

Charge to Reviewers
Global Ocean Monitoring and Observing (GOMO)
5-Year Program Science Review
July 11-14, 2022

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Purpose of the Review

Program science reviews are conducted every five years to evaluate the quality, relevance, and performance of research conducted in the National Oceanic and Atmospheric Administration (NOAA) Office of Oceanic and Atmospheric Research (OAR). This review is for both internal OAR/NOAA use for planning, programming, and budgeting, and external interests. It helps the Program in its strategic planning of future research activities. These reviews are also intended to ensure that OAR research is linked to the NOAA Research mission and priorities, and other relevant strategic plans. Lastly, it is intended to ensure that research is of high quality as judged by preeminence criteria, and is carried out with a high level of performance.

Scope of the Review

This review will cover the program activities of GOMO over the last five years (2017-2021). The three focus areas for the review are: 1) US leadership of an ocean and arctic observing research enterprise; 2) Frontiers in ocean observing; and 3) Information and product development to ensure data access and usability and to increase the value/impact of ocean observations.

Proposed Schedule and Time Commitment for Reviewers

The review will be held **July 11-14, 2022** in Silver Spring, Maryland, US. The review is being planned as an in person event, though we will prepare for an online meeting as a backup option. OAR will hold two teleconferences for the review panel in advance of the review to discuss the review process and answer any questions you may have. To ensure that there is ample time for discussion during the review, many presentations will be pre-recorded and posted on the review website at least two weeks prior to the review. Panelists are expected to have reviewed these presentations ahead of the review to fully engage in the interactive panel discussions with staff and scientists during the review.

Each reviewer is asked to independently prepare their written evaluations and provide these to the review panel chair. The Chair, a federal employee, will create a report summarizing the individual evaluations, due within 45 days of the review to OAR. The chair will not seek a consensus of the reviewers. OAR will send any technical comments within 14 days of receiving the draft report and the panel chair will send a final report no later than 30 days after that.

Review Team Resources

OAR will provide resources necessary for the review team to complete its work, including:

- Information to address each of the Program’s focus areas will be posted on a public review website.
- Travel arrangements for the onsite review will be made and paid for by OAR.
- On-site review team support to acquire and deliver to the team any additional, relevant documents requested during the review to aid in assessing the Program.

Background

Global ocean knowledge and conditions have widespread relevance to missions across NOAA, other agencies, and beyond. The ocean affects weather, climate, the environment, marine ecosystems, and coastal regions, and ocean data contributes to skillful forecasts. 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, anthropogenic carbon, nutrients, and key dissolved atmospheric gases (such as oxygen and carbon dioxide) that impact the global environment and the future state of the climate, including sea level and ocean acidification.

NOAA’s Global Ocean Monitoring and Observing (GOMO) Program has been the federal source and international leader for global ocean in situ observations on seasonal to decadal timescales for more than 20 years. GOMO 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. Our 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, climate, marine, and ocean prediction models, helping us understand our changing ocean and benefiting those who use the wide range of NOAA products and services.

Global ocean observations and research sponsored by GOMO are conducted on ships, as well as by robotic observing instruments, including Argo floats, gliders, drifting buoys, moored buoys, and uncrewed surface vehicles (USVs) such as Saildrones. GOMO works with partners across NOAA, the Cooperative Institutes, and academia as well as other national and international partners, to collect and standardize timely data and information across the global ocean, and to share that knowledge to serve society.

The activities conducted by GOMO directly support 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 to: (1) explore the marine environment; (2) detect changes in the ocean and atmosphere; (3) make forecasts better; and (4) drive innovative science.

Specifically, GOMO 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.

The Global Ocean Monitoring and Observing Program can trace its history back more than 20 years. It was most notably an activity under the Office of Global Programs (OGP), and most recently, a division under the Climate Program Office (CPO). In April 2020, OAR announced the official reorganization of NOAA labs and programs, which elevated the former Ocean Observing and Monitoring Division to the current Global Ocean Monitoring and Observing Program. This promotion highlights the value and contributions of ocean observations within NOAA's Research line office (OAR). Since becoming a program, GOMO has developed refreshed mission and vision statements (see below), and released the [Strategic Plan](#) for Fiscal Years 2021-2025. You may also reference the [2015-2020 Strategic Plan](#) and additional program information on the [GOMO website](#).

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.

Description of GOMO Activity Areas:

GOMO's Program mission is 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. GOMO's strategic plan has four major goals:

- Goal 1: Sustain long-term continuity and improve the quality and efficiency of critical ocean-based observations;
- 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, and
- Goal 4: Develop and capitalize on the expertise and capacity of the ocean observing enterprise.

