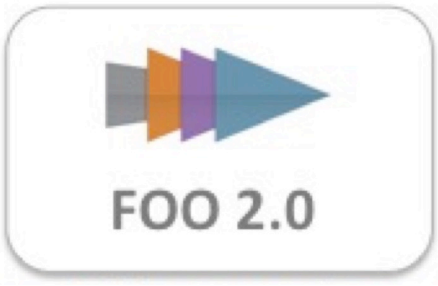

FOO 2.0 Summary Report
April 2019

A community-wide review of the Framework for Ocean Observing's usefulness was launched in August 2017. Twenty-one extensive one-on-one interviews were conducted with representatives from federal agencies, research institutions, academia, and the private sector. Community feedback was also collected at project briefings, Town Halls, and conference presentations.

Discussions focused on three broad categories:

- Technology and Implementation,
- Data and Analysis, and
- Management and Governance.

This effort has resulted in several key findings that will guide the improved utility of FOO during the next decade.

Technology and Implementation

Since the adoption of the FOO by GOOs in 2012, and given the tremendous focused-work done on the 'input' or requirements setting elements of the observing system, it was no surprise that a good deal of effort for the next 5 – 10 years should seek to improve the downstream aspects of the system, as they relate to the system 'processes' or deployment and maintenance. Feedback on the effectiveness of using the FOO spoke to the difficulties related to implementation, especially when it came to activities associated with network design and prioritization.

Key findings Included feedback related to:

- Extending FOO Text Beyond Requirements (EOV) Setting
- Platform Pro and Con Review and Assessment
- Documentation and Socialization of Best-Practices
- The Path to Maturity
- The Role of Pilot Projects
- Design and Implementation of Best Practices

Extending FOO Text Beyond Requirements (EOV) Setting

The Technology and Data Implementation Teams may benefit to the same degree of definition and emphasis that the Expert Teams received since their creation within GOOS during the past five years. A redraft of the Implementation and Data sections of the Framework document is needed to reflect the same level of detail given to identifying measurement requirements (EOVs) in the initial document.

- There is a definite need to expand on the data and information components of the FOO.
- The FOO has been helpful as a process development tool but more detail is needed in order to be useful for implementation of an observing system.
- It would be nice to see a critical assessment on how effective the FOO was in improving an observing system. Many found the document helpful but then difficult to implement.
- The feedback loops need development or at least some measure of consideration, especially as to 'the who' of those most relevant here; ranging from national concerns to data integrators.

Platform Pro and Con Review and Assessment

Articulating the effectiveness of measuring ocean variables from different platforms will assist in the evaluation of technology trade-off assessments needed to optimize observing networks. Various platforms hosting ocean-observing sensors have inherent strengths and weaknesses. Articulation of these can assist in tabulating trade-off assessments.

- Given that EOVs did not drive the need for networks in place today there is a disconnect between the planning process and a path forward to improve upon the linkages among EOVs, the networks, and the nations which are building the networks.
- In order to effectively create requirements of the system there is a need to look at incoming as well as outgoing needs of users as well as both internal and external users.

Documentation and Socialization of Best-Practices

To move beyond EOVs (system input) and mature all elements of an observing system, additional guidance is needed on best practices for implementation and maintenance. Streamlining implementation practices may reduce costs through adoption of standardized sensors and maintenance practices and data policies. Documentation of EOV measurement best-practices for operations and maintenance is needed, preferably similar to the guidance for EOVs in the original document.

- The experience of agreeing to EOVs at all geographic scales has proven helpful, the outcomes did help with forward motion, however the process did not assist with implementation.
- There is a need to determine ways to more formally discuss how the Framework has had a positive impact on the most critical elements of an observing system.
- The Framework should highlight the where and why within the system architecture patterns exist and thus where the adoption of best-practices are most important and/or needed.

- Identification of EOVs is important to research endeavors. However, research and science are not the same thing – science is more operational – so this recognition needs development across the system.
- There exists a need to recognize that the implementation of the entire observation lifecycle process takes a long time, and that it is often difficult to consistently engage the concerted expertise of science volunteers.
- Generally, there needs to be a more formal way to identify major groups collecting ocean data, distributing it, processing it, and developing applications.
- There could be real benefit to the development of courses that demonstrate concerted exposure to ideas and best practices rather than a formalized certification course.

The Path to Maturity

Several GOOS processes are used to assess technologies for inclusion in global sustained observing efforts. The ability to declare new observing technologies "mature" or "fit-for-purpose" assists funders and implementation teams in their efforts. Clarifying processes to assess the readiness of ocean observing technologies will help transition and mature technology into operational and sustained use.

