GCOOS

GULF OF MEXICO
COASTAL OCEAN
OBSERVING SYSTEM

Gulf of Mexico Ocean Observing System–Regional Association

Observing System Plan
Version 1.1

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Prepared by the
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1.0 EXECUTIVE SUMMARY

The Gulf of Mexico Coastal Ocean Observing System (GCOOS) produces data and products in response to user requirements. These requirements fall within the seven broad objectives of the U.S. Integrated Ocean Observing System (IOOS):

- Detecting and forecasting oceanic components of climate variability;
- Facilitating safe and efficient marine operations;
- Ensuring national security;
- Managing resources for sustainable use;
- Preserving and restoring healthy marine ecosystems;
- Predicting and mitigating against coastal hazards; and
- Ensuring public health.

The role of Regional Associations (RAs) in the U.S. IOOS is oversight of the development and operation of the Regional Coastal Ocean Observing Systems (RCOOSs) subject to the philosophy and guidelines developed by Ocean.US and approved by the Committee on Ocean Policy. A regional approach was chosen to provide coherent systems over large scales, yet still be responsive to unique local concerns. The RAs will be established to design, implement, operate, and improve their RCOOSs. These will be accomplished by increasing the resolution at which variables are measured, supplementing the variables measured by the national backbone with additional variables, and providing data and information tailored to the requirements of stakeholders in the region, as well as by implementing programs to improve public awareness and education.

This Observing System Plan includes information to date on observing system requirements in the Gulf of Mexico, observing system strategies and implementation, and determining priorities for observing systems. The content of this plan will evolve with development of the U.S. IOOS and GCOOS. As such, this is a living document that is subject to continued revision.

2.0 INTRODUCTION

The Gulf of Mexico Ocean Observing System (GCOOS) is a regional observing system formed to advance the understanding and measuring of coastal ocean processes and systems in the Gulf of Mexico. GCOOS, comprised of partners from Texas to Florida, will provide data and information to a number of users in the Gulf including academic researchers, local, state and federal government agencies, educators, the private sector, and the general public. As a regional observing system, GCOOS will support local needs and, at the same time, form an integral part of the U.S. Integrated Ocean Observing System (IOOS).

The GCOOS produces data and products supporting the user community within the seven broad objectives of the IOOS:

- Detecting and forecasting oceanic components of climate variability;
- Facilitating safe and efficient marine operations;
- Ensuring national security;
- Managing resources for sustainable use;
- Preserving and restoring healthy marine ecosystems;
- Predicting and mitigating against coastal hazards; and
- Ensuring public health.

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This document is the Observing System Plan for the GCOOS-RA. In order to achieve the objectives of the GCOOS-RA, it will serve as the required overall operational plan. This plan includes information relative to:

- Identification of oversight responsibility;
- Support staff to oversee operation and respond to changes in the System (emergency response plan);
- Measurement techniques (platforms, sensors, methods);
- Backup sensors (especially homeland security, safe navigation, and emergency response);
- Real-time support and maintenance of observational infrastructure;
- Evaluation mechanisms to ensure that the plan is responsible to the users' needs; and
- Data management.

3.0 OBSERVING SYSTEM REQUIREMENTS

An analysis of observing system requirements include (1) user needs, (2) an inventory of existing system elements, and (3) a gap analysis to assess the mismatch between what is being done and what the needs of the stakeholders are.

3.1 Assessment of User Needs

3.1.1 Introduction

The potential users of GCOOS include researchers, government agencies (including resource managers and emergency responders), the private sector, educators, and the general public especially in the areas of tourism and recreation. The needs of these stakeholders are diverse, and the GCOOS-RA has begun the process of collecting information about these needs through targeted stakeholder workshops, participating in scientific, engineering and industry association meetings, and direct contacts with representatives of local, state, and federal governments, industry, and the research community. The remainder of this section provides some examples of needs of selected classes of potential users of GCOOS data and products.

Researchers have stated their needs clearly and succinctly as plans for the U.S. IOOS have developed. Their needs include data in the following areas: geological, physical, biogeochemical, and biological, including both in situ and space-based remotely sensed data. The products requested include maps (e.g., of surface currents, hypoxic zones, water quality, or ecosystem conditions), algorithms and models, and more generally data within a Geographic Information System (GIS) framework.

Resource managers include federal agencies such as the National Park Service (NPS; e.g., Gulf Islands National Seashore encompassing the Florida and Mississippi barrier islands), the Fish and Wildlife Service (FWS; e.g., Breton Wildlife Refuge and designated Wilderness, Louisiana). Both the NPS and FWS develop comprehensive conservation plans that address conservation of fish, wildlife, and plant resources and their related habitats, while providing opportunities for compatible wildlife-dependent recreational uses. An overriding consideration reflected in these plans is that fish and wildlife conservation has first priority in park and refuge management, and that public use be allowed and encouraged as long as it is compatible with the park or refuge purpose. In support of the National Parks, the goal of their inventory and monitoring program is to acquire the information and expertise needed by park managers in their efforts to maintain ecosystem integrity of the park system. One such system encompasses the barrier islands of Cat, East and West Ship, Horn, and Petit Bois that comprise the Mississippi part of the Gulf Islands National Seashore. The information needed for ecosystem management (both marine and terrestrial) includes baseline inventories of basic biological and geophysical natural resources, and long-term monitoring for ecosystem status and trends over time at various spatial scales. Similarly, the Wildlife Refuges need baseline information in order for managers to make rational management decisions. For example, the Breton Wildlife Refuge, which encompasses the Chandeleur Islands, was devastated by Hurricane Katrina and the restoration plans need to be guided by the answers to questions concerning where the sand went, have the islands passed a threshold beyond which they will not recover, and does it make sense to restore them? These answers need information provided by hydrodynamic modeling and long-term observations of island evolution in response to storm events. Both the National Seashore and marine/marsh refuges serve as outdoor laboratories for the study of physical, biological, and cultural systems and their components.

Resource managers also include state agencies such as state departments of environmental quality, natural resources, and/or marine resources. In Louisiana, the Department of Environmental Quality is partnering with the five Gulf States in the Gulf of Mexico Alliance (GOMA) to address issues of water quality and clean beaches, reducing nutrients in State and Gulf waters, habitat identification and characterization, and restoration. The Louisiana Department of Natural Resources is similarly concerned about coastal wetlands restoration and storm protection. In Mississippi the Department of Marine Resources is concerned with protecting and restoring oyster habitat, which is a function of salinity. These and other coastal state agencies are in need of accurate data as they make restoration and land management and marine habitat decisions. Their coastal responsibilities include coastlines, wetlands, and barrier islands, and their concerns include all natural and anthropomorphic events and activities that affect their land areas. Sister agencies in Florida, Alabama, and Texas have similar responsibilities, concerns, and requirements.

