UN DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT

The vision of the UN Decade of Ocean Science for Sustainable Development 2021 - 2030 is to deliver the science we need for the ocean we want.

With this powerful vision the Decade provides a convening framework for diverse stakeholders to co-design and co-deliver transformational science for the future of our ocean. The Decade will:

- energise the development of solution-orientated services and tools for decision and policy makers, and managers at all scales, to contribute to 2030 Agenda and complementary policy frameworks;
- promote an extensive stakeholder engagement network to catalyze new partnerships;
- stimulate innovation and increase access to data and technology;
- strive for full gender, generational, and geographic diversity;
- attract participation from a wide range of stakeholders – including research institutes, governments, UN entities, industry, philanthropy, NGOs, and community groups.

The draft Implementation Plan for the Decade will be presented to the United Nations General Assembly in late 2020, it includes ten Challenges to unite partners around the immediate Ocean Science for Sustainable Development priorities. One of the Ocean Decade Challenges is to **ensure a sustainable ocean observing system that delivers timely data and information accessible to all users on the state of the ocean across all ocean basins** in recognition of the fundamental importance of observations to the success of the Decade.

GOOS and the global ocean observing networks will play an important role in achieving this goal over the next decade. Arising from the OceanObs'19 Conference, several ideas (or Actions) are being developed for the Decade[1]. Some of these are likely to be submitted in response to the first "Call for Actions" for Decade endorsement, to be released in October 2020.

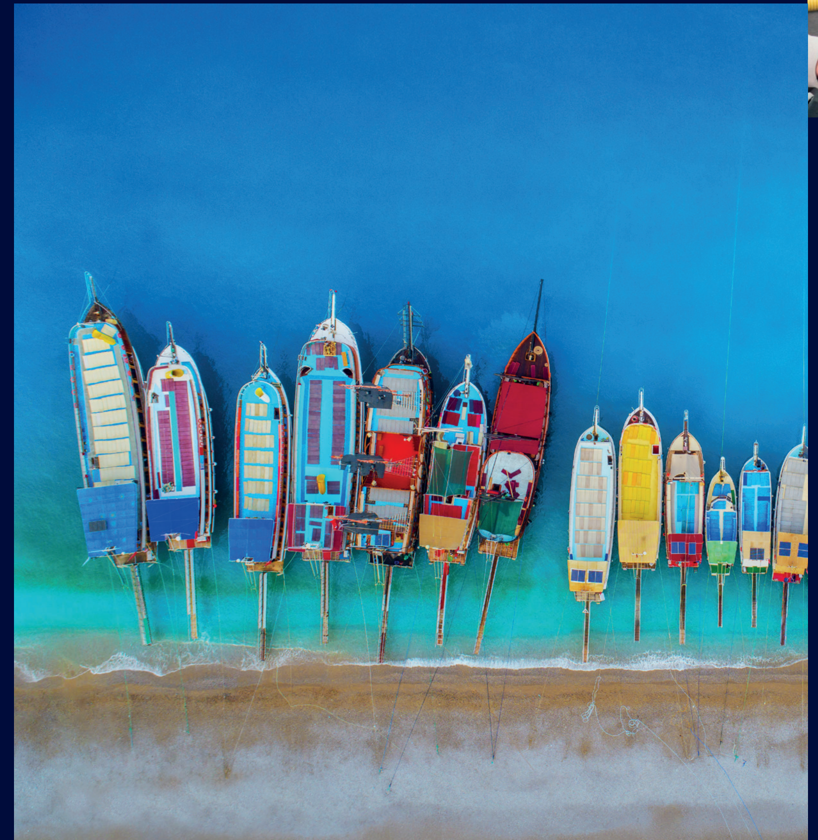
More information can be found on www.oceandecade.org

