GCOOS
GULF OF MEXICO
COASTAL OCEAN
OBSERVING SYSTEM

Strategic Plan
2020–2025

THE GCOOS MISSION

The mission of the Gulf of Mexico Coastal Ocean Observing System is to provide information about the Gulf's coastal and open ocean waters on demand that is accurate, reliable and benefits people, ecosystems and the economy.

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For more information, contact:

Dr. Barbara Kirkpatrick,

Executive Director

941.724.4320

Barb.Kirkpatrick@gcoos.org

ACKNOWLEDGEMENTS

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Introduction

A decade ago, the Gulf of Mexico Coastal Ocean Observing System (GCOOS) was in its infancy — a long way from the comprehensive system envisioned as part of an international network of ocean observation systems.

In those early days, many organizations in the Gulf were using ocean instrumentation to gather data, but hosting it individually with little ability to share real-time and near-real-time information quickly and easily among users. Also missing was an organized way to look at overall observational capabilities to determine where overlap was occurring or gaps existed. Visionaries led dozens of workshops that brought together the Gulf's best and brightest minds; together they developed an initial plan for a comprehensive regional observing system and began putting the pieces into place that would bring it to life.

That led to the birth of the GCOOS Regional Association (GCOOS-RA), officially created as a member-driven organization in 2005 and incorporated as a nonprofit organization in 2013. Today it is one of 11 certified regional coastal ocean observing systems under the banner of the U.S. Integrated Ocean Observing System (IOOS).

GCOOS has grown to include 162 members, representing the academic, industry, governmental and nongovernmental sectors with organizations streaming data, information and products on marine and estuarine systems to the GCOOS online portal where thousands of users — from ocean modelers to ship captains — have easy access to it when they need it.

In addition to providing a comprehensive online site for data collection and dissemination, GCOOS has also undertaken a series of workshops to identify societal needs and priorities for new data and products, gaining input from 630 individuals from 297 organizations. The result was the development of the GCOOS *Build-Out Plan* (see Appendix p. 29), a comprehensive document that prioritizes observational system implementation, as well as numerous data products. This "living document" is regularly reviewed and now in its second version.

Our overall vision is to build a robust, user-driven, sustained, operational GCOOS that integrates physical, meteorological, biogeochemical, biological, bathymetric and other data from diverse providers, assures data consistency and

quality and creates new data products needed by users. It will also provide accurate data, products and services to IOOS, decision-makers and the public in a timely and efficient manner to benefit human communities and the economy, as well as natural ecosystems.

While much progress has been made toward a fully developed Gulf observing system, the 2010 Deepwater Horizon Oil Spill provided a vivid example of the ocean observing needs that still exist in the Gulf of Mexico. This GCOOS *Strategic Plan* provides a further roadmap — complete with priorities, objectives and deliverables — that will help this observing system reach maturity.

The Gulf of Mexico Today

The Gulf of Mexico is the ninth largest body of water in the world. The watersheds of 33 states drain into the Gulf from more than 150 rivers, including 20 that are major river systems, such as the Mississippi River. If the states along its border — Texas, Louisiana, Mississippi, Alabama and Florida — were their own country, they would rank as the world's ninth largest economy for gross domestic product.

GCOOS is the only certified observing system whose sole focus is on the Gulf of Mexico.

For the U.S., the Gulf is of strategic importance for homeland security and military operations, international commerce and transportation, energy production, natural resources and recreation. It is also a vital economic driver providing jobs for 20 million people and generating $234 billion annually. Such economic and ecological significance brings with it a wide audience of GCOOS data users and stakeholders who have equally broad priority issues facing them today and into the future, including:

- The demands of a growing population expected to increase 40% by 2025;

- An oil and gas industry that produces about 44% of the crude oil, 43% of the dry natural gas and more than 50% of the liquid natural gas in the U.S. but that is also vulnerable to strong currents, hurricanes and coastal inundation of nationally significant land-based infrastructure — its ports, refineries and petroleum reserve facilities;

- National ports — 14 of the country's top 20 by tonnage — that require real-time water depths and currents for safe navigation through coastal waters and to and from one of the nation's most important trade highways, the Mississippi River;

- A commercial fishing industry that yields 69% of the shrimp and 70% of the oyster catches in the U.S., in addition to many commercially important fish species, that requires healthy ocean and coastal ecosystems.

Other priority issues arise from industrial activity in the Gulf's coastal waters, including shipping and energy, that could result in spills of pollutants requiring effective and efficient response; the occurrence of harmful algal blooms (HABs) affecting human and animal health and low-oxygen (hypoxic) zones that impact ecosystem health and human activities. Finally, extensive use of coastal habitats by boaters, surfers, divers and beachgoers as well as urban development in the Gulf's low-lying and subsidence areas requires extensive knowledge of currents, waves and storms so models can be developed of coastal flooding probabilities and for human safety and successful search and rescue missions.

Looking Ahead

The next five years, 2020-2025, will be a critical period for GCOOS. To achieve our goals, the organization must engage new partners and collaborators — including international partners in Mexico and Cuba, which also share the Gulf — to expand the array of observations collected and shared in the Gulf of Mexico. Our continued efforts will include engaging our many stakeholders, developing new products and services based on stakeholder needs and providing information to decision and policy makers. The GCOOS *Strategic Plan* demonstrates our commitment to building and sustaining a robust observing system in the Gulf of Mexico.

Key Focus Areas

While the Gulf of Mexico audience may be wide and its priorities broad, there are four main areas where a robust coastal and ocean observing system plays its most important role in supporting human safety, the economy and the health of the environment. GCOOS has defined these items as its four Key Focus Areas. They are:

- Marine Operations
- Coastal Hazards
- Healthy Ecosystems & Living Resources
- Human Health & Safety

Cross-Cutting Themes

Cross-cutting themes are items that are common to each Key Focus Area — that is, they help GCOOS fulfill its mission of providing information about the Gulf's coastal and open ocean waters on demand that is accurate, reliable and benefits people, ecosystems and the economy. These cross-cutting themes are:

- Stakeholder Engagement
- Data Management & Communications
- Numerical Modeling & Forecasting
- Monitoring Long-Term Environmental Change

Funding the System

The majority of the GCOOS-RA funding is competitively awarded through the U.S. IOOS office, but we must note that academic, governmental and nonprofit entities contribute data to the GCOOS data portal with minimal funding support from our organization.

In order to fulfill its mission and build the comprehensive observing system envisioned in its *Build-Out Plan*, GCOOS will need additional funding. The numerous funds set up following the Deepwater Horizon present the most likely opportunity for new support for observational tools.

But the GCOOS-RA alone will be unable to garner the resources and carry out all of the many activities needed for a fully realized Gulf observing system as envisioned and designed in the GCOOS *Build-Out Plan*. That's why the building of the GCOOS will continue to be closely coordinated with other groups that also seek to achieve a sustainable, healthy and resilient ecosystem in the Gulf of Mexico and support a robust Gulf Coast economy. Our partners will continue to come from academia, government, private-nonprofit, business and industry as well as the international community.

GCOOS always has been and will always remain a 'system of systems' — an umbrella organization bringing stakeholders together to develop a scientific, reliable collective of information about the Gulf of Mexico.

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About This Document

The GCOOS *Strategic Plan* is a living document designed to provide guidance and prioritize goals to ensure that the coastal and ocean observation system in the Gulf of Mexico is meeting the needs of its users. Human and environmental needs may change over time and, as such, our Key Focus Areas may need to be updated.

Each year, the GCOOS Executive Director will lead a team to review operational plans and action items to ensure that they are still relevant to the community. Every three years, the Executive Director and Executive Committee of the GCOOS-RA Board of Directors shall review this document in its entirety, gather input from members as needed and make appropriate updates to the *Strategic Plan*.

KEY GCOOS PARTNERS

Our local data providers:
Dauphin Island Sea Lab, Louisiana State University, Louisiana Universities Marine Consortium, Mote Marine Laboratory, Sanibel Captiva Conservation Foundation, Texas A & M University — College Station and Corpus Christi, University of Colorado, University of South Florida, University of Southern Mississippi

Nongovernmental Partners:
Include the Gulf Coastal States' Governors' Alliance for Healthy and Resilient Gulf Coasts, the Gulf of Mexico Alliance (GOMA), the Gulf of Mexico University Research Collaborative (GOMURC), Gulf of Mexico Research Initiative (GOMRI) and the National Academy of Sciences Gulf Research Program (NAS-GRP).

Governmental Partners:
Including, but not limited to, BOEM, DOD, DOI, NASA, NOAA and the RESTORE Council.

Business and Industry:
Including the BMI Group, BP, Fugro, Shell, Liquid Robotics, Marine Industries Science and Technology Cluster, PORTS/Harbor Pilots, Research Partnership to Secure Energy for America, Shell, Vencore Services and Solutions, WeatherFlow, Inc., Woods Hole Group

Other Regional Associations:
The GCOOS-RA will continue to coordinate closely with the other regional associations, especially the neighboring regional associations Caribbean Regional Association (CaRA) and Southeast Coastal Ocean Observing Regional Association (SECOORA).

International Partners:
Including the Global Environment Facility of the United Nations Industrial Development Organization and Mexico's Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT).

