SEA-COOS: Southeast Atlantic Coastal Ocean Observing System

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***Abstract*-The recently-funded SEA-COOS initiative is an eleven-institution collaboration to begin development of a regional coastal ocean observing system for the southeast (NC, SC, GA, FL) United States. A three-pronged program of observing, modeling, and data management will be established while simultaneously conducting outreach studies of user needs and exploring governance models for the program in future years. Details of the program specifics are given.**

I. INTRODUCTION

The Southeast Atlantic Coastal Ocean Observing System (SEA-COOS) is envisioned as one of the regional systems ringing the U.S. to form the coastal component of the Integrated Ocean Observing System (IOOS) [1]. One of the challenges faced in developing IOOS is how to move forward from the planning stage. SEA-COOS is an initiative to start building a regional system for the Southeast and is based, in part, on the results of a planning workshop held in Miami, 27 – 29 June 2001. We will enhance and expand existing observing systems, test and develop needed sensor support infrastructure such as data transmission and power systems, develop data management capabilities such as Web-based regional DODS servers and a gateway for data and metadata to national repositories, and develop data-assimilative model products. Because these components are required by all coastal observing networks, advances made within this project will benefit the development of the national system.

The SEA-COOS partnership includes five academic institutions, four Sea Grant offices (at North Carolina State University, South Carolina Sea Grant, University of Georgia and the University of Florida), a not-for-profit private firm (MCNC), and a state agency, the South Carolina Department of Natural Resources. The initial SEA-COOS partnership also includes twelve no-cost partners; the full list of participants is given in Table 1.

This article presents first background scientific information on the SEA-COOS domain, then identifies information needs for the region. This motivates the structure to SEA-COOS and establishes the components needed of an information delivery system – an observing subsystem, a modeling and information products subsystem, and a data management subsystem. Each of the system components is then briefly described, alluding to the scientific rationale that serves as the basis for the design, and pointing out consistency with Ocean.US plans where appropriate. A section describing outreach efforts is followed by a brief discussion of project management and governance, and a summary of the project goals.

TABLE I
SEA-COOS PARTNERS AND NO-COST COLLABORATORS

Partners	No-cost collaborators
University of North Carolina(UNC)	Naval Surface Warfare Center/USN
University of South Carolina(USC)	Center for Operational Ocean Product Services/NOS/NOAA
Skidaway Institute of Oceanography (SkIO	Naval Atlantic Meteorology and Oceanography Center/USN
University of Miami (UM)	National Data Buoy Center (NDBC) /NOAA
University of South Florida (USF)	National Centers for Environmental Prediction (NCEP) /NWS/NOAA
North Carolina State University (Sea Grant)	Florida Keys National Marine Sanctuary/NOS/NOAA
South Carolina Sea Grant	Atlantic Oceanographic and Meteorological Laboratory/NOAA
University of Georgia (Sea Grant)	National Coastal Data Development Center (NCDDC)/NOAA
University of Florida (Sea Grant)	Jacksonville and Miami Regional NWS Offices/NOAA
South Carolina Department of Natural Resources	Field Research Facility/USACE
NC Supercomputing Center/MCNC	Southeast Fisheries Science Center/NMFS/NOAA

II. BACKGROUND

A. *Response of the coastal ocean to physical forcing*

Cyclones and the synoptic scale atmospheric forcing over the South Atlantic Bight (SAB), East Florida Shelf (EFS) and West Florida Shelf (WFS) sub-regions of SEA-COOS often excite a strong physical response in the coastal ocean. The response includes sea level changes, cross-shelf and along-shelf currents (including near-inertial motions), changes in stratification due to advection and turbulent mixing, and changes in the surface wave field. The response impacts cross-shelf exchange of water and tracers, sediment resuspension and transport, nutrient availability, optical properties, drift trajectories, and productivity levels. With the exception of the tide in parts of the SEA-COOS domain, the oceanic response to atmospheric forcing is often the most energetic signal in observations and therefore readily measured. Integrated over seasons, the coastal ocean response induced by atmospheric forcing plays a defining role in the seasonal

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variability on the shelf and controls the residence times of particles in shelf waters.

