



Newsletter **2019**

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Impact on Atlantic Ocean Observing – The leverage of AtlantOS
beyond the project lifetime

AtlantOS



Email: atlantos@geomar.de | Website: www.atlantos-h2020.eu | Twitter: [@atlantos_h2020](https://twitter.com/atlantos_h2020)

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What is the H2020 project AtlantOS

The AtlantOS H2020 EU research and innovation project pools the effort of 57 European and 5 non-European partners from 18 countries to collaborate on optimising and enhancing Atlantic Ocean observing. The project has a budget of about € 21 Million for 4 years (2015 – 2019) and is coordinated by GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany (Prof. Dr. Martin Visbeck). The vision of AtlantOS is to improve and innovate Atlantic observing by using the Framework of Ocean Observing to obtain an international, more sustainable, more efficient, more integrated, and fit-for-purpose system. The AtlantOS initiative aims to have a long-lasting and sustainable contribution to realizing societal, economic and scientific benefit arising from this integrated approach with implementation extending beyond the project's lifetime. Advances will be achieved by improving the value for money, extent, completeness, quality and ease of access to Atlantic Ocean data required by industries, product supplying agencies, scientists and citizens.

Credits

Editors: Laura Ebeler (GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany) and Sandra Ketelhake (German Marine Research Consortium (KDM), Germany)

Layout: Simon Keeble (Blue Lobster, United Kingdom)

Cover Photo: Participants of the First International AtlantOS Symposium in Paris (France), March 2019 (Credit: Maarten van Rouveroy)

Editorial

Martin Visbeck, Anja Reitz, and Laura Ebeler
(GEOMAR Helmholtz Centre for Ocean Research
Kiel, Germany)

Sandra Ketelhake (German Marine Research
Consortium (KDM), Germany)

After almost four years of the AtlantOS project's lifetime, this last newsletter focuses on 'Impact on Atlantic Ocean Observing – the leverage of AtlantOS beyond the project lifetime'.

Our ambition for AtlantOS, the project, was to improve and innovate Atlantic Ocean observing by using the Framework of Ocean Observing as a guide to work towards a more international, more sustainable, more efficient, more integrated, and fit-for-purpose ocean observing system. We are particularly pleased about the exciting and groundbreaking work that we have done and reported on in a large number of deliverables, the willingness to innovate, to cooperate across disciplines and regions as well as the integration of existing initiatives, improving data flows and establishing a large number of good and best practices. The reports document how improvements and innovations to the current observing system were made, why ocean observing gives plenty of value for money. Work packages have worked hard to improve spatial and parameter coverage, basin scale completeness, quality, authority and ease of access to data. Furthermore, user consultations with ocean information product generating agencies, the private sector, ocean and climate scientists, NGOs and educators and those who provide ocean literacy to citizens have been improved.

The AtlantOS partners and the wider ocean observing community achieved those successes together, some funded by the H2020 project, others by providing national or private sector resources. This allowed to make progress on system design, connecting different observing networks and achieve more cooperation, improve timely data delivery, interoperability, integration and harmonization, and to show the value of integrated ocean observing by exemplary products that fulfil the societal needs. We are particularly pleased to have been able to work with several member states, the IOC, WMO and GEO programs and also initiated a cycle of observing system evaluation and review. Looking ahead, AtlantOS the project has laid the foundation towards a sustained All-Atlantic Ocean Observing whose ambition was articulated in the recently published AtlantOS High-level Strategy (formerly known as the AtlantOS Blueprint process).

The 'Focus' of this newsletter is on a few selected success stories of the AtlantOS project and some views on future perspectives. The contributions range from (i) data harmonization and integration, (ii) monitoring the Atlantic Ocean through joint international efforts to cooperate on operational innovation and enhancement, (iii) data products and (iv) information products to (v) the All-Atlantic Ocean Observing System (AtlantOS) Program.

With these examples, we would like to encourage the Atlantic Ocean observing community to continue and intensify their engagement for the AtlantOS program. The First International AtlantOS Symposium (25 – 28 March 2019, Paris, France) marked the transition from AtlantOS the project to AtlantOS the program. In the coming months, an interim AtlantOS program steering group will work and consult with all of you on the implementation of AtlantOS. At the OceanObs'19 conference (16 – 20 September 2019, Hawaii, USA) these ideas will be further developed and are expected to be a significant contribution the UN Decade of Ocean Science for Sustainable Development.

AtlantOS the project together with its partners has laid the foundation to implement the comprehensive All-Atlantic Ocean Observing System (AtlantOS) program that benefits all of us living, working and relying on the ocean.



Focus Area

Impact on Atlantic Ocean Observing – The leverage of AtlantOS beyond the project lifetime

All-Atlantic Ocean Observing System (AtlantOS)

– Enhanced ocean observing for the Atlantic –

Brad deYoung (Memorial University of Newfoundland, Canada)

Martin Visbeck (GEOMAR Helmholtz Centre for Ocean Research Kiel and Kiel University, Germany)

Sandra Ketelhake (German Marine Research Consortium (KDM), Germany)

Ocean observations touch our lives every day from the food we eat to the clothes we wear, to how we spend our leisure time. The data collected through ocean observations in the Atlantic Ocean is enormous and critically needed e.g. to predict weather and climate, to document climate change impacts to the ocean, and to guide ocean economic developments.

The AtlantOS High-level Strategy describes

- An integrated concept for a forward-looking framework and basin-scale partnership to establish a sustainable, multi-disciplinary, multi-thematic, efficient, and fit-for-purpose ocean observing system in the Atlantic as a whole.

AtlantOS Vision

A comprehensive All-Atlantic Ocean Observing System that benefits all of us living, working and relying on the ocean

Many nations are engaged in Atlantic Ocean observing but the activities are loosely coordinated, the data are not fully available, nor do we take full advantage of all observations made and our present observing systems are not sustainable. The current system makes it difficult to argue that we are getting the best value for the investment in observing activities. A lot of ocean data is shared and capacity building is supported but the ocean observing community could do better to meet user needs. In addition, the wider society must be engaged more effectively in ocean observing to demonstrate the importance of these observing systems to people and to society. In 2016, a team of 19 ocean observing experts with diverse expertise and from different countries around the basin gathered in the context of the [EU H2020 project AtlantOS](#) to develop a 'BluePrint' for an Integrated Atlantic Ocean Observing System. The team delivered the now called AtlantOS High-level Strategy that points to a vision and the contents of an All-Atlantic Ocean Observing System. This strategy is supported by and has been endorsed by the ocean observing community and we now enter in a new phase through [AtlantOS the program](#).