Marine Operations include recreational boating, fishing and diving; search and rescue; commercial fishing; marine transportation and shipping; dredging activities; extraction of offshore mineral and energy resources, including oil and gas, wind farms and other emerging energy extraction processes; and associated infrastructure impacted by water-level trends; and air-borne marine operations and training.

To support marine operations in the Gulf of Mexico region, we need to provide observations for product and model needs including, but not limited to, the following:

- Improved water depths and bathymetry in harbors, ports and transit areas;
- Accurate shoreline locations;
- Water-level elevation;
- Surface waves, currents and winds;
- Visibility; and
- Weather forecasts, with particular emphasis on storms.

Goal 1: Facilitate safe navigation to and from U.S. ports for industrial users by providing real-time oceanographic conditions that improve safe navigation of commercial vessels and barges.

Goal 2: Support product development that synthesizes real-time ocean observations and forecast models, such that a broad spectrum of users can easily access and utilize for operations.

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Action Items

1. Facilitate Gulf-wide coastal long range High Frequency (HF) radar coverage in support of marine operations.
2. Determine which real-time physical oceanographic data and information products would be most helpful to prevent maritime accidents.
3. Review data and information with stakeholders to determine which would be most impactful to marine operations.
4. Estimate costs for the creation and maintenance of ocean observations that provide needed data and information for recreational and commercial users.

Deliverables/Metrics

- An update of our comprehensive list (See Addendum 1) of stakeholders and prioritized list of their data and information needs.
- Advice to policy-makers on cost-effective mechanisms for supporting ongoing and reliable physical oceanographic observations for real-time use in marine operations.
- Three services and/or products defined in detail to provide decision support of marine operations.

Outcomes

- Fewer incidents in coastal areas (i.e. ship groundings, recreational accidents, energy industry incidents) and reduced collisions in ports and channels.
- A safer marine community less likely to need search and rescue operations.

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Fourteen million people live, work and play along the Gulf Coast — an area particularly vulnerable to many coastal hazards, such as tropical cyclones, winter storms, sea-level rise coupled with land subsidence, and loss of wetlands, marshes and beaches. These factors collectively increase vulnerability for coastal communities.

Combined with its 25,000 miles of oil and gas pipelines and more than 4,000 oil and gas platforms, the Gulf Coast is also vulnerable to contaminant spills — as evidenced by the blowout of the Deepwater Horizon, the largest man-made disaster in the nation's history that released an estimated 4.9 million barrels of oil into the Gulf.
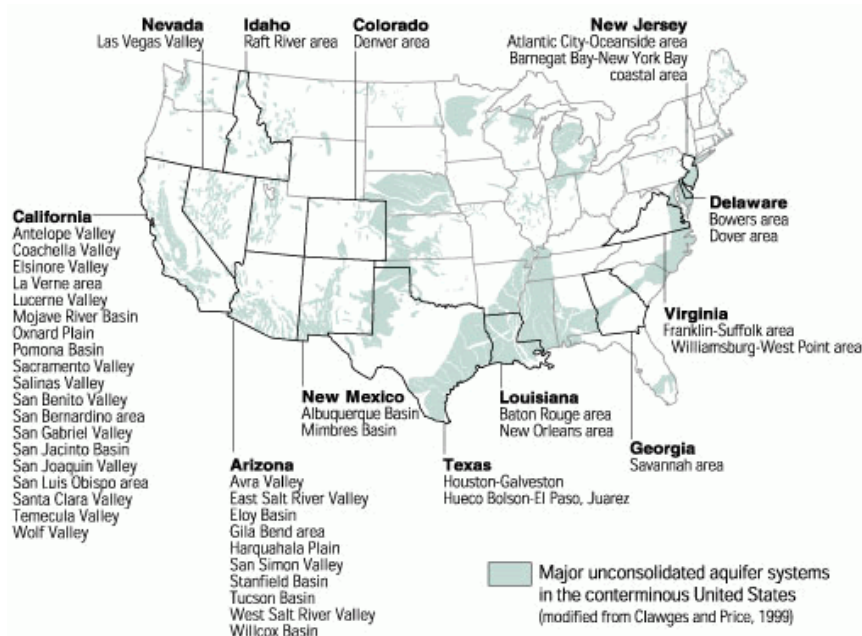
Map of the U.S. showing some of the areas where subsidence has been attributed to the compaction of aquifer systems caused by groundwater pumpage. From "Land Subsidence in the United States," USGS Fact Sheet-165-00, December 2000.

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The solution to mitigating the effects of a changing coastline, storm events, sea-level rise and contaminant spills is to foster more resilient communities, with easy access to current, reliable information and to provide better models and tools that help track hazards. To support more resilient communities, we need to provide quality, timely data to address the following:

- Improve intensity and tracking estimates for hurricanes and other storms for accurate evacuation warnings and emergency preparedness;
- Develop better guidance for storm surge, tidal and precipitation flooding, and runoff;
- Increase knowledge of rip currents, surf-zone dynamics and shoreline currents;
- Monitor coastal, shoreline and bathymetric changes over time; and
- Increase knowledge of ocean currents, both at the surface and at depth.

Goal 1: Improve real-time and on-demand coastal observations and model forecasts, as well as accessible, custom products for users.

Goal 2: Develop a real-time reporting system of observations and model results to provide guidance for mitigating coastal hazards.
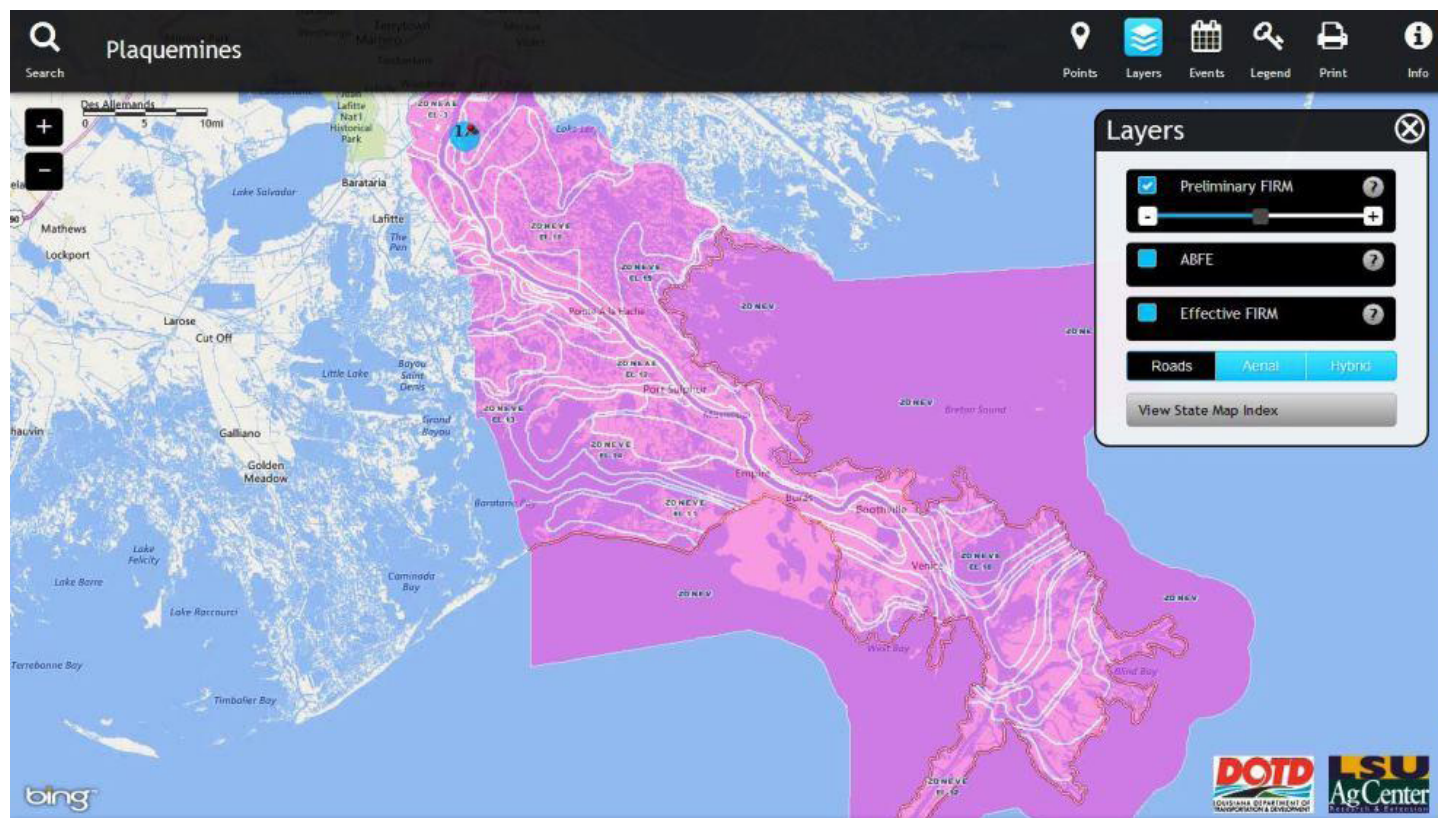
Flood Insurance Rate Maps show the vulnerability of coastal Louisiana to inundation.