Educators want information for classroom training and outreach to the general public. A series of Coastal Ecosystem Learning Centers (CELC) have been designated for the five Gulf States. The Louisiana CELC will be in the New Orleans aquarium, the Mississippi one will be in the J L Scott Museum in Biloxi when it is rebuilt. These types of education initiatives requested by the Gulf States will be recipients of all types of ocean and meteorological information. The states are serious enough about their commitment to ocean education that they have hired an education coordinator through the Gulf of Mexico Alliance, Lee Yokel, who sits at the Alabama Sea Lab on Dauphin Island. She and the GCOOS-RA education and outreach coordinator, Chris Simoniello, act as the liaisons between the GOMA education and outreach activities and those of the GCOOS-RA.

Emergency responders include the U.S. Coast Guard, Federal Emergency Management Agency, National Guard, and state and local agencies. In emergencies, they need weather, surge, and wave forecasts, information on distribution of pollutants by currents or winds, flood and inundation maps, and other similar products in near real time.

Gulf of Mexico Alliance. Governments of the five states bordering the Gulf of Mexico have formed an alliance to address pressing environmental issues affecting the coastal regions of the Gulf in a coordinated manner. The five Governors developed an initial Action Plan (http://www.gulfofmexicoalliance.org) with five targeted priorities:

1. Improvement in Gulf water quality, with an emphasis on healthy beaches and shellfish beds;
2. Restoration and conservation of coastal wetlands;
3. Environmental education;
4. Identification and characterization of Gulf habitats to inform management decisions; and
5. Reductions in nutrient loading.

These priorities can be mapped to sampling requirements as shown in Table 1. Although Table 1 lists parameters that require sampling, it does not include any information on the temporal and spatial scales that are required to properly address each issue.

Table 1. Matrix of Gulf of Mexico Alliance Priorities and Sampling Requirements ('x' denotes a primary requirement and 'y' denotes a secondary requirement)

Gulf Alliance Priority Issues	**1 Water Quality**	**2 Wetland Restoration**	**3 Education**	**4 Habitat Characterization**	**5 Nutrient Loading Reduction**
Sampling Requirements					
Temperature	x			x	y
Salinity	x	x		x	y
Currents	y	x		x	y
Waves	y	x		x	y
Topography/Bathymetry	y	x		x	
Dissolved Oxygen	x	x		x	
Nutrients	x	x		x	x
Pollutants	x			x	
Subsidence		x			
Harmful Algal Blooms	x				x

3.1.2. GCOOS Assessments of User Needs

In order to begin collecting the necessary information on the needs and requirements of stakeholders, the GCOOS-RA is holding workshops and meetings for stakeholders. The workshops and meetings held to date are:

- A Workshop to Explore Private Sector Interests and Roles in the U.S. Integrated Ocean Observing System; Focus on the Southeastern U.S. and Gulf of Mexico, 2-4 March 2004 at Marathon Oil Company in Houston, TX.
- NVODS Workshop for Managers of Coastal Observing System Activities in the Gulf of Mexico, 14-15 January 2003 at Stennis Space Center, MS.
- HABSOS-GCOOS Workshop, 13-15 April 2004 in St. Petersburg, FL.
- GCOOS and the Private Sector: Oil and Gas and Related Industry Workshop, 2-4 November 2005 in Houston, TX.
- GCOOS-SECOORA-NOAA CSC Storm Surge & Inundation Workshop, 24-26 January 2007 in New Orleans, LA.
- Harmful Algal Bloom Integrated Observing System Plan for the Gulf of Mexico Development Workshop, 14-16 November 2007 in New Orleans, LA.

Information on priorities for needed measurements and products and for suggested pilot projects to move toward meeting those needs was assembled at these meetings and workshops. That information is contained in the reports available on the GCOOS web site (http://www.gcoos.org) and are summarized in Appendix A. The GCOOS Observing System Committee (OSC), Products and Services Committee, Stakeholder Council, and Board of Directors will use this information when considering observing system enhancements needed to address user requirements.

3.1.3 Targeted Socioeconomic Studies

Targeted socioeconomic studies are crucial to more comprehensively address the impacts of the IOOS. The GCOOS OSC endorses the funding of such studies and recommends that the IWGOO determine funding sources for such studies.

3.2 Inventory of Existing Systems

3.2.1 Observing Systems

The local coastal ocean observatories are listed in Table B.1 in Appendix B. Observing system assets are in constant flux. In order to be able to track the status of the NOAA funded coastal observing assets around the U.S., the NOAA Coastal Services Center (CSC) developed a registry (http://www.csc.noaa.gov/cir/regobs.html) for ocean observing systems. After the status of observing system assets are set up by the institution operating them, a server at the CSC automatically updates the status of the IOOS by using file transfer protocol (ftp) to transfer status files from the participating observing system. It is the responsibility of each observing system to keep its status files up to date. The registry information on the CSC server, in turn, can be automatically ftp'd and used by the GCOOS-RA to check the status of the non-federal components of the observing system within the GCOOS region.

The GCOOS OSC recommends that the GCOOS Data Portal project develop scripts to automatically cull the information from the IOOS Registry for the status of the non-federal Gulf observing assets, and that the GCOOS Board work with Ocean.US and NOAA to develop a capability for registering federal measurements in the Gulf which are part of the National Backbone. At any time a manager/user could then query the GCOOS Data Portal for the current status of that part of the U.S. IOOS in the Gulf. Furthermore, scripts should be developed to allow users to develop statistics about the status of the observing system (e.g., histograms of spatial separation between sea surface salinity measurements).

3.2.2 Observing Standards and QA/QC Procedures in Use

The observing standards and QA/QC procedures used will be included in metadata. The GCOOS data portal will set up an analogue to the NOAA CSC Data Registry in which a server will daily query the observing systems to build a dynamic catalog of standards and QA/QC practices in use and build a file of the most recent practices.

3.2.3 Recommendations

- The Data Portal developers should include means to automatically harvest Gulf of Mexico information from the IOOS Data Registry for a dynamically generated inventory.
- The GCOOS Board should work with NOAA to expand the IOOS Data Registry to include assets of the National Backbone in the Gulf.

3.3 Observing System Design

After prioritized stakeholder (user) requirements for products (or measurements) have been identified, a design for the observing subsystems necessary to meet those requirements may be prepared.

Developing a rigorous design requires that the measurements needed for the required products be identified, that the accuracy of needed measurements be identified, and that the frequency for which products must be produced and delivered be identified. Identification of this information may take a number of iterations involving both stakeholders and observing system designers/managers.

With the foregoing information in hand, design of a "theoretical" observing subsystem can proceed if the correlation coefficients are known, or can be realistically estimated, for the required measurements and the spatial ranges of remotely-sensed measurements are known. Note that correlation coefficients are likely to be dependent on space and time, and the same may be true for spatial ranges of accurate remotely-sensed variables.

Normally however, we are not designing observing subsystems from scratch. As discussed in Section 3.2, we have many existing components of observing subsystems which must be used in our designs. When designing a subsystem it often may prove desirable to relocate or modify (e.g., to change frequency of reporting or accuracy) existing assets as well as add new assets—the assessment of needed new assets often is referred to as "gap analysis" (see Section 3.4).

Another major consideration in designing an observing system to produce an array of different products for various stakeholders is that different products may depend on some of the same variables—particularly on common physical variables such as temperature, currents, or waves. Moreover, the different products may be required at different frequencies and the accuracy required of a specific variable may be different for different products. Many other differences in requirements can be envisioned and must be taken into account when producing a design. In fact, compromises may be required.