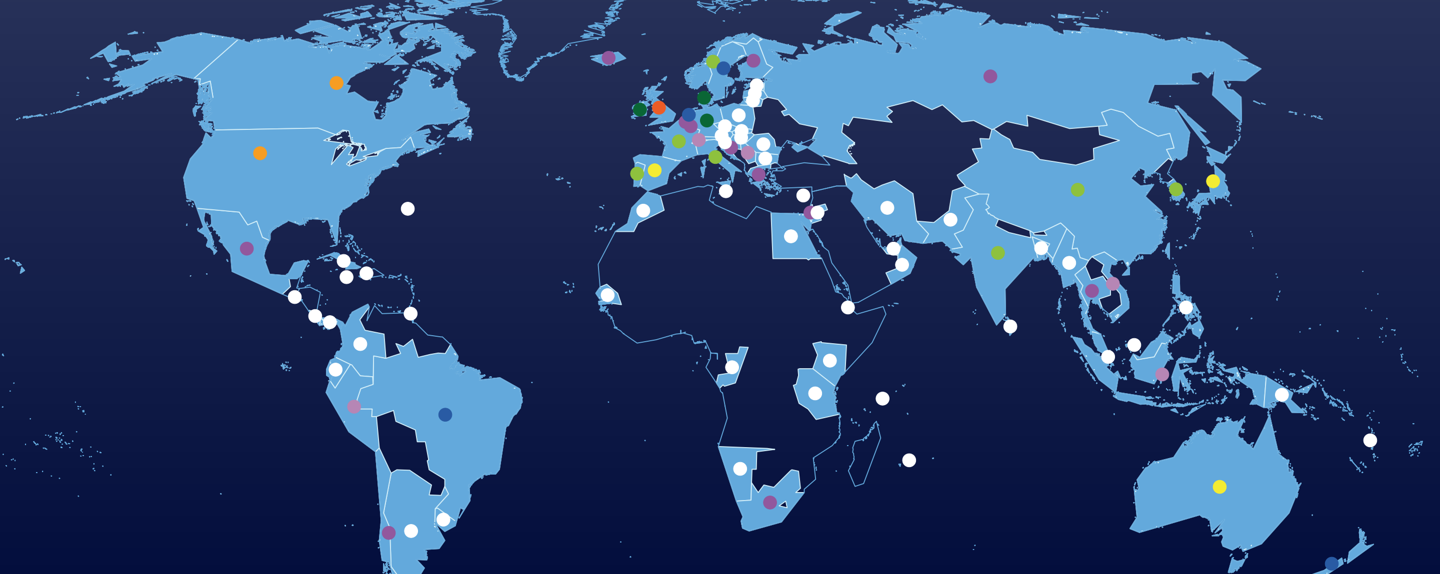
2021 2030 United Nations Decade of Ocean Science for Sustainable Development

As the global population is set to reach more than 9 billion people by 2050, impacts on the ocean associated with human activities will only escalate.

Understanding the variability of the ocean and the related impacts on our society, through sustained ocean observations and ocean science, will be of vital importance for the benefit of the nature and humankind.

(1) Watch GOOS-Intergovernmental Oceanographic Commission (IOC) Newsletters for updates.





Number of supported networks

1 ● 2 ● 3 ● 4 ● 5 ● 6 ● 7 ● 8 ● 9 ●

Based on operational platforms registered at OceanOPS as of June 2020: 86 countries.

The GOOS Observations Coordination Group takes the opportunity to thank all its partners for their support and a special thanks to all the observing network system implementers who are working so very hard during the Covid-19 pandemic to maintain system function. As we continue to ensure the maintenance of critical system components we ask for increased international collaboration and encourage new partners to join the challenge of building a truly global ocean observing system that delivers the essential information needed for our sustainable development, safety, well-being and prosperity.

More information at:

www.ocean-ops.org/reportcard2020

CONTACTS

General information: **www.goosocean.org**
Networks status: **www.ocean-ops.org**
Report Card information: **reportcard@ocean-ops.org**
If you wish to contribute to the global ocean observing system, please contact: **support@ocean-ops.org**

Authors: Observations Coordination Group (OCG) and Observations Programme Support centre (OceanOPS)

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Ocean Observing System Report Card 2020

GOOS Observations Coordination Group

COVID-19'S IMPACT ON OCEAN OBSERVATIONS

In April 2020 the Global Ocean Observing System (GOOS) organized a systematic review of the impact of Covid-19 pandemic on the ocean observing system, across the global *in situ* ocean observing networks. The review assesses risk to the delivery of essential climate and ocean variables used in services from weather forecasting to commercial shipping, and ocean policy.

