I. Interoperable Data Discovery, Access, and Archive

Data Management and Communications Plan for Research and Operational Integrated Ocean Observing Systems

Part III. Appendices

Appendix 4. User Outreach

IOOS DMAC User Outreach Team

March 2005

The National Office for Integrated
and Sustained Ocean Observations
Ocean.US Publication No. 6

Contents

User Outreach Team Members

Philip Bogden, Chief Executive Officer, Gulf of Maine Ocean Observing System, Portland, ME

Carol Dorsey, Microbiologist, Alabama Department of Public Health, Mobile Division Laboratory, Mobile, AL

David L. Eslinger, Oceanographer, NOAA Coastal Services Center, National Ocean Service, Charleston, SC

Larry Honeybourne, Water Quality Program Chief, County of Orange Health Care Agency, Environmental Health Division, Santa Ana, CA

Mark Luther, Director, Ocean Modeling and Prediction Lab, University of South Florida, College of Marine Science, St. Petersburg, FL

Michael McCann, Monterey Bay Aquarium Research Institute, Monterey, CA

Roy Mendelssohn, Operations Research Analyst, NMFS/Pacific Fisheries Environmental Laboratory, Pacific Grove, CA

Phillip R. Mundy*, Science Director, Gulf of Alaska Ecosystem Monitoring and Research Program, Exxon Valdez Oil Spill Trustee Council, Anchorage, AK

Malcolm Spaulding, Professor of Ocean Engineering, University of Rhode Island, Narragansett, RI

Margaret Srinivasan, Altimeter Applications Lead, Ocean Science Element, NASA/Jet Propulsion Laboratory, Pasadena, CA

Joseph J. Tamul, Jr., Cooperative Program Director, Oceanography Department, Naval Oceanographic Office, Stennis Space Center, MS

Suzanne Van Cooten, National Data Buoy Center, NOAA, Stennis Space Center, MS

* Team Leader and Report Editor

Introduction

The User Outreach Team was formed in June 2002 to serve the U.S. Integrated Ocean Observing System (IOOS) Data Management and Communications Steering Committee (DMAC-SC). The DMAC-SC was formed in March 2002 at Airlie House, Warrenton, VA during a national meeting convened by Ocean.US, the national office for integrated and sustained ocean observations. The Steering Committee is working to implement the DMAC vision for the data and communications component of the IOOS. The Airlie House workshop defined an ambitious process for developing a detailed, phased implementation plan to make this vision a reality. The first step in this process was to establish a DMAC Steering Committee, whose responsibilities include oversight of the planning process, oversight of initial pilot projects, guiding the Expert and Outreach Teams, and writing the plan.

PURPOSE OF THE TEAM

The User Outreach Team serves as support to the four DMAC expert teams, to help them define and refine their products in terms of user-defined issues that ultimately will become data system requirements. The makeup of the outreach team, listed above, was balanced with respect to the subject areas defined by the seven Airlie objectives outlined below. The User Outreach Team members are "scientists whose disciplines are data intensive (i.e., modelers) or who interface with other users (some scientists, some not) who need products based on the IOOS "data stream," such as oil spill trajectories and maps of natural hazards."

The User Outreach Team fulfilled two primary immediate roles: (1) produced the Community Issues Lists and (2) in the process of compiling the lists, served as a communications clearinghouse for the other teams on identifying user groups, getting feedback from user groups, and identifying their issues and related requirements for the system. It is essential for the DMAC to be in touch with the definition of "community" and "issues" from the outset of its work. The entry-level definitions of community and issues are directly derived from the seven objectives for the IOOS identified in the Airlie Conference:

1. improve the safety and efficiency of marine operations (marine operations),
2. more effectively mitigate the effects of natural hazards (natural hazards),
3. improve predictions of climate change and its effects on coastal populations (climate change),
4. improve national security (national security),
5. reduce public health risks (public health),
6. more effectively protect and restore healthy coastal marine ecosystems (Coastal Marine Ecosystems), and
7. enable the sustained use of marine resources (sustained use).

The entry level issues with respect to the DMAC concern data management and information transfer aspects of the top 30 or so key variables (e.g., ocean temperature, ocean salinity) identified by the Airlie process. Other issues will be provided by User Outreach Team members, under the responsibilities outlined below.

DUTIES OF THE TEAM

The duties of the User Outreach Team are summarized as follows:

1. Community Issues Lists—Primary responsibility is to serve as a point of contact to solicit inputs to the DMAC Plan for the designated community, as captured in the Community Issues Lists. Together with white papers prepared by the other non-outreach teams, the Community Issues Lists will form the first draft of the user outreach section of the DMAC report. Issues are to be focused on the top 30 variables identified at the Airlie conference, as a starting point. Each team member is to edit, refine, and prioritize her/his list, as a reflection of the inputs received from the community.

2. Recommend to the DMAC-SC a list of requirements of users, represented by the seven communities of the seven objectives established at the Airlie conference.

3. Keep Team Leader informed of progress on a regular basis.

4. Make recommendations to the DMAC-SC on a structure that ensures ongoing communications between IOOS DMAC managers and user groups—identifying new user needs and providing feedback on any identified inadequacies within the evolving system.

What is the definition of users for the purposes of DMAC? IOOS is, by definition, user-driven (see Figure 1), and user groups were identified, to an extent, during the process of putting the Airlie meeting together, and by the choice of the seven goals, above. Based on these beginnings and the experience of operational programs like Rutgers' Long-term Ecosystem Observatory's (LEO) and Coastal Ocean Observation Laboratory public service web site known as the "COOLroom" (www.thecoolroom.org), there is a dynamic pool of end users, fishers, recreationalists, and private companies that support commercial marine transport and other marine industries that is beyond the reach of the DMAC Plan writing process. This pool is out of reach because it changes depending on circumstances, such as natural marine disasters, and changing threats to national and seasonal activities of users. It is also out of reach at the moment because of the limited time available to this phase of the DMAC process.

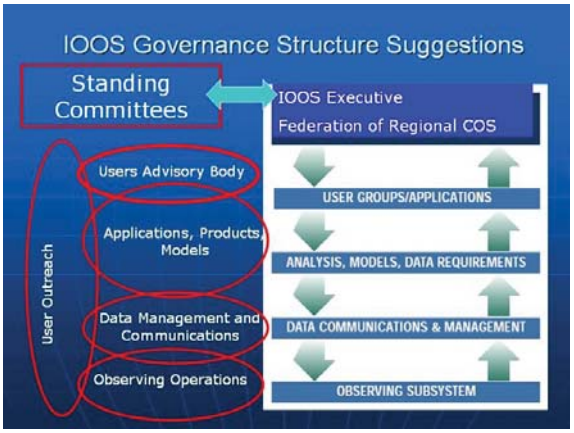

Figure 1. Recommended committees and advisory bodies (inside ovals) necessary for Ocean.US to implement the end-to-end, user-driven ocean observing system.

The users for the DMAC purposes are found at the Data Communications and Management and Analysis Models and Data Requirements levels (Figure 1). People at these levels are either (1) data management (IT) professionals trained primarily in computer science who are concerned with Data Communications and Data Center (and Product) Management, or (2) other scientists whose disciplines are data intensive (i.e., modelers) or who interface with other users (some scientists, some not) who need products based on the IOOS "data stream," such as oil spill trajectories and maps of natural hazards. One task of the Facilities Team is to work with outreach to the first category (IT professionals), whereas the User Outreach Team is primarily to be focused on the second category (seven scientific and technical communities).

METHODS

Members of the User Outreach team were selected for expertise in one of the seven communities defined by the IOOS goals, as identified in each of the seven Community Issues sections. The starting point for the definition of user needs was the 2002 Airlie House workshop, where approximately 100 national experts in the seven communities of IOOS met to define needs and priorities for the U.S. observing system. Within each community issue, members were encouraged to consult with as many other members of the community as possible, taking into account the short time frame available for this portion of the planning process. Different methods were used by different community groups, so no standardized approach was applied to develop the community issues lists. Overall, due to the extensive use of the Internet, it is estimated that 1,500 to 2,000 concerned individuals were contacted, informed of the IOOS needs, and given the opportunity to comment, across all seven communities. Nonetheless, the approach to development of user-based requirements for the data system is an iterative process, where broad sections of the concerned communities will have future opportunities to review and comment, and the lists will be broadened and deepened as a consequence of this ongoing review process.

Community Issues

MARINE OPERATIONS

Team Members: Mark Luther, Phil Bogden

Introduction

One goal of the Integrated Ocean Observing System is to improve the safety and efficiency of marine operations. The composition of this community of consumers includes users involved in near-shore port operations, as well as mariners operating in open-ocean conditions near the coast. Harbor pilots who are responsible for maneuvering large ships and tankers in dangerous waters have been especially strong supporters of widely available real-time observations. Their needs are mirrored by other users operating at sea, such as commercial fishermen, recreational boaters, commercial shippers, the U.S. Coast Guard, and others. These groups are interested in forecasts, but they are much more interested in immediate access to buoy data. They seem less trusting and consequently less interested in model forecasts. The Coast Guard is apparently a big user of the real-time data for planning their own sea-going activities, as demonstrated by web-site hits, but we do not believe they are using information about real-time ocean currents (either from models or from HF radar) for Search and Rescue.

Issues

Port Operations

Users: Harbor Pilots, Ship Masters, Port Authorities, Shipping Agents, Shipping Companies, Ship Yards, Tow boat operators, Dredging contractors, USCG Marine Safety Office

1. **Timing of slack water for safe maneuvering of ships in harbors**—Many vessel maneuvers cannot be made except near slack water (currents less than 0.1 m/s or 0.2 kts.). Having real-time current measurements available to users (primarily pilots and masters), rather than relying on tidal predictions, widens slack water window in which maneuvers can be made safely. In the United States the vanguard program for delivering real-time oceanographic data to mariners is the Physical Oceanographic Real-Time System (PORTS), which dates to 1991. PORTS is a public information acquisition and dissemination technology developed by the National Ocean Service (NOS) in cooperation with the Greater Tampa Bay Marine Advisory Council. In Tampa Bay, the pilots state that having real-time current information available from PORTS aboard ship widens the slack water window from 1-2 hours to 3-4 hours for approaches into Port Manatee and Old Port Tampa, both of which have channel entry paths that perpendicular to the main tidal flow.