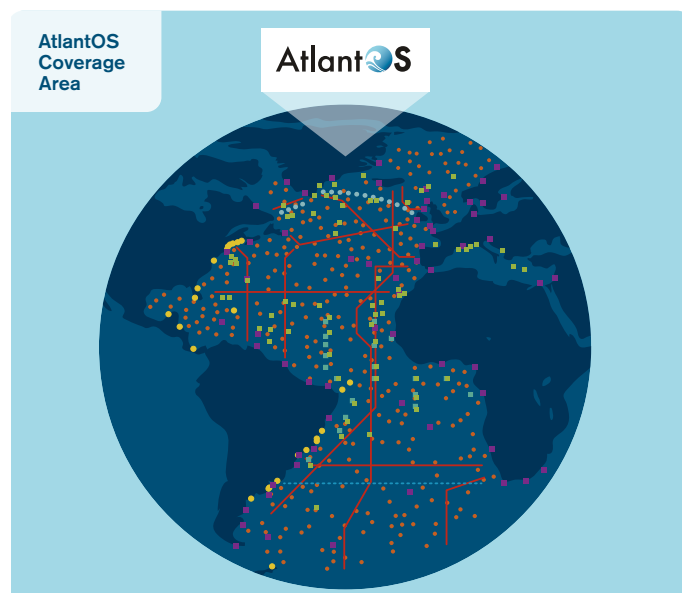
- A system that goes beyond the status quo by connecting countries around the Atlantic to join and deliver a basin-scale system. AtlantOS builds on observing platforms, networks, and regional systems that already exist and operate at various maturity levels.
- The contribution to international bodies that coordinate global ocean observing: the Global Ocean Observing System (GOOS) and the Group on Earth Observations (GEO) Blue Planet Initiative.
- The connection to the Galway Statement on Atlantic Ocean Cooperation, the Belém Statement on Atlantic Research and Innovation Cooperation, and the United Nation's Decade of Ocean Science for Sustainable Development.

AtlantOS will generate value

- By focusing not only on the physics but also on the biology, ecology and biogeochemistry of the ocean and seafloor,
- By sharing information widely, encouraging multiple uses of data,

- By responding to user needs,
- By saving time, money, and energy by working together,
- By coordinating the implementation of observing systems and the collection of ocean data in the Atlantic Ocean, and
- By supporting multidisciplinary diversity in all forms and transnational partnerships.

In building AtlantOS, it is important that we define and follow clear and transparent principles. The implementation of the AtlantOS vision will lead to a sustainable comprehensive observing system in the Atlantic basin from which societies, governments, and industries around the Atlantic will benefit. It defines the principles of the system, how partners could contribute, and presents the benefits that will be derived from an effective ocean observing system. The vision is an implementation that points to the operational challenges and approaches and offers guidance on real actions for the ocean observing system and the roles of different partners.



AtlantOS Coverage Area: The Atlantic Ocean, depicting the focus area of ocean observing for AtlantOS. Dots and lines conceptually indicate current ocean observing activities by major networks, such as Argo, GO-SHIP, PIRATA, OSNAP and MBON (Credit: AtlantOS).

Monitoring the Atlantic Ocean, an international and innovative effort

Michèle Barbier (Institute for Science and Ethics, France)

Hervé Claustre (CNRS- Sorbonne Université, Laboratoire d'Océanographie de Villefranche (LOV), Institut de la Mer de Villefranche (IMEV), France)

Grigor Obolensky (Euro-Argo ERIC, France)

Sylvie Pouliquen (Euro-Argo ERIC, Ifremer, France)

The ocean plays a major role in the global climate system. Through its continuous exchange of energy and fresh water with the atmosphere, it is the primary regulator of global climate. To cope with the impacts of global change on the ocean, observations are required, not only to better quantify the change, understand and predict the role of the oceans and seas in climate, but also to help decision-makers acting wisely to mitigate and to adapt to climate change.

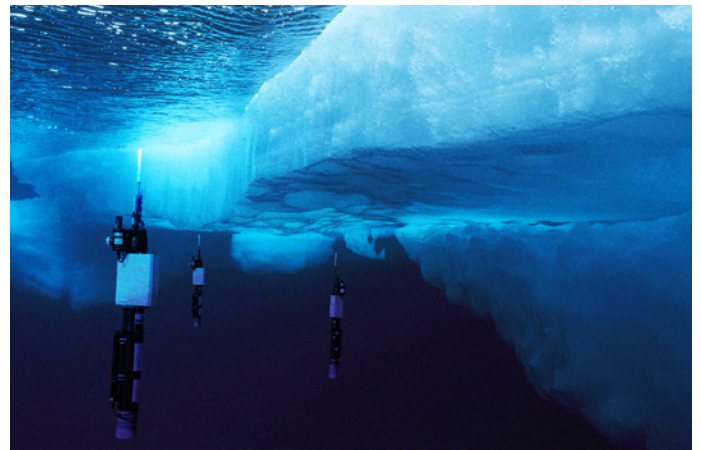
The Atlantic Ocean covers approximately 20 percent of the Earth's surface. To monitor changes in this interconnected ocean with Arctic, Southern Pacific and Indian oceans, an Atlantic Observing System has been established, based on in-situ and satellite observations, from coastal domains impacted by human activities, to high latitude areas or to the deepest parts of the oceans. Among the components of this observation system are the Argo floats, autonomous in-situ observing platforms, providing accurate data on physical and biogeochemical parameters in real time and from the sea surface

Argo

Argo is one of the most important components of the in-situ ocean observing system, complementing ship measurements in many regions. Euro-Argo ERIC, the European component of Argo, provides in-situ ocean observations to various user's communities interested in the ocean state and evolution. This European Research Infrastructure aims at maintaining one fourth of the international Argo network and developing its extensions to high latitudes, abyssal ocean and biogeochemistry, hence contributing to fill identified gaps in the Atlantic Ocean Observing System.

down to approximately 2000m depth (see box). In this international observation network, Europe plays an important role through the Euro-Argo ERIC,

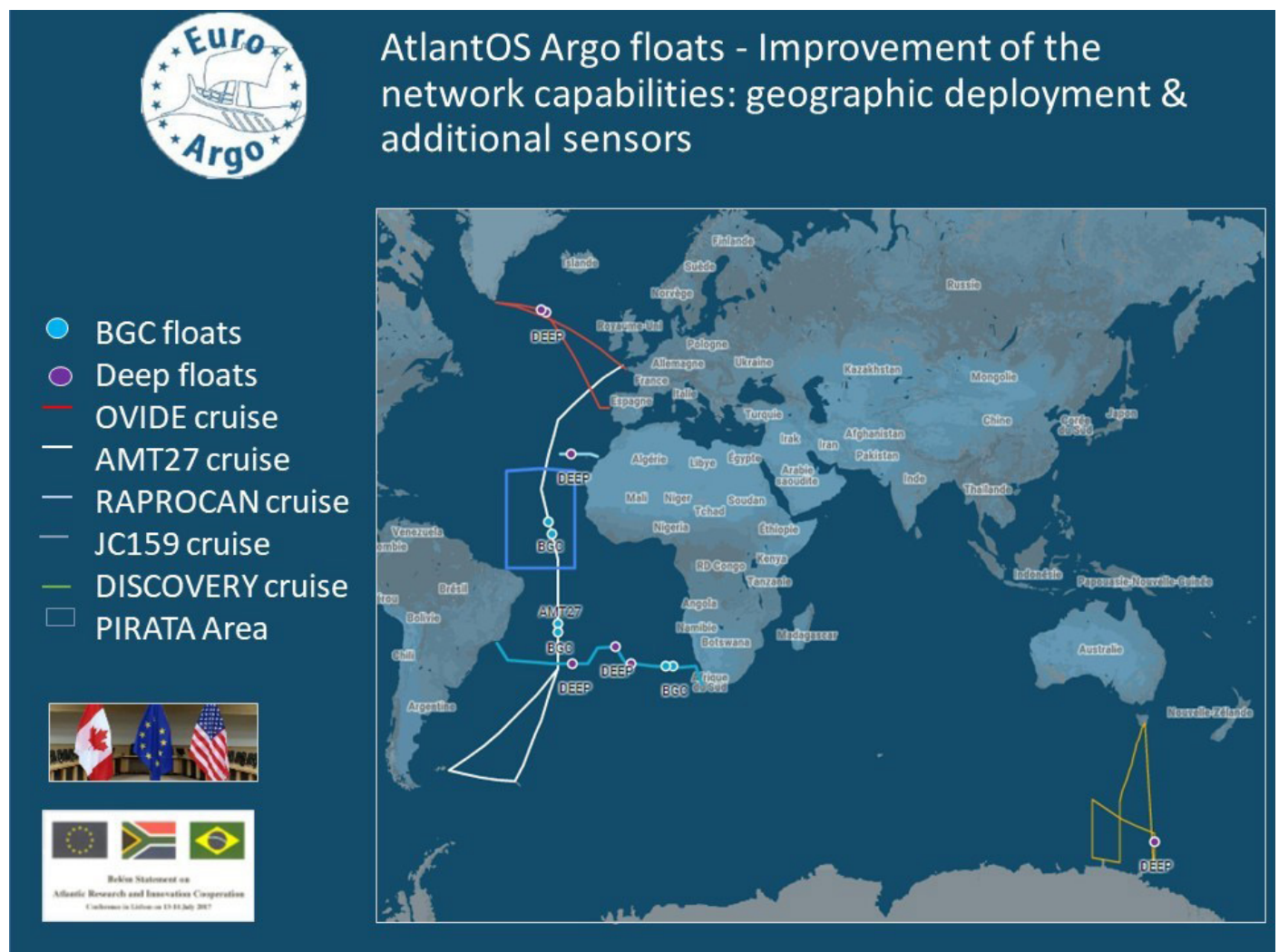
a structure that coordinates a network of research infrastructures, supported by the Member States and the European Commission. Europe provides not only the technology to access the deepest part of our oceans (up to 4000m deep), the least explored region (such as the Arctic and Antarctic) but also the very precise biogeochemical states of our oceans.