- Readiness Level assessment was a very positive outcome of adopting FOO processes; and has been one of the great benefits of using the FOO.
- It may be helpful to apply 'Science Readiness Levels' to observations.
- In further developing the FOO, it may be helpful to incorporate a consideration of different time scales when assessing the value of observations.

- Need to develop cross-function interfaces designed to assess how well the system is responding to the needs of intermediate users.
- A more robust user connection needs to be established with internal or 'intermediate' users.

The Role of Pilot Projects

A better understanding of the various types and levels of pilots can help the community assess their role in establishing best-practices and maturing FOO processes and technologies. Pilot Projects can be a powerful tool in testing and assessing new technologies for ocean observing.

- If done properly a Pilot Project can be a mechanism to used to bring things into the mainstream so that all stakeholders seem smarter not appearing to know less.
- Today the process for becoming an official GOOS Pilot Project is far too ad hoc for there to be much concerted benefit from them.
- There exists a need for a good description of what is meant by a pilot project, this may be helpful toward understanding their value; to assess their contribution it is important to understand what it is they are trying to accomplish.
- Governance structure needs to identify and socialize language of what pilots are and what they are designed to accomplish (example: TPOS 20202 First Report).

Design and Implementation of Best Practices

The analysis and negotiations required to determine a cost effective, technologically feasible system often requires expertise from a broad spectrum of geographically distributed individuals and implementation groups. Measurement of EOVs often requires a blend of technologies, so the determination of which sensors on which platforms can become quite complex.

- The FOO does not do a good job of reconciling local, regional, global needs.
- The global sustained observing system (facilitated by the FOO) needs to consider data needs as user driven.
- Much planning, design, and implementation is still done in a compartmentalized way. There are Task Teams and Working Groups that may work thematically or are platform focused; however true integration thinking is often somewhat limited.
- Once a project or program and its measurements mature it is beneficial to create theme driven Working Groups and depending on the scale, a coordinating Project Office. These thematic WGs (science, engineering, data management) can be organized to feed into Regional Working Groups (RWGs) that then become an effective way to keep the science moving forward through more efficient engagement.

Data and Analysis

Much has changed in the data and analysis arena in the past decade. Open data policies, improved communications technology and methodologies, and the adoption of data management techniques that facilitate sharing and integration, now allow data managers and analysts to better serve their community with quality data, data products, and services. As the observing system becomes increasingly fit-for-purpose the data community is challenged to allow users to discover and use available data that addresses thematic, local, regional, and global concerns.

Key findings Included feedback related to:

- Improving Data Efforts (Legacy and New)
- Building Data Analysis Capacity
- Supporting Various Data Levels

Improving Data Efforts (Legacy and New)

There is a growing and urgent need to overcome the difficulties in data discovery, delivery, and stewardship to meet the needs of the entire ocean observing community. There are many legacy ocean data systems. The ultimate goal of each is to have all ocean observations quickly stored in standard formats, in rapidly accessible, user-friendly data stores.

- The global ocean observing system is under tremendous pressure to reconcile the requirements generated by the growing and inhomogeneous amount of data that are available from observing systems today and to provide consistency and interoperability.
- Embedding unique data solutions within specific technologies leads to a larger issue of data archeology that will persist into the future.
- There is a need to build on the growing practice of sharing data by developing software data product management best-practices and maturing de facto standards.

- Improved coordination is needed such that all relevant information resources (data, metadata, services) appear to the user like a constellation of data and services (both satellite streams and those from small *in situ* efforts in remote regions).
- To better meet user needs it may have been more helpful to have first looked at indicators rather than EOVs.
- Certain data sets and streams should be allowed to mature prior to release in order to better assess and/or evolve their value to the system.
- There now is a more developed or mature community working on hybrid, or coupled data assimilation models. It would be advantageous to get these groups to come together; though not sure what it looks like.

- In the data arena an issue exists that when projects are funded there is just enough funding to apply the data but little else to demonstrate ongoing progression of its use and resolution of known problems.
- Technology transfer and international science issues are deeply related to capacity building and data management.

- A global data policy needs to find a sweet spot with not too much top down administration, but enough to allow for traction when adhered to, and results in funding or national support.
- An improved understanding of data management and implementation teams is needed; they seem to be more of an idea rather than organizations with long-term sustained funding and Terms of Reference.
- Data centers and data management need to develop as separate entities from the development of data products/models.
- A structure should be created to support a federated data architecture.

Supporting Various Data Levels

Some data sources are reluctant to release their data because it is not of sufficient quality for use by other groups. A well-defined raw, unprocessed data level might encourage more sharing from such data sources. To encourage the publication and sharing of more ocean observing data, it may be desirable to define multiple levels of data standards. Data providers can then release data and products at these standardized levels without concern for the need to fully clean or refine their data.

- It is critical that all data generated from observations can be used, anything less is a waste of resources.
- Within governance there is little-to-no dialog between data providers and the rest of the observing system.

