PAPER

Building on the SEACOOS Experience: Recommendations from the Final SEACOOS Workshop

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ABSTRACT

The final SEACOOS workshop included discussion of several topics relevant to further development of the SE regional coastal ocean observing system (RCOOS). First, many of the Information Management (IM) tools developed in the SEACOOS program can be migrated to a future RCOOS. It is recognized that IM is evolving, and continued communication with national and regional IM efforts will be required. Of particular importance is the establishment of standards for data quality assurance/quality control. Second, serving various user needs will require development of specific products (applications). Mechanisms to better link research and development (R&D) conducted by the RCOOS to applications development are needed, and dedicated funding for both R&D and for migrating from pilot to operational applications is required. It was suggested that the regional association (RA) could play a key role in this process; interfacing with users, prioritizing potential applications in relation to RCOOS capabilities, and coordinating with federal agencies and private industry. Third, it is essential that roles and responsibilities are clearly defined for the RCOOS and for the federal agencies contributing to the "national backbone" of the U.S. Integrated Ocean Observing System (IOOS). This requires agreement on a Concept of Operations (CONOPS). The CONOPS must be defined at several levels and over a time frame sufficient to accommodate the transition from research/pilot to operational stages. To help coordinate regional and federal agency efforts in coastal ocean observing in the near-term, an interim CONOPS should be defined and designs for the RCOOS should be documented and evaluated.

Introduction

SEACOOS was one of a number of pilot efforts in regional coastal ocean observing programs that were initiated in the early 2000s. Seim and Mooers (this volume) provide an overview of the origins of SEACOOS in the context of other national and regional initiatives. Further informed background is provided by Briscoe et al. (this volume), who describe the evolution of global, national and regional ocean observing systems, assess the present status of the U.S. Integrated Ocean Observing System (IOOS), and list a number of urgent near-term action items.

The organizational structure that has emerged for coordinating regional coastal ocean observing activities is the Regional Association (RA), with the Southeast Coastal Ocean Observing Regional Association (SECOORA; www.secoora.org) providing this for North Carolina, South Carolina, Georgia and Florida. (Florida activities will also be coordinated under the Gulf of Mexico Coastal Ocean Observing System Regional Association, GGOOS-RA). The RA will oversee operation of the regional coastal observing system (RCOOS); the observing, data communications, modeling and information management components of the system. The RAs are in turn coordinated nationally through the National Federation of Regional Associations (NFRA; http://usnfra.org). One of the objectives for documenting the SEACOOS experience in this volume is to contribute to the further development of the SE RCOOS under SECOORA. This effort was initiated at the final SEACOOS community workshop.

Biannual workshops were conducted by SEACOOS from 2002-2006. These alternated between fall workshops focused on program planning (largely internal discussions) and spring workshops that emphasized engagement with the broader community (see Seim et al., this volume). The 10th and final SEACOOS workshop, held in October, 2007 (St. Pete Beach, Florida), was intended both as a review of the SEACOOS program and as a forward-looking discussion of future development of the SE RCOOS. The first part of the workshop looked back at the development of the major elements of SEACOOS (Program Management, Information Management, Modeling, Observing, Extension and Education), emphasizing key "lessons learned" over the five-year program (see other papers in this volume), and presented an initial RCOOS design for the SE (based on Seim et al., 2008). Additional SEACOOS program documentation is posted at the project website, including the Strategic Plan, Implementation Plan, report from an External Evaluation of the SEACOOS program (conducted in January, 2005), and reports from workshops (http://seacoos.org/; see "documentation", and "General Information / SEACOOS Workshops").

Discussion and recommendations from the second part of the October, 2007 workshop are presented here. Three topics that the workshop organizers felt were pertinent to further development of the SE RCOOS

under SECOORA were addressed: 1) Implementation of the Information Management system under SECOORA; 2) Connecting research and development (R&D) activities within the RCOOS to the development of specific applications for RCOOS information; and 3) Developing a "Concept of Operations" (CONOPS) for the RCOOS. In each of these areas, it was felt that SECOORA will need to engage in effective interactions within the region, with other regional associations, and, in particular, with the federal agencies that are contributing to the "national backbone" of IOOS.

