



The Global Ocean
Observing System

GOOS 2030 Strategy

*31 May 2018 version
DRAFT for review*

Our Vision

A truly global ocean observing system that delivers the essential information needed for our sustainable development, safety, wellbeing and prosperity

The Global Ocean Observing System (GOOS) plays an essential role in the evolving relationship between the ocean and society by coordinating many pieces of a distributed observing system to serve global and local needs. GOOS delivers a systematic approach to ocean observing by identifying the essential information needs for a wide range of end users and ensuring delivery in a sustained and increasingly responsive way.

People benefit from the ocean in a myriad of ways. The ocean essentially supports life on our planet – it produces most of the oxygen we breathe and it regulates our climate. Over 50% of us live in the coastal zone and many of our communities rely on the ocean for their livelihoods and well-being. A healthy and safe ocean provides transport, food, and essential recreational space. The impact of the ocean extends well beyond the coastal zone through its role in weather and climate.

Since its creation in 1991, GOOS and a committed global science community have played a vital role in developing and coordinating observations of the ocean's physical properties. These observations provide the backbone for ocean forecasts and deliver understanding of the ocean's role in the global climate system and how climate change is today affecting ocean dynamics and health.

GOOS is a collaborative platform that provides countries and end-users with critical information on the physical, chemical, and biological aspects of the ocean. GOOS monitors the ocean through an interconnected network of data collection systems.

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Our challenge now is to grow the systematic observations of the ocean beyond these physical properties, in order to understand the chemical, biological, and ecological properties of the ocean. We need to urgently assess human pressures on the ocean, particularly in vulnerable coastal areas. There is an equally urgent need to better connect observations to end users in governments, communities and industry, who need this information as the base for sound decisions and policies.

Over the coming decade, the demand for knowledge to underpin responses to climate change and variability will arguably be greater than ever. As the human population expands and related stress on ocean ecosystems increases, there will be a profound need for better information to guide our progress towards sustainable development, and to ensure that we identify and move quickly to restore the health of vulnerable ecosystems.

Ocean knowledge and information also have the power to generate profits and jobs in the marine economy, unlocking solutions to the sustainability of essential ocean ecosystems, and helping to mitigate increasing risks from coastal hazards and climate change. However, ocean processes vary on long time scales, and our decisions must be based on the foundation provided by sustained ocean observations.

By 2030 we envision an ocean observing system with greatly expanded coverage, delivering a wider variety of essential information to a broader range of end users.

GOOS is sponsored by the Intergovernmental Oceanographic Commission of UNESCO (IOC), the World Meteorological Organization (WMO), UN Environment, and the International Science Council.

Our Mission

To lead the ocean observing community in growing an integrated, responsive and sustained global observing system

GOOS plans to lead innovation in technology, capacity, and governance, focused on achieving our vision by 2030. The aim of GOOS is to provide one integrated system that can deliver ocean information across three key application areas: **climate, operational services, and marine ecosystem health.**

- GOOS provides critical ocean information that is central to both the global issue of greenhouse gas mitigation and the fundamentally local issue of adaptation to climate change and seasonal weather forecasts.
- Operational ocean information services, such as forecasts and early warnings, generate benefits for individuals, industries, and governments because they help to manage risks from ocean-related hazards and support the development of the marine economy.
- The sustainable health of marine ecosystems is also tightly linked to knowledge that can only be generated and verified by monitoring key variables, compatible across regions, basins and globally. Sustainable ecosystems are a building block of sustainable economic development.

The sustained monitoring of a key set of ocean variables is vital to all of the above—these are the GOOS Essential Ocean Variables (EOVs).

A fully implemented GOOS will provide the critical ocean information needed to address climate change, generate forecasts, and protect marine ecosystem health

To achieve its Mission GOOS will:

- lead a **hub of cooperation**, providing the global platform through which many different players can coordinate their activities, multiplying individual actions in a systematic way;
- strengthen the **partnerships for delivery** of this essential information by creating connections across the value chain from observations to end users, enabling feedback and the provision an efficient system that is truly fit for purpose. This process will highlight the value of observations, develop new user connections, and help maximize the use of ocean information;
- raise the **visibility of the benefits** of ocean observations, energizing funders to support concerted lines of action.

Our community encompasses in situ networks and satellite systems, governments, UN agencies and individual scientists. By working together on observing tools and technology, the free flow of data, information systems, forecasts, and scientific analysis, this global community can leverage the total value of all these global investments. The process of sharing good practices and innovation across the observing system allows each individual piece to do its job better.