The southeast United States is especially susceptible to both tropical and extra-tropical cyclones and winter storms such as Nor'easters and cold-air outbreaks (see 1989 JGR special issue on Genesis of Atmospheric Lows Experiment). Given the high probability of landfall and the broad coastal plains characteristic of the SEA-COOS domain, with its vast areas of low-lying land, accurate prediction of the oceanic interaction with, and response to, tropical storms is vital to enable a timely response to this form of natural hazard. Two other physical mechanisms that force large net displacement and control water mass properties of shelf waters are buoyancy input from river discharge (and groundwater) and influence of boundary currents at the shelf margins (i.e. the Loop Current/Florida Current/Gulf Stream (LC/FC/GS) complex). We choose to emphasize the circulation response to atmospheric forcing, with a secondary emphasis on boundary current interactions at the shelf margins, in this initial effort. We anticipate that subsequent development of SEA-COOS will incorporate studies of the inner shelf.

B. Current understanding of regional physical oceanography

Continental shelves are buffer regions between the coast and the deep-ocean. There, land drainage-derived and ocean waters mix to determine the material properties of the coastal ocean. By material properties we refer to any conservative or non-conservative state variables such as sea level, velocity, temperature, salinity, and nutrients. The overarching question regarding the variations in these and other coastal zone water properties is the relative importance between local and deep-ocean forcing. Here we define local forcing as the shelf-wide inputs of momentum (by winds and pressure) and buoyancy (by surface heat flux, evaporation minus precipitation, and river inflows). Similarly, deep-ocean forcing is defined as the momentum and buoyancy input at the shelf break by boundary currents, eddies and tides. Along with these dynamically active forcing functions are the fluxes of dynamically passive materials (nutrients, plankton, fish larvae, etc.).

A conceptual picture of these processes is shown in Fig. 1 in our domain of concern. The SEA-COOS domain extends from the Mississippi River in the southwest to north of Cape Hatteras in the northeast. While the Florida peninsula may appear to divide the SEA-COOS domain into two separate regions geographically, this is not the case oceanographically. Water properties within the SEA-COOS domain are influenced by the Mississippi River, which drains the U.S. heartland, and by the rivers of Appalachian origin.

Water properties are linked in the SEA-COOS domain by the LC/FC/GS complex, that enters the Gulf of Mexico through the Yucatan Strait, flows around Florida through the Straits of Florida, follows the topography along the eastern seaboard, and separates from the coast at Cape

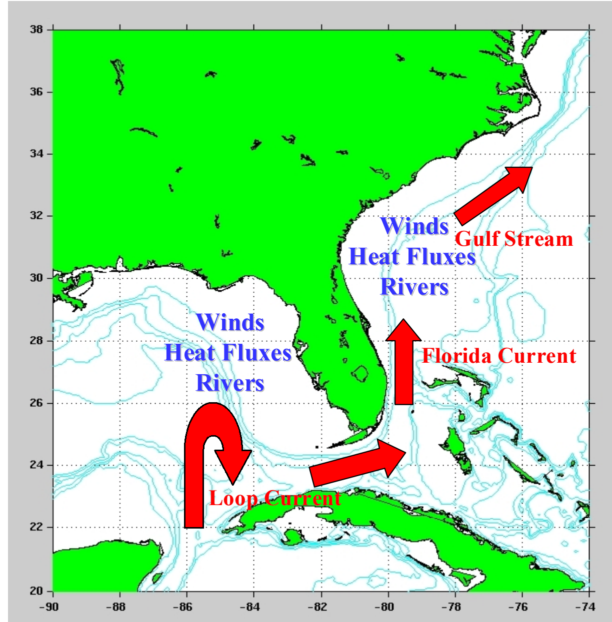

Fig. 1. The coastal waters of the SEA-COOS domain are linked by the Loop Current/Florida Current/Gulf Stream complex. Shelf waters respond strongly to atmospheric forcing by winds and air-sea fluxes and are also influenced by inputs from the Mississippi River and rivers of Appalachian origin.

Hatteras. The subregions are also linked atmospherically by regional-scale extra-tropical and tropical weather systems as noted above. This oceanographic linkage also influences the SEA-COOS region's climate. Surface winds are derived from atmospheric pressure gradients and are influenced directly and indirectly by sea surface temperatures (SST). Except in summer, SEA-COOS domain SST gradients are determined by the temperature contrasts between the relatively warm waters of the LC/FC/GS complex and cooler waters of the continental shelf. Moreover, the LC/FL/GS complex, especially in winter, is the Earth's region of maximum latent (and sensible) heat exchange between the ocean and the atmosphere. Winter storms that originate over the Gulf of Mexico are a major moisture source for the U.S. heartland and Nor'easters gain explosive intensity off the SAB coastline usually over these warm ocean waters. Along with such extra-tropical weather in fall through spring, tropical weather systems in summer are also fueled by the relatively warm waters of the LC/FC/GS [2].