The focus areas for the GOMO Program review reflect the primary Program goals. The fourth goal will be addressed within each of the focus areas.

Focus Area 1: US leadership of an ocean and Arctic observing research enterprise.

Global ocean long-term, high-quality, *in situ* observations and products are vital in determining the ocean's role in the earth system, characterizing changes of the global ocean environment, and increasing predictability of many subseasonal and longer forecasts. NOAA's GOMO Program is the U.S. leader for sustained, in situ global ocean observations and information and has been instrumental in establishing the initial global ocean observing system. It supports more than one million measurements of the ocean each day and more than 5,000 platforms serving a suite of stakeholders from scientists, policymakers to government agencies. GOMO supports various international observing networks and platforms (e.g., Argo, PIRATA, GO-SHIP) to record and distribute high-quality measurements and improve these networks through more efficient network designs, new technologies, and new capabilities. Such improvements have enabled greater coverage, better understanding of processes controlling the ocean surface state and the distribution of heat, salinity, carbon, nutrients and ecosystems of the ocean interior; and detection of climate signals that underpin IPCC findings on sea-level, ocean warming, ocean carbon absorption/acidification and the cryosphere.

This focus area is geared to evaluate GOMO's program strategy and development; partnerships; and management practices. Please consider the following questions to guide the evaluation of this focus area:

- What role has GOMO played in establishing the global ocean observing system and how is GOMO positioned to support future development of a sustainable global ocean observing system?

- How has GOMO, through support of global ocean observing, contributed to OAR and NOAA strategic objectives? e.g., How do GOMO's observations contribute to improved models, climate and weather forecasting, and predictions including sea level rise, carbon cycle projections, changes in currents and ocean circulation, sea ice forecasting and other climate and weather phenomena (e.g., ENSO and tropical cyclones)?
- Are GOMOs operations and practices configured appropriately to develop and implement an annual and multi-annual strategy? Does GOMO have the correct advisory structure to provide it with (independent) advice on the development and implementation of its strategy? Does GOMO have the correct combination of assets and planning platforms to meet its goals (e.g. Strategic Plan)?
- How can GOMO improve how it manages its strategic financial and human resources?
- How has GOMO used partnerships across NOAA, interagency, national and international partners to achieve its strategic aims? How effective have those been?
- What external risks/threats (e.g., commercial sector (Saildrone), private-public-engagement, adequate ship time) should GOMO be aware of and how is it addressing these to enhance likelihood of continued success?
- How is GOMO developing capacity and fostering the next generation of ocean observing scientists and users of scientific information?

Focus Area 2: Frontiers in ocean observing.

Ocean observing needs are continuously evolving due to our changing climate and subsequent impacts on ocean health and society, increasing the need for a responsive ocean observing system that takes advantage of innovative technologies and approaches. GOMO supports a variety of ocean observing and monitoring activities covering a wide-range of marine disciplines, including ocean carbon and biogeochemistry, regional basin-scale planning/design efforts (e.g., Tropical Pacific Observing System), and applications of autonomous and uncrewed observing platforms to catalyze next-generation observing initiatives and contribute to global efforts such as the UN Ocean Decade of Ocean Science and Sustainability and the Global Ocean Observing System (GOOS). GOMO has supported technological advances, including the development and evolution of profiling floats, gliders, and USVs. In recent years, the global ocean observing enterprise has seen remarkable advances in the suite of observing assets and their ability to collect observations from the sea surface to the sea floor, capturing sea surface fluxes, atmospheric variables (e.g., sea level pressure), and biogeochemical variables (e.g., dissolved oxygen). GOMO's strategic plan is geared towards expanding the use of innovative platforms and sensor technologies to allow for an increased suite of observations that support emerging needs and

opportunities. Future technology development will focus on providing enhanced understanding of ocean processes and changes particularly in undersampled and critical regions, such as the Tropical Pacific and Arctic, to better inform science, policy and the public

In this focus area, GOMO seeks recommendations for improving observational capabilities to address emerging requirements and new areas of research and technology development. Please consider the following regarding GOMO's role:

- What current and future questions/topics/requirements is GOMO uniquely positioned to address?
- How has GOMO engaged with partners to address new (or developing) requirements of the ocean observing enterprise through development of new technologies?
- How is GOMO working to evolve the observing system to be more reactive and responsive to end-user/stakeholder/local and indigenous community/policy needs, emerging issues and needs, both globally and regionally, e.g. through improved planning and design activities?
- How can GOMO incorporate concepts such as the GOOS co-design and co-development of ocean observations with user and stakeholder communities?
- How are new activities considered in GOMO for support, and how does the program address competing needs for resourcing?
- How does GOMO's work address the need to expand worldwide expertise of ocean observationalists and users, and ocean observing capabilities of potential national partners?

