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| Project | AtlantOS – 633211 |
| Deliverable number | 4.4 |
| Deliverable title | Sustained transatlantic coastal observations Report: Strategy for transatlantic sustained measurements in the coastal ocean, based on the strengthened forum for interaction between US IOOS, GOOS regional alliances and EuroGOOS. |
| Description | DoA: Task 4.4 Transatlantic cooperation and sustainability This task will enhance the European Forum for Coastal Technologies and establish a formal link between the US Alliance for Coastal Technologies and the European Forum for Coastal Technologies. We will strengthen links with coastal observing initiatives around the Atlantic basin including links between EuroGOOS ROOSes, and the regional operational oceanographic systems in the US and Canada. In doing so, we will create a forum for interaction between US IOOS, GOOS regional alliances, and EuroGOOS. The task will develop a strategy for transatlantic sustained measurements in the coastal ocean, building on developments such as OceanObs, Coastal GOOS and JERICO FP7 project, to deliver data for social and economic benefit. |
| Work Package number | 4 |
| Work Package title | Interfaces with coastal ocean observing systems |
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| Submission date | 23 rd March 2019 |
| Due date | 31 st December 2018 |
| Comments | Deliverable report was delayed due to issues of working schedules related with the deadline coinciding with the end of the year and ensuring the community had a chance to review the document. |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 633211.



Stakeholder engagement relating to this task*

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|---|---|
| WHO are your most important stakeholders? | Coastal Ocean Observing Community; scientists (operational and research) |
| WHERE is/are the company(ies) or organization(s) from? | All national and regional coastal ocean observing communities around the Atlantic, e.g., the GRAs (Global Ocean Observing System Regional Alliances) |
| Is this deliverable a success story? If yes, why? If not, why? | <p>This deliverable can only be considered a success story if the recommendations are seriously considered by the target audience, i.e., State agencies (policy), governance/coordinators of regional systems, Industry, Government, Policymakers) & Funders.</p> <p>This deliverable is considered a success in terms of getting the Coastal Ocean Observing Community involved and actively contributing to the document content.</p> |
| Will this deliverable be used? If yes, who will use it? If not, why will it not be used? | The target audience of this document include State agencies (policy), governance/coordinators of regional systems, Industry, Government, Policymakers), Funders and the ocean observing community in the Atlantic. |

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1. Executive Summary

Information on [Essential Ocean Variables](#) gathered by operators and researchers can address the societal needs of coastal nations and Atlantic basin coastal communities. Scientific information from coastal to open ocean areas advance knowledge to provide significant improvements to the number of products available to assist societal benefit areas (e.g., climate, disasters, ecosystems, health). The physical, chemical and biological marine data collected is critical to understand and address the needs and issues of governments and civil society such as weather forecasting, climate change impacts, water quality issues, food security and renewable energy resources. This report looks at ways to continue to build and strengthen connections between Atlantic regional communities and provide recommendations to maximize future community cooperation in the Atlantic.

This report highlights the importance of coastal ocean observations and the need to strengthening linkages between Atlantic communities. Civil society need coastal ocean observations (near coast to open ocean) to understand and address issues such as hurricane tracking, flooding of coastal areas, clean water, sustainable fisheries and renewable energy. A strategic framework was developed by gathering information from several sources (AtlantOS reports, recent OOS strategies documents and the literature, discussions with community experts, AtlantOS team meetings, a Strengths, Weaknesses, Opportunities & Threats / SWOT analysis workshop and at external meeting). An overview of existing initiatives working to strengthen pan-Atlantic links between coastal ocean observing communities is provided in the report. There is a requirement for greater connectivity and collaboration among the Atlantic Ocean observing community (Strategic Focus Priority 1 & 3). Sustained funding and resources (infrastructure and human) must be assured to allow sustainable coastal ocean observations (Strategic Focus Priority 1 & 2). Information gaps remain for some Atlantic regions. The analysis in this report shows that, to ensure pan-Atlantic collaborative success, support should be initiated at national level (coordinated across all relevant agencies and institutions) with ocean policies linked to national development plans and harmonized at regional to Atlantic basin scale.

To facilitate this process, it is recommended that the following key strategic enabling actions are used to help guide future efforts, continue to build and strengthen a pan-Atlantic community cooperation in coastal ocean observing.

2. Recommendations

Strategic enabling actions to strengthen links for sustained transatlantic coastal observations

1. Increase the number of, and empower the Atlantic Coastal Ocean Observing National Focal Points¹ to represent national ocean observing activities and interests; leading to an increased communication within and between countries and, help nations address and act on global issues, e.g., implementation of the 2030 UN SDGs Agenda.
2. Facilitate a sustained funding structure to enhance and strengthen observations and ensure the coastal ocean observing infrastructure is fit-for purpose.
3. Capacity Retention and Development
 - Support the use of shared pan-Atlantic infrastructure and resources, e.g., through International transnational access grants, an exchange of ideas and trained personnel working to build new partnerships.
 - Support data and information sharing based on the FAIR² principles of digital assets and support the harmonization of quality assurance and quality control procedures building on existing initiatives like the US QARTOD and in Europe, JERICO.
 - Support the implementation of common best practices across the Atlantic basin through leveraging the AtlantOS supported Ocean Best Practices System to facilitate interoperability and capacity building.
4. Implement the All Atlantic Ocean Observing System Strategy (aka the BluePrint) to strengthen alliances within the Atlantic Coastal Ocean Observing Community, build a fit-for-purpose integrated Atlantic Ocean Observing System and continue to enhance measurement of biological and biogeochemical observing abilities, track progress and monitor improvements.

Vision: “A lasting cooperative and thriving pan-Atlantic coastal ocean observing community committed to sharing ocean monitoring activities and innovations, delivering products and services that help protect marine ecosystems and support sustainable marine economic activities”

Mission: “Foster, develop and strengthen integral partnerships between coastal ocean observing communities in the Atlantic and identify the steps needed to enable an optimised and integrated coastal ocean observing system”

¹ The GOOS [National Focal Points](#) are the appropriate contact points in each Member State for affairs regarding the implementation of the Global Ocean Observing System at national and global levels.