Those working with GOOS and its partners set the agenda and direction for the observing system through its shared governance structures. Through **building community consensus**, GOOS enables stakeholders to engage with the system as a whole, providing a powerful impetus for greater funding.

By 2030 we envision an ocean observing system with a greatly expanded level of partnership and participation—from countries, in governance structure, and through connection to end users.

Our Strategic Objectives

GOOS will work with its partners over the next decade to achieve this vision through 11 Strategic Objectives, grouped under 3 overarching goals which will focus our work ahead:

Goal 1: Deepening Engagement & Impact

Deepen engagement and partnership through the value chain from observations to end users, in order to advance the use and impact of the observations, and to improve visibility of the work of the observing system:

1. Strengthen partnerships, to improve delivery to end users from observations through forecasts, services, and scientific assessments;
2. Build advocacy and visibility for the sustained observing system with stakeholders, including key users and national funders;
3. Regularly evaluate the system to assess fitness-for-purpose;
4. Strengthen knowledge and exchange around value creation from ocean observation, empowering the spread of end user applications at a local level.

Goal 2: Supporting Integration & Delivery

Deliver an integrated observing system that is fit for purpose, built on a systems approach as outlined in the Framework for Ocean Observing:

5. Provide authoritative guidance on implementation for integrated observing, synthesizing across evolving requirements;
6. Sustain, strengthen and expand observations coordination through GOOS and partner communities, promoting standards and best practice, and developing metrics to measure success;
7. Ensure GOOS ocean observing data and information are findable, accessible, interoperable, and reusable; with appropriate quality and latency.

Goal 3: Building for the future

Building for the future through innovation, capacity development, and evolving good governance:

8. Support innovation in observing technologies and networks;
9. Develop capacity to ensure a broader range of stakeholders participate in, and benefit from, GOOS;
10. Extend systematic observations to understand human impacts on the ocean;
11. Play a leading role in establishing effective governance for global in situ and satellite observing, together with partners and stakeholders.

The global context and GOOS strategy

1. Introduction

The ocean and our wellbeing

The ocean affects all of us in many ways. It ultimately provides most of the air we breathe and the fresh water we drink. The ocean is also the primary controller of the global climate that makes this planet habitable for humankind, taking up 93% of the excess heat and 30% of global emissions of greenhouse gases.

Healthy marine ecosystems provide a wide range of direct benefits to people. These include food from wild fisheries and aquaculture, livelihoods and economic opportunity across a range of areas including: marine industries; coastal protection; tourism and recreation.

The ocean can also be a source of hazards including: tsunamis; storm surges; and sea level rise. An ability to monitor and forecast the ocean and its links to weather and climate extremes helps us mitigate risks via early warning systems.

Economic opportunities

Both investors and policymakers are increasingly looking towards the ocean for economic opportunities. OECD projections¹ suggest that the Ocean Economy, evaluated as 2.5% of the world economic value of goods and services produced, is expanding rapidly. By 2030, ocean industries have the potential to double in size, outperforming the global economy as a whole, and making an important contribution to employment growth. Scientific and technical advances are expected to contribute to this economic growth, and to help address ocean-related environmental challenges. The World Bank² identified healthy oceans and seas as great contributors to inclusiveness and poverty reduction in Small Island Developing States and Least Developed Countries with coastal areas. For these nations the ocean is central to achieving the United Nations Sustainable Development Goals by 2030.

Resilience in the face of change

The ocean is changing. Climate change is shrinking ice cover, provoking sea level rise, ocean acidification and deoxygenation of large parts of the ocean, as well as increasing weather and climate extremes.

Increasing human pressure on the ocean has led to degradation of habitats, an increase in plastics and other pollutants, over-exploitation of fish populations, the death of coral reefs, and a wider decline in biodiversity.

¹ The Ocean Economy in 2030, OECD, <http://dx.doi.org/10.1787/9789264251724-en>

² World Bank and United Nations Department of Economic and Social Affairs. 2017. The Potential of the Blue Economy: Increasing Long-term Benefits of the Sustainable Use of Marine Resources for Small Island Developing States and Coastal Least Developed Countries. World Bank, Washington DC.

The unexplored ocean

The ocean remains the least known and least visited part of our planet. Only 5% of the seafloor has been mapped at high resolution, and the ocean may be home to one million or more species, with 230,000 so far described by science. Biodiversity is profoundly important to ecosystem resilience, a source of economic potential, and a generator of ideas and wonder.