As the global pandemic took hold, some of the immediate impacts included:

- the recall to home port of almost all research vessels and the postponement of many deployment, maintenance and repair missions to deep sea moorings;
- cancellation of four invaluable full-depth ocean surveys, of over a dozen different climate and ocean related variables, such as carbon, temperature, salinity and water alkalinity;
- slowdown in deployment of autonomous instruments, such as drifting buoys, profiling floats and underwater gliders;
- cessation of surface carbon measurements from ships, which tell us about the uptake of greenhouse gases by the ocean;
- loss of 80% of data flow from the Ship of Opportunity Programme's ocean temperature profile measurements.

The global system showed resilience to these immediate impacts, due to the diversity of platforms, the increased use of autonomous platforms - able to operate for months without human intervention - and through the actions of individual operators in maintaining network function whilst working from home under Covid-19 restrictions.

But months on from the initial impacts and with research vessel operations far from returning to normal, GOOS has growing concern for parts of the global system.

"There is a real risk that equipment will fail, resulting in the loss of both data and potentially the equipment itself, like the moorings." explains Johannes Karstensen, co-lead of the OceanSITES interdisciplinary moorings network. The loss of even a single one of the over 300 operational moorings could mean a gap of two to five years of data.

The Argo network is also heavily reliant on research vessel cruises for reseeding the global array of profiling floats, which already shows a 10% decline in observations to the real-time data delivery systems compared with early 2020.

On the impacts of the potential loss of ocean data, *"The data is critical for projecting ocean heat waves, which can trigger toxic algae blooms that shut down commercial fishing and aquaculture operations, and cause mass die-offs of marine mammals and birds. It also is important for projecting the strength and paths of tropical storms and hurricanes that affect the United States and many other countries."* writes Bob Berwyn, Inside Climate News[1].

"GOOS is calling for careful international coordination across national research vessel fleets to ensure we do not compromise essential data for weather prediction and climate, especially for the maintenance and deployment of important deep sea mooring arrays." says Toste Tanhua, co-chair of GOOS.

"We need to support international cooperation and look at operational flexibility, such as contracting commercial vessels, using ships of opportunity or navy vessels, and partnership with local and indigenous populations" he continues. *"There are still many challenges for the GOOS ahead, however this is also an opportunity to strengthen operations for the future."*

GOOS *in situ* networks	Covid-19 impact	
	June 2020	Projected status December 2020
Ship based meteorological measurements	Minor	Minor
Ship based aerological measurements	Minor	Minor
Ship based oceanographic measurements (XBT)	Major	Major
Sea level gauges	Minor	Minor
Drifting and polar buoys	Minor	Minor
Moored buoys	Minor	Minor
Interdisciplinary moorings	Medium	Medium
Profiling floats	Minor	Minor
Repeated hydrographic transects	Major	Medium
OceanGliders	Medium	Minor
HF radars	Minor	Minor
Animal borne ocean sensors	Minor	Medium

(1) Inside Climate News: https://insideclimatenews.org/news/24072020/oceanographers-coronavirus-research-science-climate

IN SITU AND SATELLITE OBSERVING SYSTEM STATUS

Recent reports (e.g. OECD 2016[1]) project ocean economic activities will increase rapidly, doubling in size from USD 1.5 to 3 trillion by 2030. Moreover, the rapidly changing ocean environment continues to be a key actor in global weather and climate changes, and is itself undergoing profound changes, such as global and regional warming and acidification in response to natural and anthropogenic forces.

Motivated by the increasing importance of ocean knowledge for development needs as well as addressing climate-related trends, this issue of the **Ocean Observing System Report Card** provides an update on the status of the global ocean observing system and its ability to address these international needs. Over 2 million ocean *in situ* observations are reported daily from the systems reflected in this report.