² Guidelines that provide and improve the findability, accessibility, interoperability and re-use

3. How the Strategy Framework was developed

The purpose of this report is to recommend strategic enabling actions that will strengthen linkages among the Atlantic Coastal Ocean Observing Community, who are working to accomplish sustained observations in the coastal ocean. Partnerships and collaborative relationships are critical to deliver results.

The AtlantOS Task Team 4.4 (T4.4) include the MI, the WP4 co-leaders (Ifremer & NOC) and EuroGOOS who became a member of the team, in February 2016, to help connect task activities with the Atlantic Global Ocean Observing System Regional Alliances (GRAs) community. In 2017, the T4.4 team connected with the wider Atlantic Coastal Ocean Observing Community by organising a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis workshop at the AtlantOS 3GA, in Plocan, Grand Canaria. The workshop was attended by community experts from Brazil, Argentina, USA, Canada and several European countries. A community contact list was generated, with 35+ members, and this group was given the opportunity to review the report prior to deliverable submission. Other colleagues in the wider community reviewed the document and/or supplied examples on “why coastal observations matter” and on “the benefits that arise from partnerships”. The main actors in this task are members of the Coastal Ocean Observing Community; scientists (operational and research). These stakeholders are the key contributors to the strategy document and their involvement is essential to help build and strengthen transatlantic linkages between their region and other coastal observing initiatives around the Atlantic basin. The Coastal Ocean Observing Community are the future advocates of collaborative initiatives, and if provided support from funders and governments they will succeed to implement the recommendations put forward in this report.

The target audience of this document include State agencies, governance/coordinators of regional systems, Industry, Government, Policymakers & Funders.

To determine the key Strategic Drivers (external and internal forces), information was gathered from

- a) AtlantOS reports, recent OOS strategies documents and the literature e.g., Benedetti-Cecchi *et al.* 2018, Larkin and Heymans 2018, Anil *et al.* 2018, Buch *et al.* 2017, UNESCO 2005, De Young *et al.* 2018, Buch *et al.* 2017 and 2019, Morin *et al.* 2015, internal JERICO-next documents.
- b) Discussions with community experts at internal T4.4 AtlantOS meetings (in person and VC) and at wider AtlantOS meetings and external meetings, e.g., EuroGOOS, AGU OS, G7 meetings.
- c) AtlantOS activities related to gap analyses, best practice, data management (flow and integration), societal benefits from observing /information systems etc.

The Strategic focus priorities i.e. initiatives the community should focus on in order to succeed in the future were identified through

- a) The SWOT analysis weaknesses & threat results (47 % community; 33 % Sustained Observing; 21 % Best Practices).
- b) Discussions with AtlantOS WP4 task team (MI, EuroGOOS, Ifremer, NOC).

The strategic enablers were determined through

- a) Task 4.4 team discussions.
- b) other AtlantOS workshop/meeting discussions
- c) the literature
- d) from the SWOT analyses results



Sustained Transatlantic Coastal Observations

Transatlantic cooperation and sustainability: build and strengthen transatlantic linkages with coastal observing communities