The value of ocean observations

The value of ocean observing systems can be identified through both direct and indirect economic benefits, such as the provision of forecasts, cost and efficiency gains; as well as through a broader set of societal benefits, policy-relevant scientific knowledge and improved safety and risk management. The value chains from observations, through data and information systems, forecasts and scientific assessments, and on to the ultimate end users, are many and overlapping.

For decades, ocean observations have supported our scientific understanding of ocean processes and helped to provide forecast and warning products, for those who live and work near our oceans and coasts. Today these observations provide data that is crucial for the work of science and for a wide range of public and commercial users in the ocean economy. They are critical for the development of policies related to climate, marine ecosystems and in managing risk from ocean related hazards. They help us both manage risk and create opportunity.

The value of ocean observing systems includes many societal and economic benefits such as improved profitability, safety and risk management

Delivering to a sustainable, safe and prosperous future

The international community has identified global goals related to sustainable development, climate change, and disaster risk reduction that all require systematic observations on which to base sound decisions and policy:

- The United Nations Agenda 2030 and its Sustainable Development Goals (SDGs) include an explicit ocean goal, SDG 14, to: "conserve and sustainably use the oceans, seas and marine resources for sustainable development." In addition, ocean information is vital in achieving many of the other of the 17 goals.
- At the June 2017 UN Ocean Conference, governments called for dedication of greater resources to sustained ocean and coastal observation, "in order to increase our knowledge of the ocean, to better understand the relationship between climate and the health and productivity of the ocean, to strengthen the development of coordinated early warning systems on extreme weather events and phenomena, and to promote decision-making based on the best available science."³
- Improved monitoring of marine ecosystems also supports global goals under the Convention for Biodiversity, regional frameworks such as Europe's Marine Strategy

³ A/RES/71/312 - Our ocean, our future: call for action

Framework Directive, and policy-relevant assessments like those produced by the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services and the World Ocean Assessment.

- The UN Framework Convention on Climate Change and the Paris Agreement (2015) note the importance of ensuring the integrity of all ecosystems, including those in the ocean, and call on countries to strengthen, "systematic observation of the climate system and early warning systems, in a manner that informs climate services and supports decision-making." Ocean observations are essential to seasonal predictions and climate services, including the validation of climate projections assessed by the Intergovernmental Panel for Climate Change.
- The Sendai Framework for Disaster Risk Reduction 2015-2030 includes the goal to, "substantially increase the availability of and access to multi-hazard early warning systems", which requires increased real-time monitoring of ocean hazards and their close incorporation in warning systems.

As more actors enter the ocean economy even more people will become exposed to risk of hazards at the coast due to climate change and variability. As human pressures on ocean ecosystems mount, the potential to create value from ocean observations will increase.

A need to act

The challenge is great. The ocean is vast and variable, making it an expensive place to operate. It is also critically under-observed, especially in biological parameters. Satellite observations can provide a broad view of the surface, but only skin deep, making complementary in situ observations a necessity.

The capability of the global ocean observing community has been constantly evolving, as a response to the unknowns of the threat posed by climate change. It is now rapidly expanding into observing for direct support to human safety, wellbeing, prosperity and sustainable development. However, the support structures for this expanded role remain the same and there is an urgent need to step up the support needed to sustain a global ocean observing system that is fit to deliver to these diverse and pressing societal needs.

Public understanding of the importance of the ocean is also rapidly rising, along with a deeper understanding of the threats posed by issues such as plastic pollution and ocean acidification.

Starting in 2021, the UN's Decade of Ocean Science for Sustainable Development, will help to link ocean science and observations to develop transformative action, bringing innovation and a global focus for ocean science.

GOOS believes that the time is right to develop a forward-looking vision for ocean observing for the next decade and to work with the community, partners, governments, and the public, towards achieving this.

2. GOOS Strategy and Structure

A step-change is required in worldwide efforts to observe, analyze, understand and predict the ocean including:

- Improved international coordination;
- Increased interaction with a wide range of users to ensure ocean products are adequate to their needs;
- Expanding observations and building capacity worldwide.

Working in partnership with other international, regional, and national programmes, GOOS harnesses support from a strong ocean observing community, allowing all partners to see the value of individual sustained observations recognised and harnessed into regional and global contexts. Our infrastructure of common platforms for identifying requirements and coordinating different networks allows all national observing programmes to benefit from this combined investment.

