



IOOS

Integrated Ocean
Observing System

U.S. IOOS ENTERPRISE STRATEGIC PLAN 2018-2022

ioos.noaa.gov

Letter from the Director



*Carl C. Gouldman, Director,
U.S. Integrated Ocean Observing System*

It's been nearly 20 years since we started our endeavour and almost a decade since the passage of the Integrated Coastal and Ocean Observation System (ICOOS) Act, which formalized the commitment in the United States to build the U.S. Integrated Ocean Observing System (IOOS) to service the nation's need for ocean data and information in support of weather forecasting, national security, maritime commerce, and more.

In that time, we've accomplished a lot. We've proven the fundamental concepts of integrating data, modeling, and information from many sources into a national ocean observing system with non-federal regional components prioritizing each region's needs. We have done this

through collaboration, development of community-sourced standards, and coordination with other national and global observing systems. We continue to build System capabilities to carry those fundamentals into the future and show the benefits by continuing to meet stakeholder needs every day. IOOS supports national safety priorities, delivering high-resolution wave data and oceanographic information to build better marine weather forecasts, and improving harmful algal bloom forecasting abilities in partnership with other NOAA programs. IOOS supports a stronger economy, uniting public and private resources to build new technologies and spur the blue economy, and unifying diverse observing efforts across the country through best practices and communication. IOOS is a strong and vital partner for navigation and port operations, operating the U.S.'s only high-frequency radar network to measure surface currents and expanding observing networks in high-traffic areas to enable greater precision in navigating busy waterways. For all these reasons and so many more (we've got a website you can check out for the "more"), IOOS is an essential partner for our strong nation to keep thriving.

One of the things that makes IOOS uniquely suited to meet these goals and serve both public and private interests is its structure, which we call the U.S. IOOS Enterprise. The Enterprise is the synthesis of the local-national-global reach and consists of not only 17

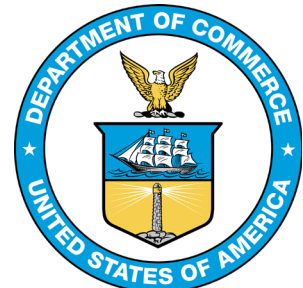
interagency federal partners, but also 13 non-federal Regional and Functional Associations, the Interagency Ocean Observation Committee (IOOC), the IOOS Association, the IOOS Advisory Committee, and connections to the Global Ocean Observing System (GOOS). It's these elements, working together toward shared goals and objectives, that make IOOS the robust, agile System that it is today and why this document encompasses the full Enterprise.

From transitioning new research to operations to supporting safe cargo transits in our booming ports to expanding and improving access to open data and supporting development of new observation systems worldwide, we're proud of what we have accomplished, and looking forward to what we'll accomplish together in the future.



Carl C. Gouldman
Director, U.S. IOOS

This document has been reviewed and approved for release by the office of the Assistant Administrator for the National Ocean Service of the National Oceanic and Atmospheric Administration within the U.S. Department of Commerce.



Foreword

The U.S. Integrated Ocean Observing System (IOOS) is a globally linked and nationally coordinated federal and non-federal network of observations and data management, analyses and communications that systematically and efficiently delivers information on past, present, and future states of the coastal ocean. The IOOS “Enterprise” is intended to represent the full scale of partners who may be contributing to, or benefitting from, the integrated ocean observing system. This includes global to local participants in ocean observing, data management and prediction from federal, academic, non-profit, and private firms or organizations. The IOOS Enterprise represents the inclusive mission of U.S. IOOS as defined by the Integrated Coastal and Ocean Observation System Act of 2009. Any entity contributing toward solutions or implementation of IOOS is welcomed as a part of the Enterprise.