Strategy Framework

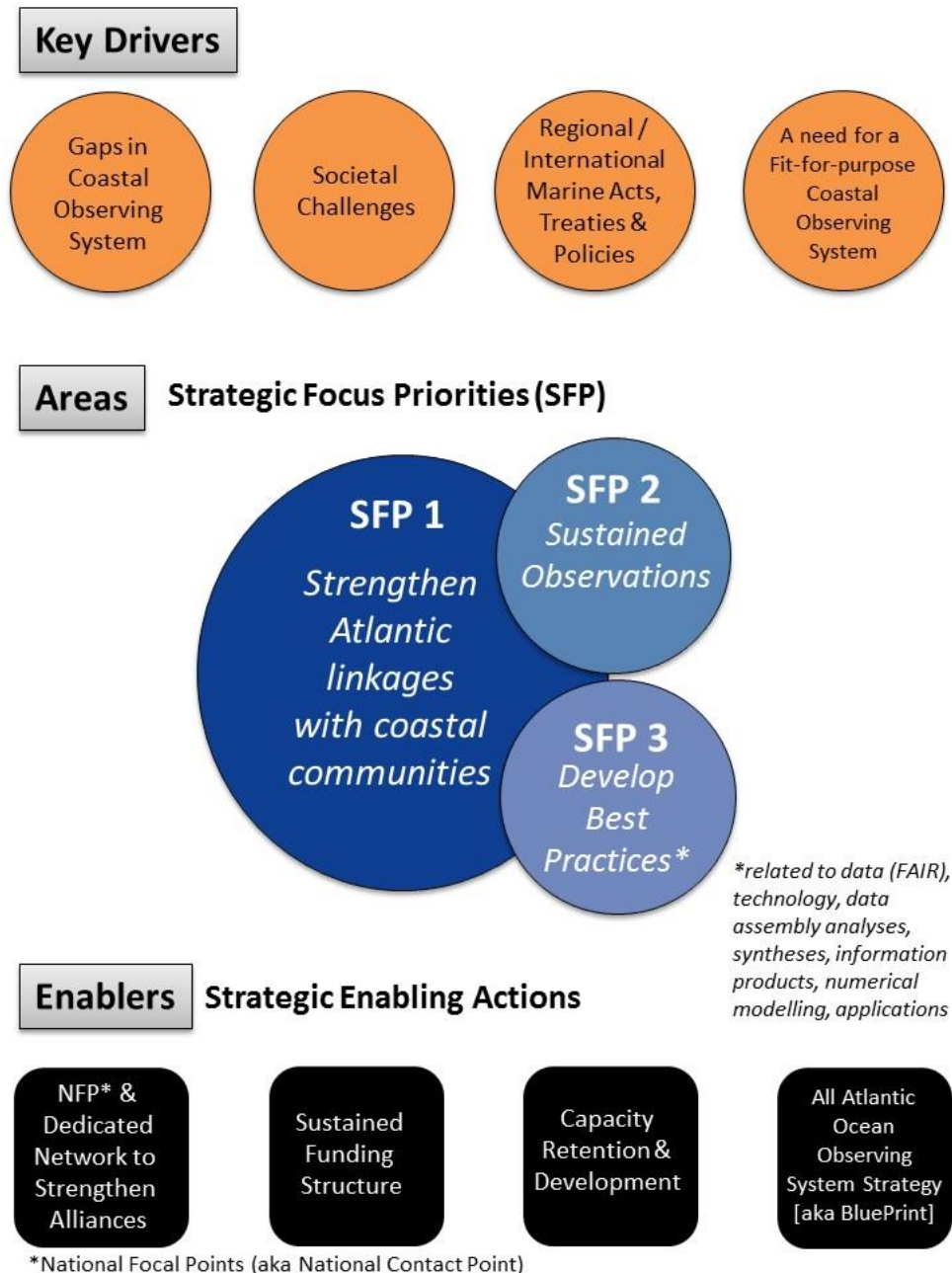


Figure 1: Strategy Framework for sustained transatlantic coastal observations

4. Introduction

A shared goal of Atlantic coastal communities is to accomplish sustained long-term coastal ocean observing abilities. Partnerships at national up to international level are deemed important to achieve success. The aim of this report is to guide ways to foster, develop and strengthen links with coastal ocean observing initiatives around the Atlantic basin including links between all Atlantic Global Ocean Observing System Regional Alliances (GRAs).

AtlantOS WP4 “Interfaces with coastal ocean observing systems” seeks to build on collaborations that can be realised in terms of harmonized observing strategies to more completely monitor the shelf seas with stronger links between coastal and open-ocean observing systems. Task 4.4 aimed to provide a context on existing cooperative activities and links between coastal observing communities in the Atlantic. Initially activities in this task were focused on establishing a formal link between the US Alliance for Coastal Technologies and the European Forum for Coastal Technologies. However, the European Forum for Coastal Technologies was not active during the AtlantOS project and it was, therefore, impossible to establish a formal link between the US Alliance for Coastal Technologies and the European Forum for Coastal Technologies. The main activities in this task then focused on the coastal observing initiatives around the Atlantic basin and on how links can be strengthened between EuroGOOS, ROOSes, and non-EU regional operational oceanographic systems. At the 3rd AtlantOS General Assembly, the Atlantic coastal observing community came together to focus on existing regional coastal ocean observing efforts. A SWOT analysis was carried out to look at the **S**trengths in the Atlantic, **W**eakness of existing coastal ocean observing, e.g., improvements needed, future **O**pportunities that the community can take advantage of, and **T**hreats / factors beyond the control of regional coastal observers which put the existing system at risk. The analysis focused on South America, North America, Europe and Africa. A key focus was on the importance of strengthened links in the coastal observing community to address the weaknesses in the system and the threats in terms of the lack of funding and the lack of infrastructure and coordination in certain regions. Results of the environmental scan with the top two most important Strengths, Weaknesses, Opportunities and Threats of the existing Atlantic coastal ocean observing system in each region are presented in Annex 1. The SWOT results for each region are presented in Annex 1 with the original data stored [here](#). Outputs from a SWOT analysis on the existing coastal ocean observing system in the Atlantic helped to formulate the recommendations in this deliverable report, as did the many recently important published/drafted ocean observing strategies (Fig. 2).

In this report, we provide a brief overview on the need for coastal ocean observations and the benefits of strengthening links between coastal regional alliances. A summary of links between the GOOS Regional Alliances active in the AtlantOS region and commonalities in their strategies is provided and an overview of coastal technology alliances. Existing and emerging initiatives that aim to strengthen alliances in the Atlantic are also reviewed. The final section of this report outlines several key recommendations / strategic enabling actions that can help to strengthen links and accomplish sustained pan-Atlantic coastal ocean observations. With greater than fifty nations with Atlantic shorelines, there is great potential to enhance and improve collaborations with communities active in the coastal and ocean observing space.



Figure 2: Recently drafted and published strategic documents on ocean observations from GOOS, GRAs, G7, Atlantic BluePrint (now called the All Atlantic Ocean Observing System Strategy), the European Strategy for Atlantic Ocean Observing that feeds into the Atlantic BluePrint and AtlantOS deliverable reports used to inform strategies.

5. Context: Why do coastal observations matter?

Forty percent of humans living on planet earth live within 100 Km (60 miles) of marine waters (Martínez *et al.* 2007). The economic value of activities carried out in coastal areas and the shelf seas is of great importance to nations (OECD 2016). For example, rich fishing grounds are often found close to land with approximately ninety percent of the world's fish captured in these high productivity regions, particularly at the shelf edge.

A growing awareness of environmental issues that threaten the health of marine waters and a need to sustainably manage marine resources has led to an increasing effort to translate ocean observing data into useful information for societal benefit by co-developing science-based products with stakeholders (general public, operational and research scientists, state agencies, policy-makers, governance/coordinators of regional systems, industry, funders) in the diverse marine sector space. Coastal and ocean observing science-based products support informed decisions and allow positive actions in response to changes in climate, ocean health and the blue economy. A further need exists to fill gaps in our scientific understanding of marine ecosystems through research and this guides policy and regulation development. Larkin and Heymans (2018; AtlantOS D10.11) provide a comprehensive look at present day science-policy drivers and new initiatives to coordinate and develop an enhanced fit-for-purpose ocean observing system in Europe, pan-Atlantic and globally. Observing gaps exist, many of which are identified between the near-coast and open ocean for Europe, in AtlantOS D4.5 (Anil *et al.* 2018) and the wider Atlantic in AtlantOS D1.3 (Buch *et al.* 2017), with key gap areas in observing networks, data availability, sustainability and technology. In European Atlantic waters, significant gaps were identified at the shelf edge, where the shelf seas meet the open Atlantic ocean (Anil *et al.* 2018). Biological and biogeochemical data in the Northwest European shelf are lacking. Emerging technologies have great potential to fill observing gaps and expand measurements to include more biological and biogeochemical Essential Ocean Variables (EOVs). A catalogue, created by AtlantOS, lists the readiness levels of a number of new and emerging sensors and instruments (Pike *et al.* 2016).