Covid-19 has impacted ocean observing in surprising ways and highlighted both strengths and weaknesses in our systems; it has also catalyzed creativity to maintain those observations and may accelerate our use of autonomous systems and approaches in the future (we are already testing such technologies!). This issue also highlights the potential value of public-private partnerships in addressing key observing needs. Finally, this year we report on the remarkable advances in animal-based measurements, which are providing data in important regions that are not well sampled by other systems.

WMO spotlights the ocean in the earth system

The 2019 historical reform of the World Meteorological Organization (WMO) has placed ocean high on the agenda – reinforcing the critical importance of the ocean in the earth system, at a time when the earth is rapidly changing.

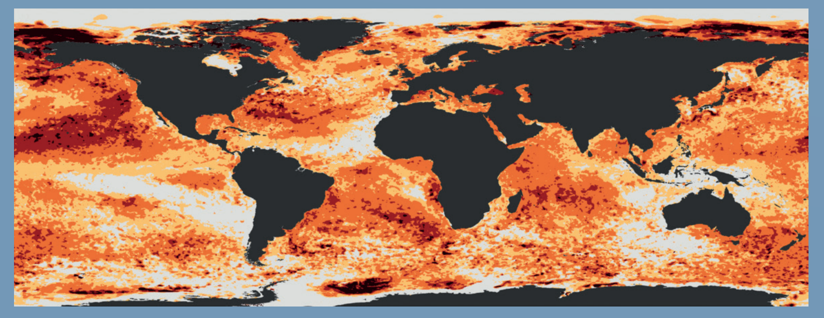
Human activities are placing unprecedented stress on the ocean, which absorbs more than 90% of the excess energy in the climate system. In 2019, ocean heat content and the global mean sea level reached the highest values on record. There were widespread marine heatwaves and continued ocean acidification and deoxygenation, according to the WMO's State of the Global Climate report.

Climate change and the associated loss of sea ice is impacting ocean currents. Higher sea surface temperature increases the potential for extreme weather, including intense tropical cyclones. Sea level rise heightens the dangers of coastal flooding.

It is therefore vital to strengthen and fill the geographical and resource gaps in the global ocean observing system to meet the growing demand for weather and ocean services and forecast products, multi-hazard early warning systems, and climate and ocean health applications. There is also a need to support new technologies and the development of autonomous observing instruments.