Now we are looking forward to 2030 by identifying our unique role and how we will work with our partners to deliver this Vision. The OceanObs'19 Conference in September 2019 (Honolulu, USA) will be an important focal point for supporting the evolution and implementation of the GOOS Strategy.

GOOS structure and evolution

GOOS was established in 1991 by the Member States of the Intergovernmental Oceanographic Commission of UNESCO, with the World Meteorological Organization, UN Environment, and the International Science Council⁴ later joining as sponsors.

Our core principles have been constant since 1998⁵ and are outlined below:

- Implement through user-driven design;
- Maintain sustained observations;
- Ensure regular evaluation;
- Set global standards and best practices;
- Encourage open data sharing;
- Develop capacity.

Over the past quarter-century, the GOOS community and structures have worked successfully, together with the Global Climate Observing System (GCOS) and our common sponsor organizations, in coordinating global ocean climate observing and information products. This infrastructure has also served as the backbone of observations for operational forecast systems. In the past decade, GOOS has had a growing focus on an integrated observing system, serving a broader range of users.

GOOS does not exist in isolation, it is embedded in a network of international, regional, and national programmes, with which it works to deliver a system that is fit for purpose. It consists of 4 key components:

⁴ At the time the International Council for Science, ICSU

⁵ GOOS Strategic Plan, 1998, GOOS-41, goosocean.org/goos-41

- Three disciplinary expert panels: for Physics (the co-sponsored Ocean Observations Panel for Climate), for Biogeochemistry (building on the International Ocean Carbon Coordination Project IOCCP), and the Biology and Ecosystems Panel. The panels develop expert guidance for global ocean observing, focused on Essential Ocean Variables (EOVs), evaluating the system and synthesising across the climate, operational services and ocean ecosystem health requirements.
- Implementation of a coordinated observing system is achieved through the the WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology Observations Coordination Group (JCOMM OCG) which coordinates across the sustained global observing networks and the 13 GOOS Regional Alliances (GRAs), which coordinate observing systems at a regional level.
- GOOS Projects which focus on advancing implementation strategy in key thematic or regional areas, such as The Tropical Pacific Observing System (TPOS).
- The GOOS Steering Committee and core GOOS Office team provide governance and coordinate, communicate, develop direction, work with key partners and advocate for support, globally.

These build on and support an active and engaged observing community, which undertakes the work and ultimately the development of a functioning system from the ground up.

GOOS is in a unique position to deliver to the Vision of a truly global ocean observing system, it has:

- a quarter-century of experience and a growing set of partners,
- community support and recognition,
- proven thought leadership and vision for the future,
- support from IOC/UNESCO Member States and other global partners, and
- existing infrastructure for delivery.

Over the next decade we will work towards a global system that is increasingly responsive to the needs of end users. In this system service delivery around climate, operational needs marine ecosystem health and human impacts will be seamlessly delivered from a system of networks that spans physical to biological realms, the coast to the open ocean, in situ and space-based observing.

Achieving our Vision will empower governments, communities and industry with the information to make the right decisions, generate profit and jobs in the marine economy, protect ocean ecosystems, and manage risk from coastal hazards and climate change.

GOOS will need to evolve over the next decade to meet the challenges of this Vision, with a more inclusive governance, additional expertise, and increased engagement, communications, and capacity development.

3. Goals and Strategic Objectives

Goal 1: Deepening Engagement & Impact

Deepen engagement and partnership through the value chain from observations to end users, in order to advance the use and impact of the observations, and to improve visibility of the work of the observing system. There are 4 strategic objectives under this goal:

SO1. Strengthen partnerships, to improve delivery to end users from observations through forecasts, services, and scientific assessments

Issue: There is a fundamental lack of connection across the value chain from observations to end use and therefore in our ability to implement end-to-end design and ensure fit for purpose delivery of information.

Action: Building on a strong base of partnership with the global climate research community, the GOOS Panels and Office will work on building strengthened engagement with new and existing partners that improve the interface from ocean observing networks and data systems to key intermediate users across climate, operational services and marine ecosystem health service areas. This will help to ensure the adequacy of the system to meet societal needs, to enhance delivery to end users and to provide evaluation mechanisms. Our initial target will be to establish partnerships with key 'super users' (those organisations that serve a broad range of end-users) as the first step in enhancing the value chain from observations to end use. As an urgent priority, GOOS will aim to make a major leap forward in establishing partnerships to link sustained observations and scientific assessment for sustaining threatened ocean ecosystem services.