It should be possible to carry out theoretical "experiments" to estimate the quality of products determined from an array design using specified fields and time series of the variables to be measured. Moreover, it may prove feasible to optimize an array design using observing system simulation experiments (OSSEs). This requires that numerical models of the required variables be available. Then different designs can be evaluated using the model outputs. Unfortunately, well-validated numerical models do not yet exist for most ocean variables. Therefore the use of

OSSEs for most observing system designs is relegated to the future. In fact, the use of any observing system experiments to formulate or improve observing system designs remains unusual.

3.4 Gap Analysis

At the present time a complete gap analysis is premature. There are many gaps in the coverage of the coastal observing system in the Gulf. The deployment of nearly any new observing asset is a significant improvement!

4.0 OBSERVING STRATEGY AND IMPLEMENTATION (HOWS)

4.1 Background

The IOOS clearly is evolving as a system-of-systems, in much the same way that the IOOS itself is a U.S. ocean component of GEOSS (Global Earth Observation System of Systems). These systems are frequently divided into those that are parts of the “national backbone" (those observing assets which are directly federally supported and maintained on a national scale) and regional assets for which oversight is maintained by the RCOOS Regional Association (and commonly provided by interests within the region). Therefore, the GCOOS observing system strategy must be two pronged. First, we must seek the maximum utilization of the national backbone assets within the region; this demands that we seek participation in processes which shape the evolution of those assets. Second, we must select and place regional observing system assets to complement the national backbone and provide valuable additional information for both regional and national use.

4.2 GCOOS Systems

GCOOS systems are also systems-of-systems. Based both on funding and operations, GCOOS began with many sub-regional observing systems supported to deliver specific information needed by the funding entity. The initial task has been to integrate these legacy sub-systems through promoting cooperation and data sharing. Table B.1 in Appendix B lists the sub-regional observing systems now within GCOOS. The GCOOS-RA must seek to determine optimum systems and placement for the regional needs even in the current modest and largely academically operated efforts within the region. As the IOOS matures and structural mechanisms for funding and programs change, the GCOOS-RA should continue a strong coordinating role in defining the most effective observing system that resources will allow.

As GCOOS members add to its observing system by fielding new sub-systems, coordination should occur under the auspices of the GCOOS Observing System Committee. Clearly, local and sponsor considerations will always be present and to some extent the primary driver of observing system type and placement. However, an integrated system requires regional coordination and NOAA has awarded two grants to GCOOS that will improve interoperability and coordination of the sub-regional systems.

The first new NOAA grant is for a project titled *Standardization of Local Data Network Nodes in the GCOOS-RA*. The project has three major objectives for improving interoperability: establishing a single common vocabulary for variables served, serving point and vector data via Open Geospatial Consortium (OGC) compliant Web Services, and serving satellite data in GIS-compatible OCG Web Coverage Service (WCS) formats.

The second new NOAA grant is titled *Integration of and Regional Enhancements to the Gulf of Mexico Coastal Ocean Observing System*. GCOOS will build and maintain a professional grade data portal and management system to serve regional data and products using community-developed, Service-Oriented Architectures such as the Open Geospatial Consortium (OGC) Web Services and OPeNDAP or hybrid OPeNDAP servers. Users will not be tied to a specific application or graphical decision support tool. Standardized QA/QC, metadata, and DMAC practices will be used.

4.3 National Backbone Enhancements Needed for GCOOS

The following recommended enhancements to the National Backbone in the Gulf of Mexico come from the GCOOS-RA Conceptual Design, Version 1.1 (GCOOS-RA 2008). The recommendations were based upon GCOOS surveys and meetings over the past six years. These are not described in detail nor are cost estimates provided in this document. However, they clearly are needed to meet requirements of stakeholders using observations and information from the GCOOS.

<u>Satellite remotely-sensed observations and their products</u>
Along with the entire Global Ocean Observing System (GOOS) endeavor, continuation and expansion of the satellite remote sensing programs is a high priority for GCOOS. This is particularly true of developments that will lead to both better processing algorithms and spatial/temporal sampling in the coastal regime.

<u>Monitor river discharge and nutrient loading</u>
Improve and enhance monitoring of water quality in watersheds, estuaries, and coastal to shelf waters, as well as fluxes between these entities. As recommended in the report of the US Commission on Ocean Policy (2004), the Council on Environmental Quality is proposing a federal water quality initiative involving EPA, NOAA, and the USGS. The GCOOS-RA would like to see a demonstration project in the Mississippi River watershed and the Gulf of Mexico that is focused on nutrient enrichment issues, such as hypoxia. Along these lines, GCOOS recommends:

- Monitor discharge of all significant U.S. rivers emptying into the Gulf of Mexico
- Monitor nutrients and other ecosystem indicators in major rivers

Among the major rivers for the region are the Mississippi and Atchafalaya rivers and the Sabine, Brazos, Trinity, San Jacinto, Alabama, Tombigbee, Apalachicola, Pearl, and Pascagoula rivers. The river monitoring information is needed by managers dealing with hypoxia, harmful algal blooms, environmental quality, fisheries, and inundation/storm surge flood management.

Implement additional Physical Oceanographic Real-Time Systems (PORTS)

Enhancing safe and efficient marine transportation is a very high priority for the nation. A thrust to "modernize heights and implement real-time water level and current observing systems in all major commercial ports" is one of five priority actions recommended to NOAA by the Hydrographic Services Review Panel. These actions are judged necessary to maintain and improve the U.S. Marine Transportation System. In the Gulf we have for some time had PORTS in Tampa Bay and the Houston/Galveston ship channel. Now there is significant growth of NOAA PORTS Systems along the northern Gulf. Observing systems are being installed and starting operation to serve the port and navigation community as well as local coastal communities and states at Mobile, Pascagoula, Gulfport, the lower Mississippi River, Lake Charles (including the Calcasieu ship channel), and the Sabine Neches region. At this time there are no plans for nowcast/forecast systems for these new PORTS areas; they are highly recommended.

Support the National Coastal Data Distribution System (NCDDC)

The NCDDC, a part of NOAA's National Ocean Data Center, is becoming a major player in the GCOOS. They are the principal distribution center for harmful algal bloom data via the HABSOS project. They are working with Gulf observing system entities to implement the IOOS DMAC standards and protocols. They have the mandate to facilitate discovery and exchange of coastal data. They are heavily involved in the developing Integrated Ecosystem Assessment. These activities require additional support for NCDDC.