Our ability to predict continental shelf processes of societal importance has been rapidly improving. Recent reviews on the effects of local wind, buoyancy, and deep-ocean forcing over the continental shelves are available in [3], [4] and [5], respectively, and [6] shows that distinguishing among these effects in nature remains a challenge, not because the concepts are not established, but because the systems themselves are complex. We intend to meet this challenge through comparative dynamical and ecological studies, incorporating in-situ measurements and models, performed by collaborating regional scientists, while at the same time providing coastal ocean observing system information to local, state, and federal agencies and to the general public. By focusing on the responses of the coastal ocean to transient and synoptic scale weather forcing from both local and deep-ocean perspectives the range of societal and scientific applications will include:

- Marine weather forecasting: new data for assimilation into NCEP models
- Marine operations safety: real-time reporting of surface meteorology, currents, waves
- Natural physical hazards: storm surge
- Ecological health: harmful algal blooms, hypoxia
- Trajectory analyses: search and rescue, toxic spill tracking, larval transport
- Cross-shelf exchange: surface and bottom boundary layer transports, role of fronts and eddies
- Sensors: quantitative comparisons of HF radars for surface current mapping.

In support of these applications, SEA-COOS is committed to establishing a real-time observing system for the southeast that will be linked to nowcast/forecast systems and that will provide information products in near-real-time, via the Web, to sponsors, other researchers, marine forecasters, coastal marine environmental managers, and a myriad of other users. While a number of the eventual products will be of an ecological nature, in the beginning, SEA-COOS will be dealing primarily with physical variables (e.g., surface winds and currents), many of which can be used to make ecological inferences. Information products will be derived from federal and academic real-time observing systems. They will also be derived from federal and academic regional nowcast/forecast models.

There is not much precedent for research and operational real-time information products in the coastal ocean. Some of the limited experience resides with operational branches of NOAA and academic groups within SEA-COOS. Hence, the best result will probably be achieved by a joint activity for product definition, development, and assessment.

D. *The structure of SEA-COOS*

These needs define a set of measurement requests and information products that SEA-COOS will endeavor to satisfy. The variables are consistent with those identified by the Ocean.US workshop (currently in draft form on the Ocean.US website, www.ocean.us.net) as being vital to addressing a suite of coastal applications. We will not be able to address all these needs initially but will put in place the infrastructure to support the collection, collation, synthesis and distribution of information products. SEA-COOS will enable this capability through the coordinated development of several major subsystems:

1. an Observing Subsystem,
2. a Modeling and Products Subsystem, and
3. a Data Management Subsystem.

The following sections summarize the overall implementation plans for these subsystems. These are followed by sections on Outreach and Project Management and Governance.

III. OBSERVING SUBSYSTEM

Observations collected by SEA-COOS will be derived from multiple sources employing a variety of technologies. The types of sensor/platform combinations to be used fall under three categories: operational/routine observations, observatories, and technique development. We discuss each of these categories in turn below. Taken together, the three components constitute the initial SEA-COOS contribution to collecting ocean observations in the Southeast. These observations will be merged with those from other observing systems (including smaller scale systems such as the Carolina Coastal Ocean Observing and Prediction System (Caro-COOPS) and larger scale systems such as the NDBC buoy array and the NOS water level network) to provide as broad coverage as possible. Site selection is driven by scientific rationale, existing infrastructure (e.g. Navy towers), existing (NDBC) and planned (Caro-COOPS) deployment sites by other groups, and the need for the integrated system to provide a sparse and relatively uniform distribution of measurement sites.

A. *Operational observing systems*

Fixed platforms will be instrumented off NC and off FL as part of SEA-COOS. In NC several Navy platforms of the Oceana range offshore of Oregon Inlet will be instrumented with basic meteorological and oceanographic systems to provide measurements of current profiles, temperature and salinity at multiple depths, directional wave spectra, and air-sea exchange fluxes. There are several motivations for making sustained observations in this area. This region is the southernmost extent of the Mid-Atlantic Bight where a remarkable amount of cross-shelf transport occurs [7] as well as along-shelf transport that constitutes exchange with the South Atlantic Bight, under strong forcing from interaction with the Gulf Stream [8,9]. Wintertime extra-tropical cyclones that can strongly impact the mid-Atlantic and Northeast often form in this area [10]. There is also a large recreational fishing industry associated with this coastline that relies almost entirely on remotely sensed thermal imagery for oceanographic observations.