2. **Real-time water-level and density data to estimate under keel clearance**—Large bulk carriers often are loaded to the minimum under-keel clearance. Availability of real-time water-level data allows for more efficient use of vessel draft. In areas of highly variable fresh water inflow and salinity, real-time data on temperature and salinity also are useful in computing vessel draft. Published estimates are that one foot of additional draft for a bulk carrier is worth $66,000 to $250,000 (depending on cargo) in additional revenue per transit. In Tampa Bay, during the five years prior to the installation of PORTS, there were 35 ship groundings. In the five years after PORTS became operational, there were 14 ship groundings. The Tampa Pilots Association states that the majority of this decrease in groundings was attributable to the availability of real-time water level, wind, and current data. A single grounding can cost hundreds of thousands of dollars in lost revenue, ship operation costs, tug boat fees, hull damage, and environmental damage. Costs can be much higher if the hull is breached and hazardous cargo is spilled.

3. **Meteorological and oceanic conditions (waves and currents) for collision avoidance**—Availability of real-time current, wind, and water-level data aid in collision avoidance by giving pilots and masters better estimates of vessel set and drift and better estimates of maneuvering room in passing or overtaking situations.

Greater availability of more accurate predictions and observations of current, water level, winds, temperature, and salinity will aid in all of the above.

Coastal Operations

Users: Mariners of all types

1. **Search and Rescue (SAR)**—USCG needs accurate trajectory simulations (hindcast and forecast), with some probability distribution, for persons in the water or vessels in distress. Present estimates of trajectory (based on available winds and tidal models) can be misleading in places like the Gulf of Maine where poorly estimated low-frequency currents can dominate tides and wind drift. Chances of survival in the waters of the Gulf of Maine are almost negligible after 2 hours in the water, so a fractional improvement in SAR effectiveness could save many lives per year. A conservative NOAA cost/benefit analysis put the potential savings at six lives/year and $24M/year for marginal improvement in the Gulf of Maine alone[1].

1See: Economics of a US Integrated Ocean Observing System, Prepared by Hauke Kite-Powell, Charles Colgan, Rodney Weiher. Airlie House, 2002. http://www.ocean.us/documents/docs/BAKDOC9_Economics.doc. See also: An Economic Case For An Integrated Ocean Observing System, NOAA Magazine, 2002. http://www.noaanews.noaa.gov/magazine/stories/mag71.htm

2. **Recreational Boating**—Huge user group in Florida and in the Gulf of Maine, as examples—Recreational boaters are interested in general availability of current information, water level, winds, temperature, and salinity for a variety of different reasons related to port operations. They use all of the data they can get their hands on. Competitive sailors use wind and current information to determine tactics during races. Fishermen use wind, current, water level, and wave information to determine the best fishing spots or even whether to go fishing. In terms of number of hits or calls to the Tampa Bay PORTS, this is the largest user group.

3. **Real-time open-ocean meteorological and oceanic buoy data coverage for safe operations**—Coastal waters in the Gulf of Maine require pilots to maneuver tankers and merchant ships over tracks of hundreds of kilometers of open-ocean conditions. Pilots need real-time buoy data because ocean and weather conditions vary rapidly on scales that remain unmeasured by the NDBC network of buoys and C-MAN stations. They use the data for trip planning and performing safe operations at sea. Existing NDBC buoys are too distantly separated, and C-MAN stations don't provide waves. These users have grown dependent on the enhanced spatial and temporal coverage provided by GoMOOS buoys.

4. **Commercial fishing and trip planning**—Anecdotal information from fishermen of various types in the Gulf of Maine (e.g., scallopers, ground fishermen, lobstermen) indicates that many mariners either don't believe or don't trust weather forecasts, and they use the last 12 hours of real-time data (whenever available) to determine their ability to go to sea. User testimony indicates that the enhanced coverage of GoMOOS buoys allows fishermen to determine the location of weather fronts and whether it makes economic sense to go to sea on any particular day.

5. **Real-time measurements of fog for trip planning for large and small vessels**—GoMOOS provides visibility measurements from its buoys. Mariners of various types have reported that the visibility measurements are accurate and helpful for planning a variety of sea-going activities. USCG representatives have indicated that fog data can influence SAR response (e.g., aircraft and sea-going vessel needs), but we're not aware that USCG in the Gulf of Maine is actually using the visibility data in this manner right now.

6. **Commercial and Recreational Fishing and Sea-Surface Temperature**—Tuna fishermen, for example, are knowledgeable about the relationships among ocean temperature, productivity, and fish location. They use AVHRR data and estimates of front location to plan trips, and desire access to more and higher-resolution data. Such data products underlie the business model for some private companies, and there has even been objection and legal action to prevent federally funded groups from providing this information for free.

7. **Hazardous Material Spills (HAZMAT)**—HAZMAT activities needs accurate trajectory and dispersal simulations/predictions for most efficient deployment of containment/clean up resources. Accurate map-based data on locations of sensitive/endangered natural resources are also needed.

8. **Forensics for law enforcement**—Forensic experts need accurate trajectory hindcasts to determine probable point of origin of bodies found in the water (the authors of this report section have been contacted by law enforcement officials two or three times in the past regarding cases like this).

9. **Trip planning and forensics for ship operations**—Ocean Routes, Inc. has based its business model on meeting identified needs for weather information and oceanographic conditions (e.g., waves) along planned (or past) ship tracks. The company's focus has been on open-ocean conditions, but applications of this kind of service in near-shore regions remains untapped. Pilots in the Gulf of Maine are using the real-time data for planning, but might also make use of data products and services provided by companies such as Ocean Routes.

10. **Data Availability at Sea**—Mariners emphatically want "dial-a-buoy." GoMOOS and NDBC have partnered so that data from both the Florida and Gulf of Maine buoy systems is now presented on NOAA's dial-a-buoy service where mariners can use cellular telephones to access current sea conditions.

NATURAL HAZARDS

Team Members: Malcolm Spaulding and Suzanne Van Cooten

Introduction

Information on the communities concerned with Goal 2 of IOOS, i.e., more effectively mitigating the effects of natural hazards, was gathered by means of an email message (Annex A) sent to two email server lists, coastal_list@udel.edu and mem@appsci.com. The first list has approximately 800 subscribers and reaches most of the coastal engineering community, while the second has 400 subscribers and is targeted to the marine environmental modeling community. Both lists are international in scope, but the majority of the subscribers are from the United States.

Respondents to the natural hazards solicitation were requested, at a minimum, to provide the following: (1) brief explanation of natural hazards that would benefit from an IOOS, (2) the principal community of interest and their characteristics, (3) principal data variables that are required, (4) issues of concern or attributes that are critical to the application (e.g., timely access to data, ease of access, accuracy). This section summarizes the responses received from this email survey on each natural hazard that would potentially benefit from IOOS. A record of individual responses is presented in Annex B. The vast majority of the responses received concern storm impacts on coastal resources. All other natural hazards, including tsunamis, received substantially less input, and so responses are summarized for two groups, storm impacts and tsunami hazards. Storm impacts are generated by the phenomena of storm surge, wind, and wave, which act on coastal areas and structures (buildings, infrastructure—roads, power lines, sewer and water distribution systems—beaches/shorelines, drainage systems, groins, breakwaters, piers, and bulkheads). Other natural hazards are functions of tsunami generation, propagation, and run-up.

The communities of interest for storm impacts include property owners, residents, or users of the impacted coastal area. In addition, those people with a financial or personal interest in structures and infrastructure subject to damage, such as roads, bridges, marinas, ports, and harbors, are clearly concerned about mitigation of coastal hazards. Included in this group are beach users, boat owners, and businesses dependent upon the impacted area.

Also concerned with storm impacts are governmental entities with responsibilities for insuring, maintaining, regulating, or protecting the groups outlined above. These include the federal (Federal Emergency Management Agency [FEMA], Army Corps of Engineers, U.S. Coast Guard, NOAA), state, and local (police, fire, sanitation, permitting, health, etc.) governments. Coastal states often have a variety of agencies with responsibilities paralleling their federal counterparts.

Communities concerned with mitigation of storm impacts need to receive timely information on variables of interest for storm impacts (all with time), such as water elevations (near shelf break and in selected coastal areas where impacts are expected to be significant), and directional deep (near shelf break) and shallow water wave heights and periods. Associated with the provision of wave height data is an additional need to provide the capability to validate wave models and account for local wind and wave transformation effects on the shelf and nearshore area. Storm impact variables of interest also include wind and atmospheric pressure measurements at selected offshore stations, mapping of pre- and post-storm impacts on shorelines and near shore areas (beaches, dunes, cliffs, coastal wetlands).

The principal communities of interest for tsunami hazards are similar to those for storm impacts, but more limited in geographic scope. Other natural hazards communities include property owners, residents, or users of the coastal areas prone to tsunami-generated waves. Those people with a financial or personal interest in structures and infrastructure subject to tsunami damage, such as roads, bridges, harbors/ports, and marinas, are clearly concerned about mitigation. Included in this group are beach users, boat owners, and businesses dependent on the facilities or beaches. In addition, governmental entities with responsibilities for insuring, maintaining, regulating, or protecting the property owners, residents, and users are concerned with tsunami impacts. These vary from the federal (FEMA, Army Corps of Engineers, U.S. Coast Guard, NOAA), state, and local (fire, police, sanitation, permitting, health, etc.) government.

Although variables of interest for storm impact mitigation are certainly relevant to mitigation of tsunami hazards, additional variables are required for tsunami hazard mitigation, such as water elevations (in network surrounding tsunami generation areas, in selected coastal areas where coastal impacts are expected to be significant), and horizontal water displacements measured from moored buoys with GPS. In addition, information on directional shallow water wave heights and periods are required, which need to provide the capability to validate wave run-up models. Run-up models are critical in areas where impacts are likely and important (e.g., harbors). Other required information needs for mitigating tsunami hazards can be derived from a network of hydrophones deployed in areas of potential tsunami generation to provide early warning of events and identification of the tsunami source. Finally, mapping of the impact of tsunamis on shorelines and near shore areas (river deltas, beaches, dunes, cliffs, coastal wetlands, marinas, harbors) is essential.

Issues

Storm Impacts Issues

- Measurements must be converted to useful products (easily understood data, maps, and graphs) and distributed by communications channels (the internet (web pages), radio, TV, warning systems) that reach those at risk (home and business owners) and response personnel promptly and often.
- System must provide accurate information, be highly reliable, and provide real-time access to observations and to forecasts (every hour for the next day).
- Data must be archived for use in future hindcast studies and research on fundamental coastal processes.
- Need to develop multiple self-contained wave and water level gauges in coastal states with more numerous pre-established mounts that would be deployed in the event of a storm to measure wave and water-level conditions that will likely impact coastal structures.
- Data standards and appropriate conversions need to be developed for key variables (water levels, waves) to ensure that the data are consistent and comparable. This is particularly critical for wave data where different sensing systems can provide substantially different results.

