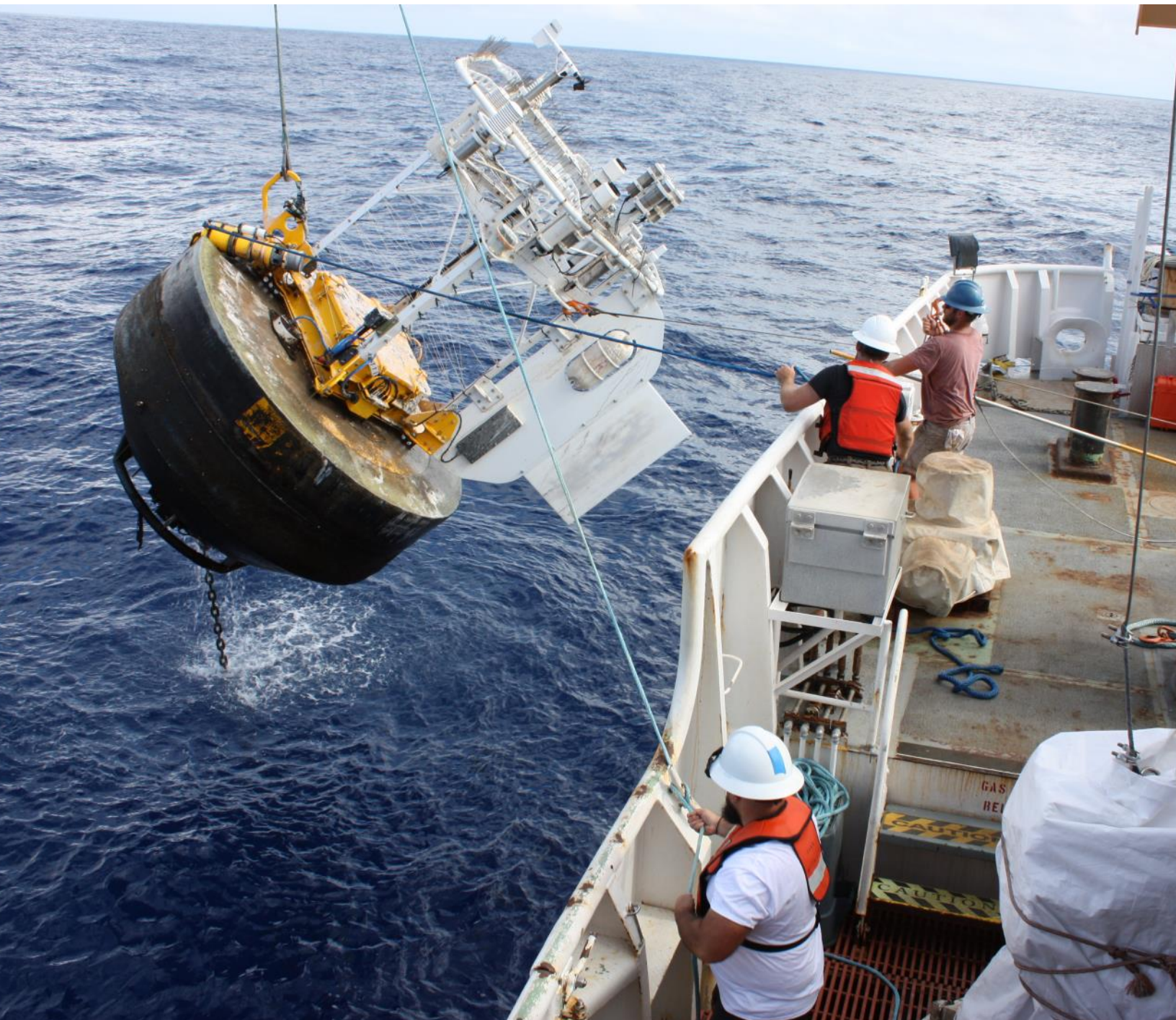
Global Ocean Monitoring and Observing
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION

Strategic Plan: 2021 - 2025



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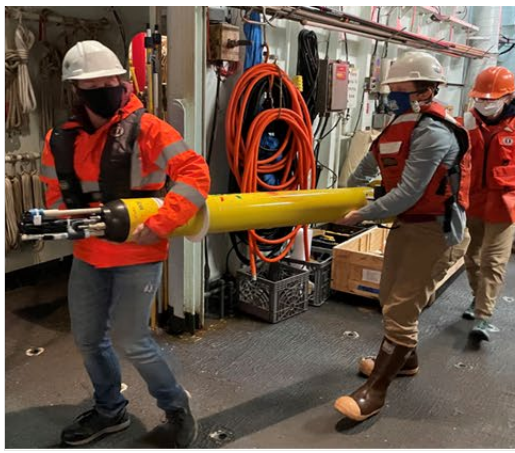
Foreword

This Global Ocean Monitoring and Observing (GOMO) Program Strategic Plan for FY 2021-2025 outlines our plans for improved global ocean knowledge, products, and capabilities that will enable NOAA to better address our responsibilities to the nation in areas of climate, weather, healthy oceans, and resilient coastal communities. Building on our heritage of international leadership, innovation, and partnerships, GOMO will continue to lead efforts across OAR and NOAA to develop and sustain global ocean observational knowledge, advance new technologies to meet emerging needs, improve data access and products, and build human capacity for the future. Realizing the Plan's objectives will lead to expanded products and ocean knowledge, and contribute to a new era of Earth system models.

Over the next five years, GOMO will expand its focus to better address a range of needs from weather to climate and the blue economy, and it will also place greater emphasis on end-users, including improved co-design of ocean observing systems, data dissemination, quality and quantity of data products and enhancing GOMO's role in weather and climate prediction improvement.

- Dr. David Legler

Director, Global Ocean Monitoring and Observing Program

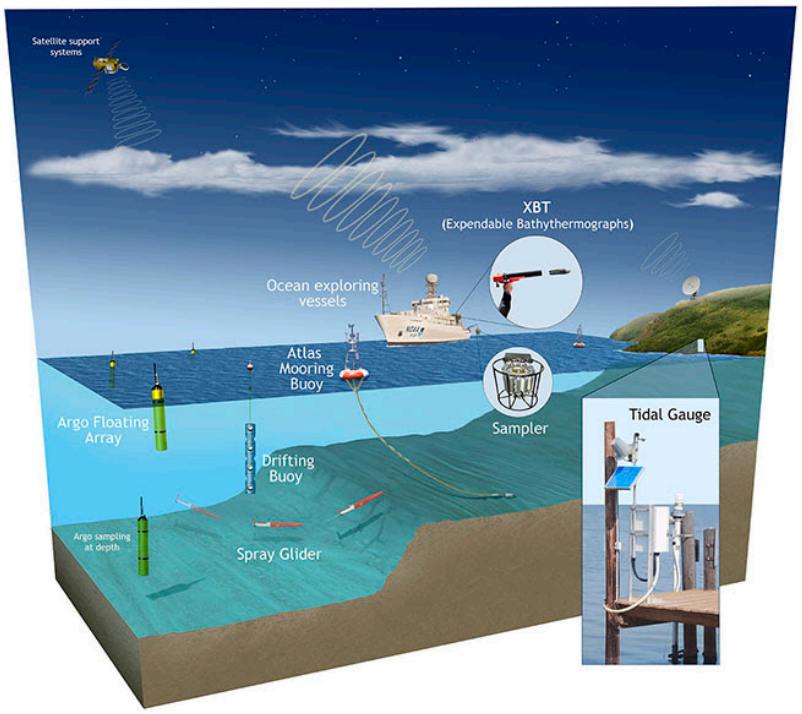
Introduction

The ocean covers 71% of the Earth's surface and contains 97% of the Earth's water. About 40% of the global population lives within 60 miles of a coast.

Observing, monitoring, and understanding the role of the ocean in weather and climate, seasonal variations, interannual variations (such as El Niño), and beyond is a core mission of NOAA. NOAA's Global Ocean Monitoring and Observing (GOMO) Program has been the federal source and international leader for in situ observing of the global oceans for more than 20 years. The GOMO Program supports research that studies and tracks changes in global ocean conditions and variables such as ocean temperature, currents, waves, sea level, salinity, carbon and oxygen.