Biogeochemistry-Argos in high latitudes (Credit: Michèle Barbier).

The European H2020 AtlantOS project has contributed significantly to the development of these tasks by supporting the Biogeochemistry-Argo (Figure 1) and Deep-Argo networks in particular in the South Atlantic that was less covered by Argo (Figure 2). The sustainability and extension of the Euro-Argo mission is important. In particular, the extension to new generations of cost-effective sensors and floats and the engagement with new end-users to meet societal needs are critical aspects of this sustainability. The Integrated Global Ocean Observing System (GOOS), comprising multiple observation networks like Argo, multiplies opportunities for deployment, for trans-Atlantic cooperation to fill gaps in ocean observations.

By fostering a coherent, interdisciplinary and interoperable set of marine initiatives across Europe and beyond, new and innovative solutions can emerge to meet the challenges of observation and data management. The Atlantic Ocean Observing System (AtlantOS) is part of this global effort and Argo and Euro-Argo ERIC are major components of this system.



Deep-Argo float networks in the South Atlantic Ocean (Credit: Michèle Barbier).

Delivering open science for contributing to the societal challenge of climate change

Gianandrea Mannarini (Euro-Mediterranean Center on Climate Change, Italy)

Would you accept that two countries such as Italy and Spain are exempted from climate change mitigation actions? I suppose not. Actually, CO₂ emissions from international shipping in 2015 were even larger than the quota of those two countries (i.e., about 2.5% of total). However, only lately the shipping sector has begun to agree on pathways for CO₂ emission reduction.

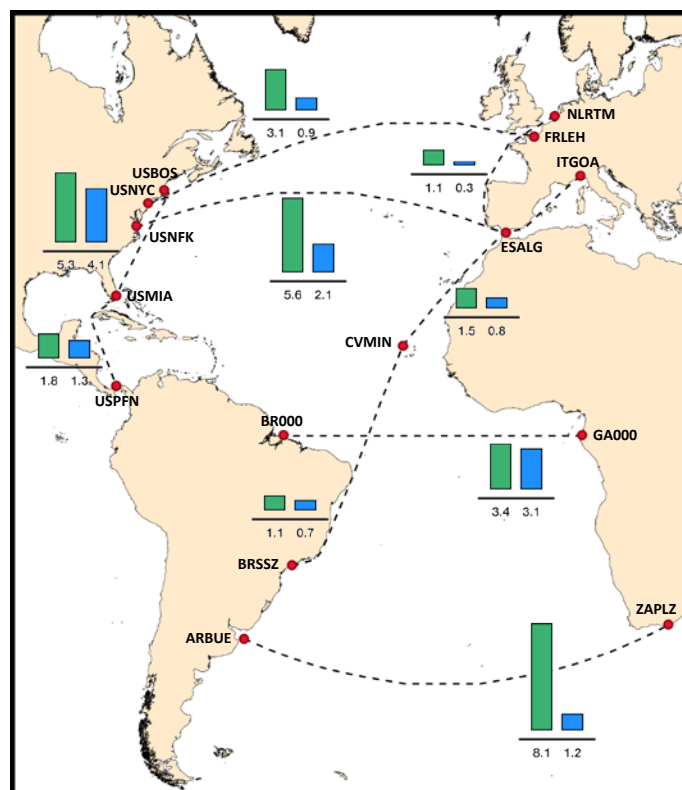
The European Union regulation (2015/757) on Monitoring/Reporting/Verification of CO₂ emissions from ships calling at and from EU ports [represents the first step](#) before defining reduction targets and applying Market Based Measures (MBM). More recently (2018), the International Maritime Organization (IMO) approved a [strategy](#) for CO₂ emission reduction with the ambition to halve them by the mid of the century. In the medium and long term, this should be achieved through MBM and the use of fossil-free fuels, but in the short term, the energy efficiency of existing vessels should be raised.

Within AtlantOS WP8 (“Societal benefits from observing/information systems”), we have addressed this urgent topic. Among others, we have further developed the VISIR ship routing model for assessing how ocean currents and surface gravity waves could be exploited for sailing on more energy efficient routes. We made use of open data from the [Copernicus Marine Environment Monitoring System](#) (CMEMS, to which AtlantOS also contributes to). These data merge ocean observations with model computations for reconstructing and predicting the ocean state and circulation. We use CMEMS data for computing the maximum speed of vessels, compliant with safety of navigation, at any location in the Atlantic Ocean over the year 2017. Then, a path optimization algorithm computes the shortest and the fastest path between given harbours. Finally, the energy efficiency of the two paths is compared by means of a standard indicator (Energy Efficiency Operational Indicator, EEOI) established by the IMO. We have assessed both the seasonal and regional dependence by varying departure date and harbours in the whole Atlantic. Furthermore, we have distinguished the total gains in energy efficiency of the voyages (green columns in the figure) from the contribution due to ocean currents (blue columns). We have found that in the Northern Atlantic both waves and currents can significantly contribute to the EEOI savings, whereas at the Equator only currents are relevant, while in the

Southern Ocean the dominant effect stems from just waves.

The results obtained via VISIR represent an initial step by which we contribute to the analysis of a societal challenge through ocean data and the numerical tools of optimization. However, the mitigation ambitions by both the IMO and the EU call for even greater advancements. In particular, we need to be much more accurate in our capacity to predict the maximum speed of vessels in a seaway. This is hard to achieve without an open access to vessel propulsion and performance data.

In the [2nd AtlantOS Newsletter](#), we have already recommended a new paradigm of open collaboration between science and industry. As scientists, we have contributed by making all our results, including the VISIR model source code, accessible with an open and free policy: www.visir-model.net. I believe a specular open data policy by the shipping industry would be beneficial to both science and business.