Tsunami Hazards Issues

- Measurements must be converted to useful products (easily understood data, maps, and graphs) distributed by communications channels (the Internet (web pages), radio, TV, warning systems) that reach those at risk (home and business owners) and response personnel promptly and often.
- System must provide accurate information, be highly reliable, and allow real-time access to observations and to forecasts every few minutes for the next 12 hours. Note that most tsunamis impact shorelines very quickly after they have been detected on the continental shelf.
- Critical to have accurate information on shelf and nearshore bathymetry to ensure accurate run-up forecasts.
- Critical to have as much information as possible about the source (i.e., landslide, volcano) and its location as tsunami wave conditions (wavelength, amplitude, and directionality) are strongly dependent on the source characteristics.
- Data must be archived for use in future hindcast studies and research on fundamental tsunami generation and propagation processes.

CLIMATE CHANGE

Team Members: Mike McCann (MBARI) and Margaret Srinivasan (JPL)

Introduction

Another stated goal of the Integrated Ocean Observing System is to improve predictions of climate change and its effects on coastal populations. The composition of this community of data users includes research scientists, modelers, climatologists, GIS data system users, and policy makers, particularly in coastal communities. This last group of users includes city governments, harbor districts, port authorities, county and state governments, planning commissions, and consultants. Global and long-term climate considerations are of particular interest to this user community. As an example, coastal development proposals in the Monterey Bay, California area must take into account expected sea level rise due to global warning estimates. Better data and improved access to data can improve these estimates.

For climate change research, the top priority is having high-accuracy data that are consistent for long-time-series data sets. Understanding the implications for long-term archiving of data as the technology advances is also a key element in successful data management and usage. Both data and metadata must be updated to reflect the current best solution to most effectively manage the delicate balance among new technology, existing hardware resources, and personnel resources, not only for current research but for archiving and storage as well. Solutions should endeavor to be as system-independent as possible, while realizing that other constraints may exist. Evaluating the status of data holdings should be a continuous process .

The issue of metadata is also an important element, primarily to data managers, but also to data users. The science that comes from the data is the ultimate resource for the research effort, but the ease in data management affects every phase of climate change research from acquisition to scientific results.

Issues

1. **Data Accuracy**: Future mission requirements should incorporate improved data accuracy. Sometimes there is a trade-off between data accuracy vs. data latency. Sufficient resources need to include research and re-processing efforts that would improve the quality and accuracy of data measurements.

2. **Consistency**: Data products need to be as consistent as possible for follow-on missions. As data accuracy improves, so do the geophysical algorithms. Therefore, resources need to be available for "data engineering" and re-processing efforts to provide data that will have identical geophysical models across missions. An excellent example of this is the SSM/I Pathfinder data available from Remote Sensing Systems. One of the problems with this particular data set is that the processing algorithm is not in the public domain, but is a closely held model "secret."

3. **Quality control**: Assessing the quality of a data set is difficult. It is often not known what sort of quality control a data set has been subjected to. Some methods of quality control often require knowledgeable personnel and significant amounts of human intervention.

4. **Modeling**: the application of models in (near) real time, like in AOSN II, will provide an interesting forcing function on improving some of these capabilities, since automation and access are so critical to correcting models in (near) real time. Problems with linking models and data are ones of time and space scales. Models are generally coarse while data can have very fine granularity.

5. **Data archiving**: Long-term data archiving, for future missions as well as heritage missions, should be a high priority. Both data products and expertise should be maintained, so that as algorithms improve the data can be re-processed 10 to 20 years later. Archive the original source observations (level 1b data) to enable data users to return to this level to fix problems.

6. **Format**: Sharing and blending of data sets from all the entities that collect and archive oceanographic data is difficult because these entities use different data formats and standards. In addition, improved subsetting engines will allow users to quickly access the data in different formats and regions. Without this capability, full use of the data sets will be impeded.

7. **Error Statistics**: In order to fully use the many Earth science data sets, attention must be paid to the necessity of providing error statistics and/or quality of information with the data sets. This involves careful thought to the quality information provided with each data set. Such strategies will need to be developed in conjunction with any metadata models. This is a major point in the SST effort of merging data sets from different satellites.

8. **Data management**: For data collection systems, there are no standardized systems or processes for up-front collection and management of important sensor, instrument, and platform metadata. Better automatic observatory data management requires this kind of metadata data management.

9. **Data cataloging**: Knowing what data sets exist, in what format (raw data, near-real-time data), and their appropriateness for a specific use is difficult because most oceanographic data sets are not cataloged. Being aware of data resources such as those in the Global Change Master Directory (http://gcmd.nasa.gov).

10. **Metadata**: The use of metadata, or rather the lack of it, impacts operational use, processing, analysis, archiving, QC, visualization, access/integration/reuse, and subsetting of data, and the automation of all the above. Better metadata definitions will improve all of these functions, in many cases by orders of magnitude.

11. **Data Discovery**: Not all climate data sets are registered with the Global Change Master Directory (GCMD). Data providers do not always realize the benefits of taking a few moments to do this. More generally, they don't always see beyond the needs of their immediate user community.

12. **GIS Access**: Typical GIS are not well suited to climate studies. They do not handle time or elevation properly and don't generally give direct access to the numerical values. The major GIS vendors need to be made aware of these needs.

NATIONAL SECURITY

Team Member: Jack Tamul

Introduction

Another goal of the Integrated Ocean Observing System is to provide information to support improved national security. National security may be broadly defined to encompass not only the protection of U.S. persons and interests, but also the promotion of the economic and social interests of the U.S. government and its citizens. Using this broader definition, many of the other themes of the IOOS have aspects that can be considered as contributing to national security. However, the broader national security will not be explicitly handled here. Instead, the scope of the National Security theme will be limited to the military's missions of war-fighting, peacekeeping, and humanitarian assistance. It includes maritime national security interests around the world, in every ocean, as well as maritime homeland security.

The oceans profoundly affect those whose job it is to ensure national security in the maritime environment (e.g., the Navy, Marine Corps, and Coast Guard). Knowledge of the ocean makes for better decision making and employment of people, platforms, and systems, increasing their effectiveness, and decreasing risks to those resources. This knowledge is used both operationally in the planning and execution of military missions, and by researchers supporting the development of new national security capabilities. "Operational" refers to those data and products for which availability is assured for time frames needed to support practical decision-making.

It is anticipated that a number of the elements of the IOOS will be useful in addressing a variety of national security issues. For example, a network of coastal radars would not only support the prediction of waterborne contaminant movement, but could also be used for port security and tracking ship traffic. Additionally, a robust U.S. coastal component of IOOS will enable the U.S. Navy to use the U.S. littorals as "surrogates" for denied areas in order to assess its coastal prediction and forecasting capabilities through data deprivation and forecasting experiments and exercises.

The variables and products required from IOOS to further national security interests are grouped below by issue.

Issues

National Security Issue 1

Improve the effectiveness of maritime homeland security and war-fighting effectiveness abroad, especially in the areas of mine warfare, port security, amphibious warfare, special operations, and antisubmarine warfare.

- Product NS-1.1: Estimates/predictions of near-surface currents on hourly to seasonal (i.e., climatological) time scales.
- Product NS-1.2: Estimates/predictions of near-bottom currents on hourly to seasonal time scales.
- Product NS-1.3: Estimates/predictions of tidal-period sea level/water level and velocity fluctuations.
- Product NS-1.4: Estimates/predictions of near water clarity on hourly to seasonal time scales.
- Product NS-1.5: Estimates/predictions of sediment transport on hourly to seasonal time scales.
- Product NS-1.6: Estimates/predictions of acoustic performance, especially on the continental shelf on daily to seasonal time scales.
- Variables required for National Security Issue 1 include:
  - 3-D Vector Currents
  - 3-D Water Temperature
  - 3-D Salinity
  - 3-D Suspended Sediment (for density)
  - Flux estimates of momentum, heat, moisture/freshwater, and radiation. Usually these are provided by NWP models. There is a need for verification by observations, such as:
    - Wind Vectors
    - Water temperature
    - Air temperature
    - Humidity
    - Long-wave radiation
    - Solar radiation
    - Precipitation amount
    - River discharge
  - Wind Vectors
  - Water Temperature
  - Air Temperature
  - Humidity
  - Long-Wave Radiation

- Solar Radiation
- Precipitation Amount
- River Discharge
- Bathymetry
- Sea Level/Ocean-Sea Surface Height
- Bottom Characteristics (type, vegetation, sediment composition and thickness, acoustic stratigraphy)
- Ambient Noise
- Nutrients
- Bioluminescence
- Optical Properties
- Ocean Color
- Surface Roughness

National Security Issue 2

Improve safety and efficiency of operations at sea.

- Product NS-2.1: Improved wave forecasts at the 3–7 day range, especially for storms and tropical cyclones.
- Product NS-2.2: High-resolution (to include variability at scales of meters) shallow-water wave and surf forecasts, especially in denied areas.
- Product NS-2.3: Real-time near-surface velocity estimates and forecasts for search and rescue.
- Product NS-2.4: Improved navigational products.
- Variables required for National Security Issue 2 include:
  - Directional Wave Spectra
  - Bathymetry
  - Wind Vectors
  - 3-D Vector Currents
  - Ice Concentration
  - Ice Thickness
  - Atmospheric Visibility

National Security Issue 3

Establish the capability to detect airborne and waterborne contaminants in ports, harbors, and littoral regions at home and abroad, and to predict the dispersion of those contaminants for planning, mitigation, and remediation.

- Product NS-3.1: Background levels of nuclear, biological, and chemical (NBC) contaminants.
- Product NS-3.2: Analyses and predictions of NBC concentrations on scales from the sub-hourly to weekly.
- Variables required for National Security Issue 3 include:
  - 3-D Vector Currents
  - Wind Vectors
  - Water Contaminant Observations (both initial conditions and real-time updates)
  - Bottom Characteristics (sediments composition)

National Security Issue 4:

Support environmental stewardship

- Product NS-4.1: Physiological descriptions of sensitivity to and utilization of acoustic signals by classes of marine mammals
- Product NS-4.2: Real-time and climatological marine mammal/protected species distributions.
- Product NS-4.3: Real-time velocity fields in locations of hazardous material spills or potential spills.
- Variables required for National Security Issue 4 include:
  - Marine Mammal Abundance
  - All variables listed for Issues 1 and 3.

National Security Issue 5:

Improve at-sea system performance through more accurate characterizations and prediction of the marine boundary layer.