The use of glider technology is gaining traction in coastal and shelf sea ocean observing operations; with a suite of sensor capabilities and multi-glider deployments possible. Palmer *et al.* (2018) provides a methodology on planning strategy, navigation and quality control for sustained multi-glider deployments. The JCOMMOPS (Joint Technical Commission for Oceanography and Marine Meteorology in situ Observations Programme Support Centre) young glider network is an excellent example of how we can fill

the essential ocean variable data gaps in the shelf seas and connect with the open ocean. Numerical modelling (hydrodynamics) is another great tool to connect coastal and open ocean waters (Wood *et al.* 2017, Barciela and Tinker 2018). Marine modelling greatly assists scientific investigations, helps address policy questions, and deliver useful downstream products and services to society (e.g., search and rescue, interconnectivity between marine protected areas or aquaculture farms, fisheries management). Numerical ecosystem models must have *in-situ* ocean observing data to help constrain and improve modelled data quality. Ecosystem modelling is a key area that requires immediate attention and investment from governments and with an increased investment necessary to fill the *in-situ* marine observing gaps (Heymans *et al.* 2018).

Ocean observing data gathered from coastal, shelf and the shelf edge can advance scientific knowledge and provide significant societal benefits (see examples in UNESCO 2005). The need for marine data varies from scientific curiosity to pressing issues that are wide ranging, e.g., monitoring invasive species, eutrophication, coastal erosion, marine spatial planning, marine litter, underwater noise, aggregate extraction, dredging, ecosystem management, ports (ship traffic), commercial and recreational shipping, renewable energy (wave, tidal, wind), pipelines and cables, cultural heritage, fisheries zones, mariculture, marine protected areas, waste disposal (solids, including dredge material, dumped munitions, marine constructions).

The following two examples (Fig. 3 and 4) demonstrate the importance of coastal ocean observing.

“Tracking Hurricanes”

A practical application demonstrating the usefulness of ocean observations is the tracking of hurricane paths. Hurricanes can have serious impacts on coastal communities in terms of flooding and loss of life.

Ocean observing efforts provide ocean surface conditions that are fed into computer models to enhance forecasts of hurricane storm track path and storm surges. The use of these models can help to provide early warning systems and reduce the damage caused by hurricanes.

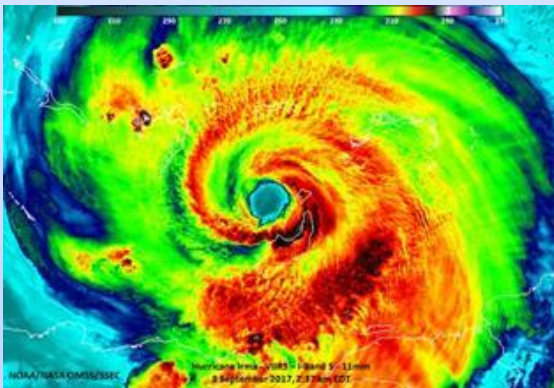


Figure 3: Hurricane IRMA originated off the west coast of Africa in the Atlantic Ocean, where it gained strength and barrelled through the Caribbean causing catastrophic damage and > 100 human fatalities. VIIRS Satellite Image 8th September 2017.

Source: USA NOAA, national weather service. Cangialosi, *et al.* 2018.

“Disruptive Seaweed”

Ocean observing activities can help to determine the root cause, monitor and forecast *Sargassum* coastal landing events. This issue needs international collaboration as it occurs in multiple regions in the Atlantic and is beyond the capabilities of one country.

The issue of the invasion of *Sargassum* seaweed landing along beaches in the Caribbean and African coastlines provides another example for the need of coastal observations.

The GEO Blue Planet is working with IOCARIBE of IOC UNESCO, GOOS Regional Alliance IOCARIBE-GOOS, UNDP Barbados and the OECS, the UN Caribbean Environment Programme, to develop a pilot project to address real region-wide issues. Further information can be found in Wang and Hu (2017) and [here](#).



Figure 4: Caribbean beach inundated with free floating macroalgae, *Sargassum*. Image credit: [hat3M](#)

In 2018, record levels of *Sargassum* inundated the Caribbean coastline resulting in foul smelling beaches as the seaweed decomposed. *Sargassum* is also a shipping hazard as it can tangle up and damage outboard motors. Deoxygenation events when *Sargassum* dies can have negative impacts on local sea life.

6. Benefits of strengthened cooperation and inter-regional collaboration

There are many benefits to strengthening Atlantic coastal ocean observing alliances and coordinating activities (Fig. 5). This includes the pooling of resources and knowledge to address key gaps in coastal ocean observing.



Figure 5: An integrated Atlantic Ocean Observing System (source: AtlantOS)

The benefits of a strengthened inter-regional collaboration include:

- Collaborating to solve common socio-economic and global challenges
- Overcoming fragmentation
- Building trust
- Knowledge Transfer, e.g., sharing complementary skills and Best Practice
- Capacity Building, e.g., sharing of assets, ability to achieve critical mass in research
- Innovation development
- Joint funding, providing value for money as well as facilitating activities which are beyond the capacity of any one country
- Developing joint strategies and increasing inter-regional visibility

A mature integrated coastal ocean observing system can leverage stakeholder efforts by creating, developing and adopting inter-community “Best Practices” linking the network efforts in coastal, continental shelf and deep ocean observing related to sampling, technology, data, as well as applications facilitating knowledge sharing and training. Such community efforts encourage increased interaction with the International Oceanographic Data and Information Exchange (IODE) programme whose “purpose is to enhance marine research, exploitation and development, by facilitating the exchange of oceanographic data and information between participating Member States, and by meeting the needs of users for data and information products” that in turn inform society. Increased interaction within and between communities leads to an increased awareness of data standards and to Findable, Accessible, Interoperable and Reusable

(FAIR) data policies and management. Constructive, dialogue and shared activities between communities lead to an increase of data submissions to international data custodians such as those linked to the Joint Commission for Oceanography and Marine Meteorology *In Situ* Observing Programmes Support Centre (JCOMMOPS), the Copernicus Marine Environment Monitoring Service (CMEMS), the European Marine Observation and Data Network (EMODnet) and SeaDataNet. This additional provision of high-quality datasets will lead to an increased uptake and use of existing data for societal benefit.