Action Items

1. Identify and support programs that determine the economic impact of coastal hazard events in the Gulf of Mexico and the effect that additional observation products and services would have on reducing this impact.
2. Identify and support community planners and emergency managers to develop consensus on the observation products that would provide key guidance to help them mitigate hazards.
3. Determine which real-time physical, biological and chemical oceanographic data, models and derived information are critical to producing products and services identified, and determine information availability, source and costs.

Deliverables/Metrics

- Sustain and review observational and modeling priorities required to support stakeholders in mitigation of natural and man-made coastal hazards.
- Provide information to policy makers regarding optimal products and services required for improved management of coastal hazards, along with cost-effective mechanisms for implementation.
- Provide products and services to support coastal hazard mitigation including updates of existing products.

Outcomes

- Better-informed coastal communities served with relevant observing elements allowing effective planning, management and mitigation of coastal hazards.

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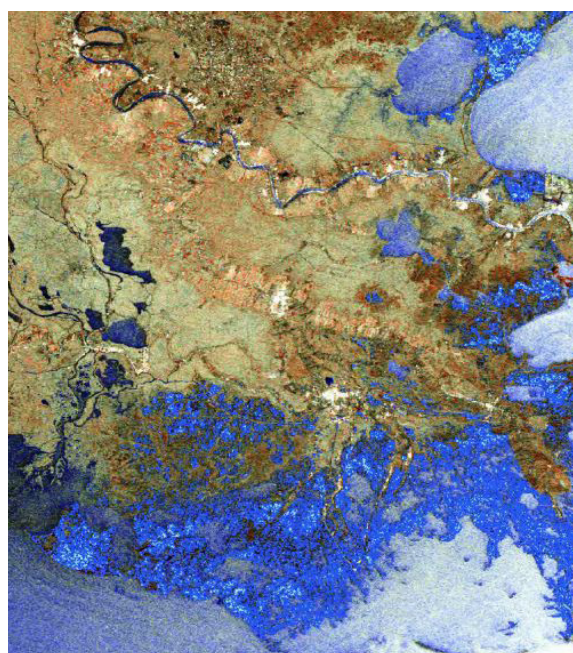
Resilient coastal communities and our own human well being depend on healthy ecosystems and living resources in the Gulf of Mexico region.

Many stressors — including overfishing, pollution, habitat degradation and climate change — challenge coastal ecosystems. These stressors are reducing societal benefits from our coastal ecosystems by adversely impacting plant and animal life, food security and water quality, to name a few. Current resource management approaches focus on the coastal ocean ecosystem as a holistic system and consider the interactive impacts of multiple and cumulative stressors.

"Unless scientists and practitioners can convince ocean users that conserving ecosystem structure and function is fundamental to obtaining the ecosystem goods and services people desire, our opportunity for progress is limited."

— Barry Gold, Director of the Walton Family Foundation's Environment Program and former Director of Marine Conservation at the Gordon and Betty Moore Foundation.

To protect healthy ecosystems and living resources, we need to provide quality, timely observations in support of holistic management. These observations must also reflect the array of interactions within the ecosystems and help meet the following goals:

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Goal 1: Collect coastal and ocean observations that allow for assessment of ecosystem health and change.

Goal 2: Provide data management resources for data that support scientific assessment of ecosystem health and their associated living resources.

Action Items

- Encourage new assets and monitoring stations for priority variables that define estuarine, coastal, shelf and deep Gulf ecosystems.
- Provide sustained, fundamental sets of near-real time observations needed by the coastal and ocean management communities to guide decision-making.
- Support a tool for geospatial queries of GCOOS data in support of management decisions related to healthy ecosystems and living resources.
- Connect with available Data Atlases that have information on biodiversity and living resources.
- Maintain data sets that generate the ability to identify long-term ecosystem changes.

Deliverables/Metrics

- Enhance the GCOOS Hypoxia/Nutrient Data Portal to assess changes in water quality over time.
- Enhance the Gulf of Mexico Coastal Acidification Network (GCAN) network to understand the impact of changing ocean chemistry on living marine resources.
- Expand the range of products that support understanding of the spread of invasive species in the Gulf of Mexico.

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- Integrate data on protected and endangered species with habitat and human use overlays to better mitigate conflicts with human activities.
- Enable the overlay of fisheries and habitat data to identify, track and mitigate changes over time.
- Create maps of marine mammal and sea turtle distributions.
- Enhance support for the collection of biodiversity indicators, including both flora and fauna.
- Expand the Marine Biodiversity Observation Network to the Gulf of Mexico, with initial emphasis on the Flower Garden Banks National Marine Sanctuary.

Outcomes

- An integrated data network that supports ecosystem-based decision-making for healthy ecosystems and enhanced living resources.

The Marine Biodiversity Observation Network

Ecosystem biodiversity is one indicator of how ocean conditions are changing — for better or worse. But without a comprehensive system that brings together data on multiple parameters and a variety of species, changes can go unnoticed.

The Marine Biodiversity Observation Network (MBON) seeks to change that reality by developing regional networks of scientists, resource managers and end-users who can integrate data from existing long-term research programs into an organized, comprehensive system that sets the stage for a better understanding of ocean ecosystem changes and connections between marine life and ecosystem functions.

MBON integrates independent historical and current biological/ecological surveys and databases with biodiversity indices. It also adds new observations that incorporate new remote sensing methods, novel molecular (eDNA) technologies, hydroacoustics, traditional environmental research tools and coordinated experiments.

GCOOS serves as the data and communications manager for the Florida Keys National Marine Sanctuary and hopes to expand MBON to other sites within the Gulf of Mexico.

Photo by: dvoevnore/Adobe Stock

Harmful algal blooms, pathogens, oil spills, weather events, dangerous currents and coastal land loss are major threats to human health and safety in the Gulf. For instance:

- Harmful algal blooms like the red tides caused by *Karenia brevis* (*K. brevis*) in the Gulf of Mexico, can have a devastating impact on coastal communities, where severe blooms can cause millions of dollars in tourism losses and send people with chronic respiratory diseases to emergency rooms. In Texas, a single harmful algal bloom cost the oyster industry $10 million in lost revenues.
- Nearly 400 named tropical storms and hurricanes have formed in the Atlantic basin since 1890, with many of the most intense and costliest storms making landfall in the five Gulf States. In 2005, Hurricane Katrina left 1,800 people dead and caused an estimated $108 billion in economic damage.

A primary GCOOS goal is to develop tools that empower people, communities and businesses to improve decision- making about their lives as they work, live and play along the Gulf Coast. To protect human health and safety, we need to provide quality, timely data to accomplish the following goals:

Goal 1: Improve tracking and reporting environmental conditions that impact human health in near-shore and coastal waters.

Goal 2: Provide water and beach quality information for use by coastal communities.

Goal 3: Provide near real-time air and water column temperatures to improve forecasting of hurricanes and climate variability.

Action Items

1. Expand High Frequency (HF) Radar installations to gain near real-time information about surface currents, wave heights, and winds.

2. Expand the Beach Conditions Reporting System, which provides twice-daily online updates about beach conditions, beyond Florida to Mississippi, Alabama, Louisiana and Texas.

3. Develop and implement cell-phone microscopy application for harmful algal bloom reporting.

4. Foster citizen-science programs to increase near-shore monitoring.

5. Facilitate glider missions for heat content during hurricane season.

6. Aggregate U.S. EPA Healthy Beaches information and other water quality data into the GCOOS portal.

7. Develop a centralized data portal for all water quality and beach quality data.

Deliverables/Metrics

- An expanded Beach Conditions Reporting System that covers major Gulf Coast beaches.
- Increased public engagement in monitoring near-shore water quality parameters.
- Better HF Radar data to support improved search and rescue capabilities and ground-truth hurricane forecasts and models.
- An improved, centralized water-quality data portal useful for the public and decision makers.

Outcomes

- Better reporting of harmful algal bloom events to protect public health and coastal economies.
- Improved tracking of long-term environmental changes that impact human communities.
- Improved search and rescue capabilities to protect human lives.

Red Tide Respiratory Forecast

Human respiratory impacts happen when the Florida red tide organism, *Karenia brevis*, is present and winds blow onshore or alongshore. Most people experience minor respiratory irritation — coughing, sneezing, teary eyes and an itchy throat — when red tide is present and winds are blowing onshore. These symptoms go away when they leave the beach.

But people with chronic lung problems like asthma and chronic obstructive pulmonary disease (COPD) can have severe reactions when they breathe in airborne red tide toxins — even ending up in the emergency room. Health officials advise that these people avoid red tide areas altogether and take all medications as prescribed, including having access to rescue inhalers. People with chronic lung disease should leave the beach if they begin experiencing respiratory problems, even if red tide is at very low or low concentrations.

Thanks to a grant from NASA's Applied Science Program, NOAA's National Centers for Coastal Ocean Science (NOAA-NCCOS) and GCOOS worked with state resource managers and NGOs to develop a new risk-level **Red Tide Respiratory Forecast** to help the public assess the best times and days to visit beaches in Florida's Pinellas, Sarasota, Lee and Collier counties during red tides.

The forecast is hosted on the GCOOS data portal — at **habscope.gcoos.org/forecasts**.

Key to creating the **Red Tide Respiratory Forecast** is a new tool, dubbed "HABscope," a portable microscope system that uses video and artificial intelligence (AI) to quickly analyze water samples collected by trained volunteers for near real-time cell counts of *K. brevis*.