Support for the National Data Buoy Center (NDBC)

The NDBC is responsible for a large suite of buoys and platforms in the Gulf. Though these stations primarily provide meteorological information in real time, they also are increasingly being used to obtain data on surface waves, surface currents, and surface salinity and temperature. Other measurements may be added as plans for additional observing sub-systems develop, e.g., optical properties, nutrients, harmful algal blooms, or carbon. Recommended enhancement of NDBC buoy and C-MAN networks include:

- Add wave directionality to wave height—useful for rip current forecasting and sediment transport estimation
- Add visibility measurements—needed near the Mississippi River and other areas for biological productivity estimation and for river-ocean connection
- Add acoustic Doppler current profilers—constraints for models and for HF radar network
- Add ecosystem measurements, as feasible
- Add water level measurements
- Increase the number of stations in these networks by a factor of five, including additional meteorological stations in the near coastal zone for use in forecasting surface currents as well as to improve regional models

In addition, the NDBC receives, quality controls, and distributes (including short-term archival) a very large number of real time data from sources other than the center. In the case of GCOOS, the NDBC is the principal collection and distribution point for our real time data. Both of these efforts require additional support for the NDBC.

Integrate the water level network for the Gulf of Mexico

- Adjust all water level measurements to a common set of datums
- Analyze all extant water level records for regional trends and assess new requirements

4.4 Review of New or Underutilized Technologies

Autonomous biogeochemical sensors are undergoing a phase of relatively rapid development, with sensors for detecting Harmful Algal Blooms and nutrients leading the way. These types of sensors will need to be utilized in much larger numbers if the IOOS is to monitor at the ecosystem level. There also are other new and underutilized technologies such as High Frequency (HF) Radar stations for remotely measuring surface currents and Autonomous Underwater Vehicles for a variety of sampling and monitoring activities. Development of an operational 3-D circulation numerical model is needed for the Gulf of Mexico. The following are examples of technologies now being developed and/or utilized in a number of projects within the Gulf, but that do not yet have widespread use:

HF Radar

Presently, within the Gulf of Mexico, HF Radar is only being operationally used by the University of Southern Mississippi (USM), University of South Florida (USF), Chevron, and British Petroleum. Establishment of an operational HF radar network to monitor surface currents is a high priority for GCOOS. This network would be part of the national surface current monitoring initiative being planned by Ocean.US.

Nutrient Sensors

In 2006, the NOAA-funded Alliance for Coastal Technologies (ACT; http://www.act-us.info/) held a workshop on commercially available real-time nutrient sensor systems and their use in coastal ocean observing systems. The workshop was motivated by the increasing number of available sensor systems and the importance of monitoring nutrients. Table 1 of the workshop report (ACT 2006) is a matrix of commercially available (or soon to be available) real-time nutrient sensor systems and the nutrients each system is capable of measuring.

Harmful Algal Bloom Detection

Mote Marine Laboratory has developed an in situ submersible hyperspectral spectrophotometer (Optical Plankton Discriminator) that can be used to detect the presence of the toxic dinoflagellate species *Karenia brevis.* This package, called the BreveBuster, has been deployed on moorings and a smaller instrument package has been developed to fit into the payload bay of a Webb Research SLOCUM glider. USM will be the first institution to acquire a commercial version of the glider deployable BreveBuster from Mote and hence will be the second institution in the Gulf with that capability.

Flow Cytometry and Microscope (FlowCAM)

Bigelow Laboratory for Ocean Sciences has designed a portable flow cytometer and microscope instrument package that can be used to automatically detect and identify a wide range of plankton, including some types of HABs. Texas A&M University has tested a modified version that is suitable for deployment on a buoy.

pCO2 and CO2 Air-Sea Flux
The NOAA Pacific Marine Environmental Laboratory (PMEL) has developed a buoy-mounted instrument to measure the pCO2 gradient between the atmosphere and surface ocean layer. The University of Southern Mississippi, the Geochemical and Environmental Research Group at Texas A&M University, and PMEL have teamed up to deploy such an instrument in the northern Gulf of Mexico to help build a "Carbon Observatory" in the Gulf.

Operational 3-D Circulation Model for the Gulf of Mexico
One or more numerical circulation models, utilizing data assimilation, for the Gulf of Mexico are needed for development of products for the future. The benefits of having both a high density model data (compared to measured data density), which dynamically interpolates the observations, and the capability to forecast the ocean state, will greatly increase the usefulness of GCOOS. For example, it would provide reliable boundary conditions for smaller-scale coastal and estuarine models. An integration and assessment of numerical circulation models for the region is a first step toward building the needed operational 3-D circulation model.

4.5 Coordinated Operations: Technical Expert Teams and Maintenance and Repair

The GCOOS-RA should coordinate the technical expertise of its members to ensure that any observing system element can properly deploy, operate, troubleshoot, and repair any observing equipment. It is recommended that GCOOS develop "Expert Teams" for various types of equipment, such as High Frequency Radar, automated nutrient sensors, and autonomous underwater gliders.

An operational system requires that spares be readily available to replace malfunctioning equipment. However, it is expensive for each observing system element to have a full inventory of replacement equipment. It is recommended that GCOOS investigate ways to create a system-wide equipment replacement pool. Since GCOOS is composed of many different institutions and companies it is a challenging task to develop a workable solution, but it is crucial to find a way to make this work.

4.6 Tropical Storms, Hurricanes, and Other Major Environmental Events

The impending entrance to the Gulf of a tropical storm or hurricane, a major oil spill, or other calamity can leave little time for deciding on evacuation of assets or implementing changes in sampling intervals to help emergency responders. This is especially the case for tropical storms and hurricanes. Evacuations of some low-lying areas in the Gulf are now begun up to 72 hours before projected landfall. The people who can make changes to sampling intervals for instruments in the path of a tropical storm also are dealing with personal emergency preparations. Emergency operational plans have to be put in place before an event occurs and, to the extent possible, people outside of the affected areas need to be responsible for making any sampling changes that can be done remotely. And, it should be clear that for observing assets that utilize satellite telemetry, backup data collection by servers outside of the affected areas should be in place.

4.7 Pilot Projects

A GCOOS pilot project is defined as an organized, planned set of activities with focused objectives designed to provide an evaluation of technology, methods, or concepts within a defined schedule and having the overall goal of advancing the development of the sustained, integrated U.S. IOOS. Potential GCOOS pilot projects should identify how eventual development into the operational system will achieve GCOOS observing system priorities in order to earn an endorsement by GCOOS. A list of the pilot projects presently under development to date are included in Table A.8 of Appendix A. Others will be developed as the GCOOS-RA Board of Directors considers suggestions from stakeholder sectors.

5.0 OBSERVING PRIORITIES

Observing priorities should be driven by considering how best to meet the prioritized requirements of stakeholders given available technologies, the current state of the observing system, and cost-benefit concerns. How and whether new observing assets may help meet stakeholder priorities through providing better forcing, boundary conditions, and/or data to assimilate into numerical nowcast/forecast models should be considered by the OSC in consultation with the Stakeholder Council (SC) and Products and Services Committee (PSC). The priorities should also be consistent with the current GCOOS Business Plan and agreed to by the GCOOS-RA Board of Directors. Figure 1 illustrates the tripartite relationship, overseen by the Board, between the SC, OSC, and PSC required to properly prioritize development of the observing system. The DMAC committee's role in the process is to make sure that all of the planning done is consistent with GCOOS DMAC policies and procedures.