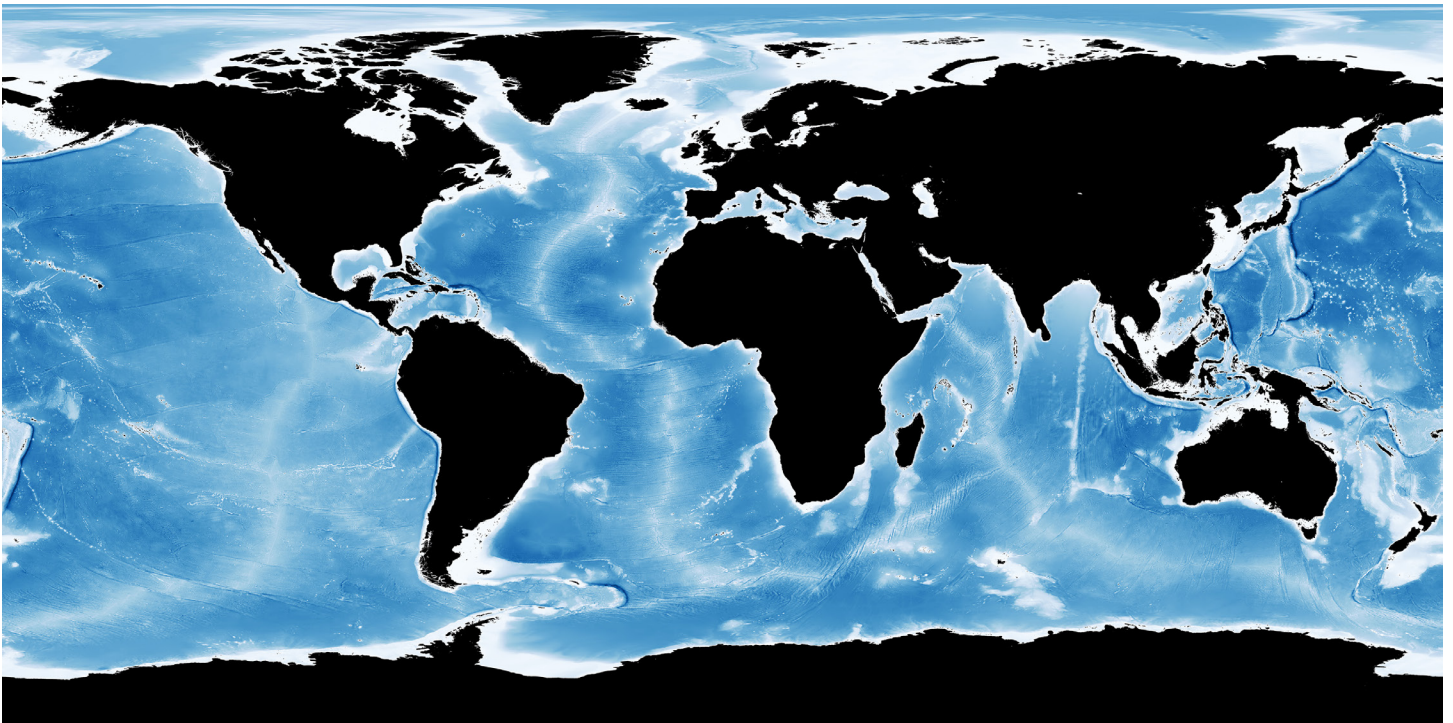
The need for a coordinated, centralized coastal observing system has long been recognized as a priority to maximize the nation’s investments. Decades of advocating, coalition building, and planning led to the establishment of IOOS. The IOOS Program was established in NOAA’s National Ocean Service in 2007, and was authorized by Congress in 2009 by the Integrated Coastal and Ocean Observation System Act. The ICOOS Act mandates the establishment of a national integrated system of ocean, coastal, and Great Lakes observing systems, coordinated at the federal level, to benefit society. Today, the U.S. IOOS Enterprise is a culmination of coastal observing activities coordinated at the national scale. But decades of maturation have advanced IOOS as a regional and national endeavor resulting in advancement of the coastal observing systems and success for the entire community.

Info Box 1 IOOS SOCIETAL BENEFITS

IOOS meets the nation’s need for ocean coastal, and Great Lakes information by integrating across seven societal benefit areas.

- Improve predictions of climate and weather and their effects on coastal communities and the nation;
- Improve the safety and efficiency of maritime commerce;
- More effectively mitigate the effects of natural hazards;
- Improve public safety and national and homeland security;
- Reduce public health risks;
- More effectively protect and restore healthy coastal ecosystems; and
- Enable the sustained use of ocean and coastal resources.