Mean relative EEOI savings [%] for several routes in the Atlantic Ocean. The values displayed in the vertical bars refer to annual average of the mean savings for the return voyages, sailed along the optimal tracks. The green bars refer to total savings, while the blue bars refer to the ocean currents contribution (Credit: Mannarini, G. and Carelli, L.: VISIR-I.b: waves and ocean currents for energy efficient navigation, Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2018-292>, in review, 2019).

An in-situ observation data harmonization and integration that benefits to the wider Atlantic Ocean community

Valérie Harscoat (Ifremer, France)

Christoph Waldmann (MARUM, Germany)

Sylvie Pouliquen (Euro-Argo ERIC, Ifremer, France)

In-situ ocean observation data can be difficult to access and use for scientists and end users who have not been involved in their acquisition. Moreover, there are no 'on the shelf' standards easily implementable by anybody to make the data easily usable, interoperable and re-usable through common features. The risk of 'mixing apples with oranges' can highly impact the quality of products that integrate in-situ observation data and derive information for end users or for research activities, especially in an operational context. Furthermore, data that is not managed properly and archived in long-term repositories will be lost for the community after 10 years.

The first concern for end users is where to find or how to access the available in-situ data acquired in the Atlantic Ocean. They want to know which systems, networks or infrastructures in place at European or international level, are collecting and distributing such data. Then they want to access their data services (viewing, downloading and monitoring). Within the AtlantOS project, a [catalogue tool](#) was set up to document and facilitate the access to the existing systems. From this central web interface, the user can discover the existing systems and readily access their data services and products related to the Atlantic Ocean. Sustainability of this tool is ensured by its [connection](#) to the [Global Earth Observation System of Systems](#) (GEOSS).

Furthermore, for end users or infrastructures ingesting data from in-situ networks:

- It is much easier and reliable to go to a single entry point to access the data, rather to connect to multiple individual scientist servers. The access to in-situ network data is enhanced by providing a unique entry point to discover and download existing data and products. Within AtlantOS, the main advances are more data in the existing global data centres (EGO for gliders, OceanSITES for fixed point platforms and transport arrays, ICOS-Ocean for some VOS and GO-SHIP carbon data), improved access to ADCP data for GO-SHIP and a new Global Data Assembly Centre (GDAC) for drifters (endorsed by DBCP/JCOMM) for data access to NRT drifter data plus best copy selection of Delayed Mode products.

- Before using such in-situ data, it must be ensured that the same data type from different in-situ networks is interoperable to avoid 'mixing apples and oranges'. Therefore, the AtlantOS community agreed to adopt and implement a minimum set of mandatory and common features relying on existing international standards and protocols. That includes metadata for platforms and data providers, vocabularies for metadata and data, Near Real Time QC procedures for a core of 7 Essential Variables (Temperature, Salinity, Current, Sea Level, Oxygen, Chlorophyll, Nitrate and Carbon).

Moreover, infrastructure managers need to enhance their tools for data ingestion and need to integrate better quality data from in-situ networks. Within AtlantOS, each infrastructure chose an adapted strategy: setting up new nodes (ICOS-Ocean, physical data from CPR) or direct GDAC data flow (on-going for Argo and to follow for Gliders, Drifters and OceanSITES) to SeaDataNet, new marine biological data flow to related infrastructures (Fish Acoustics to ICES, ETN to EMODnet-Biology) and more data in Copernicus Marine In Situ Thematic Centre through GDACs harvesting.

Finally, data providers would like to keep track of the data usage for the platforms they operate, even when shared with other centres. This is the aim of the traceability of use service set up in the framework of the AtlantOS project. This integrated service relies on minimal and common tracking information shared by the systems and computes data usage statistics in a central [web dashboard](#).

In the last four years, all the systems involved in AtlantOS have entered an improvement loop to ensure that in-situ data from different and diverse observing networks operating in the Atlantic Ocean are readily accessible and useable to the wider community, including the international ocean science community and other stakeholders. Relying on existing infrastructures that will last after the end of the project lifetime, AtlantOS has moved forwards along the implementation of the FAIR principles for Atlantic observations (Findable, Accessible, Interoperable, and Re-Usable).

GLODAP and SOCAT – Improved structure and methodology of biogeochemical data products

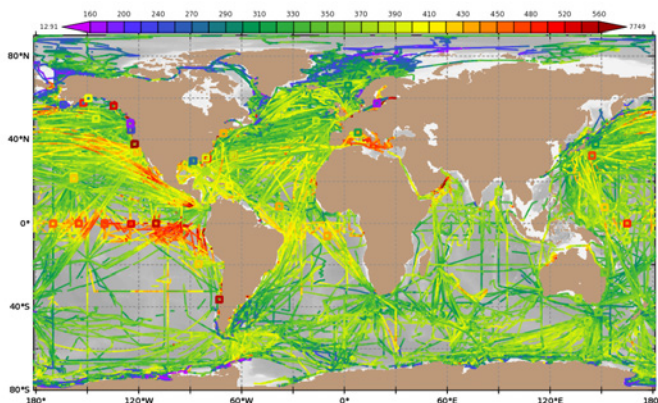
Toste Tanhua (GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany)

GLODAP and SOCAT are two different data products for biogeochemistry in the ocean; SOCAT is focusing on the partial pressure (rather the fugacity, f) of CO_2 in the surface ocean, whereas GLODAP is an internally consistent data product for interior ocean “carbon relevant” variables. Although both data products have been available for more than a decade, the regular updates of these, and the improved structure and methodology has been supported by the AtlantOS project. Both products have provided the needed database for hundreds of scientific papers, and are contributing to regular assessments of the ocean’s role in the carbon budget; this would not be feasible if without these quality controlled data products in a coherent format. Currently, GLODAP is evolving to, roughly speaking, be compatible with the SOCAT data infrastructure with the aim of more streamlined production and release, and increased interoperability.

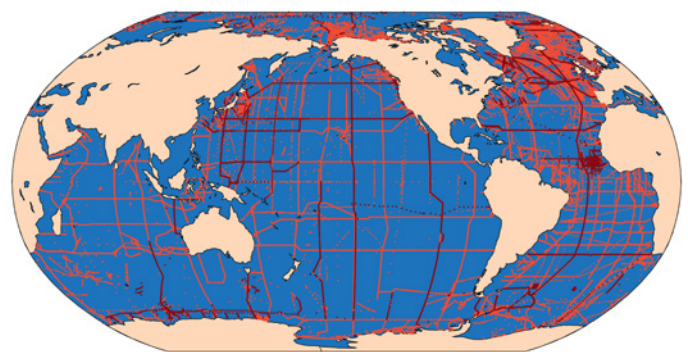
SOCAT: The Surface Ocean CO_2 Atlas (SOCAT, www.socat.info) documents the increase in surface ocean CO_2 (carbon dioxide), as the oceans are taking up about one quarter of the global CO_2 emissions from human activity. SOCAT version 6 has 23.4 million quality-controlled, in situ, surface ocean $f\text{CO}_2$ (fugacity of CO_2) observations from 1957 to 2017 for the global oceans and coastal seas, as well as calibrated sensor data. SOCAT enables quantification of the ocean carbon sink, ocean acidification, and evaluation of ocean biogeochemical models in a changing world. SOCAT represents a milestone in biogeochemical and climate research and in informing policy and high profile climate negotiations. SOCAT is a synthesis activity by international marine carbon scientists (>100 contributors) with annual public releases. Continuation of the SOCAT effort requires sustained funding and community involvement.

Version 7 of SOCAT will be released in June of 2019; SOCAT has adopted an annual cycle of submission deadline, community QC, and release of the product. SOCATv2019 contains almost 100 new data sets compared to the previous version (531 vs. 433 data sets). You can find more information here: <https://www.earth-syst-sci-data.net/8/383/2016/>.