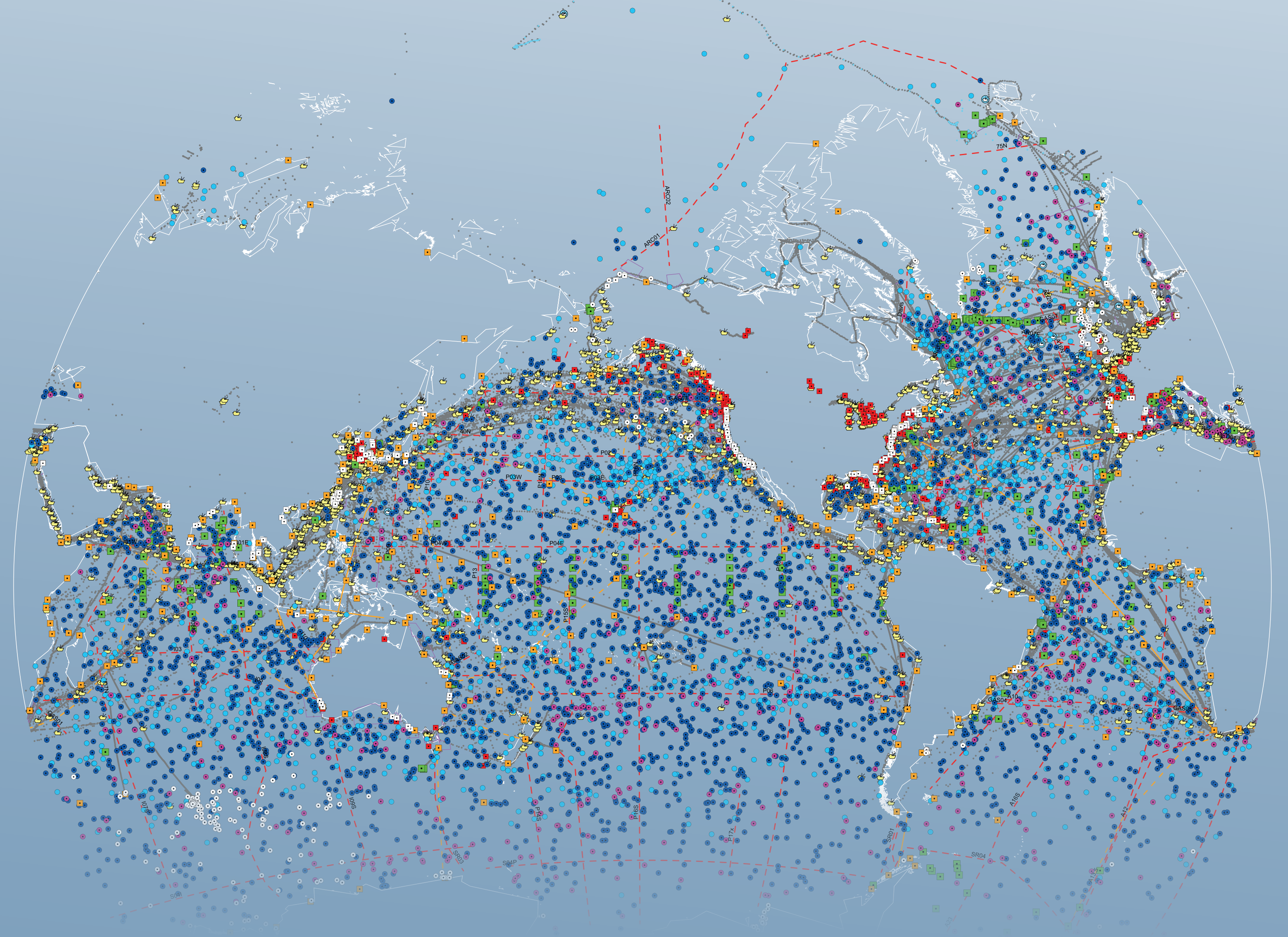
Supporting much of this work is the joint WMO-IOC *in situ* Observations Programme Support Centre OceanOPS (formerly named JCOMMOPS) based in Brest (France). OceanOPS formally became a WMO UN Office in 2019 through an agreement with French authorities, opening a new chapter of cooperation with France, for the ocean observations.

International cooperation and collaboration are key to finding impactful global solutions using the earth system approach, to advance research, observations, prediction and services, in support of the sustainability and safety of people, property and the planet.



Global map showing the highest Marine Heat Waves (MHW) category experienced at each pixel over the course of the year 2019, estimated using the NOAA OISST v2 dataset (reference period 1982–2011). White indicates that no MHWs occurred in a pixel over the entire year. From WMO Statement of Global Climate 2019.

(1) OECD (2016): The Ocean Economy in 2030, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264251724-en



See *in situ* networks table for map legend. OceanOPS data source as of September 2020: operational platforms latest location (Argo, DBCP, AniBOS, VOS, ASAP); fixed platforms location (GLOSS, HF radars, OceanSITES); reference lines (GO-SHIP, SOOP); sampled sites (OceanGliders). Dashed lines for GO-SHIP and SOOP have not been sampled after Covid-19 impact; dots for VOS and ASAP show August 2020 observations. Symbols size is not to scale, in the map they are exaggerated to an order of hundreds kilometers for readability.