Through this strategic plan, IOOS will integrate across five goals, which address IOOS core and emerging capabilities of observation, data management and communication (DMAC), modeling and analysis, user-driven products and tools, and Enterprise excellence. IOOS evaluates end user and stakeholder needs to prioritize mature and emerging observing systems and DMAC capabilities. The Enterprise will continue to infuse emerging technology into operations, resulting in a more efficient and advanced ocean, coastal, and Great Lakes observing system. This strategic plan is the first step in achieving a more coordinated, efficient, and advanced Enterprise. Next steps include implementation planning and the development of measures of success. Once implemented, IOOS will become the premier source of high quality ocean, coastal, and Great Lakes information that meets the safety, economic, and stewardship needs of the nation.



Bathymetric image of the world. Credit: Imagery by Jesse Allen, NASA's Earth Observatory, using data from the General Bathymetric Chart of the Oceans (GEBCO) produced by the British Oceanographic Data Centre.

Vision

Improve lives and livelihoods with ocean, coastal, and Great Lakes information

Mission

To produce, integrate, and communicate high quality ocean, coastal, and Great Lakes information that meets the safety, economic, and stewardship needs of the nation.



Credit: GCOOS



Credit: CARICOOS

Guiding Principles

Stakeholder-driven,
science-based, and policy
neutral

Nimble, responsive
services support diverse
and evolving priorities
and end-user needs

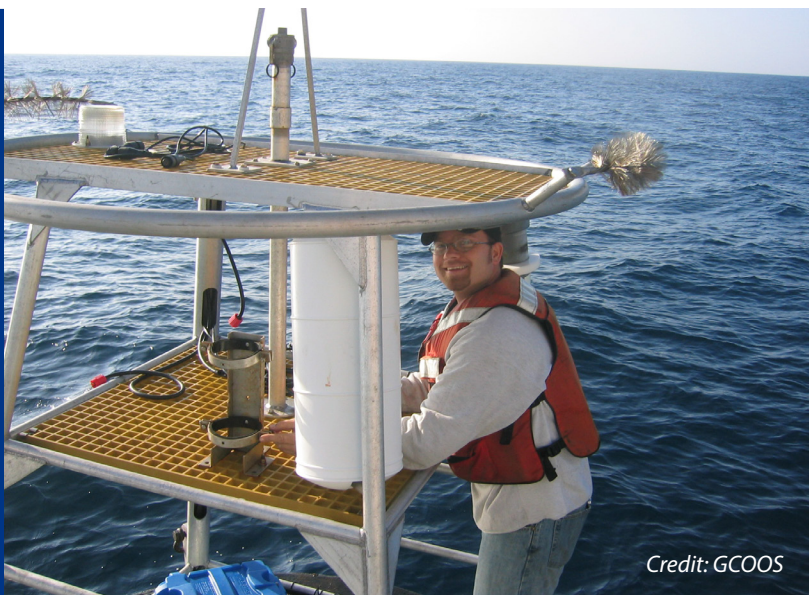
Leveraged resources
and innovation produce
efficient, sustainable
observing systems

Integrated, high quality,
and reliable data

Easy and open
exchange of information

Networks of people,
technology, and
information

Productive public-private
partnerships



Credit: GCOOS



Credit: NOAA

Goals and Objectives

Goal 1

Sustain long-term, high-quality observations of ocean, coastal, and Great Lakes environments to address local, regional, and national needs.