▶ **habscope.gcoos.org/forecasts**

Integrating real-time and near-real-time data streams collected from scientific partners throughout the Gulf of Mexico and providing it in a single, easy-to-navigate website is at the heart of the GCOOS mission. But since its beginning days, GCOOS organizers knew that collecting information was only one piece of developing a robust and interactive coastal ocean observing system. GCOOS has an overarching objective of helping to build resilient ocean-literate, climate-literate and energy-literate Gulf communities that truly make use of the data and products developed through a comprehensive and sustained observing system.

Therefore, the need for Stakeholder Engagement — about the available information, services and products offered about the Gulf of Mexico — cuts across each of the four Key Focus Areas outlined in this *Strategic Plan*.

GCOOS has been the only regional observing system to provide continuous funding for engagement activities since its inception and maintains a volunteer Council comprised of representatives from entities across the Gulf that are involved in ocean-focused outreach activities. The Council provides essential guidance for the development of programs and materials designed to address regional needs for outreach and public awareness of coastal, ocean, climate and energy issues. GCOOS has also committed to supporting public relations and marketing activities to further share information about GCOOS, its mission and its public service activities through the media, social media and to targeted audiences through its monthly enewsletter.

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Goal 1: Expand knowledge of GCOOS and use of its products and tools to new audiences.

Goal 2: Engage new partners and members in GCOOS programs, especially in industry and underserved communities.

Goal 3: Increase knowledge of GCOOS activities, services and benefits to the media, the public, decision-makers and other targeted audiences throughout the Gulf.

Goal 4: Facilitate and engage citizen science groups throughout the Gulf to enhance data collection, storage and dissemination.

Goal 5: Support the measurement and evaluation of GCOOS activities — from products offered to the success of educational and outreach activities.

Goal 6: Increase knowledge of STEM careers related to ocean observing among K-16 students and provide training opportunities and materials for informal and formal educators.

Action Items

1. Define key user audiences for GCOOS data and products and expand outreach to those communities through appropriate activities (eg. providing information materials, training, other guidance).
2. Identify potential new partners — particularly in industry and underserved communities — and develop appropriate programs and pilot projects to engage them.

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The GCOOS website and data portal offer products for many different user groups.

3. Develop a comprehensive communications plan that supports *Strategic Plan* goals, actions and objectives.

4. Assess current GCOOS products and services to determine whether they are fulfilling a public need and are being utilized; assess educational programs and outreach activities to ensure learning goals are met.

Deliverables/Metrics

- Wider use of GCOOS tools and products among key user groups; increased GCOOS membership.
- Greater awareness of GCOOS, its mission and societal benefits across all sectors, but especially among decision-makers and industry.
- Increased use of GCOOS-developed educational materials by formal and informal educators — particularly those in underserved communities.

Outcomes

- More resilient ocean-literate, climate-literate and energy-literate Gulf communities.
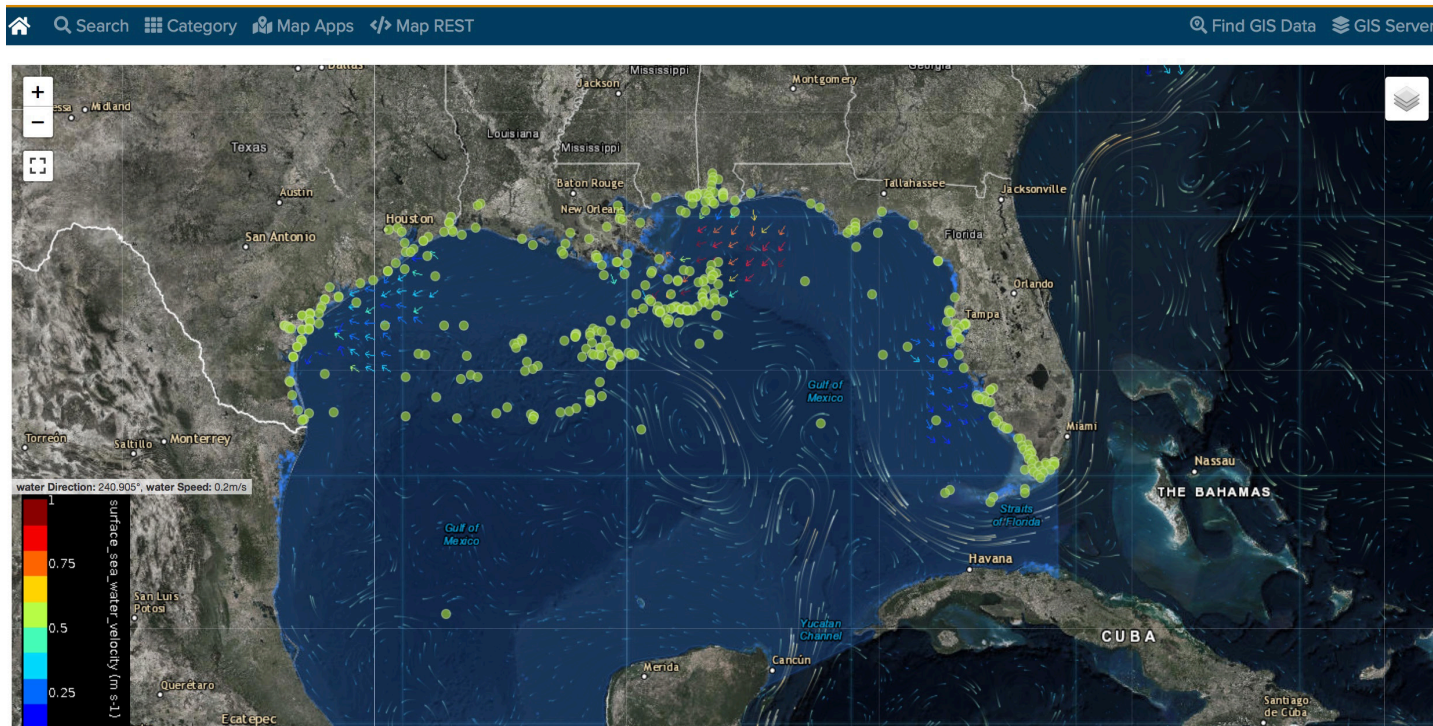
The goal of the GCOOS-RA DMAC subsystem is to aggregate high-quality observed data and model output from providers and partners within our region. By doing so, GCOOS then makes the resources and data-based products we and others develop widely available to diverse stakeholders for a variety of purposes by publishing them in uniform formats that make them easy to discover, access and use.

Goal 1: Provide more information for beachgoers, with a particular focus on the Human Health & Safety Focus Area.

Goal 2: Improve real-time forecasting for Coastal Hazards.

Goal 3: Increase the amount of historical data used in GCOOS products and available through the portal.

Goal 4: Develop a system for near real-time monitoring of nitrogen and phosphorous contaminants.

Goal 5: Support MBON database assembly at the Flower Garden Banks National Marine Sanctuary.

Action Items

1. Assemble relevant observations and forecasts that include UV index, water quality, wave forecasts and HABs to develop physical state forecasts for beachgoers on an easily accessible public portal with modern look and feel.
2. Develop Coastal Hazard web page content for smartphones and tablets.
3. Transform existing historical data to NetCDF for serving via ERDDAP/TDS.
4. Identify historical data not on hand, acquire and transform to NetCDF for serving via ERDDAP/TDS.
5. Identify sources of near real-time nitrogen (N) and phosphorous (P) data.
6. Identify, assemble and transform data useful to the National Marine Sanctuary Condition Report for the Flower Garden Banks.

Deliverables/Metrics

- Beach and water quality data portal formatted for all screen devices.
- Coastal Hazard information and products with format for all screen devices.
- Enhanced historical data available through GCOOS data portal.

Outcomes

- Improved stakeholder access to observations and products to facilitate informed decision making about beach-going activities.

Gliders

About this Product: Gliders Launch The main feature of this product is tool that tracks and maps gliders currently deployed...
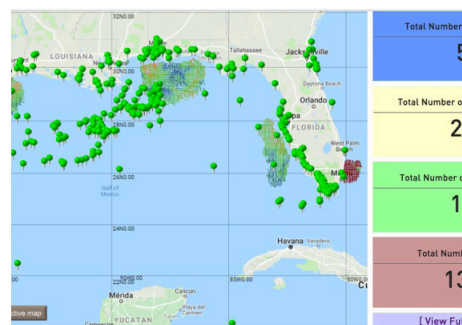
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Harmful Algal Blooms