Global ocean conditions affect weather, the environment, marine ecosystems, and coastal regions. The ocean provides food, resources, diverse ecosystems, a means for shipping and transportation, and is responsible for a $3-6 trillion economy each year. The global ocean also stores heat, nutrients, and key dissolved gases (such as oxygen and carbon dioxide) that impact the global environment and the future state of the climate. Global ocean circulation (ocean currents) transports these properties around the planet, exchanges significant amounts of heat, water, and key gases with the atmosphere, and affects variations in sea level. These sea level variations have major impacts on storm surges, coastal populations and infrastructure.

The GOMO Program supports half of the world's ocean observing research and has encouraged the participation of over 100 nations in developing the current distributed ocean observing system. These global ocean observations provide the foundation for describing the changes over time in our ocean, and they are used every day in weather, marine, and ocean prediction models, helping us understand our changing ocean and benefiting those who use the wide range of NOAA products and services.



The above graphic shows the variety of ocean observing instruments, or platforms that make up the global ocean observing system.

Global ocean observations and research are conducted on ships, as well as by robotic observing instruments such as

Argo floats, gliders, drifting buoys, moored buoys, uncrewed surface vehicles such as Saildrones, and an increasing array of innovative tools designed to detect environmental change. GOMO works with partners across NOAA and the Cooperative Institutes, as well as other national and international partners, to collect data and information across the global ocean, and to share that knowledge to serve society.

The activities conducted in GOMO are directly in support of NOAA's mission of *Science, Service, and Stewardship.* The GOMO Program supports the larger goals and objectives of NOAA's Office of Oceanic and Atmospheric Research (OAR), which include: (1) explore the marine environment; (2) detect changes in the ocean and atmosphere; (3) make forecasts better; and (4) drive innovative science.

NOAA's Mission: *Science, Service and Stewardship*

1. To understand and predict changes in climate, weather, oceans and coasts;
2. To share that knowledge and information with others; and
3. To conserve and manage coastal and marine ecosystems and resources.

The Global Ocean Monitoring and Observing Program supports OAR's mission directly by: (1) observing new parts of the global marine environment every day; (2) documenting significant changes in sea level, ocean temperatures, ocean carbon, and more through careful observations and products; (3) contributing to numerous forecast improvements with research from tropical buoys and other platforms; and (4) investing in new ocean technologies to increase our capabilities to observe the ocean environment.

This Strategic Plan outlines priority goals and objectives to advance the mission of GOMO and NOAA. Updated mission and vision statements are described below:

MISSION

To provide and support high quality global ocean observations and research to improve our scientific understanding and inform society about the ocean's role in environmental change.

VISION

A resilient, innovative, and fully integrated global ocean observing system that benefits scientific research, fosters environmental stewardship and serves society.

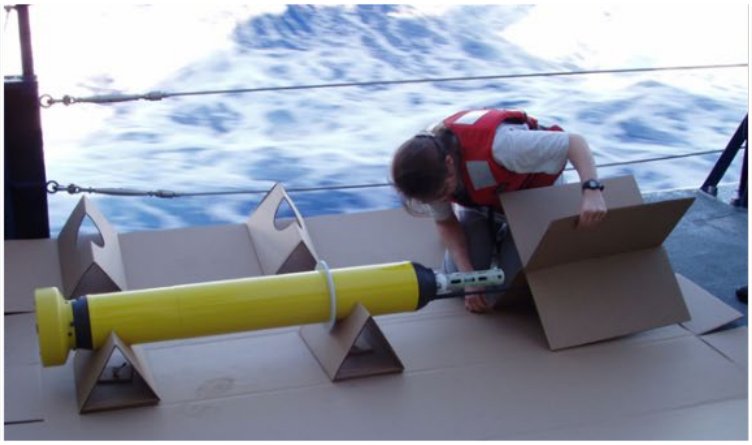
Strategic Goals:

Goal 1: Sustain global ocean monitoring and observing for long-term continuity and improve data quality and system efficiency.

Goal 2: Innovate and evolve the ocean observing network to address emerging needs and opportunities for ocean health, ocean economy, weather and climate.

Goal 3: Improve the value, accessibility, and usability of observational data for informed decision-making.

Goal 4: Develop and capitalize on the expertise, diversity and capacity of the ocean observing enterprise.