Outcome:

- An increase in fit-for-purpose ocean information products (forecasts, indicators) based on sustained observations;
- A strengthened, responsive and delivery-focused observing system;
- Strong partnerships for delivery.

SO2. Building advocacy and visibility for the sustained observing system with stakeholders, including key users and national funders

Issue: The current ocean observing system is mainly funded through national investment, which is frequently fragmented across a variety of different funding channels and mechanisms, and dependent on short-term research projects. There is a need to advocate for long term thinking around funding mechanisms to support ocean observing. There is a growing need for: more nations to step up and support the system; for ocean observing to move further up the political agenda, and; for nations to understand how and why they fund ocean observing.

Action: GOOS will ensure greater visibility for the vital work undertaken by the observing community, and the value it provides, to policy makers, funders and the general public. This will include explaining why investment in ocean observing is critical for assessments,

projections and predictions of climate, ocean state and marine ecosystem health, and as a foundation for sustainable growth for all the aspirational “blue economies” of the world. GOOS is in a unique position, through IOC, to be an advocate into international processes, and to seek vocal advocates within agencies and organisations. It can provide the observing community with the communications required to help make the case at the appropriate funding levels. All components of GOOS are involved in this effort.

Outcomes:

- Significant step-up in the external recognition of value of GOOS in climate, operational services, and marine ecosystem health areas;
- A vocal community external to GOOS who are advocates for the need for funding an evolving and sustained observing system;
- Increase in longer-term sustained funding for ocean observations.

SO3. Regularly evaluate the system to assess fitness-for-purpose

Issue: The *Framework for Ocean Observing* identifies the need for regular cycles of evaluation, at different levels: to ensure the data products coming out of the observing system meet the designed requirements, and to ensure that the information generated is having the impact on the societal issues the observing system is designed for. At present, one framework for evaluation of global ocean observations for climate exists through the Global Climate Observing System and another through the World Meteorological Organization’s Rolling Review of Requirements. However, we have little guidance to evaluate the observing system against other objectives, or on regional and local levels.

Actions: Working through the Framework process and with partners, GOOS will support regular evaluations of how the observing system is delivering fit-for-purpose information for societal benefit areas and applications.

This assessment process will be guided by the requirements expressed against applications and knowledge challenges, Essential Ocean Variables, satellite and in situ observing networks, and ‘super users’. We aim to have measurable metrics to evaluate the performance towards delivering on high level global mandates, and to provide guidance on evaluations that are performed for regional, national, or local objectives. These metrics should capture the status of the observing networks, data flow to science users and models, the impact of the data, and governance. They will be developed with and through partners, JCOMM OCG and the GRAs.

These evaluations and metrics will evolve, as the GOOS projects and other innovation activities improve the capabilities of the system.

Outcomes:

- Provision of operational tracking of the adequacy of the observing system against targets for climate, operational services, and marine ecosystem health;
- Identification of global observing system status and gaps across the observing system (disciplines and domains) and at global, regional, and local scales;
- Increased efficiency in use of observing resources to meet requirements.

SO4. Strengthen knowledge and exchange around value creation from ocean observation, empowering the spread of end user applications at a local level

Issue: Multiple national and regional investments have been made towards the development of products and services using ocean observations and forecasts. Although there are many successes they are scattered across sectors, regions and stakeholders. Outside of weather forecast systems, there is no collective knowledge base regarding what ensures successful and value creating implementation of ocean data products and services.

Action: GOOS will strengthen knowledge about the value of ocean data by employing external economic expertise, such as OECD, to increase understanding the end-to-end value chain, from observation to end users. In order to help seed successful implementations ocean products and services, GOOS will work through the GRAs and other bodies to identify successful implementations, understand the nature of that success, and share this knowledge as examples of best practice within product and service development.

Outcome:

- the spread of valuable end user applications
- innovation in services, building capacity, and strengthening partnerships for delivery
- heightening local impact of observing systems

Goal 2: Supporting Integration & Delivery

Deliver an integrated observing system that is fit for purpose and built on a systems approach as outlined in the Framework for Ocean Observing. There are 3 Strategic Objectives under this goal:

SO5. Provide authoritative guidance on implementation for integrated observing; synthesizing across evolving requirements

Issue: The requirements for the ocean observing system are expanding rapidly and exponentially, with users in different economic sectors requiring information at different levels of quality and latency. Creating a specific system focused on the needs of each delivery area is clearly not sensible nor economic.