Harmful Algal Blooms There are thousands of species of algae — phytoplankton — in fresh and marine waters worldwide. They...
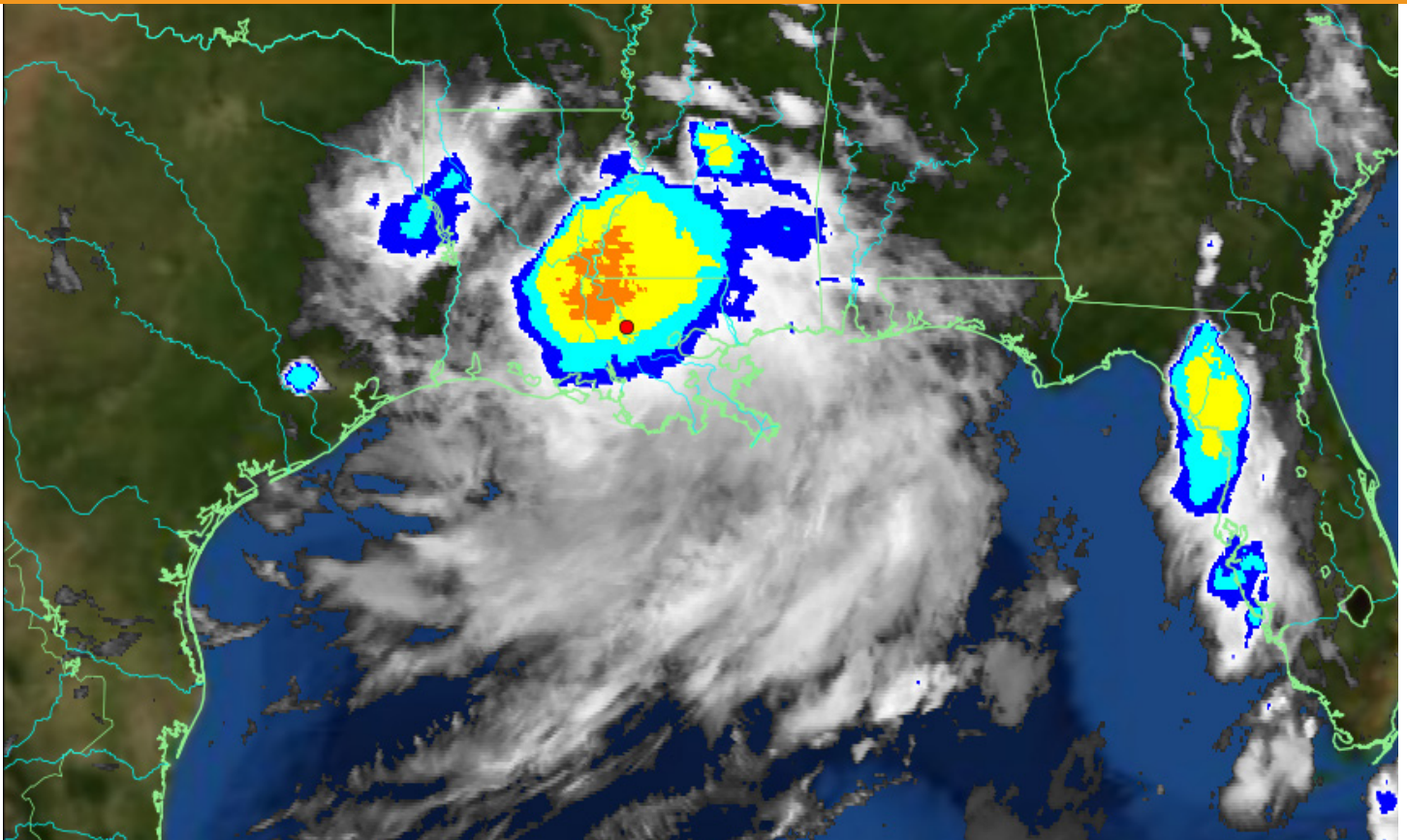
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GCOOS Data Portal

About this Product: GCOOS Data Portal Launch The GCOOS Data Portal is a comprehensive source of near real-time observations in...

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Numerical modeling and forecasting is vital for many applications in the marine environment — from ecosystem studies, to forecasting harmful algal blooms, to supporting safe navigation and search and rescue operations.

Physical ocean models, or circulation models, use powerful computers to solve mathematical equations. These equations require information regarding the waters (such as temperature and salinity), the domain (such as water depth and shorelines) and about freshwater river inputs and forcing (such as winds and solar radiation). In order to achieve useful predictions, 3-D models require a great deal of accurate data as well as computing resources.

Satellite data and measurements from coastal buoys, drifting buoys, surface and subsurface underwater drones and oil platforms are assimilated into models that cover some past time period and can be used to create "nowcasts" — predictions of the current state of the ocean that incorporate current variables or forecasts of the future state.

While a number of ocean circulation models are employed in the Gulf of Mexico at a variety of space and time scales and used for a variety of applications, they are not as comprehensive as needed. Among the improvements that can be made are more detailed (finer-grid resolution) models, more realistic ways of simulating river inputs, better atmospheric forcing fields, coupling wave and/or atmospheric models with circulation models and better targeted observations for assimilation. These

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will help to better map Gulf circulation patterns so that better predictions can be made about things as varied as hurricane movements to the trajectories of oil spills and harmful algal blooms. Additionally, coupling the physical circulation models with biogeochemical models will aid in understanding the ecosystem.

Goal 1: To routinely provide probabilistic nowcasts and forecasts as well as retrospective and so-called "re-forecasts" to allow for short- and long-term predictions of the 3-D ocean environment.

**Goal 2:** Develop information products based on nowcasts that support stakeholder needs.

Goal 3: Improve models for long-term ocean changes through forecast and modeling techniques that couple numerous variables, including patterns of ocean, air, waves and other components.

Goal 4: Develop new modeling tools and systems for the nearshore environment to provide greater protections for public health and coastal economies.

Goal 5: Build Observing System Simulation Experiments (OSSE) to demonstrate and quantify how observing systems can aid model-based analyses and forecasts.