Goal 1: Sustain global ocean monitoring and observing for long-term continuity and improve data quality and system efficiency.

GOMO's first goal is focused on preserving high-quality measurements throughout GOMO-supported observing networks and improving these networks through more efficient designs and innovation. Improvements will allow for greater spatial coverage of the ocean and a better understanding of the processes controlling the ocean surface state and the distribution of heat, salinity, carbon, nutrients, and ecosystems.

Long-Term Continuity

1.1 Sustain high priority observations (see 1.4), high-quality standards, and improve temporal and spatial coverage of ocean observations through technical innovation and more efficient network designs.

1.2 Fill gaps in the coverage of observations in critical areas of the ocean such as the Tropical Pacific and the Arctic.

Quality and Efficiency

1.3 Implement recommendations from the GOMO observing network reviews to improve observational quality, efficiency, and coverage.

1.4 Evaluate the status and quality of GOMO observing networks and establish program priorities.

1.5 Develop and advocate for a long-term strategy to meet GOMO ship-time needs.

1.6 Develop a plan for evaluating and transitioning ocean observing activities through the 'R2X' lifecycle.

1.7 Improve observational data quality through increased intercomparisons across observing networks.

R2X: Research to X - R2X refers to the transition of a research project outcome to operations, applications, and services (e.g. to decision makers). Research to Operations (R2O) is an example of R2X.

Goal 2: Innovate and evolve the ocean observing network to address emerging needs and opportunities for ocean health, ocean economy, weather and climate.

GOMO will focus on expanding the use of innovative platform and sensor technologies that increase spatial density, depth profiling, and temporal resolution, and expand our capabilities into observing additional ocean characteristics to address emerging needs and opportunities. These efforts will greatly advance our understanding of ocean change and support more accurate information for science, policy, commerce, and society.

Innovative Technologies

2.1 Increase the use of autonomous systems including vehicles, robotics, and gliders to extend observational capabilities with a focus on boundary currents, the Tropical Pacific, and the Arctic.

2.2 Maintain and improve the integrity of sensors with measurable advances in sensor life, accuracy, and resolution.

2.3 Globalize and transition towards an integrated Argo Program.

Network Expansion

2.4 Implement a collaborative and transparent process to prioritize the evolution of existing observing networks.

2.5 Expand boundary layer observations of heat, moisture, wind stress, and carbon fluxes to better inform Earth-system models and decision-making.

2.6 Establish partnerships and implement two-way learning with local and Indigenous communities to build awareness and advocacy for shared priorities and the ocean observing enterprise, and to increase observations in the Arctic.

Ocean Health

2.7 Improve the understanding of processes that influence ocean health by expanding biogeochemical sensors and measurements on multiple platforms.

2.8 Conduct a series of demonstration projects in collaboration with NOAA internal and external partners to better understand ocean ecosystem health.

Ocean Economy

2.9 **Increase open-ocean wave observations to reduce uncertainties and enable documented improvements in wave forecasts for marine transportation safety and operational efficiency.**

2.10 **Expand Arctic ocean and sea-ice observations to improve sea ice forecasts for navigation, shipping, and local and Indigenous community activities.**

Weather and Climate

2.11 **Assess feasibility of adaptive sampling strategies for extreme weather events to improve predictability and mitigate impacts.**

2.12 **Enhance GOMO's ocean observing technologies to improve hurricane intensity forecasting through partnerships with others in NOAA and externally.**

2.13 **Evolve the Tropical Pacific Observing System in response to the Tropical Pacific Observing System (TPOS) 2020 Project recommendations.**

2.14 **Increase the spatial resolution of ocean carbon observations to better understand interannual variability in the ocean uptake of atmospheric carbon dioxide.**

2.15 **Focus observations on tracking marine heatwaves and associated changes in carbon storage to help assess their impacts on ecosystems.**

Goal 3: Improve the value, accessibility, and usability of observational data for informed decision-making.

The need to provide a Findable, Accessible, Interoperable and Reusable (FAIR) data management strategy is paramount for interfacing with the modeling and satellite communities as well as promoting research and the direct use of data by policy and academic communities. In addition to providing FAIR data, GOMO will build collaborations that expand the range of data-based products and improve data assimilation tools/capabilities. These data assimilation products can provide vital information across a spectrum of users that include researchers, local, state, and regional decision-makers, and policymakers.