Caro-COOPS is being established with funding from NOAA. Deployment of coastal and shelf moorings is one of the components of Caro-COOPS, and the first deployment of stations is expected in the fall of 2002. As part of SEA-COOS three middle to outer shelf moorings funded by Caro-COOPS will be upgraded to include surface buoys and telemetry through the Iridium system to provide real-time observations on the shelf off South Carolina. These moorings will measure currents, temperature and salinity at multiple depths and should permit monitoring of Gulf Stream meandering north of the Charleston Bump.

We will also install a new measurement site for the WFS, an instrumented tower located on about the 25m isobath west of Florida Bay (northeast of the Dry Tortugas). This new location will accomplish two goals. The tower deployment will fill in the offshore wind field by direct measurements in a way that will improve data assimilation into NOAA NCEP models. It will also serve as a monitor of the Loop Current or eddy interactions with the shelf break that we now know impacts the inner shelf currents.

Fig. 2 summarizes our planned enhancements and additions and the resulting gridwork of real-time observing locations. These include: NC Navy towers northeast of Cape Hatteras; the Caro-COOPS moorings; and a Navy tower W of Florida Bay. These locations help fill large (> 100 km) gaps in the current observing system.

B. Observatories

The South Atlantic Bight Synoptic Offshore Observational Network (SABSOON, [11]) tower array off Georgia, and advanced moorings used in the Coastal Ocean Monitoring and Prediction System (COMPS) on the WFS, constitute facilities that function as research observatories; that is, they maintain platforms capable of serving as test-beds for new sensors and measurement techniques and have the infrastructure to host intensive process-oriented research programs. Further development of observatory capabilities will be part of the SEA-COOS program.

The near-term strategy for continued development of SABSOON will emphasize extension of the network and enhancements of the core observatory infrastructure. Increasing the sampling density for real-time current profiles, water level and the mass field is of particular importance for developing and validating data assimilative modeling approaches, notably the local area model being developed for the SAB region with NOPP funding (http://www.ncsc.org/nopp/sablam). Enhancements of SABSOON power, communications and data acquisition systems, and system monitoring functions will also provide the basis for hosting a range of operational and prototype instrument systems. These capabilities should provide additional opportunities for leveraging support for focused studies. As part of the SEA-COOS effort, SABSOON system installations are targeted at five towers (Fig. 2).

COMPS will continue its associated missions of providing real time data to local emergency managers, federal and state agencies, the general public, and to other scientific users. Applications to harmful algal blooms continues, and as part of a multidisciplinary team we were recently awarded funding through the Monitoring and Event Response to Harmful Algal Bloom (MERHAB) program. MERHAB involvement includes the development of new technologies [through the USF Center for Ocean Technology (COT)] for red-tide detection, and for monitoring T/S and other chemical fields using bottom stationed profiling floats (BSOP). These BSOP units,

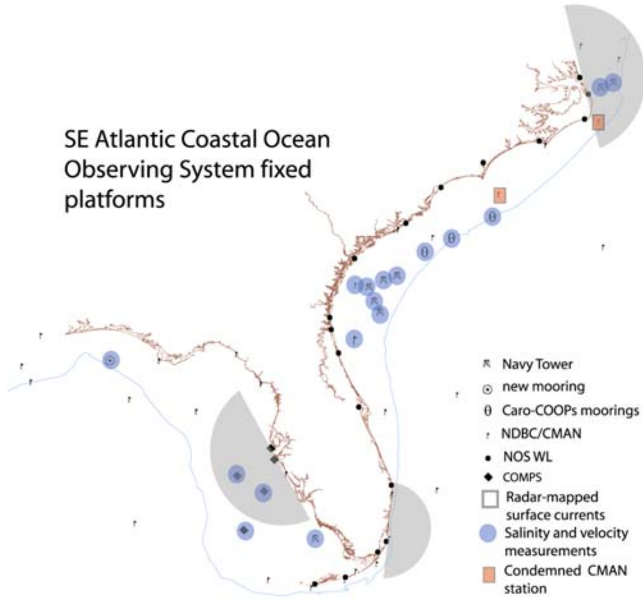

Fig. 2. Distribution of all real-time reporting fixed platforms and HF radar footprints in the SE coastal ocean (more than 3 mi offshore) after deployment of SEA-COOS observing subsystem components. Blue shading marks locations measuring currents and mass field properties, orange marks condemned CMAN stations.

deployable for several months duration, are designed to park on the bottom in between profiles and to telemeter their data by email via ORBCOM. We envision a fleet of these, deployed for mapping purposes, providing water column information for assimilation into models.