Action: GOOS undertakes multidisciplinary assessment and synthesis across a range of evolving requirements through the GOOS Panels and Projects, to guide and support implementation decisions from global to regional, and across platforms, networks and technologies. This starts with an understanding the needs for ocean information for public policy, individual and private sector decision-making, and the information products that serve those applications. Requirements then are expressed against scientific or operational applications, and the ocean phenomena, EOVs, and time and space scales, that need to be sustainably observed to inform those applications defined, taking into account the design of complementary satellite and in situ observing networks.

This guidance delivers a global focus in achieving goals for society through the complexity of individual observing system decisions and investments, that enabling nations to understand where and why investment is needed, in order to leverage that investment and gain maximum the utility from the observing system. Through cycles of assessment, defining requirements, providing implementation planning/guidance, and tracking, the design of the system is evolved.

Outcome:

- A refined design for essential global observations needed for global issues that maximises return on investment;
- Testing of a modular design approach to guide and support implementation decisions at the national level.

SO6. Sustain, strengthen and expand observations coordination through GOOS and partner communities, promoting standards and best practice, and developing metrics to measure success

Issue: GOOS's core of observations is made up of many different observing platforms, sensors, techniques and communities. Together they have to respond to global, regional, and national requirements, and together deliver common data streams. All observing implementers can benefit from learning from best practices in global approaches, and increasing integration will provide opportunities to serve more uses.

Action: GOOS will build on coordination activity in the JCOMM OCG, the GRAs, GOOS Projects, emerging biological and ecosystem observing networks, and national systems. This coordination will include global tracking of observing system status, platforms for coordination of national activity at global and regional levels, the development and promotion of standards and best practices, tracking of data flow from platforms to data systems, and the promotion of increasing readiness of new observing technologies and networks.

Outcome:

- Greater availability of ocean data through the adoption of common approaches;
- Efficient use of resources through sharing of knowledge, including a system for identifying and sharing of ocean best practices with widespread citation of documentation;
- Increasing observing networks, sensors and platforms with Technology Readiness Level of 7 or more (mature).

SO7. Ensure GOOS ocean observing data and information are findable, accessible, interoperable, and reusable; with appropriate quality and latency

Issue: The ocean sustained data system architecture, from acquisition to dissemination, is incomplete and fragmented. Some ocean data are incorporated into the meteorological WMO Information System for coupled ocean-atmosphere forecast systems, and the IOC and ocean community are developing the concept for an Ocean Data Information System. The cultural revolution of free and open data sharing that has been achieved for most platforms measuring open ocean physical variables is not universal to biogeochemical and biological variables, and to certain areas under national jurisdiction. To ensure a data system that is fit for purpose and responsive, there needs to be a clear connection from observations to users that can be refined via evaluation cycles.

Action: Building on GOOS principles and IOC oceanographic data exchange policy, we will promote that ocean observations are made available to users on a free and unrestricted basis, ensuring full and open exchange of data, metadata and products at minimum time delay and need to be preserved and remain accessible indefinitely.

GOOS will track compliance of in situ observing networks to these principles, through specified data assembly centres (often platform specific). We will engage with data aggregators to bring these data streams together, ensuring timely data submission and mechanisms to provide credit, relevant information on data provenance and processing (metadata), interoperability between data systems (including satellite), ensuring availability for each EOVS.

We will support the flow of data by promoting the use of modern information and communication technology, ensuring that data and associated metadata are discoverable. Data flow will be brought into the evaluation cycle for end-to-end delivery, with an understanding of quality and latency appropriate for users, to ensure end-to-end responsiveness.

GOOS will work with partners on all levels to encourage the adherence to the FAIR principles - findable, accessible, interoperable, and reusable - from observations to information products.

Outcome:

- An identified and tracked global observing system data architecture as part of broader oceanographic, atmospheric, and earth system data architectures;
- Data products based on EOVs available in a timely manner, with appropriate quality.

Goal 3: Building for the future

Building for the future with innovation, capacity development, and evolving good governance. There are 4 strategic objectives under this goal:

SO8. Support innovation in observing technologies and networks

Issue: Observing technology evolves rapidly, while a sustained observing system has to balance continuity and responsiveness.