GLODAP: The Global Ocean Data Analysis Project (GLODAP, <https://www.glodap.info>) is a synthesis effort providing regular compilations of surface to bottom ocean biogeochemical data, with an emphasis on seawater inorganic carbon chemistry and related variables determined through chemical analysis of water samples. GLODAPv2.2019 was officially released on March 26, 2019, during the AtlantOS General Assembly in Paris. GLODAPv2.2019 adds data from 116 cruises to the previous version, extending its coverage in time from 2013 to 2017 while also adding some data from prior years. GLODAPv2.2019 includes measurements from more than 1.1 million water samples from the global oceans collected on 840 cruises. The data for the 12 GLODAP core variables (salinity, oxygen, nitrate, silicate, phosphate, dissolved inorganic carbon, total alkalinity, pH, CFC-11, CFC-12, CFC-113, and CCl_4) have been subjected to extensive quality control, especially systematic evaluation of bias. The data are available in two formats: (i) as submitted by the data originator but updated to WOCE exchange format and (ii) as a merged data product with adjustments applied to minimize bias. These adjustments were derived by comparing the data from the 116 new cruises with the data from the 724 quality controlled cruises of the GLODAPv2 data product. Additional information can be found here: <https://www.earth-syst-sci-data-discuss.net/essd-2019-66/>.



Position and fugacity of CO_2 , for the SOCATv2 (Credit: Toste Tanhua).



The station network in GLODAPv2.2019 data product. The stations in darker red are new to the 2019 version (Credit: Toste Tanhua).

Requirements for Ocean Observations to Benefit Society

Michael Ott (IOC-UNESCO, France)

The uses of ocean information in society, industry, and science vary greatly, so there is a need to map the user requirements for a wide diversity of products and services. These range from detailed or summarised current conditions, often in real time, to short-term forecasts and long-term projections, to baseline monitoring, to scientific process studies, and risk assessments. Service providers and ocean observers then have to translate these requirements into needs for in-situ and remotely sensed observational data, often with differing accuracy, timeliness and resolution in time and space.

The oceanographic community is beginning to establish mechanisms to regularly capture and refine requirements in the context of political trends, changing ocean states, new technologies, and emerging risks. The AtlantOS Refined Requirements Report further developed the approach to user requirements and coordinated observations developed by the Global Ocean Observation System (GOOS) in its Framework for Ocean Observation (FOO). The report catalogues some of the known requirements (e.g., from international accords, such as the Sustainable Development Goals) and provides recommendations on how to establish an ongoing dialogue with the wide range of users, sensor and application developers, and observation experts, to continuously organise and harmonise approaches and vocabulary. In particular, the report suggests a number of actions for GOOS and, within Europe, EuroGOOS; EuroGOOS itself outlined a vision of how it will coordinate European contributions to an all-Atlantic Ocean Observing System, including leadership in understanding user needs.

User-defined observation requirements are but one input into deciding what ocean data is observed and with what technologies and sampling strategies. Other considerations include the intersection of data impact (contribution to society, industry, or science) with technological feasibility (readiness: maturity and sustainability), as outlined in the FOO; the relative costs of present and future observation programmes, as described in the AtlantOS Cost and Feasibility Study; historical legacies; political realities; and how best to coordinate individual observation programmes.

One powerful tool to optimise the integration of these programmes is numerical simulation studies. AtlantOS designed, for the first time, a closely coordinated multi-system set (i.e., allowing inter-comparisons) of Observing System Design Studies (OSSEs) to assess the relative impact of current and planned future sampling strategies of a number of observation programmes on reducing model uncertainties in ocean prediction. AtlantOS WP1 partners had to develop several new analysis and data assimilation techniques to perform these data assimilation OSSEs and climate OSSEs, which, in the Synthesis of OSSE Results report, described the current and, in some cases, important future contribution of a number of observation programmes to improving ocean prediction, particularly in the case of physical variables. It noted that assimilation of in-situ biogeochemical data is relatively immature, and indicated specific steps needed to develop this field.

The Model Guidance for the Evolution of the Observing System report put these results into context of the overall observation system and made specific recommendations for future observing design activities and OSSEs. The Refined Requirements Report integrates these recommendations with those related to other aspects of the ocean observation system (as described above), suggesting a number of key goals and actions that GOOS and EuroGOOS could take to establish a regular process for these numerical studies, including strong co-design of experiments between the observing and forecasting communities.

Optimising integrated ocean observation systems requires improvements in all aspects of the ocean-information value chain: observations, data management, analysis (including modelling), and the provision of services. The AtlantOS project has advanced knowledge and practice in each of these areas; WP1, in particular, has improved our understanding of user needs and how they inform the design of observation programmes, and provided a roadmap for further improvements in the future.

Opinion Page

Opportunities and challenges for an All-Atlantic Ocean Observing System — Perspectives from an NGO

Kellee Koenig (Conservation International, USA)



Kellee Koenig from Conservation International, USA.

Ocean observation data can play an important role in marine conservation, including the effective planning and implementation of projects across scales and jurisdictions. At the same time, ocean observation data can also be an unbiased way to monitor and measure a project, guiding future efforts to maximize effectiveness. While the work of [Conservation International](#) (CI) generates data to help answer these questions, like most non-profit organizations we also rely deeply on the data produced by others from a variety of sectors as a cost-effective way of achieving our mission.

As a brief introduction to CI, we were founded in 1987 and have over 1,000 staff in 28 countries throughout the world with a mission that focuses on protecting nature, both marine and terrestrial, for the benefit of all humanity. Some of our core competencies are in science, corporate engagements, and conservation finance, and we work with government and community partners at all scales, as well as with industry and academia. Our oceans work in the Atlantic Basin at the site and regional level currently focuses on Brazil, Colombia, and Liberia, which is part of our larger portfolio that spans the globe.

One of our biggest challenges in working across so many geographies and scales, and this dependence on external sources for data, is the need for consistent global data that is updated on a timely basis. Efforts like the [Ocean Health Index](#) (OHI)

transform ocean observation data into information to define, measure, and evaluate ocean health. Without underlying and accessible data made possible by scalable Earth observation systems, it would be impossible to fully and accurately understand and value the ocean as an ecosystem and its contribution to people and economies. This information is critical to enhance our ability to make effective governance and management decisions affecting the oceans that humanity relies upon.

The AtlantOS project and its members have clearly made progress to address this need as they move towards a systems approach to resolving data gaps to make such decisions, and we applaud your continued support of regions including the Caribbean and West Africa where data paucity can hinder relevant stakeholders in their sustainability efforts. Coincidentally, the week before the AtlantOS Symposium, the government of Liberia, in partnership with CI and the Swedish Embassy, hosted a [Blue Oceans Conference](#) to address the long-term sustainability of Africa's marine environment. Events like this highlight the data needs, but also the opportunity for data support of developing nations to have an impact.

Partnerships are a key to our success in ensuring a sustainable and productive ocean that benefits all life on Earth, and indeed, in this spirit, CI was kindly invited to attend the recent AtlantOS Symposium to see the results of the AtlantOS project, to hear the perspectives of other sectors, and in turn, to share how we use ocean observation data in our work as a conservation non-profit organization. There is an awareness of the need for a more sophisticated sense of the data and platforms to achieve international frameworks conventions like the SDGs and we have observed a concerted effort in projects like AtlantOS to address this. The partnerships forged and strengthened through the AtlantOS project come at a critical time to address the growing challenges for marine conservation, and as the United Nations Decade of Ocean Science for Sustainable Development approaches, AtlantOS as a program will be well-poised to meet it.