- Product NS-5.1: Improved prediction of electromagnetic/electro-optic propagation through the marine boundary layer in support of strike warfare, antiaircraft warfare, and antisubmarine warfare.
- Product NS-5.2: Improved prediction of near-surface visibility
- Variables required for National Security Issue 5 include:
  - Water Temperature (especially sea surface temperature)
  - Humidity
  - Marine Boundary Layer Height
  - Directional Wave Spectra (especially, wave height)
  - Aerosols
  - Atmospheric Visibility

PUBLIC HEALTH

Team Members: Carol Dorsey and Larry Honeybourne

Introduction

Public health stakeholder issues of concern for the coastal component of IOOS include exposure to pathogens during body-contact recreation, chemical, and microbial contamination of seafood and anomalous weather, marine organisms, and/or surf events. Stakeholders and product consumers' use of data related to public health issues may include, for example, regulators, commercial shellfish harvesters, researchers evaluating raw water quality data to assess harmful algal blooms, or a Midwestern tourist checking the quality of coastal marine waters for swimming or fishing activities. Though the stakeholders and consumers are varied and have differing degrees of technical expertise, they are united in a need to access relevant data for decision making. The diversity of the public health group is reflected in the responses of individuals to requests for information for this report (Annex D).

Some public health data collection activities are rooted in regulatory decision making such as swimming advisories for recreational waters. According to EPA's *National Beach Guidance and Required Performance Criteria for Grants*, June 2002, "'Good' quality data are those that enable the user to make the decision at hand with an acceptable risk of error within the required time frame." Regulatory actions in the interest of public health require reliable, accurate data based on good science and delivered in a timely manner. The process of continual quality assurance helps ensure that the data meet specified standards and is legally defensible.

For example, regional bacterial water-quality observing systems for body-contact recreation purposes have been extensively implemented along the Southern California coast for many years. Coastal water surf-zone monitoring is conducted by local health departments and publicly owned wastewater treatment works (POTWs) to meet statutory and NPDES requirements, respectively. Data are compiled from both sources by local health departments to determine compliance with the State of California, public-health-based, body-contact recreation standards. The development of software for data transfer, assimilation, analysis, and compliance determination has recently been successfully completed by the Southern California Coastal Water Research Project in conjunction with several Southern California county health departments and POTWs. This regional observing system includes data acquisition, management and analysis. Regional products include Internet-accessible public health beach reports and metadata. This cooperative, operational pilot project could be utilized as a model for the data management portion of the recently enacted federal BEACHES bill as part of IOOS.

Another example of data sets for regulatory purposes is the water quality for shellfish-growing waters, which exist as required components of the National Shellfish Sanitation Program. These data may be in paper files, digital data sets in assorted forms, and with varying availability and accessibility. Though the program does not stipulate how long data are retained, many states archive decades of microbiological, chemical, and physical data related to the classification of shellfish growing waters. NOAA and NOS are developing a demonstration project of these data in the Shellfish Information Management System (SIMS). Coastal state agencies, FDA, and EPA also participated in workshops to prepare a single source of shellfish growing water information with GIS functionality. The regional project is considered platform independent and may be tailored to the state's need for data manipulation. The data are generated by FDA-evaluated laboratories, which are held to a high degree of accountability. However, the present restrictions on access prevent use of the site except by permission from the users. The data are considered proprietary and are not available to consumers outside of the project. Such issues of accessibility, security, and availability must be addressed in an integrated ocean observing system.

Current buoy and satellite-based technologies have limited value in most public health applications. Satellite imagery is used successfully to identify and monitor HAB in offshore, Gulf of Mexico waters, but the resolution and specificity render its use inappropriate in the coastal-zone areas. Bacteriological water quality, harmful algal cell densities, mercury in finfish, and shellfish toxin concentrations continue to be lab-based analyses. Promising new technologies could eventually be employed in buoy modules, but there must be an IOOS commitment to pursue the development and quality of these products.

Numerous stakeholder and consumer groups have an interest in assessing the need for immediate and long-term databases. These data sets include a variety of subjects (biological, chemical, oceanographic, epidemiological, atmospheric, model output, demographic data) and varying degrees of technicality. The proposed national backbone could assist in correcting problems with existing data communications and management by standardizing the way data are edited across applications, languages, and platforms. Planning protocols now will assure that new data sets can be appropriately formatted and assimilated into the national platforms. Regionally developed observing systems and databases will provide the functional, standardized products for the federally funded backbone. This network will provide critical information to users of ocean and coastal information and service.

Some data users for the public health issues of interest:

- EPA
- FDA
- CDC
- State and local health departments
- POTWs
- Commercial shell fishers
- Educators
- Recreational water users
- Marine safety organizations
- Coastal counties and cities
- Researchers
- Regulators
- Health professionals
- Environmental groups and non-governmental organizations
- Hospitality/Tourism Industry

Issues

The author of this report section polled several public health professionals concerning their data management issues with respect to a national ocean observing system. Individuals' responses to requests for feedback are documented in Annex D. The individual responses are summarized by the following points, which serve as an introduction to the issues:

- Multi-source integration,
- Geographic layering,
- At least two layers of technical depth-general consumer and technical user,
- Security,
- Standardized protocols and platforms,
- Increased fishery data of the appropriate type (fisher-dependent, such as onboard boats and interviews),
- Communication in place prior to information dissemination so that there is adequate alert for situations with a minimal false alarm element,
- Physical and chemical telemetered data could be used in modeling efforts with public health applications.

The major data management issues with supporting detail from the public health perspective are as follows;

- Assess current and future public health needs and goals so that data sets and the integration of data will best serve the system.
  - Many states use a multiple-agency approach to managing the coastal zone. In such an approach, there may be overlap or gaps in coverage. Sanitary surveys, bacterial source tracking and water chemistry may be measurements taken by one or several agencies on the same areas. This makes data integration important. Issues of data availability, accessibility, distribution, and integration should be addressed to improve use.

- Identify on a nation-wide basis, existing databases related to public health issues.
  - Extensive monitoring of coastal waters has been recorded for the purpose of classifying shellfish growing waters, recreational quality, and illness related to the consumption of shellfish and finfish. These data sets often cover decades of data, generated using standardized methods of analysis.
  - Bacterial water-quality monitoring databases for recreational waters are available from Local or State Health Departments, POTW's, and Water Quality Regulatory Agencies. Data set access, quality, and formats are highly variable.

- Develop QA/QC standards to evaluate existing and yet-to-be-developed data products.
  - Data products must be assessed for accuracy, precision, reproducibility, etc. by technical experts and data managers. Written standards for procedures such as those employed in the National Shellfish Sanitation Program and EPA certified laboratories, which are used to generate the data, are critical to the quality and reliability of the measurements. For data products, programs such as the National Coastal Data Development Center offer guidance as they develop and maintain a catalog of available coastal data, ensuring the quality of these data and associated metadata, populating and maintaining databases. Quality assurance is integral throughout the process of data production. Public health regulatory action must be supported by "good," legally defensible science delivered in a timely manner.

- Evaluate the data sets for availability and accessibility to consumers.
  - Surveys of coastal and ocean areas generate data used in the determination of water quality in recreational areas and seafood harvest. These data sets vary in their levels of accessibility.
  - Levels of accessibility
    - General consumer
    - Pre-arranged approval
    - Proprietary, with time limitations
    - Proprietary, not available outside of project or network

- Ensure relevancy of observations to public health users by identifying the update intervals of the data sets and adequacy of the frequency of measurement.
    - Timely measurements and posting of data are important to use of and incorporation into a public health response to a situation. An example of this might be the issuance of swimming advisories when water samples exceed standards or response to seafood- related illness outbreak. Nearshore sensing stations producing real-time data streams of swells, tides, and wave heights could be useful in the public health and safety issues for swimmers, surfers, and fishermen. Other data sets may yield sufficient coverage monthly, seasonally, or annually.

- Evaluate data sets for level of processing (raw data points vs. analyzed with interpretation). Regulatory compliance requirements at the federal, state, and local levels and the subsequent usable product will require processing and interpretation; however, raw data could be available to specified user groups, i.e., researchers.
    - Data sets range from local paper files to national digitized databases. Within these instruments users may find raw data, for example, telemetry from buoys such as tide levels that may be seen at http://www.co-op.noaa.gov/. Some databases contain numeric data points with some interpretation as is published on BEACH water monitoring in Alabama http://www.adem.state.al.us/FieldOps/Monitoring/monitoring or data which have been interpreted according to state standards as seen on the Florida Marine Research Institute's Red Tide Status or satellite images, http://floridamarine.org/features/category_main.asp?id=1884. The degree of processing influences the extent to which the data may be used and by whom. For example, research may find numeric data points (CFU) more useful than a Red, Yellow, Green warning system, but for swimmers the color code will suffice.

- Determine in what formats data are stored and how should new data elements or objects be designed and delivered.
    - Paper,
    - Digital with substantial manipulation of format to meet platform specifications,
    - Digital with easy conversion and assimilation into specified platform.

- Evaluate and/or develop new technologies for the detection of human pathogens, indicators of pollution, or hazardous conditions using remote sensing or permanent monitoring stations for the timely communication of information used in public health decisions. The development of new technologies should be integrated into the enhanced platforms envisioned for the IOOS system (moored buoys, satellite sensors, remote sensing, etc.)

COASTAL MARINE ECOSYSTEMS

Team Member: Dave Eslinger

Introduction

The Integrated Ocean Observing System is intended to enable efforts to more effectively protect and restore healthy coastal marine ecosystems. The community of data users for these ecosystems includes those who derive economic benefit from healthy ecosystems (e.g., the commercial fishing, sports-fishing, and eco-tourism industries), those who derive recreational benefit from these ecosystems (e.g., beach-goers, sports-fishers, divers, boaters, surfers), those who derive aesthetic benefit from a healthy coast (e.g., coastal residents, tourists), and those whose job it is to understand, manage, and protect these environments (e.g., state and local departments of environmental protection, fish and game, and health; academics). These coastal ecosystem stakeholders share a number of concerns about the data they need. These can be summarized as needing: (1) operational and (2) archival data, (3) collected at appropriate times, with (4) high spatial and (5) temporal resolution, and delivered in a (6) user-friendly format.

Issues

1. **Operational**: Operational data are consistent, timely data that are available on a regular schedule.
   a. Consistency: Although collection instruments wear out, get upgraded, and change through time, data streams delivered to the end user need to remain constant in terms of accuracy and format. This will require a data-delivery system capable of delivering data that may require reformatting, conversion of units, and other operations, in a manner that is transparent to the end user.
   b. Timeliness: Coastal ecosystems are physically and biologically dynamic. IOOS data must be delivered to users quickly enough to be of use in understanding ongoing processes. In many cases, this means within 1 hour to 1 day, at a maximum. For many management applications (e.g., harmful algal blooms, pollution events), fast information may be more valuable than absolutely accurate information. Therefore, the data system should be capable of rapid delivery and of reprocessing data to a high level of accuracy and quality.
   c. Regular delivery: Data that cannot be consistently counted upon may be interesting, but not useful. The maximum utility in the IOOS observations will come when the data streams can relied upon to be there—same time, every time.