Workshop Organization

To increase participation by representatives of federal agencies and other regional coastal ocean observing programs, the Fall 2007 SEACOOS workshop was scheduled immediately prior to the annual meeting of NFRA. There were 74 participants in the workshop, 31 associated with SEACOOS and 43 associated with a range of organizations in the broader coastal ocean observing community. The workshop report is posted at the SEACOOS web site (listed above). Following review of the SEACOOS program documentation (this volume) and a proposed initial RCOOS design (Seim et al., 2008), representatives of key federal agencies involved in activities related to IOOS provided brief updates on agency activities. Robert Jensen summarized plans for a surface waves observation plan developed through collaboration of the U.S. Army Corps of Engineers (USACE) and NOAA's National Data Buoy Center (NDBC) (see NOAA/IOOS, 2008). He also described the USACE coastal component of the surface wave network envisaged for IOOS, and collaborations with regional observing programs. Paul Moersdorf reviewed the growth and present status of NOAA's NDBC coastal ocean observations and data management system. Robert Bassett described the status and scope of observing activities of NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) and summarized planned operational coastal modeling efforts. Three concurrent sessions were conducted to address the topic areas listed in the preceding paragraph.

Summary of Topic Area Discussions

1. Information Management (IM)

Background

The development and organization of the SEACOOS IM system are described in Fletcher et al. (this volume). Strong cross-institution coordination by the SEACOOS Data Management Coordinating Committee (DMCC) was an essential part of this process. Beyond the development of the SEACOOS IM system, DMCC personnel also contributed to the planning and initial implementation of the IM structure for SECOORA and played a central role in extra-regional exercises that developed capacity for and demonstrated interoperability between data systems of regional and national programs involved in pilot IOOS efforts (i.e., the capability for standards-compliant discovery, translation and use of data across operating systems and software applications). Discussion at the October, 2007 SEACOOS workshop focused on future directions for IM implementation for SECOORA.

Discussion and Recommendations

Many of the operational elements of the SEACOOS IM system provide functional and proven IM tools for SECOORA. These include dynamic and fixed mapping applications for web displays; the data conventions adopted by SEACOOS (see documentation at www.seacoos.org/documents); "data scout" functions (routines that automatically acquire and format recent data from servers across the region and nationally); and a database scheme for rapid aggregation of data from many sources for online applications. The SEACOOS IM group employed a number of open source solutions, such as tools developed by the Open Geospatial Consortium (OGC), which can be easily transferred to the developing regional association and other groups.

A number of observations and recommendations were made regarding the next steps for implementation of the IM system for SECOORA.

- A priority area is data quality assurance and quality control (QA/QC). Further development of mechanisms to ensure adequate QA/QC of disparate data sets acquired through RCOOS activities will require focused attention at the regional level and close coordination with national QA/QC initiatives, notably the Quality Assurance for Real-Time Ocean Data (QARTOD) project (see www.quartod.org). SECOORA has also sponsored QA/QC efforts building upon QARTOD initiatives, and it is hoped that these can serve as templates for similar activities in other regions.
- IM standards, such as those of the OGC, continue to evolve. Given the present multiple-path developments in this area and the fluid nature of open source documentation, tracking these developments is a potentially complex issue.
- Mechanisms to deliver time-sensitive products need to be developed. Examples include mapped, web accessible products focused on "events" such as storms and harmful algae blooms.
- Effective communications will be critical for further IM progress under SECOORA. Priority areas include attention to mechanisms for establishing cross-working group liaisons and developing closer links between the data management group and stakeholders. Establishing opportunities for feedback from users of the information system will be needed, and how best to accomplish this (e.g., web-based versus other mechanisms) must be assessed.
- IM system redundancy must be evaluated. The disruption of the national NOAA NDBC network caused by Hurricane Katrina (in late August 2005) demonstrated the vulnerability of a single data distribution source in the Southeast U.S. The requirements for full redundancy are considerable, thus

critical elements of the IM network must be identified and priorities for back-up systems defined.

- Web development for the RCOOS, and ongoing upgrades of these services, will be a major task and will require dedicated personnel support.
- Mechanisms to accommodate data providers and users who have limited capabilities should be developed. As part of this, IM system documentation should include "how-to" instructions appropriate for various levels of data providers and data users.

2. Linking Research and Development to Applications/ Supporting Applications

Background

A key role for the RA will be to engage users and develop the capacity to address regional information needs. User and needs assessments conducted by COOS programs and NOAA show a wide range of potential users and information needs (e.g., see http://secoora.org/documents/needs-assessments). How to effectively serve the needs of diverse applications and user groups is a key challenge for RCOOS strategic planning.