Action: GOOS will encourage increased partnerships across the ocean research and operational communities to assess and improve the readiness levels of observation technology and platforms to measure each EOVS by merging research and operational requirements into observing systems fit for both. GOOS will also seek to capture the observing innovation outcomes of the UN Decade of Ocean Science for Sustainable Development and GOOS Projects into the sustained observing system.

Outcome:

- Speeding of technological development for the observing system

SO9. Develop capacity to ensure a broader range of stakeholders participate in, and benefit from, GOOS;

Issue: There are profound gaps in our ocean observing coverage. This is not a matter simply of one-off investment, but of sustained capacity development in the techniques of observation, the design of responsive regional, multi-platform observing systems that also take advantage of global satellite and in situ observations. This also involves the use of the data flowing from the system for science and specific applications, including meeting national reporting requirements under global agreements. Without this pull it is difficult to conceive of sustained new observing capacity.

Action: GOOS will partner in a broader context of the IOC and other programmes to implement actions that sustainably develop capacity in ocean observations, data systems, and other elements of the value chain to deliver local benefit. This will require strong engagement with GOOS Regional Alliances and national ocean observing programmes.

Development will focus both on developing human capacities, as well as the transfer of marine technology including knowledge on observing techniques and best practices, based on GOOS EOVS and observing networks. Certain contexts may require the development of observing tools and best practice guides adapted to local conditions for deployment and maintenance of observing networks.

The engagement of countries that already have a strong marine science community can be achieved with the modest use of new resources that link existing GOOS global and regional structures. But, in order to have any lasting impact, developing the sustained ocean observing capacity of least developed countries and small island developing states has to be done in the context of broader end-to-end initiatives that are linked to development-targeted environmental processes, like the Sustainable Development Goals, climate adaptation, the Large Marine Ecosystem programmes, or Regional Seas Conventions.

GOOS will also seek to leverage bilateral programmes between nations and regions.

Outcome:

- a greater number of countries actively participating in GOOS and benefiting from information products;
- new best practices and data products addressing the needs of a larger and more diverse participating countries.

SO10. Extend systematic observations to understand human impact on the ocean

Issue: A need to integrate the pressures from human activity with observation and modelling of climate and marine ecosystem health, combined with advances in observing system technology, strongly suggests that the time could be right to extend ocean observing capacity to monitor human pressure variables.

Action: GOOS will develop knowledge of the requirements landscape around human pressures and assess elements or variables that it would be suitable to integrate within an integrated global observing system. GOOS will identify and implement pilots to assess the viability and value of this approach, considering delivery channels from observations to end users. One possible pilot could focus on ocean noise.

Outcome:

- A pilot project around a variable related to human pressure
- Recommendations for the implementation of the monitoring of human pressures within GOOS

SO11. Play a leading role in establishing effective governance for global in situ and satellite observing, together with partners and stakeholders

Issue: As we grow from a focus on serving climate science and policy, to serve a broader suite of users across operational services and marine ecosystem health, encompassing open ocean and coastal applications, the complexity of the “system” (as defined by the Framework for Ocean Observing) multiplies. We operate now with a historical accretion of organizations and networks, working on different links in the value chain from observations to end users; at a global, regional, and national level, and focused on different segments of users. An inclusive and global governance architecture is needed to enable direction setting and coordination of ocean observing within this complex landscape.

Action: Building on engagement with stakeholders, key users, and funders, we will foster a discussion with the ocean observing community on the characteristics of good governance, which can set global directions and design for observations that respond to global issues. This will also help to foster global approaches that ease local implementation of ocean observations.

We will help to develop a community understanding of a governance architecture that is designed for decisions about ocean observations at the appropriate level (global, basin-scale, regional, national, or local), and identifies principles, institutions and processes of this governance through a best practices and consensus-building approach, building on existing structures wherever possible.

Outcome:

- A governance architecture for GOOS and related regional and national programmes, with clarity in roles and processes; a cycle of evaluation of governance; and a clearer single voice for ocean observations.

4. Partnership, governance and evolution

A broad ocean observing partnership

Partnership is embedded in GOOS through the common sponsorship of elements of the GOOS structure, The *Global Climate Observing System (GCOS)* plays a key role in the identification and delivery of systematic observations and products relevant for climate (and jointly sponsors the Physics Panel - OOPC), and the *Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)* is vital for for coordination of global observing networks and links into weather-related operational services and systems through the JCOMM Observations Coordination Group.