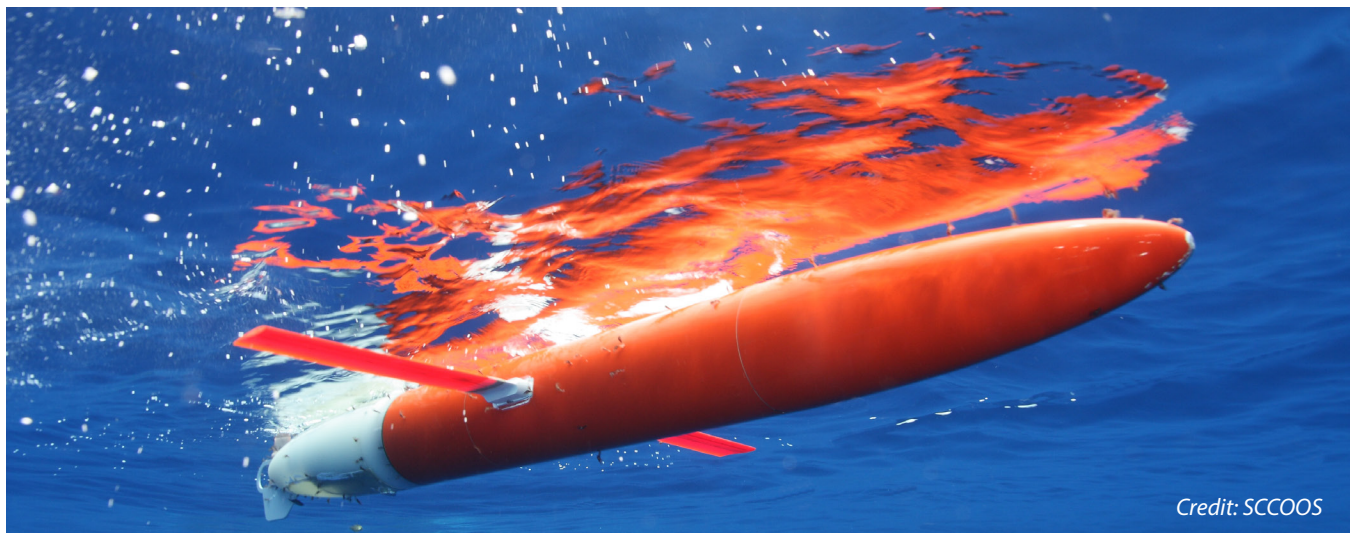
Background: Sustained observations of coastal, ocean, and Great Lakes systems are critical for the nation's economy and security. U.S. IOOS, with its regional and federal partners, supports an integrated system that combines in situ (e.g., moorings, gliders, and shore stations) and remotely sensed platforms (high frequency radars (HFR) and satellites) to observe the range of physical, biogeochemical, and biological parameters necessary to meet an array of user needs. The national network of regional associations enhances the ability of federal agencies to provide tailored information at the scale needed to solve national issues that manifest at the regional and local level. Wave buoys and HFR systems provide vital wave height, wind speed, wind direction, and surface current information to support safe navigation, recreation, and efficient commerce. Biological and ecological observing activities support a prepared and productive nation empowered to predict and manage for harmful algal blooms (HABs), hypoxia, acidification, and temperature anomalies, and to understand marine biodiversity and animal movement. IOOS fosters the development and adoption of effective and reliable new technologies that address user needs in a cost-effective and reliable manner through the regional associations, the Alliance for Coastal Technologies, and the Ocean Technology Transition program. U.S. IOOS facilitates collaboration and leveraging of resources among its many public and private partners to promote efficiencies, cost savings, and increased return on investment.



Credit: Jacobsen Pilots

Goal 1 Driver: Ocean and coastal observations are difficult to sustain, operate, and maintain over long timeframes. Public support is often directed to new, emerging marine initiatives and technologies. To sustain the Enterprise, IOOS must balance the maintenance and operation of the mature observing system while expanding the system to tackle emerging societal issues.

- Objective 1.1** Leverage investment to improve system efficiencies, identify synergies, and provide common platforms to execute various missions.
- Objective 1.2** Sustain and operate a national network of regional observing systems comprised of multidisciplinary observations from a variety of technologies.
- Objective 1.3** Fill critical gaps in the nation's observing networks to address high priority national and regional needs and improve coverage of regional coastal observing systems.
- Objective 1.4** Incorporate innovative technologies to address existing and emerging needs and transition proven technologies to operational use or other applications.