2. **Archival data**: Archival data are older data sets that are available for comparison with current measurements.
   a. Older data sets: For the data management system, this issue implies data mining, data rescue, and keeping an ongoing archive as operational data become archival data.
   b. Comparison: This could require data mangers to find and understand older metadata, translate older data sets into appropriate units, and reformat older data for consistency.

3. **Collected at appropriate times**: Data are most useful when they can be easily integrated with other data sets for analysis. In the coastal ecosystem, that means that data from different sensors must be collected at almost the same time. The data management system must be capable of keeping the data streams organized and of delivering the needed section of multiple data sets.

4. **High spatial resolution**: Coastal processes occur over relatively small spatial scales. IOOS data must be collected at high spatial resolution to observe and monitor these processes. This high resolution could come from large numbers of *in situ* sensors or from high-resolution, remote-sensing systems. For the data management and delivery system, storing and delivering these data sets to users will require massive storage capacity, excellent cataloging/relational data base capability, and a high-volume delivery system:
   a. Massive storage capacity: It takes 900 times the data volume of currently available IKONOS imagery (approximately 1 m resolution) to cover the same area as one pixel of "old" Landsat (30 m resolution) imagery.
   b. Excellent catalog/relational data base capability: Multiple data sets must be able to be searched, sub-set, and selected areas extracted to be useful.
   c. High-volume delivery system: Users need these large amounts of data delivered in a useful period of time. This will require efficient compression technologies and fast, reliable delivery mechanisms.

5. **High temporal resolution**: Coastal ecosystems have processes that users need to monitor occurring over time scales of storms and tides to El Niño and on to sea level rise. To address this variety of issues will require high temporal resolution data collected over long periods of time. This will add to the requirements for massive storage capacity, excellent cataloging/relational data base capability, and high-volume delivery systems.

6. **User-friendly format**: IOOS data will be of no use if they cannot be found, related and used.
   a. Found: Users must be able to easily locate the data they need. This will require a data management system with an understandable interface for conducting searches of the data by type, location, time, and other parameters. The system must work with a variety of different computer types.
   b. Related: Users must be able to conduct queries to get different types of data that they may wish to relate. For example "all wind and wave observations within 50 miles from lighthouse X and 3 months prior to…"
   c. Used: Data must be delivered in a format that end users can readily use. It should be understood and imported into a variety of readily available software packages.

SUSTAINABLE USE OF MARINE RESOURCES

Team Member: Roy Mendelssohn

Introduction

The Integrated Ocean Observing System is intended to enable the sustained use of marine resources. This sustained use of marine resources is a cross-cutting issue, as it depends on healthy coastal ecosystems, natural hazards and marine operations, and for proper long-term management on the effects of climate change. The composition of this community of consumers includes, on the research and management side, a variety of interests that are dominated by federal, state, and tribal government scientists and policy makers working in the management of fisheries. The fishing industry itself, from fishermen through processors, includes both potential users of the data from the system, as well as groups that may be affected by the data needs of the system. Harbormasters, recreationalists, and educators also have interests in the sustained use of marine resources and are potential consumers. Other highly visible potential IOOS user communities are composed of the scientists and agents of user groups representing commercial, recreational, subsistence, and non-consumptive interests.

Issues

1. **Data Formats**. At present, OpeNDAP on the server side supports relatively few formats and supports relatively few programs on the client side. The OBIS format is mainly used in museums and universities. For this to become the standard “middle-layer” of the communication system, much more work would have to be done to be consistent with formats and programs used in both state and federal government agencies concerned with sustained use. Many groups are now applying GIS-based systems, so easy ingestion of IOOS data into such systems would appear to be a necessity.

2. **Data Entry Timing, and Quality Control**. The currently applied model for data collection appears to be based largely on systems of sensors, etc., where the data are readily available in some electronic form immediately after collection. Much fisheries data are collected on paper forms, and there is often long lag times before the data are entered into an electronic format and subjected to data quality assessment procedures. The design of the IOOS system will to take into account some amount of time delay before certain types of data would become available. Quality control in general is more difficult with biological data—for example, sea surface temperature data exhibit a certain consistency in time, seasons, and space that allows possible outliers to be flagged. Such “neighbor consistency” does not often for biological data, which make the prescription of quality-control indicators for biological data more difficult to define.

3. **Data Confidentiality**. Unlike measurements of sea surface temperature and winds, much biological data are provided by individual businesses, so there may exist a legal obligation to maintain confidentiality of the raw data. If the raw data are to be put into the IOOS system, how will confidentiality of the data be protected? Is there necessary information available to create adequate algorithms to safeguard the confidentiality of these data? If only some form of aggregate data are to be put into the IOOS system, what are the guidelines for maintaining privacy and confidentiality while still providing useful data to the system?

4. **Data Archiving**. Where, how, and in what format (e.g., aggregated, raw) biological data should be archived has not been fully addressed so far in the IOOS DMAC planning document. Given the confidential nature of much of the raw biological data, this remains a non-trivial issue.

5. **Right to publish**. Data collected by government scientists, even when obtained in a format that allows for immediate availability (e.g., pop up tags, satellite), generally are not available for sharing until technical papers have been published in the open literature. What mechanisms does the IOOS system plan to provide to protect a researcher's right to "first publication"?

Variations on these five issues may be found in the literature. For example, see Boehlert and Schumacher (1997).

Team Conclusions

REQUIREMENTS

The lists of community issues are the ultimate source of the user's requirements for the data system being designed by DMAC. As IOOS evolves, the development of institutional infrastructure, such as committees and regional representatives, should make it possible to capture and use more detailed information on user requirements in the design and implementation of the data system. For the interim, the following are highlights of data management and communications issues that appear to be common to all types of consumers of oceanographic data, as entry-level system requirements. Note that end users make a sharp distinction between data (as raw observations) and information (as data organized in ways that make it easy to use). These requirements are more extensively defined and discussed in the references of the bibliography.

1. Data integrity must be assured. The origin, chain of custody, accuracy, precision, and other vital characteristics of the data must be known and verifiable.

2. End users want useful information products. For the majority of users of IOOS data, raw data need to be converted to descriptive statistics, other types of mathematical summaries, such as models, and visualizations, such as graphs and maps (GIS).

3. Data need to be available in a timely fashion. The length of time between observation and dissemination needs to be minimized, recognizing that certain types of data, such as biological, will require different lengths of time to complete the three-step cycle of observation, QA/QC, and dissemination. Timeliness is especially critical to users in government agencies with regulatory responsibilities.

4. Easy access to data through commonly available hardware and software should be provided. Users expect to be able to get the information and data needed.

5. Open access is provided to all data collected with public funds. Access to data collected with government funds needs to be open to all, save for considerations of national security, scientific professional courtesy, QA/QC being performed.

6. Data need to be preserved indefinitely. Although some information products are ephemeral, i.e., the flight conditions now prevailing, or the wave heights at the surfing beach today, the data that goes into those products should be stored for future retrieval.

7. Continuity of time-series observations needs to be preserved. The establishment and maintenance of long time series is of vital interest to a variety of different types of users, but especially to physical and biological modelers working on systems with "long memories."

8. The size of the 4-D cube of interest is defined by user groups. There are user-specific requirements for data to be packaged into 4-D cubes, where 4-D cubes are observations grouped by time, and by space in three dimensions. Cooperation among users, data managers, and those managing the observing system is essential if IOOS is to meet the needs of the maximum possible number of users with the available sampling budget.

RECOMMENDATIONS

User Outreach needs to fulfill roles within IOOS that transcend the needs of the Data Management and Communications Subsystem. IOOS will need to establish an infrastructure of standing committees in order to function. As illustrated by Figure 1, the functions of the standing committees correspond to the subsystems associated with the end-to-end user driven system, as originally envisioned (Nowlin and Malone, 1999). In the future, it is recommended that DMAC maintain a strong and active connection to users, through formally structured interactions with users, i.e., via a User Outreach Committee that seeks out and understands the needs of current and potential users. The User Outreach Committee would work with a Users Advisory Body, and Applications, Products and Models Committee, a Data Management and Communications Committee, and an Observing Operations Committee. In this way the needs of users could be represented in all of the key subsystems of the end-to-end user-driven observing system.

User Outreach should function at the level of an IOOS Standing Committee (SC) and it should provide liaison to the following standing committees;

- Users Advisory Body
- Applications/Products
- DMAC
- Observing Operations

User needs should be a common currency that is used to some extent in all of the operations of IOOS.

Bibliography

Boehlert, G. W., and J. D. Schumacher. 1997. Changing Oceans and Changing Fisheries: Environmental Data for Fisheries Research and Management. Proceedings of a workshop held 16–18 July, 1996, Pacific Grove, California. NOAA-TM-NMFS-SWFSC-239.

Nowlin, W., and T. Malone. 1999. Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System. National Ocean Research Leadership Council, Washington, D.C.

Opishinski, T., and M. L. Spaulding. 2002. Application of an integrated monitoring and modeling system to Narragansett Bay and adjacent waters incorporating Internet based technology, Proceedings of 7th International Conference on Estuarine and Coastal Modeling (ECM 7), November 5–7, 2001, St Petersburg, Florida.

Oceans US. 2002a. An integrated and sustained ocean observing system (IOOS) for the US: Design and Implementation, prepared by Oceans US, Arlington, VA., 21 pp.

Ocean US. 2002b. A multi-year phased implementation plan for an integrated ocean observing system for the US, prepared by Oceans US, Arlington, VA. (Draft)

Ward, M., and M. L. Spaulding. 2001. A nowcast/forecast system of circulation dynamics for Narragansett Bay, Proceedings of 7th International Conference on Estuarine and Coastal Modeling (ECM 7), November 5–7, 2001, St Petersburg, Florida.

Annex A: Solicitation to Natural Hazards Communities

Dear Colleagues,

Ocean.US, the national office for integrated and sustained ocean observation system (ISOOS), convened a workshop in March 2002, which resulted in a report entitled: "An integrated and sustained ocean observing system for the US, Design and Implementation" (May 2002). This report is available at the Oceans.US web site for those interested. The goals of ISOOS are to:

1. improve the safety and efficiency of marine operations (marine ops),
2. more effectively mitigate the effects of natural hazards (natural hazards),
3. improve predictions of climate change and its effects on coastal populations (climate change),
4. improve national security (national security),
5. reduce public health risks (public health),
6. more effectively protect and restore healthy coastal marine ecosystems (CM Ecosystems), and
7. enable the sustained use of marine resources (sustained use).