Action Items

1. Take ensemble-forecasting into the next generation.
2. Implement model coupling techniques so that various forecast components can "exchange" information.
3. Develop adaptive sampling algorithms that direct observations to specific geographical areas to maximize forecast skill and minimize forecast error.
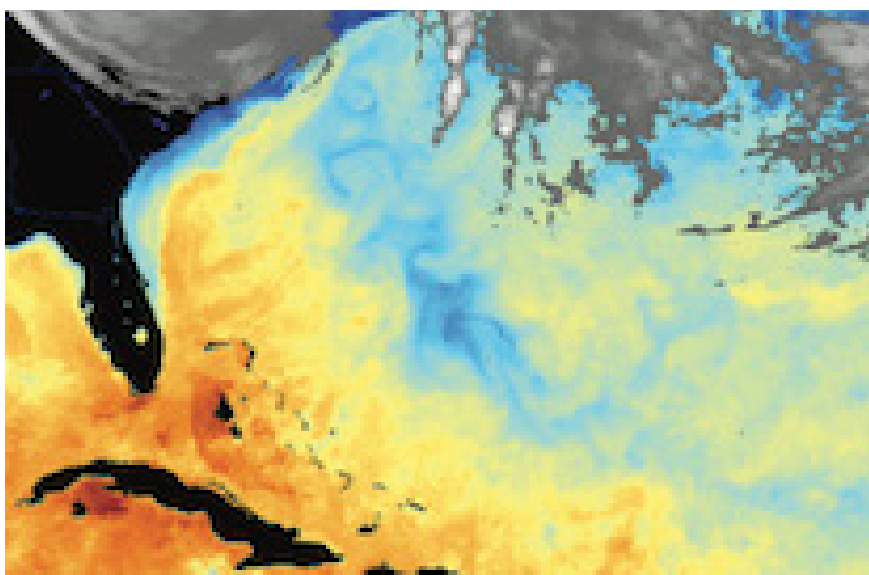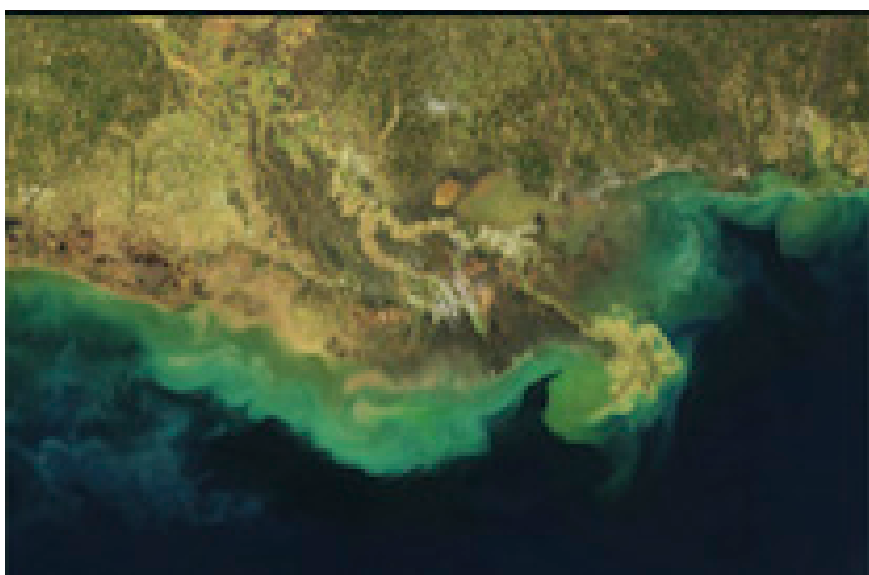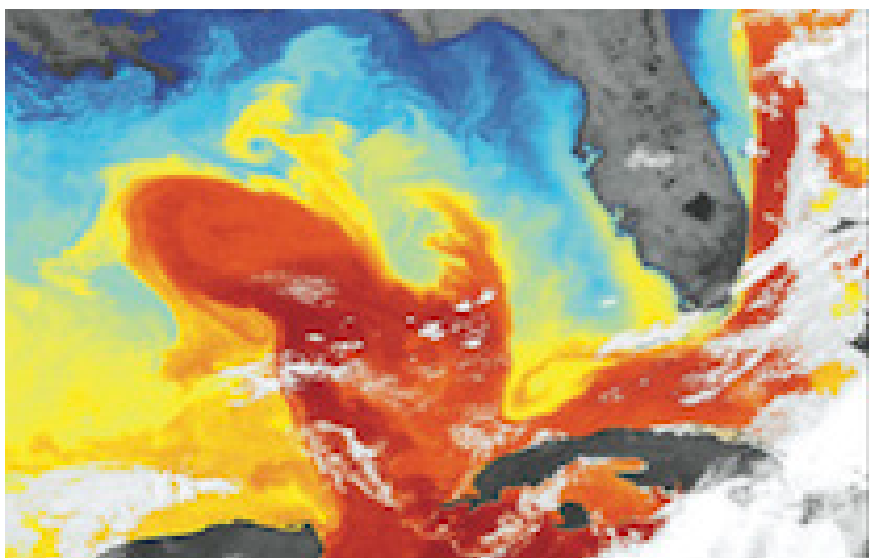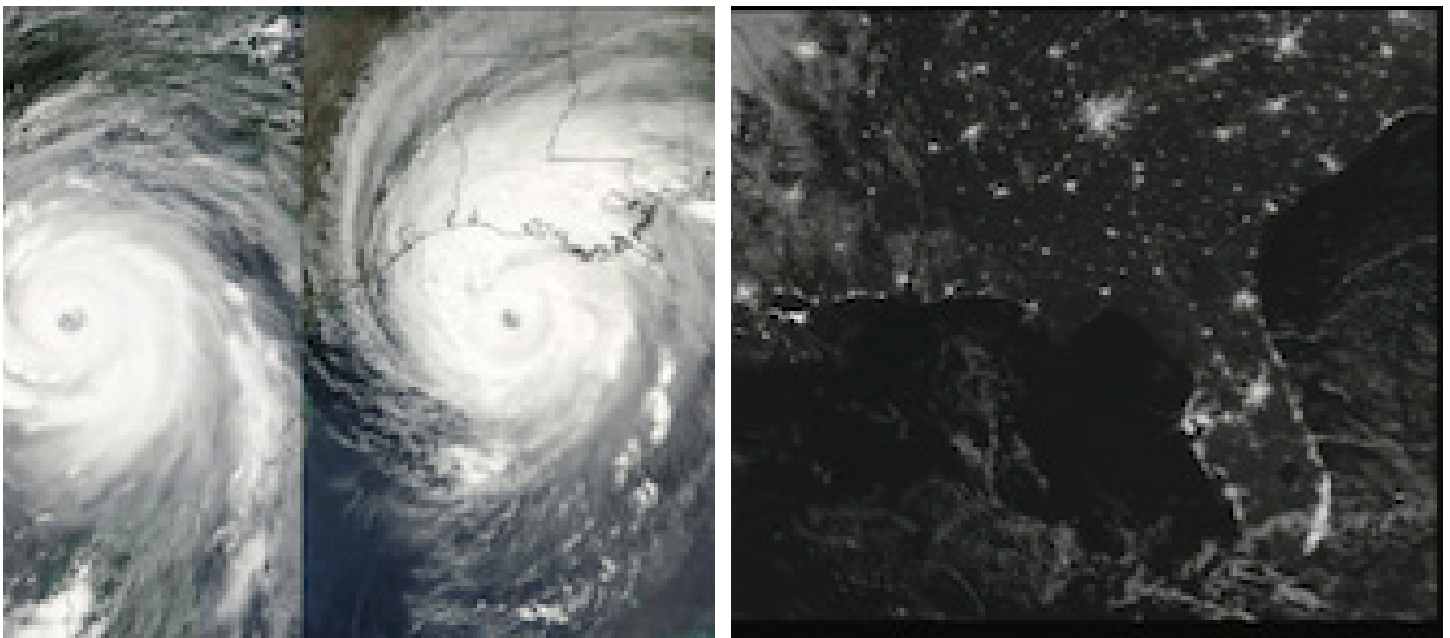
4. Fact-finding: Work with experts in the nearshore environment to understand the state-of- the-art models for wetlands, sediment transport, plume dispersion, etc., in order to integrate submodels into a single system capable of ingesting observations and generating nowcasts and forecasts.
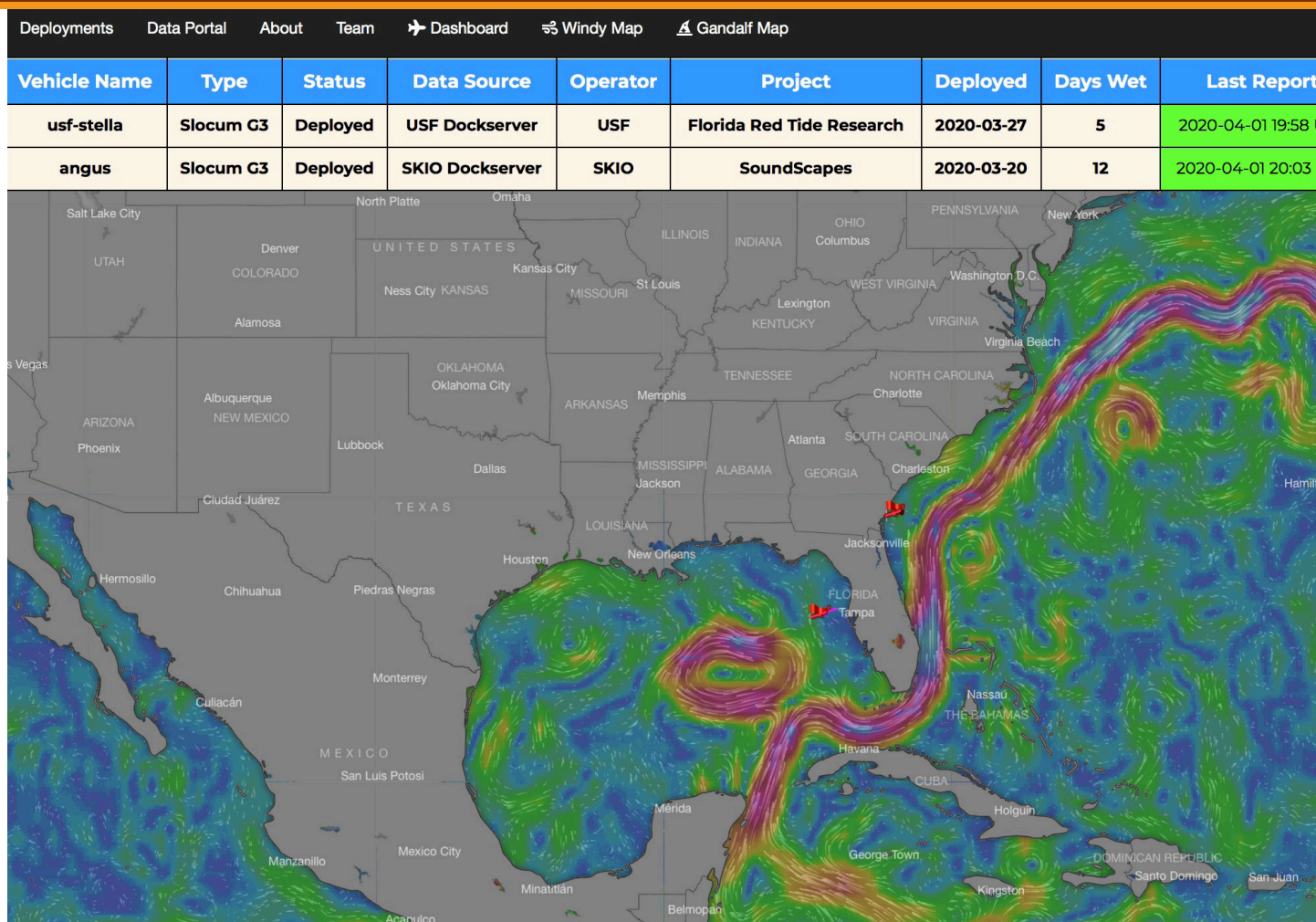
Deliverables/Metrics

*   Provide more accurate real-time analyses and forecasts of the physical, biological and ecological environment to the Gulf Coast community.
*   Use OSSE for optimal placement of limited observational assets and platforms to maximize cost-benefit and provide maximum assistance in decision-making, disaster mitigation and minimization of forecast error.
*   Link ocean analyses with models of surface and groundwater flow, wetlands, estuaries, surf-zone dynamics, coastal geomorphology and sediment transport, discharge and plume dispersion, pathogens, toxins, harmful algae and biogeochemistry.

Outcomes

*   Increased forecasting accuracy and availability over a wider temporal and spatial scale to support marine operations, coastal hazard mitigation, healthy ecosystems & living resources and human health & public safety.

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Vehicle Name	Type	Status	Data Source	Operator	Project	Deployed	Days Wet	Last Report
usf-stella	Slocum G3	Deployed	USF Dockserver	USF	Florida Red Tide Research	2020-03-27	5	2020-04-01 19:58 U
angus	Slocum G3	Deployed	SKIO Dockserver	SKIO	SoundScapes	2020-03-20	12	2020-04-01 20:03 U

Long-term environmental changes are expected to affect the frequency and intensity of storm events and the impacts such storms have on the low-lying Gulf Coast where more than 14 million people live, work and play. Over time, coasts are expected to see increasing sea level rise and storm surges, increased flooding, higher water temperatures, increased acidification of our oceans and even changing ocean current patterns. These changes may alter how ecosystems function, change shipping routes and even the availability of ports.