Info Box 2

IOOS CORE VARIABLES¹

PHYSICS

- Bathymetry
- Bottom character
- Currents
- Heat flux
- Ice distribution
- Salinity
- Sea level
- Surface waves
- Stream flow
- Temperature
- Wind speed and direction

BIOGEOCHEMISTRY

- Acidity
- Colored dissolved organic matter
- Contaminants
- Dissolved nutrients
- Dissolved Oxygen
- Ocean color
- Optical properties
- Pathogens
- Partial pressure of CO₂
- Total suspended matter

BIOLOGY & ECOSYSTEMS

- Biological vital rates
- Coral species and abundance
- Fish species/abundance
- Invertebrate species and abundance
- Marine mammal species/abundance
- Microbial species/abundance/activity
- Nekton diet
- Phytoplankton species/abundance
- Sea birds species/abundance
- Sea turtles species/abundance
- Submerged aquatic vegetation species/abundance
- Sound
- Zooplankton species/abundance

¹ Updated list includes Biological Integration and Observing (BIO) Task Team recommendations from 2016.

Goal 2

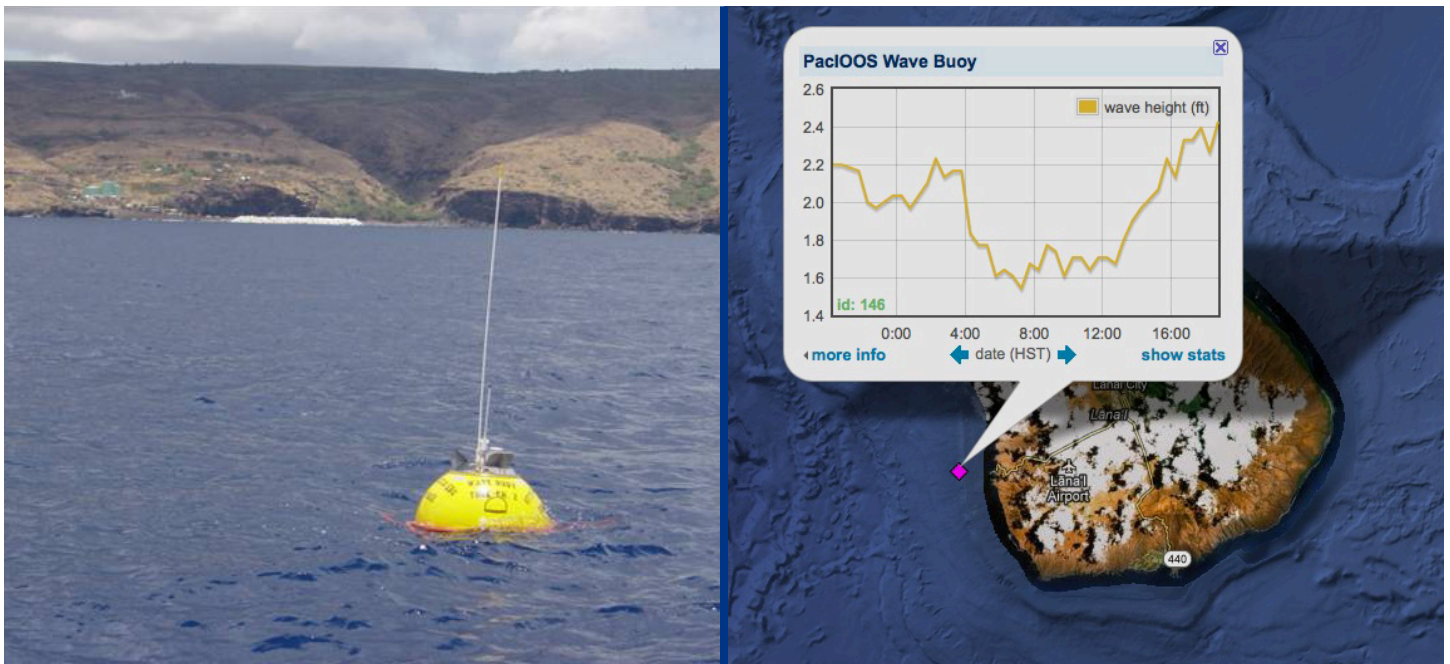
Deliver standardized, reliable, and accessible data.