During this workshop a Data and Communications (DAC) Working Group (DACWG) was formed to develop a plan for the data and communications component of the ISOOS. The DACWG was divided into Expert and Outreach Teams. The User Outreach Team is to play two roles, (1) produce the community issues lists, and (2) serve as a communications clearinghouse for the other teams on identifying user groups, getting feedback from user groups and identifying their issues and related requirements for the system. I have been selected to serve on the User Outreach Team and assigned the responsibility to develop an outline of user community-specific issues that a national data and communications subsystem of the ISOOS would have to address in its development and operations. I have been specifically assigned primary responsibility in the natural hazards (storm surge and coastal flooding, coastal waves, tsunami, coastal erosion) area, with secondary responsibility in marine operations.

In the interest of obtaining input from the coastal engineering and the marine environmental modeling community I solicit your thoughts on user specific community issues. As a minimum I need the following: (1) brief explanation of natural hazards that would benefit from a ISOOS , (2) the principal community of interest and their characteristics, (3) principal variables that are required, (4) issues of concern or attributes that are critical to the application (i.e. timely access to data, ease of access, accuracy, etc.).

I must provide a summary of my input to the team not later than August 25, 2002 and hence would appreciate any input you might have. You can contact me at 401-874-6666 if you would like to discuss your input in more detail.

Malcolm Spaulding, Professor of Ocean Engineering, University of RI

Annex B: Natural Hazards Correspondence

X-Sender: mooers@mail.rsmas.miami.edu
X-Mailer: QUALCOMM Windows Eudora Version 5.1
Date: Mon, 19 Aug 2002 13:07:09 -0400
To: "Malcolm L. Spaulding" <spaulding@oce.uri.edu>
From: "Christopher N.K. Mooers" <cmooers@rsmas.miami.edu>
Subject: Re: User Input on ISOOS

Malcolm - I am glad to know you are working on this challenging task. Perhaps I could best help by responding quickly to a strawman since I will be in town for the next few weeks. - Chris

At 11:05 AM 8/19/02 -0400, you wrote:

****

Date: Thu, 22 Aug 2002 10:12:09 -0400
From: Spencer Rogers <rogerssp@uncwil.edu>
Subject: Re: Coastal_List: User Input on ISOOS
X-Sender: rogerssp@pop.uncwil.edu
To: "Malcolm L. Spaulding" <spaulding@oce.uri.edu>
Cc: houston@soest.hawaii.edu
X-Mailer: QUALCOMM Windows Eudora Version 5.1

Mr. Spaulding,

In response to your coastal-list email, US programs measuring waves and coastal engineers in general are unaware that the most common design use of wave predictions in the US is for building design not beaches or other marine structures. The FEMA-prepared flood maps publish minimum floor elevation requirements for most coastal communities. They assume depth limited waves on a numerically modeled storm surge that is calibrated using historical storm surge data. Though crude, the depth limited wave is probably not unreasonable. "Hurricane Storm Surge and Wave Conditions: Research Needs" by Sam Houston, then with the NOAA Hurricane Research Division and I, was published in the conference proceedings for Ocean Wave Measurement and Analysis (1997, ASCE, v. 2, p. 1414). We compared traditionally collected post-storm still water elevations with nearby evidence of the lower limit of wave induced damage or gaged storm surge elevations and concluded that there are major inaccuracies in the reported storm surge elevations. Localized setup and wave runup appear to routinely cause unimpeachable still water level elevations to exceed even the wave damage elevations nearby. In short, we are taking good measurements of water levels but we do not know what we are measuring.

The issue is interesting science but becomes a significant national problem when the erroneous water marks are eventually used to calibrate the next round storm surge model studies. The water level errors are further amplified when depth-limited waves are added.

The paper concludes that the only way to make sense of the measured water marks is to install wave gages where we intend to apply the data, around oceanfront buildings when a hurricane threatens. Multiple self-contained wave gages in multiple states with more numerous pre-established mounts are necessary to have a reasonable chance of catching a direct hit of a design level storm. I encourage you to include the issue in your summary of coastal hazard data collection needs. I can fax a copy of the paper if you do not have access to the proceedings.

Waiting for a hurricane may seem far fetched to some, but a similar effort to measure hurricane wind pressures on coastal buildings is already underway. Twenty houses have been pre-installed for multiple pressure transducers in Florida and ten are planned in South Carolina, both projects through Clemson University. One building in North Carolina has been instrumented since the late 1990s.

Thank you for the opportunity to make suggestions.

Spencer Rogers

Date: Thu, 22 Aug 2002 11:37:58 -0400
From: “C-S. Wu” <Chung-Sheng.Wu@NOAA.GOV>
Organization: DOC/NOAA/NWS - National Weather Service
X-Sender: “C-S. Wu” <cs.wu@hqmail.nws.noaa.gov>
X-Mailer: Mozilla 4.77 [en]C-CCK-MCD (Win98; U)
X-Accept-Language: en,zh-TW,pdf
CC: “Malcolm L. Spaulding” <spaulding@oce.uri.edu>
Subject: Re: Coastal Hazard Input on ISOOS

Malcolm,

>

> I'd suggest that you contact FEMA (HAZUS program), which seems to focus on the areas interested. A good contact is Claire Drury at FEMA in Washington (202-646-2884).

c-s Wu

****

From: "David McGehee" <bigwave@emeraldoe.com>
To: "Malcolm L. Spaulding" <spaulding@oce.uri.edu>
Subject: Re: Coastal_List: User Input on ISOOS
Date: Thu, 22 Aug 2002 10:44:25 -0500
X-MSMail-Priority: Normal
X-Mailer: Microsoft Outlook Express 5.50.4522.1200
X-MimeOLE: Produced By Microsoft MimeOLE V5.50.4522.1200

Dear Malcolm:

I'm afraid I'm going to ignore your specific request and bring up a single issue that I feel strongly about, and I which I believe should be of overriding interest - standards for ocean data, most especially wave data. The free exchange and wide utilization of wave data is severely hampered by the babble of formats, definitions, and methods of computation in use by the various agencies and organizations that collect and/or distribute wave data. I managed the US Army Corps of Engineers Field Wave Gaging Program for 12 years, which funded the operation of more wave observation stations than any other program (yes, including NDBC).

One of my most vexing problems was simply intercomparing data from two stations operated by two different organizations, or even the same organization using different instruments. In most cases, it required several hours of a technicians time to simply lay the two data sets on the same plot. Validating model output with data taken within its domain was even more trying. If you make any attempts to integrate the available wave observations into a single distribution system, you'll soon run into the same problem. While the average scientist familiar with writing code or tools such as Matlab may not find this a difficult problem, it is a recurring one, and a major impediment to the utilization of wave data by managers and the general public.

I began a solution by development of standards. The first was a standardized method for converting time series into spectra and wave parameters (Earle, M., McGehee, D., Tubman, M. 1995. "Wave Data Analysis Standard" Technical Report FWGP 95-1, US Army Engineer Waterways Experiment Station, Vicksburg, MS, April 1995.) I was in the process of developing wave data file format specifications (including model output), and had held a series of workshops on wave climate statistics standards, but I went into private practice before either issue was completed. One manifestation of the effort was the "Harvest Project", a gage intercomparison experiment with the synchronous goal of developing a gage intercomparison engine http://cdip.ucsd.edu/harvest_experiment/).

One of the ultimate objectives of this plan was to provide a one-stop "clearinghouse" for access to ALL measured and modeled (hindcast, nowcast, and forecast) wave data. In addition, a standard suite of intercomparison tools (plots and statistics, such as are shown on the Harvest page) would allow anyone to compare any two data sets - or evaluate any model. There was some resistance by the modeling community to this concept.

In any event, I still feel strongly that the full benefits of wave information to the engineering and research community and to the general public will never be realized until these issues are addressed. Please contact me if you wish to discuss this further.

David D. McGehee, P.E., M.Oc.E.
Emerald Ocean Engineering
www.emeraldoe.com
850.932.9111

X-Sender: rjs@splash.ucsd.edu
X-Mailer: QUALCOMM Windows Eudora Pro Version 4.1
Date: Thu, 22 Aug 2002 10:16:13 -0700
To: "Malcolm L. Spaulding" <spaulding@oce.uri.edu>
From: Dick Seymour <rseymour@ucsd.edu>
Subject: Re: Coastal_List: User Input on ISOOS
Cc: rtg@coast.ucsd.edu

Malcolm:

1) The most damaging natural hazard on the coast is, of course, the impact of wind waves. Unlike earthquakes, damaging wind waves can be forecast to some degree (we are publishing reliable 3 day forecasts on the web at this time.) Wave runup is roughly proportional to the deep water wave height such that large waves, especially if they coexist with high tides, can cause flood damage and increased structural impact damage. In areas with broad shelves (most of the coasts) strong onshore winds can cause significant storm surge, greatly increasing the flooding and structural damage. This makes local wind forecasting extremely important. Wave driven flooding, in addition to direct inundation, often causes overwash of beach sand that clogs storm drains and prevents the runoff of rainfall, adding to the flooding hazards. The loss of beach or dune sand during storms can create a hazard in that the normal protection from wave damage has been compromised or lost. Therefore, a knowledge of the state of the beach is important to decision making on both a short term (temporary protection of vulnerable areas) and a long term basis (planning for beach nourishment programs.)

Tsunamis are rare events and damage from distantly-generated tsunamis is limited to particular coastal geometries that amplify the runup. Because of the lack of reliable warning, especially for locally generated tsunamis, loss of life as well as significant property loss is often suffered.

Deep water directional wave measurements coupled with effective models can provide nowcasts of nearshore wave conditions sufficiently in advance to allow for local evacuation or protection measures. Large scale events, such as hurricanes, must depend on meteorological forecasts to provide sufficient warning time.

2) The community of interest can be readily divided into two groups. The first are the property owners, residents or users of the coastal area. Those people with a financial or personal interest in structures and infrastructure subject to damage such as roads, bridges and marinas are clearly concerned about mitigation of coastal hazards. Included in this group are beach users, boat owners and businesses dependent upon beach tourism. The second group are governmental entities with responsibilities for insuring, maintaining, regulating or protecting the first group. These vary from the federal (FEMA, Corps of Engineers, Coast Guard, NOAA, etc.) to the local (police, sanitation, permitting, health, etc.) Coastal states have a variety of agencies, often paralleling their federal counterparts.

3) The parameters that require measurement by a system like ISOOS include:

a. Deep water directional wave gaging
b. Sufficient nearshore directional wave measurement capability to validate propagation models, and to account for modification by wind over the shelf
c. Wind measurement on the shelf
d. Long wave and sealevel variation measurement in deep water (GPS makes this easy, now)
e. Rapid response broad area assessment of beach and dune health following severe hazards.
f. Seasonal broad area 3D mapping of beaches, dunes and cliffs.