A basic premise underlying the development strategy for SEACOOS was that understanding coastal ocean processes is fundamental to addressing a broad range of user needs. The SEACOOS Implementation Plan was thus defined in terms of a phased development, with an initial focus on improved capabilities for estimating and forecasting physical state variables and the applications directly served by improved information on coastal ocean circulation (e.g., search and rescue; dispersal and recruitment aspects of fisheries management). The pilot effort in near-shore surface wave measurements undertaken in SEACOOS (see Voulgaris et al., this volume) was intended to complement the anticipated development of national agency directional wave programs (NOAA NDBC, USACE). Coordination with supra-regional and national coastal inundation observation and modeling programs was also explored. Longer term, biological and biogeochemical applications were envisioned, along with targeted applications for specific user groups that would typically require more tailored information products (such as K-12 and free-choice education).

The proto-type RCOOS development undertaken in SEACOOS was intended to establish the initial capacity to address applications. For the most part, this emphasized implementation and demonstration of capacity, building on existing sub-regional efforts. Serving targeted applications during the system development was challenging. Based on this experience, two main areas of discussion were posed for the workshop session: 1) how to more effectively link ongoing R&D conducted by the RCOOS with the development of applications addressing user needs; and 2) how the regional program can be structured to better engage various stakeholders (potential users of the RCOOS information system) in this process.

Discussion and Recommendations

SECOORA and other RAs are intended to coordinate regional capabilities and assets, and bring these to bear on important issues that have been defined for the regions. In this capacity, RA functions will include identifying information gaps, fostering and articulating consensus to help set priorities, and assessing how the available resources can be allocated to best address priorities among diverse applications (e.g., search and rescue, hazardous material tracking/forecasting, ecosystem-based management of living marine resources). It will be important to ensure that targeted applications are appropriate for the established capacity, that applications and products developed by the RA complement federal agency missions (avoid duplication of effort), and that these do not result in conflict with private industry. These requirements point to the need to incorporate a Systems Engineering approach in the design and ongoing evaluation of the RCOOS. Further, it is clear that a strong R&D program is needed to underpin the operational activities of the RCOOS. In addition to providing observations and model estimates of important variables (along with associated error estimates), an important function for the RCOOS operated under SECOORA will be to provide science-based interpretation of this information. The academic sector can thus play an important science advisory role for the RCOOS.

Recommendations from the session were:

- Sufficient resources should be allocated for R&D efforts so that this can be a robust and ongoing part of the RCOOS program. This should include field and numerical experiments in addition to evaluation of observing technologies and modeling systems.
- A process for transitioning from research/pilot to operational status must be part of the RA operational plan. In the National Weather Service, this process has been referred to as going through the "valley of death"; that is, many pilot applications never reach the intended operational status. To address this, it was suggested that the RA will need well-articulated processes for developing applications, including evaluation, validation, and verification of observations and model output. Based on the SEACOOS experience, Seim et al. (2008) proposed that such applications development functions might be most effectively provided by "forecast, applications and analysis centers" associated with the RA. By grouping personnel dedicated to product development, resources would be optimally utilized and strong communication among developers would be fostered.
- A key issue for applications development will be to ensure that there are sufficient resources allocated to accomplish it. An approach adopted by the Office of Naval Research has been to set aside 10% of the project budgets in the applied area, and then use this for targeted support of engagement between pilot and operational programs. Dedicated support for the proposed "forecast, applications and analysis center" might serve this purpose for the RA.

- Mechanisms should be established to allow the RA to be responsive to environmental "events," both in terms of allocating resources for additional targeted observations and modeling, and in terms of generating event-oriented information (e.g., for storms and their impacts, harmful algae blooms, anomalous river discharge or wind conditions and the associated response of the coastal ocean). Such information can provide important opportunities for Extension & Education activities and broaden the engagement of the RA with the public and various user groups.