Background: Ocean, coastal, and Great Lakes data are produced by a complex network of public and private partners. IOOS Regional Associations ingest, store, and host data from buoys and moorings, high frequency radar systems, gliders, and even animals equipped with oceanographic sensors, with a priority on local and regional needs. IOOS national data management activities include assimilating these data at a national scale, operating functional Data Assembly Centers for specific data types, and long-term archiving. Collectively, IOOS data are provided at both national and regional scales via standard web services allowing for interactive maps and applications, and individual Regional Association portals. Regardless of the data source, IOOS strives to ensure that all data are clearly attributable, meet quality standards, and are interoperable to deliver the information that end-users and stakeholders trust and value. Improving data access, delivery, and archiving to meet operational needs will continue to increase the functionality and value of IOOS data systems.



Goal 2 Driver: Ocean, coastal, and Great Lakes data come from a variety of systems, in many formats, and is available through a number of Web-based sites. IOOS strives to simplify and streamline integrated data access and discovery by providing data sources at regional and national scales.

- Objective 2.1** Promote standardization, automation, discovery, and access of data.
- Objective 2.2** Strengthen data stewardship to improve data quality, access, attribution, exchange, delivery, and storage across federal agencies and regional partners.
- Objective 2.3** Provide data infrastructure at the regional level through trusted, certified regional data centers to increase the availability, interoperability, and use of high quality data.
- Objective 2.4** Support ongoing maintenance and operation of data management systems to sustain long-term data stewardship.
- Objective 2.5** Create, maintain, and expand the capacity of functional data assembly centers as go-to data sources through collaboration with IOOS, National Data Buoy Center, National Centers for Environmental Information, and other partners.

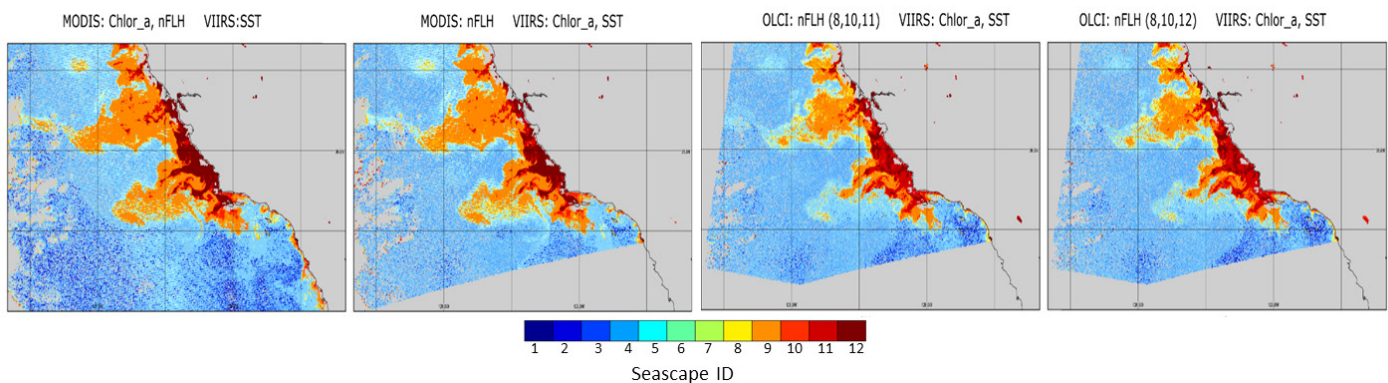


PacIOOS's Lanai wave buoy in the water (L) and as seen on their Voyager data portal (R).

Goal 3

Support model predictions that address a wide range of user requirements.