C. Observational technique development

A limited number of variables can currently be measured operationally in the ocean. Investment in new technologies that promise to provide autonomous measurement capabilities, improve communications, or improve at-sea power systems is vital to enable coastal ocean observing systems to address the myriad science and societal issues of the coastal region. SEA-COOS will make an initial investment in the following areas: HF Radar; UW video (fisheries applications); new battery/power systems for offshore stations; and incorporating additional sensors into the existing observing system deployment packages and data streams.

For year one, three HF radar nodes are proposed for SAB (Duck, NC), WFS (Tampa, FL), and EFS (Miami, FL). Each node will provide coverage over a 100 km or more sector of the coastal ocean (Fig. 2). A WFS deployment will operate several types of radar simultaneously over the COMPS array as an inter-comparison study, and a regional test bed for radar will be established off Miami. An existing UW video system at SABSOON will be upgraded with the implementation of automatic annotation software and protocols in collaboration with the Monterey Bay Aquarium Research Institute. We will also evaluate Lithium solid polymer

(LSP) battery technology as an alternative to the lead-acid batteries used in ocean observing systems and by the US Navy systems in the region.

IV. Modeling and Model Products

The integration of observations through the models is necessary to be able to provide a coherent description of the environment on the continental shelf from the West Florida shelf to Cape Hatteras (see Fig. 3). This goal can be addressed in the delayed-time, retrospective, or hindcast analysis, and/or re-analysis mode, but we also wish to pursue the real-time nowcast/forecast mode. How best to achieve this goal will be the focus of the modeling efforts during the initial phases of this project.

Three modeling activities are underway by the PIs at USF, UNC and UM. Each group uses a 3-D time-dependent, baroclinic primitive equation formulation, with free-surface and higher order (Mellor-Yamada) turbulence closure to study the tidal and sub-tidal structure of the currents in the region from the inner shelf (coastline at the 2 m isobath) to the shelf-break. Of necessity, UM extends from the inner shelf across the Straits of Florida. Model resolution in each case is variable, ranging from 1-10 km in the horizontal, and a sigma-grid with 20-30 levels in the vertical. Forcing includes tides (prescribed elevation at the model open boundaries), wind stress and atmospheric pressure (from NCEP ETA), river runoff, and in some cases surface heat flux with a flux correction applied based on SST. Coupling with offshore forcing (e.g., deep ocean currents) is handled differently by each group. The USF model uses a radiation condition for the open boundary, plus surface elevation for tides and other purposes, whereas the UNC-CH model inverts for the boundary condition through assimilation of ADCP data in the domain, and UM uses a "feature model" for the upstream Florida Current.

A. Deliverables in the coming year

Our goal during this first year is to provide an integrated view of the SEA-COOS domain using modeling capabilities already in place. Without actively coupling or linking the models, in the coming year we will determine over the entire SEA-COOS domain a common set of external forcings (e.g., atmospheric forcing through the ETA model, the same tidal constituents, etc.), model parameters including internal dynamics (e.g., details of closure terms), output strategies and formats (e.g., NETCDF) , and consistency in visualization methods, in order to generate spatially- and temporally-consistent maps of the relevant model variables for the entire SEA-COOS region. Model products will include daily 2-3 day hindcast/nowcasts and forecasts of selected model variables, including multiple horizontal maps and vertical sections and time-series (subtidal and in tidal time) at selected locations. Products will be available and displayed over the Internet (through already established sites and through the SEA-COOS web site).