The Observing System Priorities will be included in this section once the process in Figure 1 has matured to the level that well developed priorities have been identified. However, there are a number of regional enhancements that are under ongoing review and are expected to evolve. These include HF radar observing system for surface currents and waves; Water level observing system for the Gulf of Mexico; System of autonomous meteorological monitoring packages; Hypoxia monitoring system for the Gulf; Harmful Algal Bloom integrated observing system; Development of a deep-ocean, advanced capability sentinel station; Data Management System with Data Portal, Regional Operations Center, and full DMAC implementation; Operation of a 3-D circulation model for the Gulf of Mexico; and Education and Outreach Program (GCOOS-RA 2008).

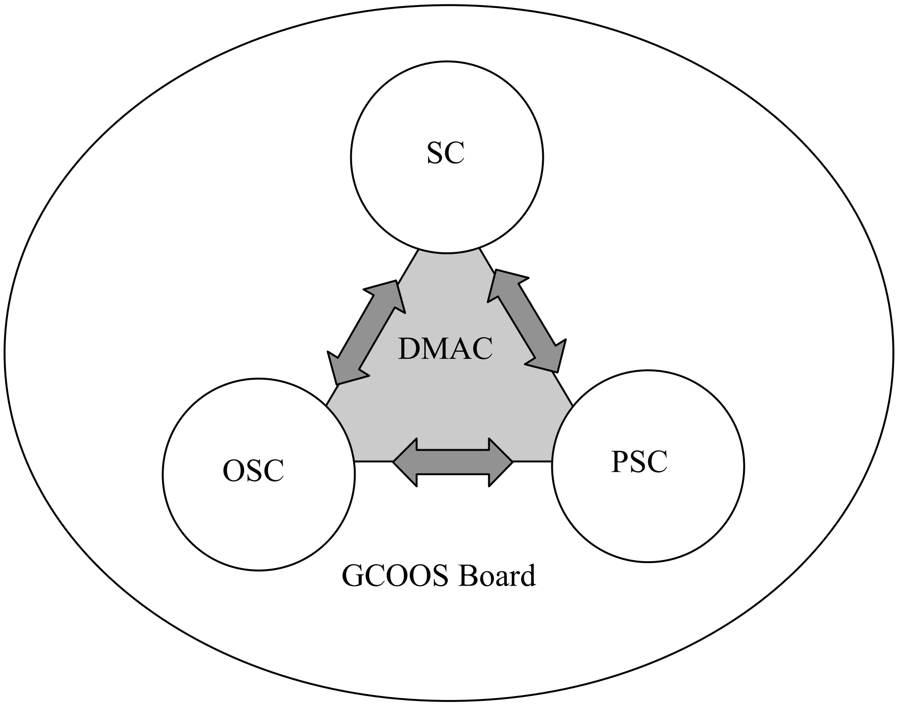

Figure 1. Observing system priorities require consultation between the OSC, SC, and PSC and approval from the Board. The DMAC committee ensures that any planning is consistent with GCOOS DMAC policies and procedures.

6.0 PARTICIPATION IN DEVELOPING NATIONAL OBSERVING SYSTEMS STANDARDS AND QA/QC PROTOCOLS

Below are listed GCOOS-RA participants in groups working to develop national observing system standards and QA/QC protocols. It is seen that GCOOS-RA members are well represented. Appendix C provides additional information on standards development. (Please add to this list as appropriate-forward information to Stephan.howden@usm.edu.)

IOOS DMAC

Steering Committee

Matt Howard, Official NFRA Rep. (Texas A&M University)
John Lever (NAVO) (Not an official GCOOS member, but resident in the Gulf)

Metadata & Data Discovery Expert Team

Julie Bosch, Co-Chair (NOAA/NCDDC)

Community Engagement Caucuses/Regional

Matt Howard, Chair (Texas A&M)

Systems Engineering Working Group

John Lever Co-Chair (NAVO) (Not an official GCOOS member, but resident in the Gulf)

DMAC Interagency Oversight Working Group

John Lever, Co-Chair (NAVO) (Not an official GCOOS member, but resident in the Gulf)

Participants in *Quality Assurance of Real-Time Data* Workshops (http://qartod.org)
A number of GCOOS members have participated in the QARTOD workshops (QARTOD 2003, 2005a, 2005b, 2006):
Vernon Asper, University of Southern Mississippi (QARTOD I)
Brenda Leroux Babin, LUMCON (QARTOD I, III, & IV)
Landry Bernard, University of Southern Mississippi/National Data Buoy Center (QARTOD I)
Julie Bosch, NOAA/NCDDC (QARTOD I, II, III, IV)
Bill Burnett, NOAA/NWS/NDBC (QARTOD II, III, IV)
Don Conlee, NortekUSA (QARTOD I, II, III)
Dick Crout, National Data Buoy Center (QARTOD IV)
Mike Dardeau, University of South Alabama (QARTOD I)
Jamie Davis, University of Southern Mississippi (QARTOD IV)
Matt Howard, Texas A&M University, (QARTOD I, II)
Stephan Howden, University of Southern Mississippi (QARTOD I,III, IV)
Lei Hu, Dauphin Island Sea Lab (QARTOD III & IV)
Ed Kearns, South Florida Natural Resources Center (QARTOD I)
Terry McPherson, NASA (QARTOD I)
Robert Raye, Shell Oil (QARTOD II, III)
Don Roman, University of Southern Mississippi & NOAA/NCDDC (QARTOD III)
Vembu Subramanian, University of South Florida (QARTOD I, III)
Neil Trenaman, Danish Hydraulic Institute (QARTOD II, III)

Participants in the QARTOF to OCG (Q2O) (NOAA CSC, Stennis Space Center 2008)
Brenda Leroux Babin, LUMCON
Julie Bosch, NOAA/NCDDC
Richard Buchard,NOAA/NWS/NDBC
Bill Burnett, NOAA/NWS/NDBC
Don Conlee, NortekUSA
Dick Crout, NOAA/NWS/NDBC
Jamie Davis, University of Southern Mississippi
Matt Howard, Texas A&M University
Stephan Howden, University of Southern Mississippi
Lei Hu, Dauphin Island Sea Lab
Vembu Subramanian, University of South Florida

Participants in the *Salinity Best Practices Workshop* (NOAA CSC 2005)
Julie Bosch NOAA/NCDDC
Bill Burnett, NOAA/NWS/NDBC
Richard Bouchard, NOAA/NWS/NDBC

Participants in the Radiowave Operators Working Group (ROWG) (http://www.rowg.org/)
Stephan D. Howden, University of Southern Mississippi
Arne Diercks, University of Southern Mississippi
Buzz Martin, Texas Land Grant Office
Brian Haus, University of Miami
John Perez, Texas A&M University at Corpus Christi
Jorge Martinez-Pedraja, University of Miami
Clifford Mertz, University of South Florida
Matthew Howard, Texas A&M University

7.0 RECOMMENDATIONS AND CONCLUSION

Through the two NOAA funded GCOOS DMAC projects, the interoperability infrastructure will be in place for the GCOOS to develop as an integrated system. It is recommended that any observing system enhancements should be required to follow relevant protocols and practices developed under the Data Nodes and Data Portals projects.

The OSC also strongly recommends implementation of an automated GCOOS observing system inventory system as described in Section 3.2, with enhancements to include the national backbone in the Gulf and QA/QC practices. A dynamic inventory system is required to keep the inventory up to date and usable.