Background: Models aid our understanding of ocean circulation and properties over various timescales. Models are an integral part of the IOOS, providing the ability to predict conditions and events. Modeling and analysis allows for interpolation, interpretation, and prediction of the environment and is highly valuable when available observations are limited. Many of the IOOS regions support modeling efforts for maritime commerce and safety, ecological forecasting, and water levels by providing an important link between NOAA, federal partners, and regional modeling capabilities. Sustained development of modeling capabilities and the application of models to enhance the design and operation of observing systems are vital components of a truly integrated system. IOOS endorses NOAA's Unified Modeling Framework to support interoperability and to more efficiently integrate systems across disciplinary boundaries. The Environmental Data Server is a platform for NOAA and other federal and nonfederal partners to test models. IOOS regional models integrate cross-disciplinary, cross-platform data from diverse partners to improve predictions of coastal, ocean, and Great Lakes phenomena. IOOS is bridging the gap between ocean and terrestrial systems through model integration involving riverine inputs, currents, storm surge, and coastal inundation.



IOOS is partnering with NASA and NESDIS to operationalize MBON satellite seascapes, which integrate multidisciplinary data, map changing ocean conditions, and forecast habitat-species interactions.

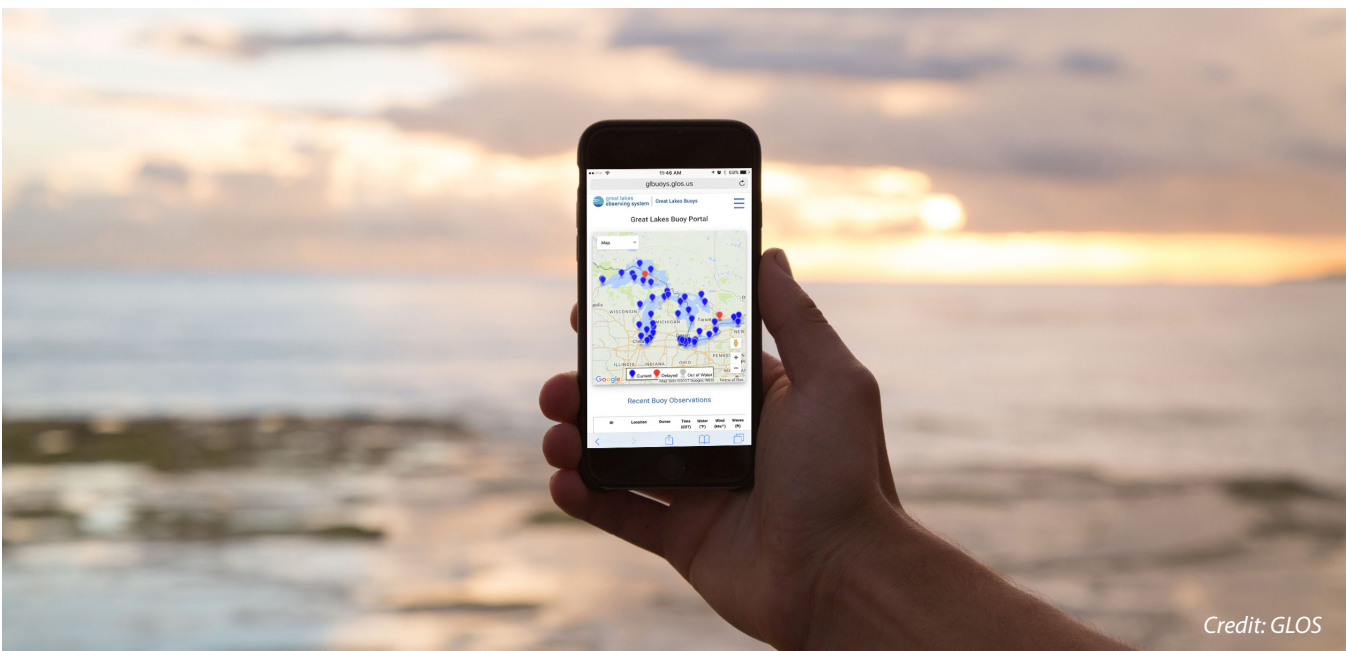
Goal 3 Driver: Data from observations alone do not go far enough to address stakeholder needs for actionable information. Numerical modeling bridges the divide between data and information by extracting relevant information for end-users, informing modelers on tool accuracy, and allowing resource managers to design optimal observing systems. IOOS supports a vibrant modeling community devoted to innovating models to link coastal to global phenomena.