Together We Can Create a Safe and Liveable World

David Millar (Fugro, USA)

In recent years, the Atlantic Ocean Research Alliance (AORA) Atlantic Seabed Mapping International Working Group (ASMIWG) and The Nippon Foundation-GEBCO Seabed 2030 Project have been working together toward a complementary goal of creating a wholly mapped Atlantic Ocean basin, with all bathymetry data publicly available via GEBCO. Now AtlantOS is embarking on a goal to create an All-Atlantic Ocean Observing System, where all underlying data are shared freely without restrictions.

A comprehensive digital atlas of the ocean and a comprehensive ocean observing system for all major basins are recognized key research and development priority areas of the United Nations Decade of Ocean Science for Sustainable Development (2021-2030).

For these programs, cross-sectoral, interdisciplinary collaboration and partnerships are paramount to success. Fugro, as a member of the private sector, has demonstrated how technical expertise and resources can be applied to help achieve these goals.

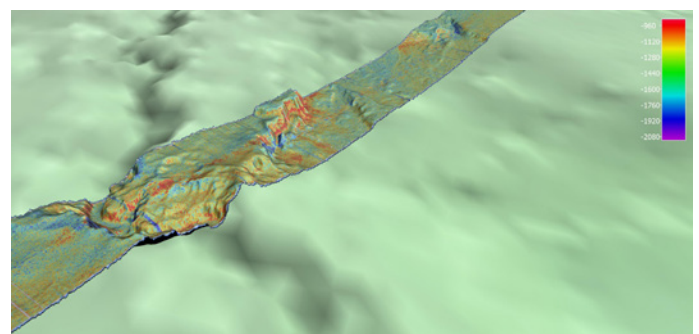
Fugro has been supporting Seabed 2030 since 2016, when the company initiated a crowdsourced bathymetry program from its survey vessel fleet. The program began with one vessel in the Americas region, collecting multibeam data during transits and developing the systems and processes needed to support remote command and control of multibeam data acquisition, as well as remote data upload and transfer. Fugro ultimately plans to extend the capability across its global survey fleet and today contributes data from seven multibeam-equipped vessels. Total contributions to Seabed 2030 currently stand at approximately 450,000 km² of multibeam data, with about 278,000 km² of that data also benefiting AORA ASMIWG.

In many cases, the contributed multibeam data included backscatter and water column data along with the bathymetry. Modern multibeam sensors can acquire all three data types simultaneously. Together, they provide significant information for characterizing the seafloor and water column, all of which is relevant to key priority areas of the UN Ocean Decade and to ocean science. In this way, Fugro's collection and contribution of multibeam sonar data from survey vessel transits has provided

invaluable information that supports the bathymetry interests of AORA ASMIWG and Seabed 2030, as well as the ocean observation interests of AtlantOS.

This high-tech crowd sourced approach pioneered by Fugro can also be applied to the collection and contribution of other ocean observation data. Examples include temperature, salinity, currents, marine mammal, and bird observations. In the United States, NOAA has implemented a Voluntary Observing Ship (VOS) program for contributing weather information at a volunteer's location, as a contribution to the Global Ocean Observing System (GOOS). One can imagine that this approach could be expanded and/or adapted to include other oceanographic data as well. Through such an approach, crowdsourced ocean observation could be born. The same principles currently utilized by Fugro to remotely command and control these instruments could also be used here to help coordinate a global effort of seafloor mapping and ocean observations.

Whether it is bathymetry data under AORA ASMIWG and Seabed 2030, or broader ocean observation data under AtlantOS, there is a unique opportunity for the private sector to contribute existing data, acquire and share crowdsourced data, and become a collaborative partner in coordinated campaigns to fill data gaps in the Atlantic Ocean basin and around the world. Fugro sees its support of these programs and ultimately the United Nations Decade as an important part of the company's vision to help create a safe and liveable world. The company encourages other private sector firms working in maritime industries to likewise get involved so that together we can fulfil the Decade's vision and obtain "The Science We Need for the Ocean We Want".



Multibeam data acquisition for seabed mapping (Credit: David Millar).



AtlantOS Early Career Scientists

Anne-Cathrin Wölfl represented the AtlantOS Early Career Researchers at the First International AtlantOS Symposium in Paris (France), March 2019 (Credit: Fabrice Gentile).

A perspective of Early Career Scientists to the “All-Atlantic Ocean Observing System”

Anne-Cathrin Wölfl, Tobias Hahn (GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany)

Antonio Augusto Sepp Neves (University of Bologna, Italy)

The AtlantOS project was a stepping stone for early career scientists (ECS) to immerse into the extensive ocean observing community, ranging from scientists, societal stakeholders, business representatives and government officials. They have learned what has been done and what is yet to be done towards an integrated Atlantic observing system. AtlantOS has linked the Atlantic research and observation infrastructure over its project lifetime, which should be sustained and accessible within the subsequent “All-Atlantic Ocean Observing System” (AtlantOS program).

One important aspect for the future is the link between the ECS and the established pool of experts. This should ensure that young scientists, who have just started their career, get the opportunity to engage with senior scientists who can provide support for their research ideas, give advice for their (academic) career path and guidance where their capacities are needed.

On the other hand, what can experts learn from ECS? How can science and society benefit from young minds? Human society is being challenged by unprecedented threats such as climate change and biodiversity loss. Facing such challenges requires new paradigms, new perspectives and new solutions. An

ECS certainly lacks academic experience compared to a senior scientist, but holds other skills, which are not listed in the curricula. The active integration of ECS into, for example, international working groups or steering committees may bring up the topics of a whole new generation of scientists to the table. This is crucial, as the consequences of the decisions taken today must be dealt with in the future. These challenges require an even further step: To overcome the isolation of science and to give a holistic view to an issue, it is essential to include all the different players around the table, or literally speaking around the ocean basin. Sectors and communities need to work together and citizens input needs to be included that has unfortunately been neglected too often, such as traditional knowledge from indigenous people.

It is time that we recognise that we are all in the same boat and that all knowledge matters. One big challenge will be how to standardise unconventional information and make it accessible and usable to the scientific community and beyond. The AtlantOS program can play a significant part in achieving this goal. Thus, we hope that all stakeholders will invest further effort to establish an operational system that in return facilitates sustainable decisions for the future of humankind and the planet as a whole.

Looking forward: the Ocean Best Practices System as a service to Ocean Observing

Jay Pearlman (IEEE, France)

The Ocean Best Practices Working Group (OBPWG), a core team for AtlantOS best practices efforts, continues the work of creating and expanding a sustained system for ocean best practices initiated under AtlantOS. We now include ocean applications for society so that we cover the whole of the value chain from sensors and calibration to platforms to modelling and applications for decision support. This is one of the consensus recommendations of the second Best Practices Workshop held at UNESCO/IOC in Paris last December. Other recommendations included expanding training and capacity building for best practices, the need for a sustained funding for continued operations after AtlantOS and continuing support of the evolving bio/eco observing activities.

In creating the System, the OBPWG has recognized that there are broad variations in best practices. A reviewer commented to us that standards and best practices are wonderful things and “everyone should have their own”. The issue came to the forefront as we looked at best practices used for monitoring Essential Ocean Variables (EOVs). For these, consistency and interoperability have a high priority as we move toward a global ocean system. As a result, GOOS has started defining an endorsement process based on expert panels that will guide the community on best practices for EOVs. The endorsement is built upon the underlying process of peer review that has been carried out, for example, by the international ocean observing networks.