Hurricanes and tropical storms dominate the concerns of residents of the Gulf States, and it is strongly recommended that plans and protocols be developed for actions to be taken by the observing system elements when such storms are developing in the Gulf or are forecast to enter the Gulf.

The most important recommendation is that the GCOOS-RA develop formal communication channels between the Stakeholder Council, Observing System Committee, Products and Services Committee, and Data Management and Communications Committee needed to develop the best observing system priorities.

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APPENDIX A
PRIORITY TABLES

Oil and Gas and Related Industry Priorities

Table A.1 Priority Products for Oil and Gas Sector (H=high, M=medium, L=low priority).

Products	Length/time scales	Key Components/Measurements	Priority
Hurricane *severity* forecasts	Accuracy of 20% CPI at 5 days	Models, Upper-level circulation, BL, ocean mixed-layer temp., offshore Doppler radar	H
Surface current forecast maps	0-15 days,10 km horiz. D/W, 1 km shelf	Models, wind, HF radar, density profiles, SST, river inflow, air-sea flux, bathymetry, front locations, tomography	H
Measurement & product archive	N. A.	List of all ongoing measurements, periodically updated. Archive of data collected after initiation of GCOOS	H
Operational maps of SST	Existing. Higher resolution TRMM	AVHRR, GOES, TRMM	H
Forecast maps of 3-D deepwater currents	0-30 days10 km horiz, 50 m vert.	Models, density profiles, SSH, SST, winds, air-sea flux, ADCP, Caribbean current inflow	H
Forecast maps of winds and waves (& crests)	0-15 days,10 km horiz. D/W, 2 km shelf	BL, offshore surface met. (V, T, P, H) sensors, atmospheric profiles, QuikSat, TRMM, Doppler Radar, currents (for waves). Store waves at 2Hz	H
3-D current forecasts on shelf	0-10 days,1 km horiz,2 m vert.	Modeling, density profiles, SST, Winds, river inflow, air-sea flux, bathymetry (in some small areas), ADCP	H-
Probability maps of bottom hazards		Turbidity current measurements & modeling, hydrate locations, soil type, bottom currents, high-resolution bathymetry, waves	H-
Marine mammal & turtle maps	Monthly	Physical sightings, tagging, currents (as a proxy)	M
Legacy measurement & product archive	N. A.	Inventory and archive of QA/QC'd data	M
Improved storm surge probability maps (not real-time)	0.5 km horiz.	High resolution model, hi resolution bathymetry & ref. water level, wind stress, bottom roughness, atm. pressure	M
Severe weather monitoring		Offshore Doppler radar, lightening strikes	M
Maps of water quality (DO, PH, etc.)		DO, PH, Nutrients, Hydrocarbons, salinity, temperature, river inputs, models, currents, winds, hyperspectral (satellite)	M
Maps of hydrocarbon seeps			L
Maps of chemosynthetic & arch. sites			L
Maps of SSH, Color Imagery			L
Bathymetry, topography, soil maps			L
Temperature/Salinity profiles			L

Table A.2 Priority Measurements for Oil and Gas Sector (H=high, M=medium, L=low priority).

Measurement	Rationale/Comments	ResponsibleParty	Priority
Hurricane severity model improvement	Two factors control damage: severity and proximity. The latter have improved substantially but the former has not.	National Hurricane Center(NHC)	H
Operational satellite altimeters, near real-time	An essential input into most deepwater current models. Several altimeters must be kept operational indefinitely .	NOAA	H
Operational satellite radiometers, near real-time	An essential input into current models and other analysis tools. Would like to see resolution of TRMM improved.	NOAA	H
Operational satellite wind (QuikSat), near real-time	An essential input into current, wind, and wave models and other valuable analyzed products.	NOAA	H
2 Hz wave data, not real-time	Measure for possible rogue waves during storm events	NDBC	H
Measurements to improve hurricane severity forecasting, real-time	GCOOS needs to dialogue with NHC to determine best ways to contribute, e.g. humidity sensors and/or Doppler radars installed on offshore platforms?	NHCGCOOS	H
Offshore meteorology measurements (V, P, T, H), real-time	Needed for current model, improvement in wind forecasts, etc.	GCOOS	H
Upper-column current & temperature/salinity profiles, real-time	Needed for current model assimilation and validation, and to provide direct measurements. Present network is sparse in the west and east.	GCOOS	H
3-D Ocean current model forecasts, real-time	Needed for offshore operations & environmental issues (hypoxia, oil spills, etc.)	GCOOS	H
Marine mammals and sea turtle sightings, not real-time	To avoid environmental damage due to necessary oil-related activity, i.e. seismic surveys	GCOOS, MMS, NMFS, Industry	H
High resolution coastal bathymetry, topography, & subsidence rates	Input for current and wave models and for subsidence, mud slides. Should include long term sea level measurements	NOS, USGS, GCOOS	H
Turbidity current, not real-time	Unclear how you would measure. Pilot project?	MMS, GCOOS	H-
Water quality parameters (DO, PH, nutrients, COD, etc.)	High priority in specific coastal regions & for riverine inflow.	EPA, USGS, MMS, NOAA, DOA, DOE, Industry, GCOOS	M-H
Offshore HF radar, real-time	Provide real-time surface current maps for model assimilation, Loop current tracking, oil spill tracking, etc.	GCOOS	M+
Caribbean inflow (Yucatán or Florida Straits), real-time	Key input into current model. Also provides long-term record of interest to climatologist. Pilot project for tomography??	GCOOS	M
Identification of hydrocarbon seeps	Could be derived from several different methods including targeted AUV surveys, SAR, etc?	MMS, GCOOS	M
Identification of chemosynthetic & arch. sites		MMS, GCOOS	L

Storm Surge and Inundation Workshop Priorities

Table A.3 Prioritized products/measurements to enhance resilience to inundation.

Priority	Product/Measurements
1	Accurate bathymetry and topography with consistent vertical control between various data sets
2	Data on sea level, winds, waves, etc. for use in forecast models, nowcast analyses, and forensic reports. Hardened data collection and communications.
3	Improved forecasts of inundation. Ensemble forecasts are needed. These should include heights of surge, tides, wave set up, precipitation, and river flow, as well as waves.
4	Improved inundation maps for hazard mitigation planning. This requires updated probabilistic methods, improved models, use of forensic data, and improved, easy access to archived data.
5	Inreach communication among emergency managers, community planners and others to develop and present consistent messages, to build expertise, and to develop a sense of "community".
6	A clearing house for pre- and post-storm information. This might have both a public access and an access only for operational users. It should include both pre-storm data (e.g., areal photos) and post-storm information for use by teams during rescue and adjustors.
7	Forensic engineering studies to access wind and flood inundation damage
Others (not ranked)	
•	Augmented Safir-Simpson scale for hurricanes with additional information
•	Improved public outreach
•	A clear process for moving storm surge models from research to operational status

Table A.4 Pilot projects to enhance resilience to inundation.