Focus Area 3: Information and product development to ensure data access and usability; and to increase the value/impact of ocean observations.

While GOMO directly supports over 3000 ocean observing platforms, GOMO support is central to, and supports the provision of millions of measurements of the ocean each day. These data are broadcast in real time to various data facilities (e.g., National Data Buoy Center, CLIVAR and Carbon Hydrographic Data Office, Scripps, AOML, PMEL, etc.) to be screened, quality controlled, corrected and distributed to the global operational forecast community and archived at the appropriate national data center (e.g., NCEI). These data are ingested directly into weather, ocean and climate models or used to evaluate and validate models and products. Findable, Accessible, Interoperable and Reusable (FAIR) data management strategies are paramount in promoting research and enabling the direct use by policy and academic communities. GOMO strives to actively enable FAIR data and to

build collaborations to enhance data assimilation products to provide vital information across a spectrum of users including researchers, local/state/regional decision-makers, and policymakers.

In this focus area, GOMO seeks recommendations on providing improved ways to collect data through unified data and metadata standards, FAIR data approach and practices, and product development that includes data to enhance the value of discrete ocean observations. Please consider the following questions to guide your recommendations.

- How effective is GOMO's range of ocean observing data systems and monitoring tools? What improvements are needed in data handling within GOMO and beyond (including identification and implementation of best practices, data/metadata standards, etc)?
- How can GOMO improve feedback mechanisms and tools to ensure GOMO data are available and useful for ocean models, predictions and products and services while also informing observing networks of needed improvements (e.g. data gaps)?
- How are GOMO data practices and strategies (e.g. data and metadata standards, technology, digital twins etc.) evolving to advance the global ocean observing data enterprise?
- How is GOMO working with the remote-sensing community to address validation challenges and develop Essential Ocean Variables-based products and information?
- What can NOAA and GOMO do to ensure data accessibility to underserved communities and engagement to meet the needs of the communities they serve?
- How effective are GOMO's communications and engagements with its stakeholders?

Evaluation Guidelines

NOAA guidance asks reviewers to consider the **quality, relevance, and performance** (as defined below) when providing an **overall rating for GOMO's focus areas**. Reviewers will provide one of the following overall ratings:

- *Highest Performance:* Program greatly exceeds the satisfactory level and is outstanding in almost all areas.
- *Exceeds Expectations:* Program goes well beyond the satisfactory level and is outstanding in many areas.
- *Satisfactory:* Program meets expectations and the criteria for a satisfactory rating.
- *Needs Improvement:* Program does not reach expectations and does not meet the criteria for a satisfactory rating. The reviewer will identify specific problem areas that need to be addressed.

In addition to the overall ratings, individual reviewers are asked to assign a **rating for each of the subcategories (quality, relevance, and performance)** for the activity they review. The narrative below provides descriptions of the criteria, evaluation questions to consider, and indicators. The [scoring matrix](#) in the appendix to this document summarizes this information.

1. Quality

Evaluate the quality of the GOMO-produced and sponsored research and development and scientific outputs (including research, data and products, assessments, decision support, outreach, education, engagement, etc.). Quality is a measure of the novelty, soundness, accuracy, and reproducibility of a specific body of research and other outputs and impacts. Assessing the quality of scientific and technical work relies heavily on the time honored tradition of peer review. Bibliometric data on peer-reviewed publications and citations, patents, awards, awards and other professional recognitions are some of the factors to consider. Understanding the quality and impact of GOMOs work in the global ocean observing enterprise is critical to assess whether appropriate approaches are in place to ensure that high quality work will be performed in the future. Assess progress toward meeting OAR's goal to conduct preeminent research as listed in the "Indicators of Quality:"

Quality Rating Criteria:

- Satisfactory rating - GOMO **produces useful and sound outputs** (e.g., publications, data, products etc.) and **contributes to the observing community** (e.g., partner engagement, knowledge advancement, model and forecasting improvement etc.). While good work is done, Program staff and supported scientists are not usually recognized for leadership in their fields. Other ratings - Reviewers should adjust their ratings up or down using the evaluation guidelines overall ratings above.

Evaluation Questions to consider:

- Is GOMO sponsoring preeminent research? Are the scientific data, products and/or technological advancements meritorious and significant contributions to the scientific, forecasting, and assessment communities?
- How does the quality of GOMO's research and development rank among Research and Development (R&D) programs in other U.S. federal agencies? Other science agencies/institutions?
- Are appropriate approaches in place to ensure that high quality work will be done in the future?
- Does GOMO support researchers who demonstrate scientific leadership and excellence in their respective fields (e.g., through collaborations, research

accomplishments, externally funded grants, awards, membership and fellowship in societies)?