Yet these changes may occur in ways that are not currently observable or predictable because of the limited availability of long-term environmental datasets.

Detecting and understanding long-term change and variability in the environment are the keys to understanding how such changes will affect all sectors of society — from human health, to the health of the ocean systems we rely on. That's why monitoring changes in the Gulf environment over time is a cross-cutting theme for GCOOS.

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Strategic Plan 2020–2025

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Goal 1: Support expansion of the Marine Biodiversity Observation Network to identify changes in flora and fauna, especially in sensitive regions such as the Flower Garden Banks National Marine Sanctuary.

Goal 2: Collaborate with NOAA Fisheries, commercial and recreational fisheries sector partners to identify shifts in species type, abundance and location.

Goal 3: Collaborate with marine mammal and sea turtle researchers to identify shifts in species type, abundance and location of these protected and endangered species.

Goal 4: Support further development of the GCOOS Hypoxia/Nutrient Data Portal to assess changes in water quality over time.

Action Items

1. Develop integrated flora — from macroalgae to seagrasses — and fauna maps of the Gulf of Mexico.
2. Aggregate Gulf of Mexico fishery data into time-series maps.
3. Aggregate marine mammal and sea turtle data into centralized portal.
4. Continue to populate and maintain the Hypoxia/Nutrient Data Portal.

Deliverables/Metrics

- Outreach products that demonstrate flora/fauna location over time.
- Fishery maps identifying fishery locations and changes over time.
- Marine mammal and sea turtle maps and/or animations identifying habitat use to mitigate human conflicts and support the rebuilding of protected and endangered species.

Outcomes

- Stakeholders will have an increased understanding of the long-term environmental changes taking place in the Gulf of Mexico and of long-term trends in marine water quality and organisms, so that negative impacts can be assessed and mitigated.

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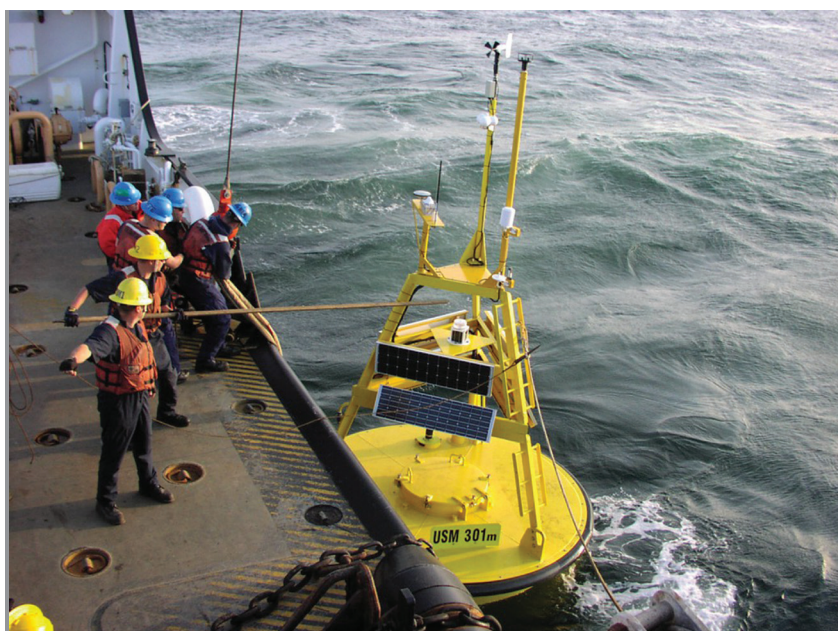
Funding the System

GCOOS is one of 11 regional observing systems under the umbrella of the U.S. IOOS, with 73 percent of the organization's funding provided by the Program Office. We should note, however, that academic, governmental and nonprofit entities throughout the Gulf of Mexico contribute the flow of their data to the GCOOS portal with minimal funding support from GCOOS. This is a testimony for the Gulf-wide belief in the need for, and importance of, an integrated observing system.

GCOOS staff works closely with the IOOS program office to determine the maximum amount of federal funds — awarded through a competitive review process — available to the organization annually.

This *Strategic Plan*, when combined with the GCOOS *Build-Out Plan*, identifies and integrates the needs — described by hundreds of Gulf stakeholders — for data, information and products into a unified whole that avoids unnecessary duplication and expenditures to fully develop a comprehensive observing system for this region.

While both this *Strategic Plan* and the *Build-Out Plan* will evolve over the coming years to meet stakeholder needs, these documents provide a roadmap for future success.

While historically our main source of funding has been the U.S. IOOS, we are actively seeking sources that will supplement this income. Currently, 27 percent of our budget is supplied by outside grants and contracts and we expect that future funding required to fully implement the *Build-Out Plan* will come from a variety of sources.

"The ocean observing system is nowhere as comprehensive as would be [preferred]. And it would be extraordinarily valuable in this instance to be able to understand in a more dynamic sense, for example, what the Loop Current is doing beneath the surface and what the flows are at different depths. We have a general understanding, but nowhere near what would be useful."

— Dr. Jane Lubchencho, former NOAA Administrator, speaking to news reporters after the Deepwater Horizon spill.

Much time and effort is required to cultivate the types of relationships that may lead to the expansion of the GCOOS. However, there is a potential major source that could support some of the build-out activities: The funds created following the Deepwater Horizon disaster of 2010. These monies have been dedicated to supporting research and restoration activities following the spill.

However, we strongly believe that it is crucial to direct some of these funds to expanding observation capabilities in the Gulf of Mexico so that we may be prepared for future spills and disasters. With more than 4,000 permitted platforms in the Gulf — and more expected in the future — the time to prepare is now so that we can avoid huge financial and human costs from a future event.

There are a number of potential ways to support a comprehensive Gulf observing system, including:

1. Direct support to GCOOS partners that are supporting implementation of the *Build-Out Plan*;
2. Direct support of GCOOS, which would then subcontract with appropriate partners for implementation;
3. Funding through partner federal agency budgets;
4. In-kind activities of partners.

Regardless of the funding path, the following two actions must occur for successful implementation of the GCOOS *Build-Out* and *Strategic* plans:

- All data from the observing system should be submitted to the GCOOS data portal so that it can be freely distributed.

- Information relevant to implementation of the system should be submitted to the GCOOS-RA office so that progress toward achieving the full plan can be monitored and reported.

Millions of people call the Gulf Coast home and use the Gulf of Mexico for recreation, employment and enjoyment. Implementing this *Strategic Plan* will provide the information people need to make informed decisions on multiple scales — from deciding when and where to take their families to the beach, to providing safe passage of cargo and pleasure craft into and out of our harbors, to understanding the changes in our coastal water quality.

We need support to make the GCOOS *Strategic Plan* a reality. If you are not a member of the GCOOS-RA, please join. If you are a member, please consider contacting your local, state or federal officials to help them understand the need for a fully realized coastal and ocean observing system.

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GCOOS Build-Out Plan
Version 2.1

A Sustained, Integrated Ocean Observing System
for the Gulf of Mexico: Infrastructure for Decision-Making

GCOOS Regional Association
Board of Directors
and
GCOOS Office Staff

Comments welcome. Send to barb.kirkpatrick@gcoos.org.

27 January 2015

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Version 2.1

**A Sustained, Integrated Ocean Observing System for the Gulf of Mexico (GCOOS):
Infrastructure for Decision-making**

1.   **Executive Summary**

The US Gulf of Mexico coastline extends from the Florida Keys westward to the southern tip of Texas, encompassing over 17,000 miles of shoreline in five U.S. states: Texas, Louisiana, Mississippi, Alabama and Florida. This region provides our Nation with many valuable resources: energy from oil, gas, wind and waves; abundant seafood; major ports and transportation waterways; beautiful beaches and extraordinary recreational activities; and vibrant coastal communities. The region has rapid population growth, expanding jobs, and a strong economy.

The **Gulf of Mexico Coastal Ocean Observing System** (GCOOS) is being developed to address a variety of societal needs that are crucial to protecting and preserving this incredible ecosystem while still providing rich natural resources.

GCOOS activities are organized around themes that illustrate the broad, beneficial uses of the observing system activities. A clear link is made between the socioeconomic themes of GCOOS and the required observing system elements. Additionally, numerous serious issues threaten the marine ecosystem and quality of life that residents and visitors to the Gulf currently enjoy. Seeking to mitigate the vulnerability of the ecosystem and community infrastructure to risks to life and property, the major societal goals of the GCOOS-RA are:

- *Safe and Efficient Marine Operations*
- *Mitigation of Effects of Coastal Hazards*
- *Public Health and Safety*
- *Healthy Ecosystems and Water Quality*

In addition the GCOOS can provide information needed for ecosystem assessment and restoration following natural or man made disasters.