GOOS *in situ* networks[1]	Implementation: Status[2]	Data & metadata: Real time[3]	Data & metadata: Archived high quality[4]	Data & metadata: Meta-data[5]	Best practices[6]	GOOS delivery areas[7]: Operational services	GOOS delivery areas[7]: Climate	GOOS delivery areas[7]: Ocean health
Ship based meteorological measurements - SOT/VOS	★★☆	★★★	★★★	★★☆	★★☆	✓	✓	
Ship based aerological measurements - SOT/ASAP	★☆☆	★★★	☆☆☆	★★☆	★☆☆	✓	✓	
Ship based oceanographic measurements - SOT/SOOP-XBT	★★☆	★★★	★★★	★★☆	★★☆	✓	✓	
Sea level gauges - GLOSS	★★★	★★☆	★★★	★☆☆	★★☆	✓	✓	
Drifting and polar buoys - DBCP	★★★	★★★	★★☆	★★☆	★★☆	✓	✓	
Moored buoys - DBCP	★★☆	★★★	★☆☆	★★☆	★★☆	✓	✓	
Interdisciplinary moorings - OceanSITES	★★☆	★☆☆	★☆☆	★★☆	★★☆		✓	✓
Profiling floats - Argo	★★★	★★★	★★★	★★★	★★☆	✓	✓	
Repeated transects - GO-SHIP	★★★	★☆☆	★★★	★★☆	★★★		✓	✓
OceanGliders	★☆☆ Emerging	★★☆	★☆☆	★★☆	★☆☆	✓	✓	✓
HF radars	Emerging	★★★	★★★	★☆☆	★★★	✓	✓	✓
Biogeochemistry & Deep floats - Argo	★☆☆ Emerging	★★★	★☆☆	★★★	★★☆	✓	✓	✓
Animal borne ocean sensors - AniBOS	Emerging	★★★	★☆☆	★☆☆	★★☆	✓	✓	✓

(1) More information at www.goosocean.org (2) Status: status vs target, external target when exists, *e.g.* GCOS; network self-assessed status when target does not exist (3) Real time: data available on Global Telecommunication System of WMO (4) Archived high quality: availability of delayed mode data with additional quality controls (5) Metadata: information required by OceanOPS (6) Best Practices: community reviewed and easily accessible documentation encompassing the observations lifecycle (7) See Network Specification Sheets: www.goosocean.org > Observations > Network Specification Sheets

Enhance understanding and describe our changing oceans through the eyes of marine animals

The newly endorsed Animal Borne Ocean Sensors (AniBOS) network provides a cost-effective and complementary observing capability to the GOOS. AniBOS monitors several essential ocean and biodiversity variables, providing inputs to estimate global ocean indicators, contributing to the quantification of the upper ocean variability and yielding data for a range of operational oceanographic applications.

Animal borne ocean sensors are used to retrieve a variety of variables in several chronically under-sampled regions. These variables include temperature and salinity profiles, but also fluorescence, oxygen or surface wave and wind activity.

In the last decade, about 500,000 temperature-salinity-depth profiles were obtained in high latitudes, coastal shelves and tropical areas, all regions that are currently poorly covered by traditional observing platforms, greatly enhancing studies of climate variability and the delivery of information to inform climate prediction estimates at global and regional scales.

A growing number of ecological studies and management applications are made possible by the use of animal-borne instruments. Formal recognition of the animal borne ocean sensors network within the GOOS Observations Coordination Group will improve our ability to observe and understand the oceans and the animals that live in them.

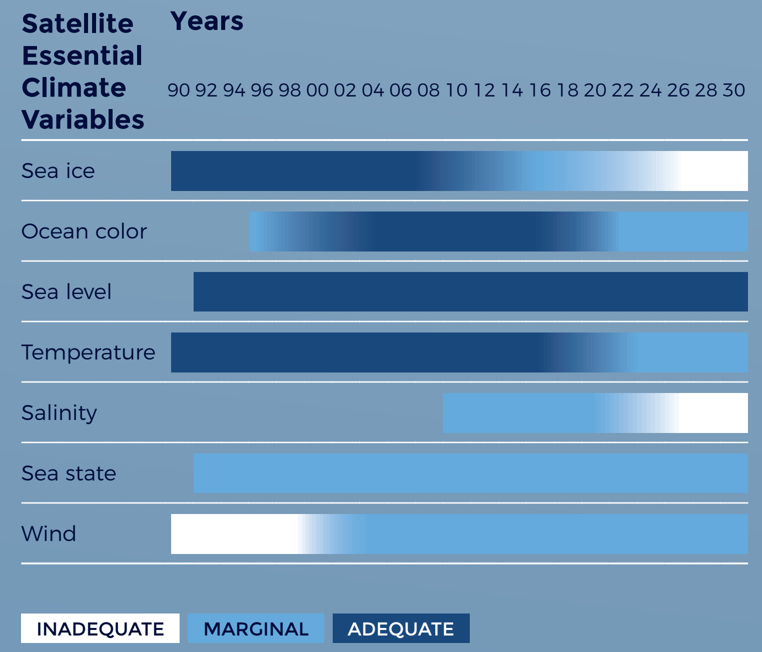
These hydrographic observations also provide a wealth of data on animal movements and behaviour that link environmental state and animal performance, that is essential to developing evidence-based policy, beneficial to protecting the animals and their habitats.