B. Additional Joint Modeling Activities.

Several tasks need to be developed jointly in preparation for a long-term integrated view of this region. The SEA-COOS region is strongly affected by weather events such as winter nor'easters and cold-air outbreaks as well as summer-time tropical storms. We will study the effect of these weather cycles over the region by examining the difference in responses – to the same events – within each of the model sub-domains. The data assimilation approach used in the SABSOON study has been to assimilate ADCP data to invert for (missing) boundary conditions using a nonlinear 3-D finite circulation model with a local-area, open-water domain [12-14]. We will continue with this general inversion strategy for assimilating velocity observations extended to handle pressure observations, and will begin to jointly experiment with recent advances in practical filtering (e.g., [15]) and methods to assimilate coastal HF radar data. We will need to impose (and eventually formally assimilate) hydrographic and pressure and/or velocity outputs at and near the SEA-COOS shelf-scale model boundaries to capture the offshore forcing. We will collaborate with PIs in GODAE (HYCOM, etc.), U.K. Met. Office and NCEP Coastal Ocean Forecast System in developing strategies for down-scaling these basin-scale model products to the coastal ocean, as they become available. It will be necessary during the first year for the modeling teams to establish a common grid from which model subregions may be generated for local applications. Geometric and bathymetric data must match across model domains to minimize "jumps" across model domains that may result in spurious circulation features once the models are dynamically linked. We will also need to evaluate how best to achieve this uniformity in data sets when coupling

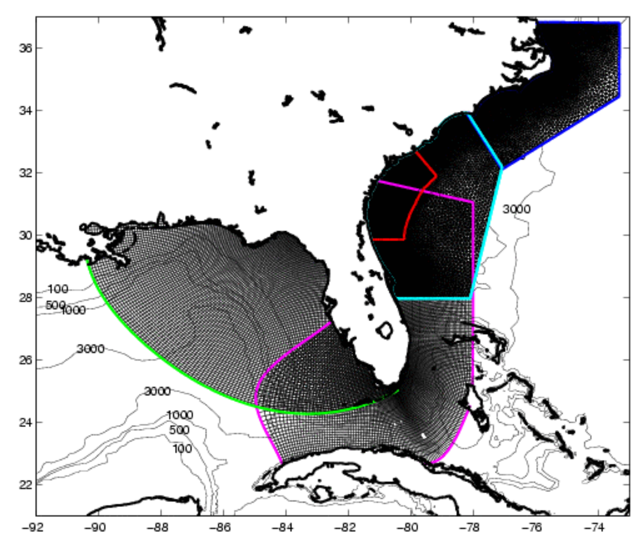

Fig. 3. Model grids used to compute circulation on West Florida Shelf (green boundary); East Florida Shelf (magenta); and South Atlantic Bight (cyan for large-scale forcing of red domain where data assimilation is implemented). The grid straddling Cape Hatteras is an extension to include the additional observational sites. Depth contours in meters.

to offshore models. We will also (i) explore modeling capabilities to study dispersal and retention of marine organisms (planktonic and with simple behaviors) and their possible use in management under a spatially explicit framework, and (ii) make progress toward identifying conditions under which Marin Protected Areas may act as sources, sinks or self-seeding populations.

V. DATA MANAGEMENT

Implementation of a robust data management and communications infrastructure will be one of the critical challenges for development of IOOS. In one of the working group reports from the recent OCEAN.US workshop, [16] identified key functional elements for data and communications, and outlined the initial steps of a phased implementation plan for an integrated national system. Regional observing systems are to be among the "backbone" elements of the national COOS. It is therefore essential to ensure that the data and communications standards for SEA-COOS are established in accordance with those adopted by IOOS. Also, as recognized in [16], regional systems will be composed of a diverse set of programs, some associated with the core national observing system (such as NDBC) and others being various "cooperating" programs. Thus, the development of the data management and IT components of SEA-COOS must address both internal and external data exchange and communications issues.

A. Data Management Strategy

The near-term goals of the data management component of SEA-COOS will be to: (a) provide timely delivery of appropriate data to the modeling efforts and regional forecasting centers; (b) ensure that data and metadata are documented appropriately; and (c) develop the regional capacity for exchange of data and data products in accordance with the standards of the emerging national IOOS. Longer term, it is intended to provide the framework for inclusion of a range of additional SEA-COOS partners within the SE region, and integration with the national IOOS.

Since a variety of functions associated with the initial acquisition, processing, and storage of data require some degree of local data management, one level of data management activities and responsibilities will be distributed among the groups responsible for maintaining the observation systems and generating model products. This includes the initial processing of raw data, local archiving of raw and processed data, establishment and maintenance of local metadata records, initial QA/QC and its documentation, entry of information for instrument maintenance and servicing logs, production of data products specific to local or project-specific applications, and generation of local web site products.