The following examples show the value of pan-Atlantic collaboration between communities.

“Ensuring Data Quality”

The US IOOS Project **QARTOD**
Quality Assurance / Quality Control of Real-Time
Oceanographic Data



In 2012, QARTOD became a US project, providing a data quality standards service for the eleven US IOOS Regional Associations. The service provides manuals on state-of-the-art methodologies for real-time quality control of observational data stream flows used by operational users. QARTOD also presents examples to guide beginners. The QARTOD manuals, focused on ensuring operators collect and process reliable and useable *in-situ* data, received a lot of international support through protocol peer reviews and contributions to the manual. International partners, including the AtlantOS community were encouraged to become more engaged with QARTOD in 2016/17, and this led to a number of QC tests in other parts of the Atlantic. Recent collaborations led to the availability of all QARTOD manuals and many of the Alliance for Coastal Technologies sensor protocols and performance results in the [Ocean Best Practices System \(OBPS\) repository](#).

This practical example demonstrates the start of a successful relationship between communities in different parts of the Atlantic whose aim is to improve coastal ocean observations. More details about the QARTOD project plan can be found [here](#).

“Floating University”

The shipboard training / floating summer school on board the RV Polarstern in 2015 / 2016/ 2019.



The Atlantic Training Transect (NoSoAT and SoNoAT) is a biennial training survey that brings together international participants through collaboration between the Alfred Wegener Institute (AWI), Partnership for Observation of the Global Oceans (POGO) and funded through the Nippon Foundation and AtlantOS. Three times the collaboration of the AtlantOS project with POGO and especially the NF-POGO Centre of Excellence enabled an excellent, state of the art training on board this research facility. This lighthouse of capacity development provides hands-on training in the set-up and operation of scientific instrumentation and equipment, acquisition and processing of samples and analysis, interpretation of the respective data, simple climate modelling and data crunching and statistics. In addition, participants receive a deep understanding of international collaboration and intercultural competence. The experience of reliable relationships, in a sometimes-stressful working environment, has in every expedition evolved as a basement of future cooperation. The results and the methods of this training will be published in a best practice manuscript in 2019 / 2020 to present the findings to other training hosts.

“Sharing Ocean Platforms”

[Eurofleets+](#) (EU H2020 project), brings together a significant group of key marine research actors in Europe, North America and Oceania.



Transnational access (sharing infrastructure) supporting the Galway and Belém Statements and meeting the evolving needs of the research and industrial communities. EuroFleets+, started in February 2019, will facilitate open, free of charge, access to an integrated and advanced research vessel fleet (27 EU and International Research Vessels), new AUVs and ROVs designed to meet the evolving needs of the user community. Through Competitive Calls, researchers will be able to access the entire North Atlantic, Mediterranean, Black Sea, North Sea, Baltic Sea, Pacific Southern Ocean and Ross Sea. European and international researchers from academia and industry will be able to apply for several access programmes, through a single-entry system. Eurofleets+ will prioritise support for research on sustainable, clean and healthy oceans, linking with existing ocean observation infrastructures, and it will support innovation through working closely with industry. Eurofleets+ will also implement diverse training and education activities, fostering cooperation across nations and FAIR data management practices across the project.

Other examples that show how collaboration between communities can achieve success, include, but are not limited to ...

a) Transferring knowledge and services to the South Atlantic - harmonized sea level data flow

AtlantOS scientists, have been working with other groups, e.g., EuroGOOS tide gauge working group, to provide a low cost service in coastal areas traditionally lacking capacity. AtlantOS has compiled a sea level catalogue with valuable information on tide gauge stations in the South Atlantic, Caribbean, Gulf of Mexico and a small section of Antarctica (Bradshaw 2017). Societal uses of tide gauge data range from information on tsunamis, storm surges, port activities and tide tables to global sea level change among other types of derived information. AtlantOS also developed a South Atlantic tide gauge data management plan (Bradshaw and Rickard 2018). Collaboration was essential to harmonise sea level data flows from tide gauges in the South Atlantic where there are resource constraints.

Cross community collaboration has allowed the

- Development of an automatic QC and processing software to improve the flow of quality-controlled sea level data in the South Atlantic;
- Production of a FAIR data policy management plan

There are future plans to continue collaborative activities with the EuroGOOS tide gauge team.

b) Building a critical mass in West Africa

The PROP AO coastal network (Sohou *et al.* 2014) is a Regional Program of Physical Oceanography in West Africa / Programme Régional d'Océanographie Physique en Afrique de l'Ouest. The network is supported and funded by the French Ministry of Foreign Affairs.

PROP AO has successfully

- Developed a regional network of coastal measurements and a regional coastal data bank for oceanographic/climatic studies;
- Promoted the formation and capacity building in regional universities, and reinforced capacity to carry on research in the partner laboratories;
- Initiated collaborations and partnership between a few laboratories dedicated to ocean sciences in the Gulf of Guinea sub-region.

c) Simplifying sensor data processing

In late 2018, partners in the, EU INTERREG Atlantic Area funded, [MyCoast](#) project (focused on links between coastal and open ocean observing systems) came together to work on a best practice, to save time and effort required to process sensor data, that complies with SeaDataNet and OceanSites data standards. The team aimed to improve interoperability, reduce the need for data centres to re-process or convert data. Data from fixed platforms are difficult to standardise due to their nature, e.g., multiple sensor-types and variables measured. Future plans of the MyCoast team are to share processing scripts to facilitate easy dataset format conversion compatible with international data integrators such as OceanSites, CMEMS *in-situ* TAC (e.g. netCDF file format). Best practices will be extended to all sensors deployed and operational to ensure the same data quality across the Atlantic Arc coastal observing systems.

d) Industry-Research partnerships

An example of a successful Public-Private partnership in Brazil is the Project [AZUL](#). AZUL aims to develop an ocean observation system in SE Brazil for the Santos Basin coastal region (dos Santos *et al.* 2015). A key area to ensure success of project AZUL was the investment made in professional and academic training in operational oceanography. Professional and academic capability in operational ocean modelling and data assimilation was also developed through establishing cooperative relationships with international universities and other scientific institutions. Project AZUL proves the feasibility of a public-private partnership for systematic long-term oceanic observation with tangible benefits to all parties involved. It is important to emphasize that Project Azul was established as a good solution to improve oceanographic knowledge off the southeastern coast of Brazil. Initiatives that follow the partnership model of AZUL are under development in other Brazilian coastal regions and are considered a good solution to enhance the oceanographic knowledge over the country ocean areas.