Satellite-based observations

The satellite network provides repeated global sampling of key ocean surface variables. These remotely-sensed variables are complementary to *in situ* observations, in that they fill some gaps in *in situ* coverage, both in time and space, while *in situ* measurements provide critical ground-truthing information for satellite sensors' validation and calibration. Together they provide foundational knowledge about the ocean environment and enable a wide range of forecasts and services.

In the last few months, while Covid-19 has impacted some *in situ* ocean observing systems and field campaigns, data streams from satellite missions have continued uninterrupted. International agencies, including the National Aeronautics and Space Administration (NASA), dedicated significant resources to look at the earth system and to deliver continuous data during the pandemic. Over the longer term, the effects of the Covid-19 pandemic might be seen in delays to satellite missions planned to be launched in the next years (*e.g.* Surface Water Ocean Topography (SWOT)).

In order to continuously get global measurements of the oceans, it is essential to ensure the continuity of satellite missions in the future. It is also imperative to keep improving the accuracy, coverage, spatial and temporal resolution provided by these satellite missions and *in situ* observations.



More information on satellite status at www.ocean-ops.org/reportcard2020

Ship's support to science and services

Ships are fundamental for deploying autonomous met-ocean instruments like drifting buoys or profiling floats, for the continuous measurement of oceanographic and atmospheric parameters with onboard instrumentation, and for the deployment and maintenance of ocean moorings. Ship observations, alongside other observations, are assimilated into global and regional climate analyses and coupled ocean-atmosphere climate models, which depict the evolution of our environment. High precision, multi parameter (physical to biological) data of the full water column can still only be collected by research ships, and these multi-decade observations provide a bedrock for climate analysis, as well as vital calibration of autonomous instruments.

With more ship observations taken and used in forecasting models, the quality and confidence in their use increases which can be critical guidance in extreme weather situations.

Observations help to ensure safety of life at sea and make shipping also more economic by allowing better forecasting of extreme weather events or ocean currents. The critical need for more voluntary ocean observations from ships to better predict the weather and ultimately protect safety of lives at sea, was deemed a priority action in 2019 at the joint WMO-International Maritime Organization (IMO) Symposium on Extreme Maritime Weather.

Recently commercial shipping and private initiatives are getting more involved in cost effective and innovative met-ocean data collection projects. A great example is Maersk: all 300 company-owned freighters have recently committed to joining the Voluntary Observing Ship (VOS) Scheme and now provide vital data in support of climate and weather forecasts. Other examples are the many race sailing campaigns that deploy autonomous instruments and take on board measurements to help scientists get essential data from remote ocean areas of the planet.

Ship operations are crucial to sustain and maintain the global ocean observation system at sea. We need a future where commercial, research, and privately owned vessels make multivariate observations, using a combination of automated and human-observed measurements, and where all data and metadata will be available to benefit users of marine information.

CALL FOR ACTION

The current global ocean observing system, reported on here, has been coordinated through WMO Members, IOC Member States, governments, and institutions. This system delivers data and information towards a range of global and regional services mainly focused on weather and climate applications.

The GOOS Strategy for 2030, calls for an expanded and more integrated global observing system that captures physical, chemical, biological and ecological ocean properties and integrates information on human pressures.

- The current system must grow, *e.g.* through the UN Decade of Ocean Science for Sustainable Development, over the next decade to address these requirements.
- It is critical that governments and the private sector work together to increase support for ocean observing, to meet the increasing need for ocean knowledge.

David Legler

Chair GOOS Observations Coordination Group