Linkage and integration of information are fundamental to the SEA-COOS concept. Thus, a number of important data management functions will be most effectively implemented through a regional center. These include:

- establishing the core data communications infrastructure for the SEA-COOS region;
- coordinating with other regional and national COOS programs;
- supplying the core expertise for critical system-wide data management functions, including installation and support of data servers, graphical interface products, and system wide web support, as well as planning for security and system backups;
- establishing data format and metadata standards for SEA-COOS and providing tools to facilitate appropriate metadata documentation;
- developing necessary QA/QC procedures, including documentation and assistance with implementation;
- ensuring that critical data are delivered within the necessary time frame to modeling programs and regional and national forecasting offices.

To integrate the regional data management activities, a Data Management Coordination Committee (DMCC) will be established to provide coordination and oversight. This committee is formed with broad representation within SEA-COOS to address common issues and development needs and provide constructive linkages among the various institutional data management activities.

B. Data Management Implementation Plan

The data management implementation plan will provide a mechanism to integrate regional data into the federal "backbone" of ocean observing systems. Also, this plan develops a system to share and integrate observational data, model output, and data products within the SEA-COOS region. Several avenues of access to data and data products will be established through distributed regional "nodes" using (i) National Virtual Ocean Data System (NVODS) components and (ii) metadata gateways (discussed below). This approach addresses different levels of user requirements (e.g. scientific, management, education and other societal applications) and provides multiple pathways to access data and data products. Our efforts in the next year will concentrate on implementing and evaluating these two approaches as a basis for the data management infrastructure for SEA-COOS.

i) National Virtual Ocean Data System (NVODS) Components

NVODS provides a mechanism for sharing SEA-COOS data that can be implemented for the time-frame desired by each data contributor, whether it is historical, recent or near real-time data, while also making the data available to a wide range of potential users for regional, national, and global applications. The existing NVODS components are:

a. Distributed Oceanographic Data System (DODS) Servers, which provide the foundation of data communication and transport over the Internet;
b. Live Access Servers (LAS), which provide a uniform ability to visualize, subset, and access data from a multitude of DODS Servers using a web browser; and
c. Searching partnerships, such as the Global Change Master Directory (GCMD).

In the first-year effort, one DODS Server will be installed at each institution in SEA-COOS providing publishing platforms for observational data and model output. Additional DODS Servers will be added as required by new instrumentation or model output. For example, due to high data output, one or more DODS Servers may be required for each HF radar. Live Access Servers will provide data access and data discovery (in a variety of formats) through a graphical user interface to the datasets at regional DODS Servers. At least two sister LAS servers will be established for the region to provide a measure of redundancy.

ii) Metadata Gateway

The NCDDC has offered to provide assistance and training for data providers in FGDC-compliant metadata and assistance in accessing the Metadata Gateway. Metadata training is also available through the Coastal Service Center in Charleston, SC, and SEA-COOS personnel will make use of these services. The NCDDC maintains a catalog of available coastal data sets (via the NCDDC Gateway) and thus provides another portal for the coastal user community to locate and access data through graphical user interfaces and geographic information systems (GIS). Since the role of the NCDDC in IOOS is in an early stage of development, we will, in this first-year effort, test and evaluate an NCDDC Gateway and associated tools for a limited set of variables measured by SEA-COOS. Issues to be evaluated include its effectiveness (1) in assisting data providers in compliance with metadata standards, and (2) providing users with necessary tools for the broader societal application of SEA-COOS data and data products (e.g., in coastal management and educational programs).

VI. OUTREACH

The establishment of a relevant and useful coastal ocean observing system depends on the identification of constituent needs as well as the form or formats in which the resultant products would be most useful. Because such a wide spectrum of needs are intended to be served by the IOOS, from data for basic research to prediction of evacuation areas in advance of natural hazards to surf forecasts for specific beaches, the broad charge of 'identifying user needs' presents a significant challenge in developing regional coastal ocean observing systems. Researchers involved with the initial implementation of SEA-COOS have already begun to establish contacts with state and federal agencies actively working with ocean information, as evidenced by the Letters of Support accompanying this proposal. However, outreach to those outside of science-based investigation/management of the coastal zone is needed.