7. Existing Coordination of Atlantic coastal ocean observing system

GOOS and the Regional Alliances

The Global Ocean Observing System (GOOS) is responsible for the coordination of the continuous and long-term system of ocean observations under three critical themes: climate, operational oceanographic services and marine ecosystem health. The GOOS is guided by the Framework for Ocean Observations (FOO) to deliver a fit-purpose ocean observing system driven by scientific requirements with a maximised user base and societal impact.

The GOOS Regional Alliances (GRAs) are responsible for aligning the global goals of GOOS with the need for services and products to meet regional and national priorities and requirements. There are thirteen GRAs active globally. Those that are active in the AtlantOS region (Fig. 7) include:

- OCEATLAN (The Regional Alliance for Oceanography in the Upper Southwest and Tropical Atlantic)
- IOCARIBE (Intergovernmental Oceanographic Commission for the Caribbean and Adjacent Regions)
- US IOOS (US Integrated Ocean Observing System)
- C-IOOS (Canadian Integrated Ocean Observing System)
- EuroGOOS (European Global Ocean Observing System)
- MONGOOS (Mediterranean Operational Network for the Global Ocean Observing System)
- GOOS Africa (Global Ocean Observing System Africa)

“GRAs are coalitions of nations and/or institutions which share GOOS principles and goals, but are mostly concerned with local priorities and organized around regional seas or coastal environments.”

GOOS is responsible for the international coordination of ocean observing activities and ensuring cooperation and utilisation of the FOO among the GRAs. The strategic plans of the GRAs have a number of key objectives in common that have been informed by the GOOS strategic goals. These are:

- Delivering sustained ocean observations that include the coastal zone
- Providing standardised data that is open access (follows the FAIR data principles)
- Supporting ocean modelling and forecasts
- Working with end users for the co-development of products, services and tools.
- Communicating and engaging regularly with relevant stakeholder groups in the scientific community, industry, policy and the general public.