In addition to the specific GOOS co-sponsors, there are numerous other well-established ocean observing partners with whom GOOS maintains close links; the *Committee on Earth Observation Satellites (CEOS)* founded in 1984, which leads on observations of the ocean surface from space; the IOC's *Oceanographic Data and Information Exchange (IODE)*, established in 1961, which coordinates many data management systems; the *Global Ocean Data Assimilation Experiment (GODAE)*, founded in 1997, which develops ocean forecast systems; the *Group on Earth Observations (GEO)*, founded in 2005 after the World Summit on Sustainable Development, which highlights the need for coordinated observations to deliver societal benefit; the *Partnership for Observation of the Global Ocean (POGO)*, founded in 2009, which coordinates work by major oceanographic research institutions.

GOOS also maintains close contact with the leaders of major oceanographic institutions around the world, focused on the implementation and integration of international global ocean observing systems.

Open Governance

GOOS is guided by a Steering Committee, with ten expert members appointed by the IOC Executive Secretary in consultation with sponsors, and five members selected by IOC regional electoral groups. The Steering Committee reports to the IOC Assembly and other sponsors, defines the GOOS work plan, and manages the structures that report to it.

The GOOS Office, headquartered at the IOC, consists of a small core team with in-kind contributions from a number of supporting agencies. The Office supports the work and actions of the Steering Committee, panels, and implementation structures of GOOS, serving as a hub of communication, and point of contact for partners.

Using the Framework for Ocean Observing

Based on general consensus at the OceanObs'09 Conference in Venice, Italy in 2009, a working group of international programme representatives proposed a systematic approach for the global community to define requirements for ocean observations, decide appropriate technology for measurements, and assess data standards and dissemination. The resulting ***Framework for Ocean Observing (the Framework)***, published in 2012, has been widely endorsed by the expanding ocean observing community, and adopted formally by GOOS as a guiding document.

The assessment and synthesis of observing requirements is delivered through the work of the three Expert Panels -- for Physics and Climate (with partner GCOS), Biogeochemistry, and Biology/Ecosystems -- and using **the Framework** to identify EOVs. New ocean biology and ecology observing groups have particularly embraced the Framework because the existence of a common language and set of processes is helping them to organize and it will also enhance their collaboration and data-sharing with other ocean monitoring groups. All three of these Panels have identified and agreed upon a core set of EOVs, and the recommendations are continuously evolved by interaction with their scientific and operational user communities. This means that under the community designed **Framework** that GOOS looks at evolving requirements for a wide range of users, and synthesizes that into a single set of authoritative guidance on implementation that integrates across requirements; leading to an integrated observing system capable of delivering to many users.

The GOOS Projects are also actively using **the Framework** process. The Tropical Pacific Observing System (TPOS) is focused on an ocean region of high importance to global seasonal climate, the Deep Ocean Observing Strategy (DOOS) is designing and implementing an observing approach for the very under-sampled areas of the deep sea. The European-led AtlantOS project aims to engage a larger set of actors around the Atlantic Ocean with a legacy system organized on a basin level. These projects cut across GOOS requirements, expert panels and observing systems, and provide insight into observing system development and best practices for future efforts. Implementation is through JCOMM OCG (with partner WMO), the GOOS Regional Alliances and the GOOS Projects.

Global to regional development

Trans-boundary issues in the ocean continue to grow, and a global and sustainable GOOS requires a determined level of capacity development. Much of this work is currently being done through the GOOS Regional Alliances (GRAs) and the JCOMM Observation Coordination Group global networks.

Co-evolution

To realize the GOOS vision, mission, and strategy, including the identification of where engagement is critically needed, the structures of GOOS will be oriented towards improved collaboration, common design and advocacy. GOOS will engage with new and existing partners to deliver in areas where present structures require support. We will communicate to our partners how we plan to work more closely with them: where we will partner, where we will interface, and where we will provide enhanced global leadership. GOOS will maintain a more detailed and shorter-term rolling Implementation Plan, with actions based on the objectives of this Strategy, and an increasing number of actions planned together with partners.

NOTE: This final section needs to be completed with some elements from the GOOS Implementation Plan and Steering Committee Meeting (June 2018) to demonstrate co-evolution around the focus on increased partner development, ideas around increased participation in governance and a little more about where GOOS will grow capability, in order to deliver. This will be completed by the end of June, however sponsors, partners, stakeholders and experts are still welcome to comment on this aspect of the document.