4) The measurements must lead to useful products. Although they will have archival value, they must provide pre-hazard warnings or post-hazard data in a timely and useful form. Therefore, models which convert measurements into easily understood web pages, radio announcements or even siren blasts are a necessary part of the system. The overall reliability of the system must be very high because users will rely on it. Forecasts must be updated rapidly, often and be sufficiently accurate that they will be taken seriously by those in harms way. For coastal hazard information, hourly updates would seem to be sufficient.

Richard J. (Dick) Seymour, Ph.D., P.E.
Head, Ocean Engineering Research Group
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093-0214
Voice (858) 534-2561 FAX (858) 455-5575
[Room 100 Isaacs Hall, 8855 Biological Grade, for Deliveries Only]
http://rseymour.ucsd.edu

Subject: RE: Coastal_List: User Input on ISOOS
Date: Tue, 27 Aug 2002 11:46:52 +0200
X-MimeOLE: Produced By Microsoft Exchange V6.0.4417.0
X-MS-Has-Attach:
X-MS-TNEF-Correlator:
Thread-Topic: Coastal_List: User Input on ISOOS
Thread-Index: AcJJ8oEk+2xGGeeOReG7GeAqLf+PSgDt1/zg
From: “Gavin Hough” <ghough@intervid.com>
To: “Malcolm L. Spaulding” <spaulding@oce.uri.edu>
Cc: <dphelp@csir.co.za>

Dear Prof Spaulding

After a couple of trips to the Antarctic, recording auroral displays with low light level cameras, we have applied various space-time imaging techniques to digital video & radar based sea state surveillance. I would be very interested in contributing to a program like ISOOS, so I've included a few video time stack (or keogram) wave scans for your interest. These and related digital image processing techniques have been used to measure the following:

[1] Wave height, Period, direction & celerity
[2] Plumes during surfacing events near marine outfalls
[3] All weather 24/7 wave period, direction & celerity
[4] Moored ship motion (6 DOF)
[5] Remote (line of site) buoy tracking
[6] Monitoring breakwater damage (breakage & displacement of armor units)

Looking forward to getting a better understanding of the services which ISOOS can offer.

Regards

Gavin.

Dr Gavin Hough.
Development Director, InterVid Ltd.
Chairman, KZN Innovation Support Center.

Annex C: Climate Change Comments Not Yet Fully in Issues

- Internet access to data: Knowing what data are available is part of the science. The big change is the web that makes not only information about the data available (hate to call it metadata) but also makes a lot of the data available online. I think the web is the big area to push and all data systems should be minimalist systems that simply employ the web for data access and distribution. We should work to build clever interfaces to access the data but we should not invent another access path. The web is becoming part of daily life and the common man knows how to deal with it. Scientists are generally a bit more skilled with it and so it should become the pervasive element of the data system. The role for the scientist is to sort out the crap from the good stuff....but then that is what they pay us for. The big change is that data is there, is available, can be ordered, can be worked with. You don't need an antenna, or to know someone with an antenna. This is all doable with regular internet access. Again formats need to be minimal allowing the maximum number of people access to the data. All efforts to force unification should be avoided and the web community should vote with its mouse clicks.

- Metadata: These are many of the basic problems that motivated EOSDIS and what it was supposed to become. The management of metadata became an all-consuming passion that unfortunately did not succeed wildly in delivering more data to us users. The goal is great to have "automatic" metadata that makes it possible to open and work with all kinds of data. The problem is that some specific decisions have to be made and once those are made you life becomes either simpler or more complex. The problem is efforts to make universal formats that do everything for everybody all fail. HDF has been an outstanding example. While the motivation was fine to pick a standard it has become the source of more difficulty in getting data from EOS instruments than any other. Don't make metadata rule the data.

- Data management: "This is a most abused term…..data management needs to be minimal. What we want is data analysis-enablers to make it possible to work with the data. We really don't want the data to be managed since the end goals are not clear."

- The reality is that when you want to put data sets together you face the music, figure out how to work with each of the datasets and then formulate a strategy to put them together. You need to learn about the instrument, its characteristics, the data, how they are generated and what will happen when you put the data together. In the present system this largely takes people, mostly students, postdocs, etc.

- Sharing data with others is generally easy once you have mastered working with them yourself. You can help others avoid the pitfalls and you will have the answers since you had to work them out for yourself. It is always a good idea to talk to someone else who has worked with that data before you try it yourself.

- As for assessing the quality of data we get into all sorts of problems. First remotely sensed data must be calibrated first in the lab, then in space. The measurements are only as good as this calibration. Second satellite sensors drift and change their characteristics making recalibration and validation a necessity. So keeping track of accuracies is important. As you say the actual value of the quality often becomes a very subjective measure and it is difficult to get agreement on the metrics that must be used to say whether or not a measurement is of value.

- Dealing with various data formats is a headache, but it is manageable by the user. However, these points are extremely difficult for an individual researcher to handle and should be managed at a higher level.

- In addition to climate studies more and more of the SST data sets are being applied to regional and coastal problems. Additionally the merging of previous global data sets can lead to better and higher quality coastal data sets with enhanced spatial and temporal resolutions. However, as a previous response mentioned, progress in merging these data sets is not hindered by lack of merging strategies or algorithms but by standard formats in reading the data. My overall impression is that the scientific community is leaning more towards net CDF as a standard. Thought needs to be put into developing the right metadata in order to fully implement the merging of data sets from different satellites.

- Data Access: Accessing and using data typically are still challenging tasks. The push to use HDF was a misguided effort that set the field back by ten years. Data formats are well known only by those who “know them well”. All others have a major struggle. An emerging trend is “interface” standards. This is a specification of how to access the data, rather than of how the data are stored. Again, data providers need to see beyond their immediate community. Climate studies typically require combining data from multiple sources and multiple disciplines. Our standards should be consistent with those from other disciplines.

Annex D: Public Health User Feedback Quotes

1. I think the Issues document sounds great. There is already some effort underway within different agencies to gather some of this data together - hopefully it won't result in duplication of effort. It would be fantastic that water sampling agencies within one state would all agree on a method and recognize each other's data as being valid. For that matter, it would be even better if the state agencies would recognize data collected by non-state agencies and processed in certified labs - consulting company data is frequently looked at by the state with great disdain.

   Diana Sturm

2. Thanks for allowing me the opportunity to review the documents. I am glad that someone is considering management of the wealth of information that exists not only in Alabama, but also around the nation. After reviewing the documents, I envision the development of a data system that would function much like the different layers of a GIS system; in that different, but related layers of information may overlay a specific geographic region/water body.

   I would also agree that the foundation for this system should be national in origin and standardized for use by all providers/users. A "regional" or "body of water" subset of this system may also prove useful from a management/use perspective. Regardless, critical to the success of this system is a standardized platform that would support the data sets. Security of the data is critical.

   Also, I believe there exists 2 basic users of the data.....the general public and those who need the data for technical purposes. Perhaps the system could be configured to allow for basic consumer/user information in one format and a different format for the technical details available for research and other uses.

   Once again, Thanks!
   jackie

3. In general:

   Increasing the level of sampling for fishery independent data is a sound concept. However, there is already a huge overemphasis toward fishery independent data in federal fisheries management. The feds generally don't want to spend the money it takes to get fishery dependent data (aboard commercial vessels or through interviews), however, I believe that new money should have at least as much emphasis in placing observers aboard vessels or in some way gathering the data directly from the fishery. Fishery independent data are often the “best available” information because they are the only available information. However, they may not be very representative either in quality or quantity of actual commercial operations.

Also, the use of temperature and salinity in the coastal zone as indicators of elevated levels of pathogens (naturally occurring or sewage related) is intriguing and probably should be pursued. This may especially be helpful for recreational use of coastal waters to alert users of increased risk for would infections (due to Vibrios) or gastroenteritis (due to enteric viruses or bacteria).

I would hate to see, however, shellfish harvesting areas opened and closed based on a remote sensing device. I doubt that is even remotely possible anyway (pardon the pun). However, it is conceivable that remote indications of lowered salinities would trigger closer investigation of growing waters for fecal contamination.

I believe the ability to detect conditions which indicate HABs is also a laudable goal. One cautionary tale: in MS a researcher actually found a potentially toxic algal bloom offshore. The researcher took it upon herself to notify the media of a potential public health threat. The bloom never reached any commercial shellfish harvesting waters, yet the media caused a “shellfish scare” with the info. The point is that proper risk communication must be in place prior to gathering the information. This is especially important if a new technique or enhanced coverage is employed.

Hope some of this is of use. Please contact me if there are any specific questions you have regarding my thoughts on the documents.

4. As I think I’ve discussed with you and Monica in the past, I’m working with the Corps to develop a numerical model of coastal processes that can assist us in determining potential health risk in the coastal waters adjacent to Newport and Huntington Beaches. Our plan is still evolving but essentially we will use historic data to determine relationships among various factors like surface currents, currents at various depths, flood channel flow rates, water temperature in the water column, wave height and direction, wind speed and direction, tide stage, meteorological conditions and bacteria hits on the beach. If the model can make any sense out of the data we will maintain a real time telemetered data system that will continuously feed this type of data to the model which will analyze the data and tell us when conditions are present that historically were present when bacteria standards were violated. The model can then tell us based on real time data when the health risk is low, moderate or high. As faster bacteriological analytical

methods or other indicators get developed the model can get further refined. It is not something you would use to post or close the beach, its more of an early warning system of potential risk that could change continuously.

How this relates to what you have sent me, is that we will have to perform big data crunches and for the circulation and dispersion phases of the model look farther afield than HB&NB. The IOOS would very helpful to us in looking at some of the more bight-wide macro level processes. We are thinking that our model development may take 5 years or so. Are we in the right time frame for the IOOS? Can I share the attachments with the Corps of Engineers?

Annex E: Pilot Project Proposal: Integrated Distribution System

An Integrated Marine Environmental Monitoring, Modeling, and Information Distribution System for Regional Seas: Application to the Southern New England Bight

Prepared by:

Malcolm L. Spaulding
Ocean Engineering
223 Sheets Laboratory
Narragansett, RI 02881
Tel: 401-874-6666
Email: Spaulding@oce.uri.edu

Date:

August 28, 2002

Submitted to:

User Outreach Team
Data and Communications Steering Committee
Ocean.US
National Office for Integrated
and Sustained Ocean Observations
http://www.ocean.us.net/
(703) 588-0848 (Voice)
(703) 588-0872 (FAX)

BACKGROUND

The consensus reached by the participants of the May 2002 US Oceans workshop was that the coastal component of the Integrated Sustained Ocean Observing System (IOOS) should be structured as a national federation in which regional systems are nested in a national backbone (Oceans US, 2002a). The backbone will measure, collection, process, and distribute core variables required in the regional system (but on a sparse network of stations) and will provide national scale capabilities in nowcasting and forecasting. The regional systems will increase the resolution at which core variables are measured, measure other variables of local interest, and provide data, information products, and predictions tailored to meet the needs of the user community in the region. The ideal regional system will provide end-to-end capability (Oceans US, 2002b). The system will include: a monitoring subsystem (platforms, sensors, measurement techniques) to measure key variables on the space and time scales appropriate to the region and issues of concern, a data communications and management subsystem to collect, quality control, disseminate, and archive/store data, and model products and a data analysis, modeling, and assimilation subsystem to nowcast and forecast variables of principal concern to the regional/local user community.