Data Accessibility and Usability

3.1 Develop a strategy to enhance the integration and accessibility of data; expand real-time access and decrease data latency in all networks where possible.

3.2 Facilitate public-private partnerships to implement new data management strategies in alignment with NOAA data management best practices and strategies.

Models and Products

3.3 Provide *in situ* ocean observing data and products for use in assessments and improving models and monitoring tools.

3.4 Collaborate with partners to develop new assessments, model and data-based products, and data assimilation tools/capabilities that focus on weather, climate, and the blue economy (i.e. wave forecasts, sea ice, hurricanes, biogeochemical cycles, extreme weather, tropical Pacific, carbon uptake and salinity).

Research Capabilities

3.5 Establish a competitive research program focused on advancing the use of new observing technologies, increased use of GOMO data in scientific investigations, new product development, and advancing observing system design.

3.6 Integrate machine learning, artificial intelligence, and cloud technologies to optimize data use.

Goal 4: Develop and capitalize on the expertise, diversity and capacity of the ocean observing enterprise.

The ocean observing enterprise includes everyone contributing toward a global ocean observing system, in and outside of GOMO. The GOMO Program recognizes the need to support development of a more diverse, equitable, inclusive and accessible ocean observing enterprise in order to benefit from a wider range of experiences, perspectives, approaches, and talent. This will also help ensure continuity of global imperatives to observe the oceans for the benefit of all. Inclusive succession planning and capacity building efforts within the global ocean observing enterprise are critical for developing and maintaining long-term partnerships vital to deepening our ocean knowledge and encouraging others to do likewise. NOAA's Global Ocean Monitoring and Observing Program is well positioned to lead such efforts and remain a recognized leader of the ocean observing community. Partnerships across NOAA and with academic, international, non-governmental/private-sector organizations and other federal agencies will be critical for expanding GOMO's contributions and impacts on science and society.

Capacity Building

4.1 Engage with partners to develop the next generation of scientists and leaders, particularly among underrepresented groups, to advance ocean observing goals and GOMO objectives in line with the principles of diversity, equity, inclusion and accessibility.

4.2 Build research capacity with partners to address observational gaps in the Arctic and Tropical Pacific.

4.3 Invest in the GOMO workforce in order to maintain its international leadership role.

Community Engagement

4.4 Sponsor and lead a bi-annual ocean observing community workshop focused on cross-cutting strategic topics (i.e. autonomous ocean biogeochemical measurements, observing extreme events).

4.5 Increase collaboration and coordination across NOAA Line Offices for improved co-development of new capabilities and services.

4.6 Expand the number and scope of public-private partnerships to attract new resources towards GOMO goals and objectives.

4.7 Implement standard metrics for GOMO Principal Investigators (PIs) to track program performance.

4.8 Develop and expand communications tools that showcase the societal benefits, impacts, and return on investment derived from GOMO's products and services to inform policymakers and the public.

Program Measures of Performance

Successful performance can be measured based on the outputs from the activities and efforts outlined in this Strategic Plan, as well as their impact on science and the observing community. Examples could include:

Output Measures

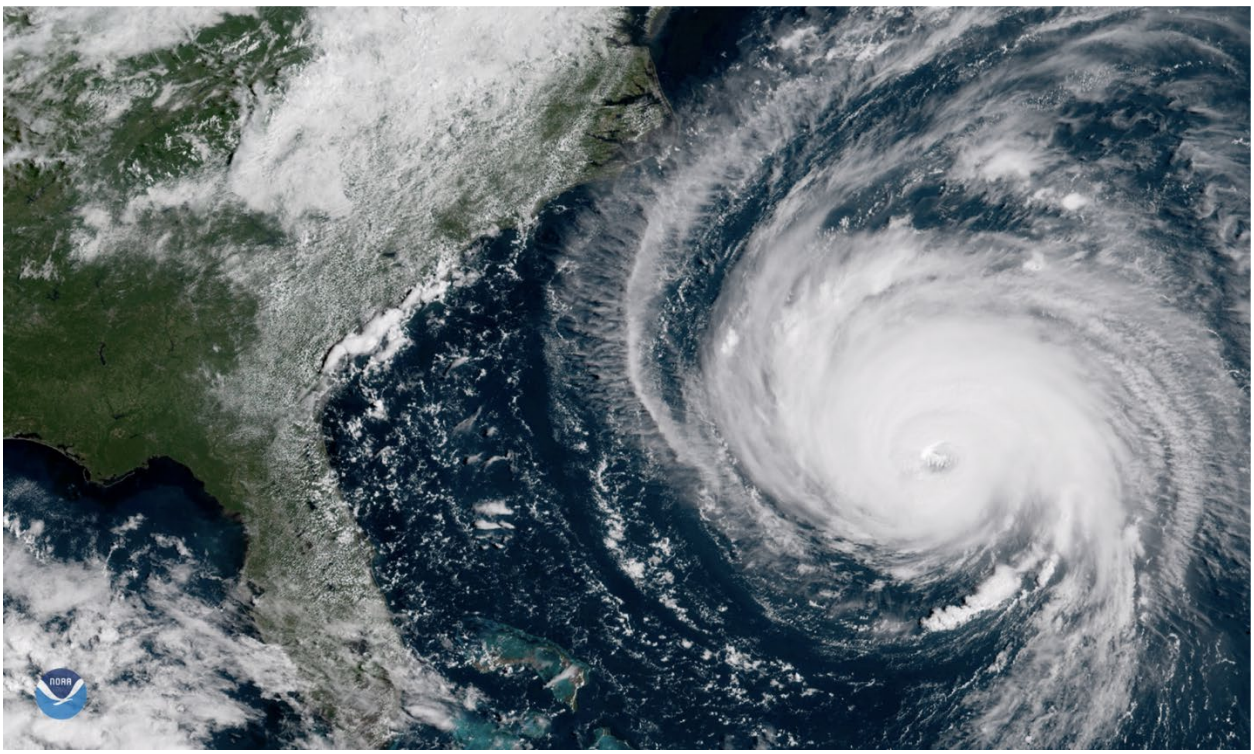
1. **Quality-controlled data or products (e.g. data reported in real-time, length of data record).**
2. **Data Return per system (e.g. number of Argo profiles).**
3. **Publications by PIs who collect and/or utilize observations or products.**
4. **Data used in models and improved data assimilation.**
5. **Data or products used in assessments to inform science and management.**
6. **Highly cited observational products and authoritative assessments (e.g. Arctic Report Card).**
7. **Number of GOMO activities reported to NOAA leadership and number of public-facing articles published.**
8. **Field tests/demonstrations of new technologies or methodologies.**
9. **GOMO PIs, personnel, and/or key partners in critical national/global ocean and marine science leadership roles.**

Historically, GOMO has tracked many of these output measures. As the program and observing system mature, there is a need to better quantify the real impact of these systems and the information they provide to a range of end-users and societal benefits. For example, GOMO data from Argo floats are used in broad applications including weather forecasts, aquaculture, pollution monitoring, ocean education, and national defense. Ongoing Observing System Experiments (OSEs) to assess the impact of Argo data will allow for better quantification of the return on investment in the system. Another area of active study involves the economic valuation of ocean data and information. GOMO and its partners will continue to invest in economic studies to better understand how ocean data and information generated by the GOMO Program contribute to the blue economy. The following are examples of impact measures GOMO will strive to develop and track over the next five years.

Impact Measures

1. **Transition of mature technologies into sustained observing**
2. **Partner engagement and leveraging of resources**
3. **Publications by others that utilize GOMO data/products**
4. **Model and/or forecast improvements**
5. **Specific knowledge advancements/monitoring**
6. **Ocean data contributing to the blue economy**
7. **Increased public awareness of the importance of the ocean in environmental change**
8. **Increased diversity, equity, inclusion, and accessibility in the ocean observing community**

Furthermore, GOMO will develop standard performance metrics aligned with the Program Measures of Performance for inclusion in PI work plans. PIs will be required to select several of these metrics and address them in their annual reporting, enabling GOMO to track and assess performance towards meeting the goals and objectives in this plan.



Ocean observations and data collected by the GOMO Program are used in a variety of applications, including improving the accuracy of hurricane forecasts.