Priority	Pilot Projects
1	Benefit-cost analysis to determine value of having current 24-hour-quality forecast at 48 hr. Use data from various past events (Floyd, Rita, Georges, Katrina).
2	Compile/develop standardized methods to measure surge elevations. Include gages, other sensors, HWMs. Utilize best practices that are out there.
3	Work with EM community to develop sample inundation forecast products for decision-making at various time steps (96/72/48/24 hr). Products should give easily digestible info, and not overwhelm individual with too many separate maps for each step.
4	Develop prototype of surge event clearinghouse. Needs assessment to get components/players. Must include min. standards/QC for data (avoid “landfill” syndrome). Can include key staff/ capabilities wanted for EOC (e.g., Science Coord., GIS expertise).
5	Sensitivity runs of storm surge models to help determine required horizontal and vertical resolutions of bathymetry.

Preliminary HABs Priorities

Table A.5 Recommended actions* for monitoring and forecasting harmful algal blooms. New priorities are being developed as the HABs Observing System Plan is prepared.

Functional Category	Description	Status
Harmful Algal Blooms Observing System (HABSOS)	Internet-based data communications and management system for accessing and disseminating data and information for HAB management.	Pilot project for FL and TX progressing
NOAA HAB Bulletin	For state managers to address the need for quick delivery of concise information on the location, intensity, and expected development and movement of blooms of *Karenia brevis*	Operational
Ocean observations	HAB monitoring can be improved by the incorporation of sentinel stations and of observing stations placed in strategic HAB areas and instrumented with additional detection sensors, and development of a plan for these stations is a high priority. The HAB community will also benefit from the contribution of additional observing stations to improve coastal ocean forecasts, the foundations for HAB forecasts.	HABs Observing System Plan is under development; Version 1 is expected in early 2008.
Models	A coordinated effort to identify the model or model output that is needed and to address which models can be used in real time, near real time, or as forecasts is a high priority for developing an HAB forecast capability.	No coordinated effort underway.
Standards and protocols	The establishment of standards and protocols for data collection procedures and for routine monitoring will facilitate data exchange and research across the U.S. and Mexican states.	
Research and development	Improvements to detection technologies to make HAB detection faster and simpler in the field is a high priority.	R&D is underway to a limited extent; more is needed.

*based on the information at
http://ocean.tamu.edu/GCOOS/Office/documents/HAB_GCOOS_report.pdf and
http://ocean.tamu.edu/GCOOS/System/HABs_priorities.pdf

Preliminary Transportation Priorities

Table A.6 Preliminary Priority Actions for Marine Transportation Sector

A stakeholder workshop on the marine transportation sector is planned for 2008. As preliminary priorities, we support those for hydrographic services improvements recommended in the Federal Advisory Committee Special Report 2007 prepared by the Hydrographic Services Review Panel (HSRP 2007). The five priority actions have been recommended to NOAA by the Panel as necessary to maintain and improve a competitive U.S. Marine Transportation System. Additional GCOOS-specific priorities will be developed at the 2008 workshop.

1. Aggressively map the nation's shorelines and navigationally significant waters
2. Integrate coastal mapping efforts and ensure federally mandated channels, approaches, and anchorages are surveyed to the highest standard
3. Modernize heights and implement real-time water level and current observing systems in all major commercial ports
4. Strengthen NOAA's navigational services emergency response and recovery capabilities
5. Disseminate NOAA's hydrographic services data and products to achieve greatest public benefit.

Preliminary Search and Rescue Priorities

Table A7. Primary (P) and secondary (S) meteorological and oceanographic data needed for planning SAR operations. Taken from "Environmental Data Needs for U.S. Coast Guard's Search and Rescue Optimal Planning System" by Arthur A. Allen of the USCG.

A7.A Meteorological & Oceanographic Parameters Needed for Planning Maritime Searches

SAR Steps	Environmental Parameters							
	Winds	Currents	SST	AST	Waves	Visibility	Cloud cover	Icing
Pre-Incident Voyage					P			P
Drift Trajectories	P	P			S			
Search Effort Allocation	S				S	P	S	
Search Operations	P		S	S	P	P		P
Account for Previous Searches	S				S	P	S	
Stopping the Case	S		P	P	S			

A7.B Anticipated NOAA Products that might be added to the U.S. Coast Guard Environmental Data Sever in 2008 and 2009

Agency	Product	Winds	Currents	Other
NOS	PORTS		Chesapeake, St John River, Galveston, NY Harbor	
NCEP	NDFD	CONUS coastal		
NCEP	NAM	Alaska	HF radar – Mid Atlantic	
NCEP	NAM			Air Temp, Visibility
NCEP	RTOFS			SST, Wave Height

A7.C Anticipated NOAA Products to be Needed by the U.S. Coast Guard Environmental Data Sever by 2010 – 2014

Agency	Product	Winds	Currents	Other
NOS	PORTS Or Regional models		San Francisco Columbia River Boston Harbor Lake Champlain Lake St. Clair / Detroit River Delaware Bay Long Island Sound Puget Sound / Seattle Prince William Sound Cook Inlet SE Alaska fjords / channels	
NCEP	RTOFS		Pacific	Dispersion / diffusion / uncertainty
NCEP	High res	Alaska		
			HF radar- CONUS & Hawaii	
NCEP	NAM			Parameters for EO/IO sensors
NCEP	WAM			Wave Spectrum

Initial Pilot Projects

Table A.8 Initial Pilot Projects Selected for Implementation Plan Development and Identification of Funding

1. Pilot GCOOS Operations Center with a data portal as the start for the Operations Center.
2. Forecasts of three-dimensional surface currents for the Gulf of Mexico.
3. Improving forecasts of hurricane severity.
4. Water quality measurements for human pathogens linked into a GOM-wide beach health indicator map.
5. Instrument regularly scheduled tanker traffic with automated oceanography and meteorology monitoring systems.
6. Measurement and products archive for the deepwater Gulf of Mexico.
7. Develop probability maps of bottom hazards and maps of hydrocarbon seeps.

Appendix B
Existing Observing Systems and Specifications

Table B.1 Observations Inventory Summary

Elements of GCOOS (Data Providers)	Geographic Coverage	Purpose of Component	Primary Measurements	Station Types	Target User Group
TCOON	Texas Gulf of Mexico Coastline	assist local officials with preparations for incoming hurricanes and tropical storms	Water-level and Meteorological at SS	Fixed in water at/near shoreline	Texas State Government Agencies
COMPS	Florida Gulf of Mexico Coastline and shelf	assist local officials with preparations for storms and flooding	Meteorological at SS, Currents and Salinity	Fixed in water at shoreline and offshore	Florida State Government Agencies
WAVCIS	Louisiana Gulf of Mexico Coastline and shelf	WAVCIS provides wave information (sea state) including wave height, period, direction of propagation, water level, surge, near surface current speed and direction and meteorological conditions on a real time basis around the entire Louisiana coast	Meteorological at SS, Wave Height/Period, Water-level	Fixed in water at shoreline and offshore	Louisiana State Government Agencies; Industry
PORTS	Houston and Galveston Bays/Shorelines; Tampa Bay	PORTS is a program of the National Ocean Service that supports safe and cost-efficient navigation by providing ship masters and pilots with accurate real-time information required to avoid groundings and collisions	Physical Oceanographic and Meteorological	Fixed in water at/near shoreline	Maritime pilots/captains, Recreational boaters
LUMCON	Louisiana Gulf of Mexico Coastline	LUMCON's Environmental Monitoring System collects and archives real-time meteorological and hydrographic data to provide a broad community of scientists, educators, students, and the public with quality-controlled environmental data from Louisiana's Gulf Coast.	Water quality: salinity, chlorophyll, turbidity, dissolved oxygen, as well as water height and meteorological.	Fixed in water at/near shoreline	Public, Scientists, Louisiana Universities