Researchers at University of RI, Ocean Engineering (M. Spaulding) and Drexel University (M. Piasecki), Civil and Architectural Engineering are leading a 3 three year, National Ocean Partnership Program (NOPP) sponsored study to develop a globally re-locatable, integrated system for real time observation, modeling, and data distribution for shelf, coastal sea, and estuarine waters. The project seeks to integrate Global Ocean Data Assimilation Experiment (GODAE) data and other global and ocean basin scale data products into the system. Additional partners include the National Oceanic and Atmospheric Administration (NOAA)/ National Ocean Survey, the Naval Research Laboratory, Brown University, Applied Science Associates, Inc, Narragansett Bay Commission, RI Department of Environmental Management, and the University of Rhode Island Transportation Center. The system is being developed and applied to Narragansett Bay and Rhode Island coastal waters as a demonstration of the practical use of the system.

The core of the project is the development of COASTMAP, a marine environmental monitoring, modeling and management system, that operates on a personal computer. This approach allows the cost of the system to remain low and at the same time provides the end-to-end functionality called for in IOOS regional sub-systems (Oceans US, 2002b). A geographic information system (GIS), data processing and analysis tools, and environmental nowcasting and forecasting models form the basic components of the system. Linkages with real time environmental monitoring stations allow users to collect, manipulate, display, and archive local environmental data through embedded data management tools (e.g. time series analysis including filtering, power spectral analysis, and harmonic analysis) with the system presenting a real time status display of all data sources. Spatial representations and animations of the data, within the context of the GIS, are also provided by the system. Environmental models, linked with the system, can access the environmental data for assimilation, validation, predictions, or comparative studies.

An Internet based data collection and distribution system has been developed and incorporated within the COASTMAP framework. This system allows GODAE and other global and basin scale model nowcasts and forecasts and real time observations to be accessed via the Internet. COASTMAP also has the capability to collect data from local monitoring systems (i.e., monitoring equipment operated through direct connection such as serial, radio, cellular or modem communications). Data collected from the various online sources is subjected to quality control processes, archived alongside traditional data sets, and automatically distributed to support high resolution coastal modeling efforts.

COASTMAP's Internet based data collection and distribution system is composed of web, data, and map server applications. Presently the system is configured for operation on three separate computers making the separation of server application functionality clear. The system is scalable and hence can be operated in a variety of multi-server/platform configurations. These might include operation of all server applications (i.e., web, data and map) on one PC or simultaneous operation of multiple data and map servers (each operating on their own platform) on a networked system with operations coordinated by the web server. To communicate with each other the web, data, and map servers require only a communication path utilizing TCP/IP protocol. This arrangement allows the servers to be located in different geographic locations and even on different network domains. Multiple map and/or data server configurations offer increased flexibility and improved efficiency when downloading and accessing large volumes of information. Such scalability allows for future expansion of the existing system and application to large-scale systems without sacrificing efficiency. For example, one might expect access to environmental data from additional data sources to occur in the near future thus increasing the bandwidth and processing time required by the single data server presently in operation. Additional data servers would allow the tasks performed by the data server application to be divided amongst two (or more) data servers, thereby reducing bandwidth and processing requirements for each individual server.

COASTMAP and its associated Internet server applications (i.e., web, map and data servers) are presently operational for Narragansett Bay and adjacent Rhode Island coastal waters (Southern New England Bight). In the present application the system provides access to real time data collected by the NOAA PORTS system, the RI Road Weather Information System (RI RWIS), and a network of water quality monitoring buoys distributed throughout Narragansett Bay. In addition the system allows access to nowcasts and forecasts from the NOAA East Coast, Coastal Ocean Forecasting System (COFS) and the National Weather Service's Extra-tropical Storm Surge (ETSS) model.

Access to predictions from the Navy's global ocean models are available based on special arrangements. As part of the NOPP project NOAA/NOS personnel have implemented a high resolution meteorological model to nowcast and forecast winds, atmospheric pressure, and air temperature fields for the southern New England Bight and adjacent areas. The forecasts are available via the internet from NOAA. Finally researchers at Brown University are providing high resolution (50 m) remotely sensed sea surface temperature data derived from Landsat ETM+ for Narragansett Bay and nearby coastal waters shortly after each satellite pass.

NOPP researchers have applied a state of the art, three-dimensional, boundary fitted hydrodynamic model to Long Island Sound, Block Island Sound, Rhode Island Sound, Buzzards Bay, and Narragansett Bay study area. The model has been applied in a two- dimensional vertically averaged mode and shown an excellent ability to predict tidal circulation and elevations in the study area. Model predictions can be visualized through the model's user interface or via COASTMAP. Efforts are currently in progress to implement forecasting of tidal and wind driven circulation in the study area using the high resolution meteorological model predictions and the ETSS waters levels as forcing and boundary conditions, respectively.

The current state of COASTMAP's development and its application to Narragansett Bay are summarized in Opishinski and Spaulding (2002) and Ward and Spaulding (2002).

One of the goals of the current NOPP project is to assess the market for COASTMAP and transition the system from a research project to a commercial operational system that can be used globally. One of the ultimate measures of success of the project is the extent to which the system is adopted and used in other locations and becomes a commercially viable product. The project team has had very good initial success in this area. The Smithsonian Institution has licensed the system to provide real time monitoring for its Carrie Bow facility off the coast of Belize. The system has also been licensed by the Georgia Port Authority (GPA) as a real time monitoring and modeling system for the Savannah River. The system has been specifically configured to collect data in support of evaluating the impact of port dredging projects on marine water quality. Most recently NAVOCEANO's, Ocean Modeling Division will be acquiring a license to COASTMAP (October 2002) and will employ the system for use in monitoring and modeling activities related to homeland security at key naval installations throughout US coastal waters. The system will be configured to integrate output from the Navy's hydrodynamic models for each facility of interest. These initial successes in the market place clearly demonstrate that the COASTMAP concept and its implementation are viable and applicable to a range of different users.

It is clear from the presentation above that COASTMAP is an excellent candidate for a regional subsystem within the IOOS national backbone. It is reasonably well developed, provides end-to-end capability, is extremely flexible, low cost, includes well developed user interfaces with data and information products that meet user needs, and is commercially viable. It is therefore proposed to extend our current NOPP project and apply COASTMAP as a regional subsystem, pilot project for the southern New England Bight (Long Island Sound, Block Island Sound, Rhode Island Sound, Buzzards Bay, Narragansett Bay and adjacent southern New England Shelf.). This area forms a logical division in regional monitoring systems for the northeast; between a system for the Gulf of Maine (GoMOOS) and one for the mid Atlantic Bight (New York/ New Jersey Harbor, Delaware Bay). It is a microcosm of these larger systems with many of the same environmental and use issues.

TASKS

The following major tasks are proposed:

- Provide links in COASTMAP to allow access to national and international databases using the Open Source Project for Network Data Access Protocol (OPeNDAP) middleware system (Oceans US, 2002b). This will allow direct link to the national backbone system when it becomes available and to other regional systems. This linkage will include the ability to use the evolving mega data structure contemplated for the backbone system.
- Access to existing data collection systems is well developed for Narragansett Bay, access to similar data collection systems for the remainder of the study area needs to be implemented. This includes not only coastal ocean monitoring systems but relevant geographic information system data sets as well.
- Extend the suite of models* and associated products in the current NOPP project to include the following: Note the models selected are based on a comprehensive survey and assessment of the needs expressed by the regional user community.
- Water level, depth, and current forecasting model (navigation aid for shipping)
- Storm surge and directional wave models (hurricane and nor'esters)
- Oil and chemical spill models
- Models to predict evolution of fecal coliforms discharged from combined sewer overflow models (CSOs) during storm events
- Search and rescue model
- Dredged material disposal predictions
- Model of thermal discharges from power plants.
- Extend the NOAA/NOS's meteorological modeling program to include the entire operational area. The output of this model will be used directly and as input to many of the models above.

The models noted above will be validated for selected areas and problems within the region.

Once the system is fully operational presentations will be made to all potential major users groups (regulatory agencies, emergency responders, power industry representatives, state environmental agencies, etc.). Pilot systems will be implemented in the facilities of key user groups and an assessment made of the how well the system meets user demands. Feedback from the assessment process will be used to better target the system and its products to meet user needs.

An assessment will be made of a variety of options for ensuring sustained operation of the system and recommendations made on the most viable approach.

* Note that all the models are available for the above problem areas. They however need to be integrated into COASTMAP, linked with appropriate input data sets, and the output customized for the regional user community.

POTENTIAL PROJECT PARTICIPANTS

Potential project participants are listed below. They represent the major oceanographic institutions in the area that have been active in marine environmental monitoring and modeling of the Southern New England Bight and the key government agencies currently working on the NOPP project. Not all of the potential participants have been contacted at this time. This will be done if there is interest in pursuing the project further.

- Ocean Engineering University of Rhode Island (Spaulding, Opishinski)
- University of Connecticut, Marine Sciences (O'Donnell, Bohlen)
- University of Massachusetts, Dartmouth, Marine Sciences and Technology (Brown)
- State University of New York (SUNY), Stony Brook (Bowman, Wilson, Wang)
- Applied Science Associates, Inc. (Swanson)
- Brown University (Mustard)
- NOAA/NOS (Kelley)

Estimated Budget and Time: $2 M per year for 3 yrs.

REFERENCES

Opishinski, T. and M. L. Spaulding, 2002. Application of an integrated monitoring and modeling system to Narragansett Bay and adjacent waters incorporating Internet based technology, Proceedings of 7 the International Conference on Estuarine and Coastal Modeling (ECM 7), November 5-7, 2001, St Pete, Florida.

Oceans US, 2002a. An integrated and sustained ocean observing system (IOOS) for the US: Design and Implementation, prepared by Oceans US, Arlington, VA., 21 pp.

Ocean US, 2002b. A multi-year phased implementation plan for an integrated ocean observing system for the US, prepared by Oceans US, Arlington, VA. (Draft)

Ward, M. and M. L. Spaulding, 2001. A nowcast/forecast system of circulation dynamics for Narragansett Bay, Proceedings of 7th International Conference on Estuarine and Coastal Modeling (ECM 7), November 5 to 7, 2001, St Pete, Florida.