Indicators of Quality: Indicators can include, but not be limited to the following:

- Number of refereed publications and citations and other measures (often in the form of an index) that represent the value of GOMO-sponsored refereed publications to the advancement of understanding and improved capabilities addressing NOAA's mission.
- Delivery of high-quality ocean data that are analyzed and applied in products and services that meet end-user needs; this can include data used in models, forecasts, improved data assimilation, observational products and authoritative assessments, and products used to inform science, management, and policy.
- Evidence of scientifically accepted/valid methodologies used to produce outputs and certainty of results considered.
- Evidence of transition of technological capabilities, systems, and activities to higher states of readiness and application beyond GOMO.
- Evidence of leadership by GOMO through awards won by groups and individuals, elected positions in relevant domestic and international scientific organizations, societies or groups.
- Evidence of engagement and collaboration with internal and external partners including Cooperative Institutes and academia, private sector, and other federal agencies.

2. Relevance

Evaluate the degree to which GOMOs activities and research and development are relevant to the mission of OAR and NOAA, and to society. Relevance is a measure of impact and value of GOMOs work beyond the GOMO program, including the ocean observing community, other stakeholders and end-users. The impact of R&D can be realized through the uptake and application of scientific knowledge to policy decisions, the improvement of operational capabilities at NOAA's service lines and other collaborating institutions, or licensing of inventions for commercial use. Relevance includes not only hypothetical value, but actual impact. It considers the question, "What would not have happened if GOMO's activities, partnerships, observations did not exist, and how much would society have missed?".

Relevance Rating Criteria:

- *Satisfactory* rating - The activities of GOMO show linkages to the OAR and NOAA mission and strategic plans, and are of value to the global ocean observing enterprise. GOMO demonstrates some efforts to engage with stakeholders to address their needs but these efforts are not consistent. Other ratings -

Reviewers should adjust their ratings up or down using the evaluation guidelines overall ratings above.

Evaluation Questions to consider:

- Do GOMO activities address existing and/or future scientific and/or societally relevant local, regional, national and international needs?
- How well do GOMO activities address and prioritize identified issues in NOAA and OAR strategic plans or other relevant policy or guiding documents ?
- Are stakeholders (e.g., end users, community, policy makers) engaged to ensure relevance of GOMOs activities, including co-designing of information and products and services?
- Does GOMO have identified plans, processes, and systems to ensure that information (e.g., data and best practices) and other work products are provided to stakeholders and end-users?
- Are there R&D topics in NOAA and OAR plans that GOMO should be pursuing but are not? Are there R&D topics relevant to national needs that GOMO should be pursuing but are not?
- Is GOMO producing timely and useful information and products?

Indicators of Relevance: Indicators can include, but not be limited to the following:

- Demonstrated linkages between GOMO's work/investments to objectives and mission in OAR, NOAA, and relevant international organizations like GOOS and GCOS.
- Efforts to cultivate two-way partnerships with a range of stakeholders including Indigenous and traditionally marginalized communities.
- Evidence of public outreach and engagement, participation in events, academic conferences, webinars, workshops, and other education efforts that directly advance GOMO's work and priorities.
- Demonstrated value of GOMO's research products, information and services, and an assessment of their impact by end users.

3. Performance

Performance is a measure of effectiveness and efficiency. It includes an assessment of the organization's leadership, management, operations, workforce, organizational culture, strategic planning, progress towards performance targets and milestones, efficiency in resource utilization, and transition of research to operations. Reviewers are asked to evaluate performance within the context of three categories: a) Leadership and Planning through clearly defined objectives, scope, and capacity to execute key activities and projects, b) Efficiency and Effectiveness of GOMO's activities, research and

development, given its goals, resources, and constraints and obtaining needed resources through NOAA and other sources, c) Transition of Research to Applications of GOMO activities and research and development into applications (operations and/or information services) by assessing the transition of technological capabilities, systems, and activities to higher states of readiness, and/or application beyond GOMO.

Performance Rating Criteria:

- *Satisfactory* rating - GOMO generally has documented scientific objectives and strategies through strategic and implementation plans (e.g., Annual Operating Plan) and a process for evaluating and prioritizing activities. The Program demonstrates effectiveness and efficiency in completing its objectives, milestones, performance measures and outputs. Knowledge and technical advances are transitioned to appropriate communities and/or organizations with minimal planning. GOMO works on increasing efficiency (e.g., through leveraging partnerships), builds workforces and diversity, and program management generally functions as a team and works on delivering most of its products/outputs to applications, operations or users. Other ratings - Reviewers should adjust their rating based on evaluation guidelines above.

