sea Grant sites throughout the region. We will specifically entrain the Sea Grant groups associated with rip current forecasting, a high priority theme at NJ, DE and MD Sea Grants. The effort will significantly leverage the NSF investment in the Centers for Ocean Sciences Education Excellence (COSEE), through both the COSEE-MA (Mid-Atlantic) and COSEE-NOW (Networked Ocean World). COSEENOW proposes to use information generated by ocean observing systems (OOS) as a powerful platform to enhance public literacy about the ocean and stimulate public support for ocean research. As the Integrated Ocean Observing System (IOOS) and the Ocean Research Interactive Observatory Network (ORION) efforts evolve, COSEE-NOW will serve as a facilitator for quality education and public outreach. The mission of COSEENOW is: to enable use of transformative ocean research and effective education practices to inspire students and the general public in ocean exploration, discovery, and stewardship. Josie Quintrell, Chair of the National Federation of Research Federations (NFRA) is a member of the COSEE-NOW Advisory Board. As with DMAC efforts, E&O efforts are envisioned to be part of MACOORA's mission. To ensure that we leverage these efforts, E&O leadership has been entrained at the base rate $25 K per year. Specific projects are envisioned at the $50 K per year level. A significant base level project is the production and maintenance of the MARCOOS website at $45 K the first year and $50 K per year for Years 2 & 3. If additional funds are available, $50 K additional funds will be allocated for a project associated with rip currents for the Maritime Safety theme, and for a project associated with fisheries for the Ecological Decision Support.

Economic impact studies are being developed similar to E&O efforts, leveraging ongoing activities by entraining leadership at the base rate of $25 K per year. If additional funding is available, two $50 K projects will be funded to examine the economic impacts of MARCOOS data on SAR and on Fishing Activities.

Project management is funded at $80 K the first year and $100 K per year for Years 2 & 3. As with all other components, this will leverage other activities, specifically the many volunteer efforts contributed by the officers and Board Members of MACOORA. Many of these same Board Members are participating in MARCOOS in the same spirit of volunteerism. This maximizes the amount of management funds directed to the Operations and Financial Managers. As indicated above, Rutgers has waived indirect costs on MARCOOS subcontracts, significantly reducing management costs by over $191,000.