3. Concept of Operations (CONOPS)

Background

While the structure for the U.S. IOOS was broadly defined at the time SEACOOS was initiated in 2001 (see Briscoe et al., this volume), both the IOOS and RA/RCOOS concepts were evolving during the program. Based in part on the SEACOOS experience, an initial design for the SE RCOOS was presented in Seim et al. (2008). This identified several issues that must be resolved before the RCOOS architecture can be fully developed. Foremost among these are (1) how the federal network (the "national backbone") will be organized, and (2) how it will interface with the RCOOS. While there was productive engagement between SEACOOS and federal agencies involved in ocean observing, many critical aspects of the relationship between the RCOOS and the "national backbone" program(s) have not been resolved. The SE RCOOS must also be interactive and interoperable with the systems operated by other RAs, particularly those of the adjacent Mid-Atlantic, Caribbean and Gulf of Mexico regions.

A Concept of Operations (CONOPS) is a process that provides clear definition of the roles and responsibilities of all parties engaged in an enterprise. Without an adequate CONOPS there may be competition rather than collaboration among the federal and regional components of IOOS, or conversely, inadvertent gaps in coverage and capabilities may result. CONOPS development (and issues associated with it) was thus targeted as one of the areas for discussion at the final SEACOOS workshop. Participants in the session were from diverse backgrounds, including academic institution partners of SEACOOS, federal agencies (several branches of NOAA, ONR), a private foundation, other regional and sub-regional COOS programs, and NFRA.

Discussion and Recommendations

Among the key challenges that must be addressed in RCOOS development plans is defining relationships to other organizations that are involved in various aspects of marine and coastal observations and forecasting. "Cultural distance" is an important consideration in defining such relationships. Even within a single organization, the differences in outlook between research and operational branches can impede coordinated efforts. One role for the CONOPS is to acknowledge such diversity in outlook/approach, and define how effective interactions may be achieved. Marine forecasting is a particularly critical topic with regard to the coordination of federal and regional efforts. Who is going to be making various forecasts, and how the forecast information, including time-sensitive warnings, is transmitted to the broader user community must be established.

A national level CONOPS for IOOS is required. It is essential that roles and responsibilities are defined at levels above the RCOOS. Given the many components of the IOOS enterprise, there must be an umbrella of CONOPS: from the national IOOS; to the NFRA; to the RA; to each associated RCOOS; and to the RCOOS components. It was felt that the CONOPS will need a time horizon of some 10 years to provide enough time to accommodate the transition from research/pilot stages to operational programs.

A well-defined set of nested CONOPS for the IOOS/RA enterprise will also be important for building and sustaining a broad base of support for the development effort. Given the level of investment required for IOOS and RA development, it will be necessary to show how the national and regional systems are complementary. As part of this process, the commercial sector must be acknowledged and accommodated through the ongoing development of the observing system. The overlapping interests between the federal agency missions and the regional efforts and agency and RA roles in addressing them must be clearly defined. It is also essential to show value for constituent pieces of the interim system as it is developing; that is, demonstrate that significant benefits can be derived from the effort even in the development process. Showing the value of improved information on coastal ocean processes could be a key role for the academic sector.

Based on the discussion of the CONOPS issue and, in particular, the question of the relationship of the RCOOS to the "national backbone", several recommendations were proposed:

- Interim roles and responsibilities for the regional and the "national backbone" components of the developing coastal ocean observing system should be further defined and documented. The existing federal asset base provides a reasonable starting point for defining the "national backbone" (with the assumption that this will be sustained). It is then one of the roles of the RAs to advocate for enhancements to the COOS network, based on regional needs.
- Alternative RCOOS designs should be documented in a white paper format suitable for presentation to federal agencies. This will help both the agencies and the RAs to evaluate what design options offer in terms of coordinating regional and federal efforts in coastal ocean observing and in terms of defining roles and responsibilities.
- The recommendations of the "Airlie House" workshop organized by Ocean.US in 2002 should be revisited (Ocean.US, 2002). The workshop participants represented a diverse cross-section of ocean interests, and through the workshop discussions, similar needs were identified in terms of core variables. The recommendations from that workshop could provide an

overarching framework for discussion of roles and responsibilities and help guide CONOPS development at the national and regional levels.

Summary

This brief summary does not reflect the full breadth of discussion at the final SEACOOS workshop. Rather, it is intended to focus on three topic areas pertinent to further development of the regional and national coastal ocean observing programs. A common theme that emerged in discussion of these topics is that effective interaction between national and regional programs is essential. While further workshops and workshop reports will be part of this process, it is the action taken to develop a functional structure for the national and regional components of the IOOS that will provide a real measure of progress.

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