We have encouraged broader access to peer review through our Frontiers in Marine Science Research Topic “Best Practices in Ocean Observing”. Sixteen very diverse manuscripts have been submitted of which 10 have been accepted and others are in the review process. Access to the published papers is at <https://www.frontiersin.org/research-topics/7173/best-practices-in-ocean-observing>. We are pleased with the community response.

Looking to the future, the Ocean Best Practices Working Group is making a strong commitment to OceanObs’19. A paper on best practices has been accepted by Frontiers and will be available soon (DOI: 10.3389/fmars.2019.00277). For the OceanObs’19

Conference, we are organizing a breakout session on best practices to address the needs for the coming decade. We will be asking participants to identify priorities in the creation and evolution of best practices across the ocean value chain, with their adoption at local, regional, and global scales. Through these discussions, we will develop a strategy and recommendations to ensure the benefits of best practices are accrued across the ocean community and lead to consistent and transparent observations in support of high quality science and support to society.

With the recommendations from the Best Practices Workshop and recognizing the needs for global level acceptance of best practices, we have started a training and capacity building activity that is aligned with the IOC/IODE OceanTeacher Global Academy (OTGA). In this, we are looking to draw upon videos of training activities to expand the reach of summer schools and web-based courses. We are looking at Massive Open Online Courses (MOOCs) that are being produced by regional groups such as IMOS. We also want to recognize IOCCP and PLOCAN for their upcoming contributions.

A focus of our work under AtlantOS has been to create a capability that can be sustained. There have been recommendations this year by the IODE Assembly and the GOOS Steering Committee to support continuation of the Ocean Best Practices System after AtlantOS. In addition, projects have recognized the benefits of the system and we appreciate the continuing interest the OBPS has been receiving.



Participants at the Second Ocean Best Practices Workshop at IOC in Paris (France), December 2018 (Credit: Jay Pearlman)

Report from the 4th GEO Data Technology Workshop

Christoph Waldmann (MARUM, Germany)

This year's GEO Data Technology Workshop was organised in Vienna (Austria) from April 23-25, 2019 at the premises of the United Nations. In general, the workshop focused on exploring how to make Earth observations-based knowledge for international policy frameworks, including the United Nations 2030 Agenda for Sustainable Development, the Sendai Framework on Disaster Risk Reduction and the Paris Climate Agreement available in an optimal way.

The idea of making data and information coming from the AtlantOS observing networks accessible in a sustainable manner lead to a number of meetings and workshops between actors on the GEOSS and AtlantOS side and finally helped to the establishment of the AtlantOS GEOPORTAL.

A contribution of AtlantOS had been solicited by the organizer of the GEO Data Technology Workshop to explore how to proceed with the ongoing activities. The development of specific data services, for instance the impact of climate variability on the marine ecosystem, will receive main attention. With the GEO Blue Planet Initiative, an adequate platform exists to continue the interaction with GEO.

Although there had been a lot of criticism around the implementation of GEOSS in the past, the workshop



*4th GEO Data Technology Workshop in Vienna (Austria), April 2019
(Credit: Christoph Waldmann).*

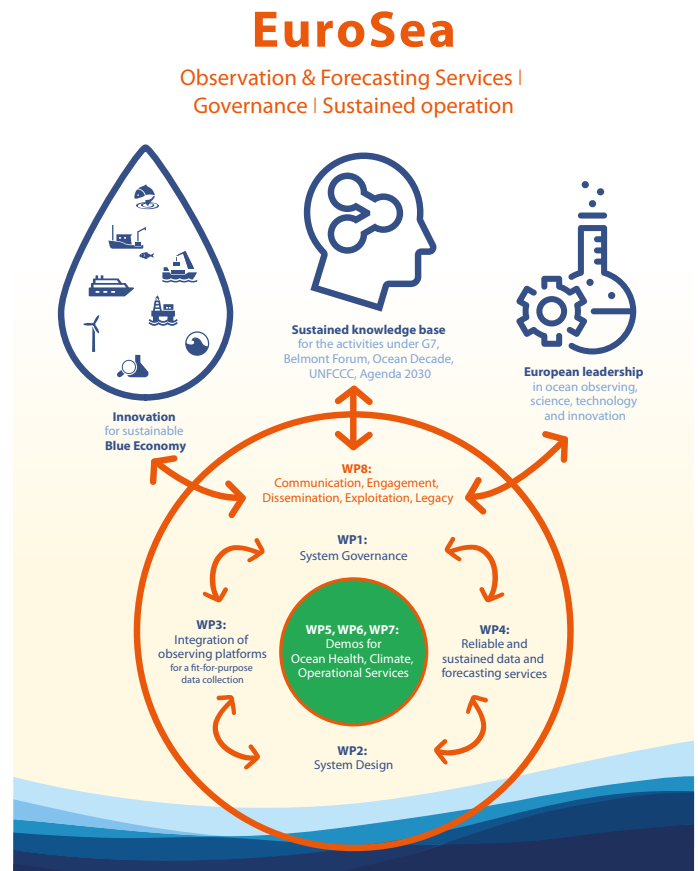
had convincingly shown that the global integration of data, information and services can bring measurable benefits to individual users and user groups. In fact, the main success stories are connected with remote sensing data, for instance how mitigation actions can be better planned in case of natural disasters. The legacy for the future is now to assign a more prominent role for in-situ data in those scenarios, something that can be instrumental for AtlantOS and its follow-ups.

EuroSea - a new EU H2020 project for ocean observing funded

Toste Tanhua (GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany)

The EuroSea project has recently been funded with a total budget of 12.6 M€ and a duration of 48 months. EuroSea has 54 partners in Europe and in North and South America. The project will be coordinated by GEOMAR (Toste Tanhua) and we plan to start it on 1 November 2019 with the kick-off meeting planned at the Royal Belgian Institute of Natural Sciences in Brussels on 27-29 November 2019.

Although the Ocean is a fundamental part of the global system providing a wealth of resources, there are fundamental gaps in ocean observing and forecasting systems, limiting our capacity in Europe to sustainably manage the ocean and its resources. Ocean observing is “big science” and cannot be solved by individual nations; it is necessary to ensure high-level integration for coordinated observations of the ocean that can be sustained in the long term. EuroSea brings together key European actors of ocean observation and forecasting with key end users of ocean observations, responding to the Future of the Seas and Oceans Flagship Initiative. Our vision is a truly interdisciplinary ocean observing system that delivers the essential ocean information needed for the wellbeing, blue growth and sustainable management of the ocean. EuroSea will strengthen the European and Global Ocean Observing System (EOOS and GOOS) and support its partners. EuroSea will increase the technology readiness levels (TRL) of critical components of ocean observations systems and tools, and in particular the TRL of the integrated ocean observing system. EuroSea will improve: European and international coordination; design of the observing system adapted to European needs; in situ observing networks; data delivery; integration of remote and in-situ data; and forecasting capability. EuroSea will work towards integrating individual observing elements to an integrated observing system, and will connect end-users with the operators of the observing system and information providers. EuroSea will demonstrate the utility of the European Ocean Observing System through three demonstration activities focused on operational services, ocean health and climate, where a dialogue between actors in the ocean observing system will guide the development of the services, including market replication and innovation supporting the development of the blue economy.



EuroSea has ten work packages (WP 9 and 10 on Ethics and Management are not displayed in the figure). EuroSea has three demonstrator WPs around ocean health, climate and operational services. The other work packages represent the aspects of the value chain of ocean observing, including coordination, design, observations by networks, data and information delivery (Credit: Toste Tanhua).