Objective 3.1 Continually develop and sustain research and community models and model-based products to provide information needed by regional stakeholders.

Objective 3.2 Transition select IOOS partner models from research to operations through the Coastal and Ocean Modeling Testbed (COMT) and/or regional associations as demonstration environments and proving grounds.

Objective 3.3 Assess model skill and advance data assimilation through data delivery, technical advancement, and regionally led research to improve model accuracy.

Objective 3.4 Advance modeling approaches to inform decisions on the design and implementation of optimal observing systems and maximize the use of regional observations.



Credit: GLOS

Goal 4

Provide integrated, user-driven products and tools.

Background: IOOS supports a variety of portals and visualization tools to translate data into usable products to promote data analysis and support decision-making. Regional associations work with local stakeholders to understand how and why they use information and to create data products that are accessible and easy to use. Regional products support preparedness and response to hurricanes, hypoxia, HABs, red tide, and other water quality criteria enabling everyday decision-making. Wind, wave, and water level forecasts support safe and efficient transportation, navigation, and marine commerce. Identifying and understanding ocean variability, chemistry, and upwelling hot spots allows resource managers and industry to make informed decisions. Biodiversity and animal movement products support ecosystem assessments, management and use, sanctuary condition reports, fish stock assessments, and compliance with protected species laws.

Goal 4 Driver: The translation of observations into meaningful information products requires the integration of variable and complex data with models and a focus on stakeholder requirements.

Users with regionally or topically specific needs often require focused integrated, user-friendly decision support tools.

- Objective 4.1** Develop regionally relevant, user-driven analysis, decision-support, and visualization products and tools to address historic and emerging stakeholder requirements.
- Objective 4.2** Generate and disseminate pan-regional products and tools to respond to environmental issues and seasonal hazards that span larger areas.
- Objective 4.3** Create national products that incorporate cross-disciplinary data to provide a single, user-friendly access point to integrated information.
- Objective 4.4** Promote IOOS products on international and cross-institutional scales to optimize usage and relevance.

Goal 5

Increase the reach and effectiveness of IOOS through partnerships, stakeholder engagement, and investment in Enterprise excellence.

Background: IOOS is a “system of systems” that links local and regional observing to the national and global level through the IOOS Program Office, the Interagency Ocean Observation Committee and the Global Ocean Observing System. To ensure partners effectively contribute to U.S. IOOS, and to link to other national and global observation systems, the U.S. IOOS maintains strong connections to, and understanding of, U.S. IOOS partners. IOOS works collaboratively, both within NOS and across NOAA line offices and Interagency Ocean Observation Committee agencies, to coordinate efforts, share information, and address changing observing requirements. In order to fulfill the need for coastal and ocean information, IOOS pursues outreach and education to new audiences, including federal, state, and local governments, tribal communities, private and nonprofit sectors, and academia to fill gaps, develop information products, and to address emerging needs.



Goal 5 Driver: IOOS partners are distributed across federal and state agencies, nongovernmental organizations, and private industries around the country. Coordination and communication is essential for success. IOOS relies on balanced and robust partnerships built on trust and a shared mission. We work closely with the national network of regional associations to develop and nurture these relationships on a regional and national level. As stakeholder needs evolve over time, IOOS partnerships must remain nimble and transparent through effective communications and engagement to remain a cohesive and effective Enterprise.

- Objective 5.1** Engage stakeholders to gather customer feedback and refine requirements for IOOS products and services.
- Objective 5.2** Increase the operational effectiveness of federal, state, and other partner investments to support regional, national, and global activities and innovative research
- Objective 5.3** Expand and strengthen the network of partnerships with new and existing stakeholders, especially industry and federal partners, to innovate ocean observations and information products.
- Objective 5.4** Empower communities of practice to expand observing capabilities and expand expertise.
- Objective 5.5** Foster the next generation of science, technology, engineering, and math specialists through targeted education, training, and research opportunities.
- Objective 5.6** Elevate outreach and engage new audiences to convey the societal and economic value of sustained ocean, coastal, and Great Lakes observing systems.



Our Eyes on the Ocean, Coasts, and Great Lakes

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