The Subsystems of GCOOS

- **Governance and Management** of GCOOS by a Regional Association must**:** identify user needs, engage new data providers, plan and implement the regional observing system, evaluate gaps in meeting needs and collaborate with other regional entities having related objectives.
- **Ocean Observing** is designed: to observe the state of the coastal ocean and associated ecosystem from heads of tide to limits of the U.S. Exclusive Economic Zone to meet societal goals.
- **Data management** links the observing, modeling and analysis, and outreach and education elements to meet stakeholders' needs for data and information on the environmental state of the U.S. coastal ocean of the Gulf of Mexico through a web-based data portal and a products generation unit, and freely delivers high quality data and products to users
- **Modeling and Analysis** is designed to improve our ability to know the coastal ocean conditions and state of the ecosystem now and to forecast those in the future, as they respond to natural and human caused changes.

- **Outreach and education** trains the teachers, provides materials that will achieve ocean and climate literacy in and out of the classroom and helps the public toward an enhanced understanding of the coastal ocean and its ecosystem.
- **Research and Development** informs the research community of current and future needs for knowledge and technology.

This plan addresses the key elements deemed needed as parts of the GCOOS in order to address the societal needs discussed above. Some observing system elements have a long history of use; others involve newer and developing capabilities (e.g., autonomous monitoring of biogeochemical parameters). So we use a hybrid approach in selecting the observing system elements. Some focus on monitoring platforms: moorings, others on observing subsystems, others on the measurand, and at least one on a particular class of instrumentation. One thing that all elements of the plan have in common is that there were selected to respond to the articulated stakeholder needs. The elements chosen are:

- Surface currents and waves network
- Mooring Network
- Autonomous Meteorological Measurement Network
- Gliders and Autonomous Underwater and Surface Vehicles
- Satellite Observations and Products
- Aircraft Observations and Unmanned Aerial Systems
- Bathymetry and Topography Mapping
- Enhanced Water Level Network
- Enhanced Physical Oceanography Real-Time Systems
- Ecosystem Monitoring
- Harmful Algal Bloom Integrated Observing System
- Integrated Water Quality Monitoring Network and Beach Quality Monitoring
- Hypoxia Monitoring
- Monitoring of River Discharge to the Gulf
- Circulation Modeling
- Ecosystem Modeling
- Data Management and Communication Subsystem
- Outreach and Education Subsystem

Additionally, the governance of the GCOOS Regional Association is an important element of the sustained, integrated observing system. A 20th element is continuing identification of stakeholder needs for data and products. The current status of such identification is contained in Appendices A and B of the plan.

We use several approaches to obtaining stakeholder priorities for measurements and derived products. (1) We hold workshops for specific stakeholder communities (e.g., recreational boaters, emergency managers, or petroleum producers) to identify with priorities the measurements and products needed by the specific community. We have held seventeen workshops involving 631 participants representing 297 distinct organizations. At least fifty other individuals have contributed via mail. These workshops are listed in Appendix C.

(2) We incorporate inputs from guiding documents such as: planning documents prepared by the Gulf of Mexico Alliance or the Southeast Coastal Ocean Observing Regional Association; A Network Gaps Analysis for the National Water Level Observation Network (Gill and Fisher 2008) produced by the National Ocean Service; priority actions recommended to NOAA by the Hydrographic Services Review Panel as necessary to maintain and improve a competitive U.S. Marine Transportation System; environmental data needs for U.S. Coast Guard's search and Rescue Optimal Planning System; or the IOOS plan for a national high-frequency radar network. Thirty-two national, regional or local documents have been reviewed and considered. In this manner the needs of many different stakeholder sectors are

incorporated into our overall planning.

(3) We use advice from the groups comprising the organizational structure of the GCOOS-RA: the Board of Directors, Councils, Committees and Task Teams. These groups consist of people from many different stakeholder sectors of the private, governmental, and academic communities, so the advice given is a realistic representation of many different sectors and contributes to the determination of priorities. Meetings of these groups are listed in Appendix C.

We are committed to freely share data, model output, and products via the Internet for the common benefit of all participants, including industry, NGOs, academia, federal, state, regional, and local government agencies and the public. It is understood that this Gulf of Mexico observing system will be integrated with other regional coastal ocean observing systems, in particular to create an integrated and sustained component of the U.S. Integrated Ocean Observing System.

This build-out plan is divided into phases because we recognize that the system will require start-up and sustained financial support from a combination of government, private, and non-governmental organizations. That will be possible only if the system is built and remains responsive to the needs of these organizations and to the public. Thus, the system will be subject to continuing oversight by representatives of such organizations and of the public.

It also is understood that the GCOOS-RA alone cannot fully implement and maintain this observing system. We welcome and will assist with the participation by all participants committed to developing and maintaining a system for all stakeholders.

This document describes a full build out for the observing system. The body of the report gives summaries of all the needed elements for the full plan. Appendix D gives suggested initial enhancements to the Gulf observing system. Those enhancements are a selection of observing stations and activities that fill the most important gaps in the existing observing system at a relatively modest cost. The estimated cost is ~$35M for capital equipment and ~$33M per year for replacement and maintenance. This initial enhancement, while a substantial step forward, is really just a foundation and ultimately should be expanded into the full plan.

The full plan may be viewed via Appendix E containing links to detailed descriptions of each element of the plan. Because of the importance of ecosystem monitoring and observations, an expanded description of that element is given as Appendix F.

The Gulf of Mexico is a precious and important U.S. resource. Many short-term and long-term management and other stakeholder decisions are based on limited information. The Deepwater Horizon disaster was a vivid illustration both that GCOOS assets are extremely valuable, and that the ocean observing and information system in the Gulf needs enhancement. The plan that follows would build-out the GCOOS system to a level that can meet the major information needs identified by a wide range of Gulf stakeholders.

This is Version 2.1 of the Build-out Plan. It will evolve over the coming years to meet stakeholder needs.

See the full GCOOS *Build-Out Plan* online at:

https://bit.ly/2R2M3CC

Become a GCOOS Member

The GCOOS Regional Association is one of 11 that comprise the U.S. Integrated Ocean Observing System (U.S. IOOS), created to track, predict, manage and help us adapt to changes in our oceans, along our coasts and in our Great Lakes. Members come from industry, academia and governmental and nongovernmental organizations.
Email **Barb.Kirkpatrick@GCOOS.org** to join.

Aanderaa Instruments, Xylem
Alliance for Coastal Technologies, Gulf of Mexico Partner
Aquatrak Corporation
Audubon Nature Institute
Barataria-Terrebonne National Estuary Program
Bureau of Ocean Energy Management
CB&I Coastal and Maritime Services
CB&I Coastal and Maritime Services
National Data Buoy Center
Chevron Energy Technology Company
COAPS, Florida State University
Conrad Blucher Institute, TAMUCC
Cousteau Divers
CSA Ocean Sciences Inc.
Dauphin Island Sea Lab
Dialytics, Inc.
Exocetus Development LLC
Fish and Wildlife Research Institute
Florida COOS Consortium
Florida Department of Environmental Protection
Florida Institute for Human and Machine Cognition
Florida Institute of Oceanography
Florida International University
Florida Sea Grant Program
Forristall Ocean Engineering, Inc.
Fototerra Aerial Survey, LLC
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Gulf of Mexico Alliance
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Mississippi Department of Marine Resources
Mississippi Enterprise for Technology, Inc.
Mississippi State University
Mississippi-Alabama Sea Grant Consortium
Mote Marine Laboratory and Aquarium
Nature Coast Biological Station, University of Florida
The Nature Conservancy
Nature's Academy
Naval Research Laboratory
Navarre Beach Marine Science Station
New College of Florida
NOAA-NCEI
NortekUSA, LLC
Nova Southeastern University Oceanographic Center
Optical Oceanography Laboratory, USF
Oyster Sentinel
PAR Government Systems Corporation
Radiance Technologies, Inc.
RDSEA
Roffer's Ocean Fishing Forecasting Service
Rookery Bay NERR
RPS Evans Hamilton, Inc.
Sanibel-Captiva Conservation Foundation

SeaTech, Florida Atlantic University
Secrets of the Sea Marine Exploration Center and Aquarium (Pier Aquarium)
Shell Global Solutions US Inc.
Shreveport Sail & Power Squadron
Society for Underwater Technology
SRI International
START (Solutions To Avoid Red Tide)
Subsea Technologies
Summer Vacation Charters
Tampa Bay Estuary Program
Tampa Bay PORTS
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ThinkBlue Solutions LLC
Titan Partners
TowBoat U.S. Tampa Bay to Crystal River
Tulane/Xavier Center for Bioenvironmental Research and LEAG
University of Florida
University of Louisiana at Lafayette
University of Miami – Rosenstiel School
University of Miami Center for Computational Science
University of South Florida, College of Marine Science
The University of Southern Mississippi
University of Texas Marine Science Institute
U.S. Environmental Protection Agency Gulf of Mexico Program
U.S. Geological Survey (USGS)
Vencore Services & Solutions, Inc.
WeatherFlow Inc.
Woods Hole Group, Inc.

Gulf of Mexico Coastal Ocean Observing System
3146 TAMU | College Station | TX | 77843-3146
979-845-3900 | Online at gcoos.org | email info@gcoos.org

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The sun sets behind a high-frequency radar installation at the mouth of the Mississippi River. GCOOS was able to support the installation of this radar and another thanks to NOAA-IOOS funding designed to fill gaps in ocean observing capabilities and coverage.