Working Meeting 'Atlantic Observation Strategies'

María Paz Chidichimo (National Scientific and Technical Research Council of Argentina (CONICET) and Hydrographic Service (SHN), Argentina)

A joint Working Meeting on 'Atlantic Observation Strategies' took place in Buenos Aires (Argentina) on 6 June 2019 in the framework of the celebration of the 20th anniversary of the Argentina-European Union Agreement on Science and Technology. Members of the Argentinian Secretariat of Government in Science, Technology and Productive Innovation under the Ministry of Education, Culture, Science and Technology, the Brazilian Ministry of Science, Technology, Innovations and Communications, the European Commission, the coordinator of the AANChOR project, and researchers from different Argentinian institutions participated. The objectives of this meeting were to strengthen collaboration on 'Atlantic Observation Strategies', showcase advances in international cooperation in ocean observing, and discuss how to maximize efforts by working together, developing strategies to demonstrate the benefits of ocean observing to people that live around the Atlantic, and possible steps for developing an 'All Atlantic Observing System'.

Four presentations were held on which the discussion was built: Sigi Gruber (European Commission, DG RTD) presented the international Ocean Governance report recently launched by the European Commission. María Paz Chidichimo (CONICET-SHN in Buenos Aires, and member of the ISTAB of the EU H2020 project AtlantOS) offered a view on the results of the First International AtlantOS Symposium held in Paris in March 2019 and the AtlantOS High-level Strategy prepared by the AtlantOS Blueprint Team. Sandra Torrusio (Comisión Nacional de Actividades Espaciales (CONAE), Argentina) presented the joint Argentina-Brazil satellite earth observation mission SABIA-Mar. Lastly, Sofia Cordeiro (Foundation for Science and Technology (FCT), Portugal), coordinator of the AANChOR project, highlighted how this project could support marine cooperation in an All-Atlantic context - especially through the implementation of the Belém Statement. The participation of Argentina in AANChOR was discussed focusing on possible



'Atlantic Observation Strategies' in Buenos Aires (Argentina), June 2019 (Credit: @ciencia_ar and #OficinadeEnlaceAR_UA).



Participants of the Working Meeting in Buenos Aires (Credit: Sigi Gruber).

joint activities, the role of the representatives in the different work packages and a brief review of the next steps and timeline. Overall, the working meeting was very fruitful, strengthened the cooperation between Argentina, the European Union, and Brazil with regard to ocean observing and offered different views on future cooperation activities.

AtlantOS the program and GOOS' side event at the 30th Session of the IOC Assembly

Brad deYoung (Memorial University, Canada)

Toste Tanhua (GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany)

Sandra Ketelhake (German Marine Research Consortium (KDM), Germany)

From 26 June to 4 July 2019, the 30th Session of the IOC Assembly took place at the UNESCO Headquarters in Paris (France). The IOC Assembly meets every two years to review the work of the commission, including the work of the member states as well as the secretariat, and formulate a common work plan for the coming two years.

On 1 July 2019, 'Observing System and Data Management' was one topic on the agenda with the Global Ocean Observing System (GOOS) as specific theme. Toste Tanhua (GEOMAR and Co-Chair of the GOOS Steering Committee) presented the GOOS Strategy 2030 and pointed to the basin-scale approach to which TPOS2020 and AtlantOS the program contribute. The responses to the strategy were positive and the member countries are looking forward to the implementation of the GOOS Strategy. After discussing the topic, they agreed on a decision. This time, they noted "the vision of the All-Atlantic Ocean Observing System (AtlantOS the program) [...]" under '7.1.1 GOOS'. Thus, the transition of AtlantOS the EU H2020 project to the basin-scale system AtlantOS the program received full recognition at international level. For the near future, the AtlantOS program Steering Group will involve stakeholders from several member countries to implement the new system.



Brad deYoung presenting AtlantOS the program at the GOOS Side Event (Credit: Sandra Ketelhake).

the GOOS Strategy 2030 by Toste Tanhua, Brad deYoung (Memorial University and AtlantOS Program Steering Committee) presented the AtlantOS program, followed by David Legler (NOAA and TPOS 2020 Resource Board) offering a view on TPOS 2020.



Participants of the GOOS Side Event in Paris (France), July 2019 (Credit: UNESCO).

The involvement of policy stakeholders in realizing the basin-scale approach already started on 1 July 2019 through a side event organized by GOOS with contributions from AtlantOS the program and TPOS2020. Emma Heslop (IOC-UNESCO) moderated this side event. After a detailed presentation about

Brad deYoung focused on the AtlantOS High-Level Strategy, how AtlantOS the program will generate value, which societal needs will be addressed, how AtlantOS will be built, and where we are now. In addition, he explained further steps around the AtlantOS program implementation process. The focus will be on the transformation of ocean data to information. Working groups will be established around particular case studies that in turn will be defined together with the Atlantic Ocean observing community. The community will be involved and reached through the participation in different meetings (e.g. OceanObs'19 and the Regional Planning Workshops for the UN Ocean Decade) and the organization of smaller AtlantOS Meetings.

National representatives from several countries took part in the side event and discussed the following key issues for the implementation of the basin-scale system:

- The dialogue between policy stakeholders and basin-scale systems needs to be continued and improved.
- To involve different scientific areas and countries around each basin (e.g. Caribbean countries for the Atlantic Ocean). It is important to include also users of ocean data and information, especially operational services, to identify the needs for ocean information.
- To get in contact with the private sector with regard to data sharing and identifying their capabilities.
- Nations need to make commitments in joining the basin-scale systems and open data policy is a topic that needs more attention.
- Integration of in-situ and satellite observations – data integration needs to be an objective within each basin-scale system.

TPOS2020 and AtlantOS the program will contribute to achieve objectives raised in the GOOS Strategy 2030. The basin-scale partnership is important and very essential. However, all involved stakeholder groups and nations should support these partnerships to generate great success.



(Credit: UNESCO)

Upcoming Events

September 2019

- ICES Annual Science Conference 2019 in Gothenburg (Sweden), 9 - 12 September 2019
- AtlantOS program Meeting in Honolulu, Hawaii (USA), 15 September 2019
- OceanObs'19 – An Ocean of Opportunity in Honolulu, Hawaii (USA), 16 - 20 September 2019

October 2019

- 7th Euro-Argo Science Meeting in Athens (Greece), 22 - 23 October 2019
- OCEANS 2019 in Seattle, Washington (USA), 27 - 31 October 2019

November 2019

- Sustainable Ocean Summit in Paris (France), 20 - 22 November 2019
- Cabo Verde Ocean Week in Mindelo (Cabo Verde), 25 - 27 November 2019
- UN Ocean Decade Regional Planning Workshop for the Atlantic Ocean in Brazil (tba), 25 - 29 November 2019

January 2020

- UN Ocean Decade Regional Planning Workshop for the North Atlantic in Halifax (Canada), 6 - 8 January 2020

February 2020

- All-Atlantic Ocean Research Forum in Brussels (Belgium), 6 - 7 February 2020
- Ocean Sciences Meeting in San Diego, California (USA), 16 - 21 February 2020



AtlantOS Project Coordination Unit (PCU)

Coordinator: Prof Dr Martin Visbeck

Deputy: Dr Johannes Karstensen

Manager: Dr Anja Reitz

Email: atlantos@geomar.de | Website: www.atlantos-h2020.eu | Twitter: [@atlantos_h2020](https://twitter.com/atlantos_h2020)