Recently the Sea Grant extension offices in NC, SC, GA and FL have begun working together on regional issues. The fortuitous overlap of spatial coverage between the Sea Grant effort and SEA-COOS permits a ready collaboration. To begin the process of identifying user needs at the local level across the region, a four-state region Sea Grant extension outreach effort to support SEA-COOS will include four objectives:

1. Identify actual/prospective constituent groups that may need or desire information from an observing system.
2. Introduce these constituents to the concept and operating principles of observing systems (what are they? what can they do? etc.).
3. Work with the constituencies to identify their information needs.
4. Develop the means by which processed data and information and final products will be made available to these constituencies.

After information exchange meetings between Sea Grant personnel and the PIs, focus groups in each state will address the objectives listed above. Reports developed from these small workshops and subsequent larger-scale meetings will complete the first round of outreach activities.

VII. PROJECT MANAGEMENT AND GOVERNANCE

The SEA-COOS concept is defined by a collaborative, interactive, multi-institutional team, and a good management plan is critical for smooth operation and implementation success. The core management body will be a PI Council, which will coordinate the activities of SEA-COOS through a set of working groups, and will make decisions on resources and collaborative planning collectively. The SEA-COOS PI will chair this Council. The UNC Office of Research will provide primary contract and grant coordination and management among the eleven institutional entities that make up the SEA-COOS collaboration.

The working groups will focus on the SEA-COOS subsystems and will interact regularly and maintain integrative discussions and information exchange. Standing working groups on observing systems, modeling, and data management have developed the concepts of the program, and will continue to evolve the plan and implementation of SEA-COOS. Additional working groups being formed will address: HF radar, field engineering/maintenance, satellite remote sensing, data management coordination, information products and outreach/education. The working groups will be open to all involved in SEA-COOS and use email, teleconference, videoconference and small workshops to foster communication. A number of individuals will belong to multiple working groups, promoting cross-fertilization of ideas and information.

With the help of the UNC Office of the President, the PI Council is identifying a SEA-COOS Board, composed of senior (non-SEA-COOS PI) academic research managers from each institution, to provide strategic guidance, coordinate program review, and supervise governmental liaison. The SEA-COOS Board may include additional outside experts. The UNC Office of the President will also sponsor a management seminar to include leaders of several successful large science programs, e.g. EPA's Southern Oxidants Study, to develop more fully the governance scheme, taking into account the needs of no-cost collaborators, users, and sponsors.

VIII. SUMMARY

SEA-COOS is a partnership of academic, federal, state and private institutions formed to build the framework of a coastal ocean observing system for the southeast Atlantic states. The initial effort will establish regional-scale elements of key components envisioned for the U.S. Integrated Ocean Observing System: an observing subsystem; a modeling subsystem; and a data management subsystem. Specific aspects of each subsystem to be developed over the first year of funding were documented above.

Key objectives of SEA-COOS targeted for the next year are:

- Increase the number of sites reporting atmospheric and oceanic observations in real-time in the coastal ocean off NC, GA, SC, and FL, providing for the first time integrated, region-wide measurements of salinity, temperature, currents, directional waves and heat and moisture exchanges between the coastal ocean and atmosphere.
- Critically evaluate key observational technologies in extended field deployments, including different HF radar systems, a number of bio-optical and chemical sensors, and new battery/power systems for offshore observatories.
- Gain experience in implementation of data assimilative modeling techniques and identify promising strategies for further development.
- Produce nowcasts and forecasts from blended circulation models for the SEA-COOS domain that will be routinely available over the Internet, develop an archival strategy for long-term model output, and establish a common region-wide computational grid.
- Implement a coordinated, regional data management system, built around NVODS components, to facilitate data exchange within SEA-COOS and provide broad access to observations and data products, and establish a metadata gateway to the NCDDC, linking SEA-COOS to the national system.
- Work with the Sea Grant offices from the four states to develop effective mechanisms of information exchange between SEA-COOS and a range of non-research users, and identify priority information needs and preferred delivery formats of user groups.
- Engage the broader SE research and management community to produce plans for further cooperative development of the offshore system and expansion into the nearshore.
- Develop a regional working partnership with NOAA and Navy operational and research entities to optimize SEA-COOS links to national infrastructure.
- Establish a Governance system that will ensure coordinated, effective effort across SEA-COOS subsystems, interface with other regional and national programs, and identify models for future growth of the regional network.

This regionally coordinated effort will put SEA-COOS in a strong position to contribute to the development of the integrated national coastal ocean observing system in future years.

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