- A well articulated suite of data levels and associated data quality definitions is a good thing with tags that data users use regularly would be of great benefit to the community overall.
- Sometimes pushing data out openly is frowned upon because the benefit is not seen, as scientists need to more regularly cite the open data that they use – so community awareness is critical.

Building Data Analysis Capacity

In many instances, 80% of data required by developing nations to address their scientific or societal needs already exists. When necessary additional observational resources can be brought to address subsequently known gaps. Researchers trained in data analysis are needed, however, to make better use of existing resources. There is a need for data analysis capacity development that includes data discovery/analysis, as well as technology training.

- A concerted training effort is needed to demonstrate the transformation from raw data to a data product as part of user capacity building.
- There may need to be fundamental changes in the IT infrastructure from the present Virtual Private Network (VPN) system to a cloud-based environment.

- Often observing system funding involves planning for a common environment designed to facilitate the integration of data, yet lacks required national funding to develop applications or services to assist with the use of data.
- By refining observational data for use within models, we can use them as tools to both refine our models and gain a better understanding of where observations should be made.

Governance and Management

When the FOO document was originally drafted it was unclear if an oversight group would adopt a system engineering approach as a working model. The FOO suggested that governance should include the ability to provide an interface to external groups and assist with the coordination of internal panels and teams; with the end result of all feeling a part of the system or enterprise. Today there continues to be a need to better address the activities associated with the 'feedback loops' of science and societal needs.

Key findings Included feedback related to:

- Coordination of Global Programs
- Resource Commit and Review Process
- Use of the FOO for Fundraising

Coordination of Global Programs

As some EOVs require the coordination of technology deployment and the integration of data, the level of buy-in among participants will vary. Therefore there is a need to assess the desired and/or potential need for coordination or collaboration based on the known levels of required 'buy-in.' For large global networks and technology solutions, long-term and wide scale buy-in is needed to mature and sustain these observations. A review of each EOV, technologies required for observation, as well as desired data and information services will assist in an evaluation of coordination needs.

- In general GOOS, and all of the community, could benefit from an enterprise approach, as this will facilitate the practice of attaching data from multiple sources to user solutions through improved interfaces among otherwise disjointed stakeholders and sponsors.
- Today many within the observing community are missing coordination and management at a national level. There is some international coordination, but it often lacks an associated national level contact point that has access to any form of a structure focused on coordination within the nation.
- GOOS processes, roles, and services need improved understanding as well as visibility to others in the coordination and management community.

- There is a need for an observing system to be reviewed by engineering architects for overall system effectiveness. Such a review would distill what elements or practices can be replicated and which should be updated or eliminated. Similar reviews have been conducted at meteorological offices.
- Need to better define role between GOOS and BluePlanet (among others).
- Conduct a series of activities that consider and explore a 'cross-walk' of items of mutual concern to both GOOS and BluePlanet.

- May want to consider a basin scale governance structure. The use of a limited governance structure more readily ensures that the activities within a basin-scale system are fit-for-purpose.

- The role of an EOV in driving network requirements needs to be addressed and a mechanism for this type of review defined.
- Governance needs to better consider a vertical vs. horizontal structure or set of interfaces. These should be designed to drive requirements throughout the system from EOVs, to networks and technologies, to data management.
- A heightened focus (traceability) is needed on societal issues and the information services and products addressed via observation platforms and technologies.

Resource Commit and Review Process

The GOOS is a voluntary system of partners that agree to participate in the system given the benefit provided to all through coordination and cooperation. It is important to track these commitments as their success and failure will have impact across the system. There is a need to establish a method of tracking commitments made by nations and groups regarding their observing goals and plans.

- It is critically important to have the ability to report on contributions. The idea of national commitment tracking is desirable and, in some instances, necessary for coordinating activities within nations.

Use of the FOO for Fundraising

There is a need for guidance on how to build an effective business case to demonstrate return on investment from ocean observing. The processes of the Framework can provide assurances to potential funders that resources requested will be well vetted among scientific experts, implementation teams, and users.

- Today FOO is not a strong fund raising tool, but it could be if used to help facilitate the creation of a better business case for observations. The FOO can naturally be used to fund raise as a brand; similar to the way some Projects/Programs create a brand.
- Moving away from an EOV or science focus creates a need for a greater focus on standards and best-practices, such as case studies of successful results based on previous requests for funding.

- There is a need to find a governance structure that understands the importance of the role played by managers of observing networks.
- Governments need to recognize that successful observation projects require more than the volunteering of expert time alone; asset development, deployment and maintenance are equally critical.
- Projects and program mangers within the observing system need to better recognize the value-added of the groups that implement the observing system; presently too much emphasis, or recognition, is given to scientific endeavors.