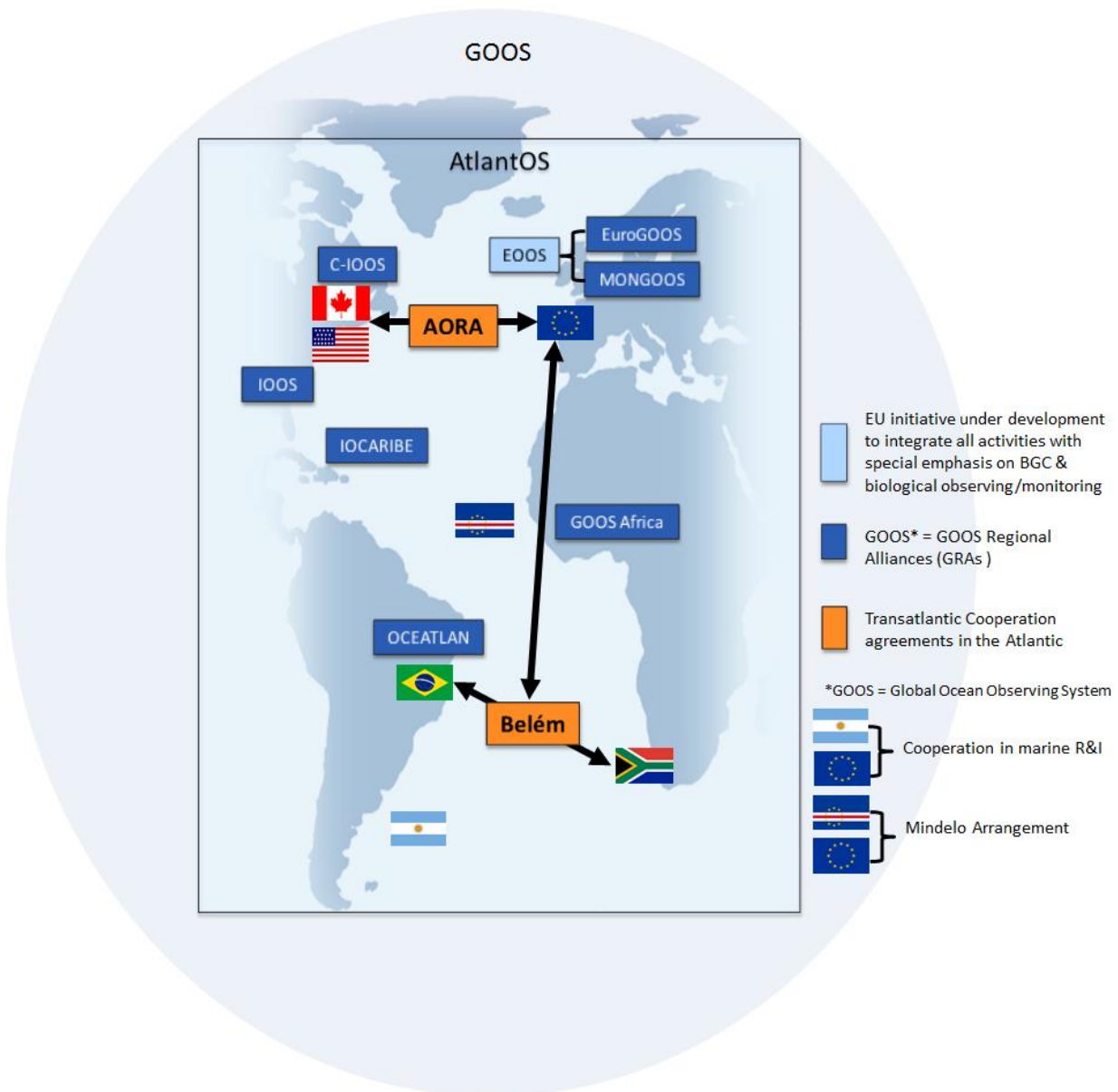


Figure 7: Leadership - Global Ocean Observing System (GOOS) Regional Alliances (GRAs) active in the Atlantic and recent coordination initiatives that will strengthen, support and facilitate Atlantic alliance interactions and cooperation. Where OCEATLAN = The Regional Alliance for Oceanography in the Upper Southwest and Tropical Atlantic; IOCARIBE = Intergovernmental Oceanographic Commission for the Caribbean and Adjacent Regions (GOOS); US IOOS = US Integrated Ocean Observing System; C-IOOS = The emerging Canadian Integrated Ocean Observing System; EuroGOOS = European Global Ocean Observing System; MONGOOS = Mediterranean Operational Network for the Global Ocean Observing System; GOOS Africa = Global Ocean Observing System Africa, EOOS = European Ocean Observing System. AORA = Atlantic Ocean Research Alliance supporting the Galway Statement, Belém = Belém Statement. AtlantOS = EU project seeking to improve international collaboration in the design, implementation and benefit sharing of ocean observing activities in the Atlantic. Note: GRA forum meets every two years and have a telecon every 3 months.

8. North Atlantic Coastal Technology Alliances



The Alliance for Coastal Technologies - USA

The Alliance for Coastal Technologies (ACT) is a partnership of research institutions, resource managers and private sector companies dedicated to fostering the development and adoption of effective and reliable sensors and platforms for use in coastal, freshwater and ocean environments. It also lists the provision of a foundation for US IOOS as one of its priorities.

FORUM FOR COASTAL TECHNOLOGIES



The Forum for Coastal Technologies - Europe

The Forum for Coastal Technologies (FCT) was established to facilitate interaction on scientific and technical issues in relation to coastal observations between industry and the observing community (Coppola *et al.* 2014). One of its key aims is to provide a strong interface between SMEs, industry and, science and technology stakeholders. A further aim was to develop a European Alliance for Coastal Technologies based on the model used by the US ACT and to collaborate with the US effort. Unfortunately, the FCT is currently inactive, although there are plans to revive efforts in future projects/initiatives.

9. Planning and Governance Initiatives to strengthen Atlantic alliances

The development of Atlantic partnerships has evolved significantly in recent years.

7.1 Established Initiatives

It is evident from the recent signing of the Galway and Belém statements that Atlantic countries want to strengthen and support Atlantic coastal and open ocean observing. The purpose of the Galway and Belém accords outlined below is to build on bilateral cooperations (e.g. scientific cooperations) and to work together on Atlantic Ocean issues of concern to society. This will be achieved by sharing access to marine research infrastructure, sharing data and knowledge, promoting training amongst others and also coordinating the planning and programming of relevant activities in the Atlantic Ocean as a whole.

Supports for the implementation of the Galway and Belém Statements are the EC H2020 *Atlantic Ocean Research Alliance - Coordinated and Support Action* (AORA-CSA) in the North and its sister flagship Coordination and Support Action called the *All AtlaNtic Cooperation for Ocean Research and innovation* (AANChOR). These support actions coordinate efforts to align research activities in the Atlantic. The objective of the Supporting Actions is to provide scientific, technical and logistical supports to the European Commission in developing and implementing pan-Atlantic Marine Research Cooperation with its Atlantic partners working towards building an All Atlantic Ocean community.

Outputs and recommendations from these CSAs feed into policy maker decisions on research funding along and across the Atlantic Ocean basin.

The Galway Statement on Atlantic Ocean Cooperation



“Recognizing the importance of the Atlantic Ocean to our citizens, prosperity, human health and well-being, adaptation to climate and other environmental change, and security, Cognizant of our reliance upon the best available science and knowledge to inform decisions affecting the Atlantic Ocean, Realizing that our countries face similar challenges in promoting a healthy and well- understood Atlantic Ocean, Acknowledging the critical interlink between the Atlantic Ocean and the portion of the Arctic region that borders the Atlantic, Appreciating the value of our ongoing cooperation on ocean science and observation in the Atlantic Ocean, and Valuing the essential role of international partnership to achieve our shared objectives and the potential of greater cooperation to advance our knowledge of the Atlantic Ocean”

[Source: [Galway Statement](#)]

The Atlantic Ocean Research Alliance (AORA) involves the cooperation of Canada, the European Union and the USA (Fig. 7) to enhance our understanding of the Atlantic Ocean and sustainably manage its resources. AORA was established at the signing of the Galway Statement on Atlantic Ocean Cooperation in May 2013. The AORA-CA H2020 project involves the coordination activity of building an Atlantic Ocean community that focuses on five key areas, including ocean observations. A key activity by the Atlantic Ocean Observing Community has been a coordinated effort to produce the All Atlantic Ocean Observing System Strategy (aka Atlantic Blueprint) for an Integrated Atlantic Ocean Observing System.

The Belém Statement on Atlantic Ocean Cooperation



“Oceans play a key role in developing national and regional economies, achieving the Sustainability Goals, addressing climate change....Realising the mutual benefit that would accrue from linking research activities in the South Atlantic and Southern Ocean with those in the North Atlantic, and exploring synergies with other initiatives...Increasing operational efficiencies by optimising use and sharing of research infrastructures and access to management of data and platforms: together with emerging methods of data science; and, Further developing common understanding and deepening scientific knowledge of marine ecosystems and the interrelations between the oceans and climate change, oceans and food, and oceans and energy systems, as well as the dynamics of the Atlantic Ocean and its interconnected Circulation Systems from Antarctica to the Arctic...” [Source: [Belém Statement](#)]

The Belém Statement is an agreement, signed in July 2017, between the EU, Brazil and South Africa (Fig. 7) to upscale research and innovation cooperation within the Atlantic basin, from Antarctica to the Arctic. A key aim of the agreement is to encourage new models of cooperation and coordination for a partnership-based approach to tackle the scientific and societal challenges of the Atlantic Ocean. Cooperation between the north and south Atlantic is strengthened by the recent cooperation agreements between the [EC and Cabo Verde](#), and between the [EC and Argentina](#) in 2018.