Table B.1 Observations Inventory Summary (continued)

Elements of GCOOS (Data Providers)	Geographic Coverage	Purpose of Component	Primary Measurements	Station Types	Target User Group
NWLON	GC (CONUS)	The Program provides basic tidal datums to determine U.S. coastal marine boundaries and for nautical chart datums. It also provides support for NOAA's tsunami and storm surge warning programs, climate monitoring, coastal processes and tectonic research. The Program also contributes to safe vessel navigation and the increased efficiency of maritime transportation.	Water-level and Meteorological at SS	Fixed in water at/near shoreline	Government Agencies, Maritime pilots/captains, Recreational boaters
TABS	Texas Gulf of Mexico Coastline	Real Time Oceanographic Data Supporting Oil Spill Prevention and Response	Physical Oceanographic and Meteorological	Buoys along shoreline and offshore	Government Agencies, Researchers, Industry
USF IMRS	Gulf of Mexico (Global)	Provides SERACOOS and GCOOS an understanding of the activities associated with acquisition, processing, archiving, and distribution of real-time satellite data, as well as costs associated with doing this in an operational manner in support of these regional associations.	Remotely sensed Imager and Ocean Color data	Satellite	Researchers
LSU ESL	Gulf of Mexico (Global)	Receiving station and image processing/analysis facility for several satellite telemetries including NOAA POES, GOES-12 GVAR, Oceansat-1 OCM, Terra-1 and Aqua-1 MODIS. Dates back to 1988. Very active in hurricane tracking for state of Louisiana and in surveillance Gulf, Caribbean and Brazil Current circulation in support of oil and gas activities.	Satellite measurements of coastal regions, oceans, and atmosphere from Earth orbiting satellites	Satellite	Researchers, Oil and gas industry, Emergency response managers
NDBC	Gulf of Mexico (CONUS - Coasts and Offshore)	Provide Sea-state for Maritime Safety, Industry, Recreational, Research	Physical Oceanographic and Meteorological	Buoys along shoreline and offshore	Government Agencies, Researchers, Industry
USACE	Gulf of Mexico (CONUS - Coasts and Offshore)	Study Shoreline erosion	Physical Oceanographic	Moored stations	Government Agencies, Researchers, Industry

Table B.1 Observations Inventory Summary (continued)

Elements of GCOOS (Data Providers)	Geographic Coverage	Purpose of Component	Primary Measurements	Station Types	Target User Group
SEAKEYS	Florida coast and Keys (Global)	Coral Reef Health	Physical Oceanographic and Meteorological	Buoys along shoreline and offshore	Government Agencies, Researchers, Industry
NAVOCEANO Drifters					
MMS Deep Water Current	Deep Water GOM	Loop current observations	ADCP	ADCP surface and seabed	Parties affected by loop current
Hydrates Monitoring JIP	Deep Water GOM	Hydrate formation	Acoustic primarily	Suspended acoustic array	O&G operators and Regulators

Appendix C
National Observing Standards and QA/QC Protocols

National observing standards for metadata and QA/QC have been, and are being, developed through a number of organizations, initiatives, and programs. These include the following:

- For quality assurance and quality control: Quality Assurance of Real-Time Oceanographic Data (QARTOD) http://nautilius/twiki/bin/view

- For data management and communications: Concrete Guidance to Data Providers (Part 1, Section 4 of the DMAC Plan)

- For Metadata standards:
  - Federal Geographic Data Committee FGDC
  - ISO 19155 –describes general metadata content and relationships
  - ISO 19139-Geographic Information-Metadata-XML Schema Implementation
  - ISO 19109-geospational data standard
  - http://www.fgdc.gov/metadata/fgdc-iso-activities

Appendix D
Acronyms

ADCP	Acoustic Doppler Current Profiler
AVHRR	Advanced Very High Resolution Radiometer
BL	Boundary Layer
CELC	Coastal Ecosystem Learning Centers
C-MAN	Coastal-Marine Automated Network
COMPS	Coastal Ocean Monitoring and Prediction System
CSC	Coastal Services Center
DEQ	Department of Environmental Quality
DMAC	Data Management and Communication
DO	Dissolved Oxygen
DOA	Department of Agriculture
DODS	Distributed Ocean Data System
DOE	Department of Energy
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
FGDC	Federal Geographic Data Committee
FWS	Fish and Wildlife Service
GEOSS	Global Earth Observing System of Systems
GIS	Geographic Information System
GCOOS	Gulf of Mexico Ocean Observing System
GCOOS-RA	Gulf of Mexico Ocean Observing System- Regional Association
GOES	Geostationary Operational Environmental Satellites
GOM	Gulf of Mexico
HAB	Harmful Algal Bloom
HABSOS	harmful Algal Blooms Observing System
HF	High Frequency
IOOS	Integrated Ocean Observing System
ISO	International Organization for Standardization
IWGOO	Interagency Working Group on Ocean Observations
LUMCON	Louisiana Universities Marine Consortium
MMS	Minerals Management Service
NAVO	Naval Oceanographic Office
NCDDC	National Coastal Data Development Center
NDBC	National Data Buoy Center
NHC	National Hurricane Center
NFRA	National Federation of Regional Associations
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPS	National Park Service
NVODS	National Virtual Ocean Data System
NWLON	National Water Level Observation Network

Appendix D
Acronyms (continued)

NWS	National Weather Service
OGC	Open Geospatial Consortium
OPeNDAP	Open-source Project for a Network Data Access Protocol
OSC	Observing System Committee
PMEL	Pacific Marine Environmental Laboratory
PORTS	Physical Oceanographic Real-Time System
PSC	Products and Services Committee
QA/QC	Quality Assurance/Quality Control
QARTOD	Quality Assurance of Real Time Oceanographic Data
ROOS	Regional Ocean Observing System
ROWG	Radiowave Operators Group
SC	Stakeholders Council
SECOORA	Southeast Coastal Ocean Observing Regional Association
SSH	Sea Surface Height
SST	Sea Surface Temperature
TABS	Texas Automated Buoy System
TAMU	Texas A&M University
TCOON	Texas Coastal Ocean Observation Network
TRMM	Tropical Rainfall Measuring Mission
UM	University of Miami
URL	Uniform Resource Locator
USF	University of South Florida
USACE	United States Army Corps of Engineers
USCOP	United States Commission on Ocean Policy
USGS	United States Geodetic Survey
USM	University of Southern Mississippi
WAVCIS	Wave-Current Information System
WCS	Web Coverage Service