Evaluation Questions to consider:

- Does GOMO have clearly defined and documented scientific objectives and an evaluation process(es) to determine priorities for activities/projects, selecting/continuing those projects with consistently high marks for merit, application, and priority fit; ending projects; or transitioning projects and ensuring alignment with the Strategic Plan? (Leadership and Planning)
- Does GOMO have the leadership and flexibility (i.e., time and resources) to respond to unanticipated events or opportunities that require new research and development activities? (Leadership and Planning)
- Does GOMO provide effective scientific leadership to, and interaction with, NOAA and the external climate, weather, and ocean observing communities on issues within its purview? (Leadership and Planning)
- Does GOMO management function as a team and strive to improve operations and foster appropriate empowerment of all GOMO employees to meet the mission? Are there institutional, managerial, resource, or other barriers to the team working effectively? (Leadership and Planning)
- Does GOMO execute its activities in an efficient and effective manner given the Program goals, resources, and constraints? (Efficiency and Effectiveness)
- How effective are GOMOs processes for managing and monitoring the execution of activities/projects? (Efficiency and Effectiveness)

- How well integrated is GOMOs work with NOAA's, OAR's and other relevant LO's planning and execution activities? (Efficiency and Effectiveness)
- Is the Program leveraging relationships with internal and external collaborators and stakeholders to maximize results? (Efficiency and Effectiveness)
- Are human resources adequate to meet current and future needs? Is GOMO organized and managed to ensure diversity in its workforce? Does the Program provide professional development opportunities for staff? (Efficiency and Effectiveness)
- Is infrastructure sufficient to support high quality results? (Efficiency and Effectiveness)
- How well is the transition of research to applications and/or dissemination of knowledge planned and executed? (Transition)
- How well are GOMO activities co-designed to ensure maximum impact? Are end users of the research and development involved in the planning and delivery of applications and/or information services? (Transition)
- Does GOMO appropriately balance investments among new research and innovation areas as well as sustained science? (Transition)
- Are the research results communicated to stakeholders and the public? (Transition)

Indicators: Indicators can include, but not be limited to, the following.

- Collaborates on the development of Program and Project Strategic and Implementation Plans to ensure GOMO activities align with goals and objectives within GOMO, OAR, NOAA, and relevant international organizations.
- Develops annual plans which contribute to the OAR Annual Operating Plan, OAR Strategic Plan, and OAR Diversity and Inclusion Implementation Plan.
- Active involvement in the NOAA planning and budgeting process including providing leadership to respond to funding opportunities such as the Hurricane Supplemental and other legislative resourcing opportunities.
- Engagement and contributions to other national and international ocean observing initiatives/plans (GOOS, WMO, Ocean Decade).
- Includes, and has actions addressing, strategic plan objectives on professional development.
- Percentage of GOMO performance measures and milestones met.
- Percentage of GOMO budget executed according to plan, including amount and timeliness.

- Transitioning of technologies, capabilities and/or intellectual property outside of GOMO (e.g., TPOS design to NWS, deep argo float commercialization).
- Maturing of observing system capabilities/technology (e.g. better Argo batteries, Saildrone within NOAA) within GOMO and OAR;
- Evidence of application of GOMO-generated knowledge and/or capabilities in specific application areas outside of GOMO.
- Significance and impact of involvement with patents, Cooperative Research and Development Agreements (CRADAs) and other activities with industry, other sectors, etc.

Appendix: Scoring Matrix

Sample Compiled Reviewer Ratings Table Template

Reviewers provide an Overall Rating (using the Ratings below) for GOMO as a whole, Quality, Relevance, Performance and Overall Ratings for Activity Areas 1, 2, and 3.

Ratings (Codes):

- Highest Performance (**HE**): Program greatly exceeds the satisfactory level and is outstanding in almost all areas.
- Exceeds Expectations (**EE**): Program goes well beyond the satisfactory level and is outstanding in many areas.
- Satisfactory (**S**): Program meets expectations and the criteria for a satisfactory rating.
- Needs Improvement (**NI**): Program does not reach expectations and does not meet the criteria for a satisfactory rating.

Reviewers

Area	Rating Categories	1	2	3	4	5	6	7	8
GOMO	Overall								
1	Quality								
	Relevance								
	Performance								
	Overall								
2	Quality								
	Relevance								
	Performance								
	Overall								
3	Quality								
	Relevance								
	Performance								
	Overall								