7.2 Emerging Implementation Initiatives



AtlantOS is an EU Horizon 2020 funded project that seeks to integrate ocean observing activities across all disciplines in the Atlantic Ocean, by using the Framework for Ocean Observations (FOO) to obtain an international, more sustainable and fit-for-purpose system. A key outcome of AtlantOS is improved international collaboration in the design, implementation and benefit sharing of ocean observing activities in the Atlantic.

The All Atlantic Ocean Observing System Strategy (aka Atlantic BluePrint; De Young *et al.* 2018) outlines an ambitious vision and a new concept for a forward-looking framework and basin-scale partnership to establish a comprehensive ocean observing system for the Atlantic Ocean as a whole that shall be sustainable, multi-disciplinary, efficient, and fit-for-purpose. Europe is prepared to make a substantial contribution to a successful implementation of AtlantOS and a European Strategy for Atlantic Ocean Observing (Buch *et al.* 2019) formulated with clear goals and concrete actions to be achieved by 2025 and 2030 to meet requirements for products and services expressed by European user communities.

7.3 Regional Implementation Initiatives

EuroGOOS Coastal Working Group

The [Coastal Working Group](#) (WG) of EuroGOOS, kicked off in May 2018, and is one of four EuroGOOS WGs with 16 participating European research and operational centers. The main objective of this group is to provide recommendations for, and facilitate the creation of coastal data-products and services by groups around Europe, using coastal data. The group also documents potential coastal data sources and users requirements of coastal products. The EuroGOOS Coastal WG examines the entire coastal ocean value chain from coastal observations (in-situ and satellite data), ocean forecasts and analysis, to science based products and services (provision of products) for coastal users. The WG examines the sustainability and fitness-for-use (upstream datasets) of the existing system and identifies the future steps needed to secure and improve all elements of the coastal value chain. The EuroGOOS Coastal Working Group plans to build upon initiatives already completed or underway with a focus on coastal observing. These include, but are not limited to, the work of the JERICO and JERICO-NEXT EC projects, activities within EuroGOOS working groups, task teams, and the five regional operational oceanographic systems (ROOS). A key early priority for the Coastal Working Group is to document the existing and planned activities and provide a status of the coastal observing system in Europe at the present time.



The European Ocean Observing System (EOOS) is a framework which aims to coordinate and connect open ocean and coastal observations in Europe and EU ocean observing capabilities internationally. EOOS development is driven by the ocean observing community with direction from EuroGOOS and the European Marine Board. Links to the Global Ocean Observing System (GOOS) are ensured through the involvement of EuroGOOS. It is also proposed that EOOS will connect with observing communities beyond GOOS, e.g., other *In-situ* marine monitoring programmes, such as those related to WFD, MSFD, numerical modelling and satellite earth observations.



The Joint European Research Infrastructures for Coastal Observations (JERICO) and JERICO NEXT projects aimed to strengthen the coastal observing activities in Europe and to progress towards the establishment of a permanent JERICO-Research Infrastructure. The Forum for Coastal Technologies (FCT) was established by the first JERICO project, but not sustained in the JERICO-NEXT project. A new project proposal, called JERICO3, will be submitted to request EC H2020 funding in 2019. If funded, there is planned cooperation with US IOOS and the Alliance for Coastal Technologies to share best practices and innovative monitoring. Cooperation initiated with non-European coastal Infrastructures shall include Northwest Association of Networked Ocean Observing Systems ([NANOOS](#); part of the US IOOS), Ocean Networks Canada ([ONC](#)) and the planned extension of its network off the north Atlantic Canadian coast, and with the Australian Integrated Marine Observing System ([IMOS](#)). The long term aim of JERICO is to build sustained collaborations between the coastal observing community and the end users and to promote innovation in the coastal marine sector, mainly in biological observations to answer societal questions linked to coastal ocean health (Morin *et al.* 2015). Such collaborations bring added value to Atlantic cooperation on coastal observatories. An important activity of the JERICO-NEXT project is the transnational access (TNA, now called TA by the EC) to coastal infrastructure; provided free of charge to interested parties from industry and academia. Plans to open the TA activities to international wide non-European users is proposed in JERICO3 and if successfully funded will focus on exchanges with other Atlantic infrastructures such as the COCA (south Atlantic coastal network), US IOOS and C-IOOS. Innovation developments (e.g., biological and chemical sampling - e-DNA extraction, flow cytometry or carbonate measurements near the coast) will be tested through international cooperation.

10. Strategic enabling actions and expected outcomes

Sustained coastal observations based on strengthened alliances

| | NFP ³ & Dedicated Network to Strengthen Alliances | Sustained Funding Structure | Capacity Retention & Development | Implement All Atlantic Ocean Observing System Strategy |
|---|--|---|--|---|
| Strategic Enabling Actions (complete by 2030) | <p>*Increase the number of, and empower the Atlantic Coastal Ocean Observing National Focal Points (NFPs; Ketelhake <i>et al.</i> 2019) to represent national ocean observing activities and interests.</p> <p>*The NFP acts as a broker between the national and international community (GOOS & GRAs) linking partners.</p> <p>*NFP coordinates updates on national infrastructure capacity, costs and regular national environmental scan (SWOT).</p> | <p>**Set-up a Funders forum as proposed in the European Strategy (Buch <i>et al.</i> 2019).</p> <p>**Forum responsible to calculate funds needed to support essential resources (personnel and infrastructure) to sustain a fit-for-purpose coastal ocean observing system.</p> | <p>*+**Advance and build on existing open access programmes in the Atlantic, e.g., TAs for researchers and industry, summer schools, floating universities.</p> <p>*+**Support and improve oceanographic academic (Master, PhD) programmes and training courses in ocean STEM.</p> <p>*+***Support data and information sharing based on the FAIR principles of digital assets. Support the harmonization of quality assurance and quality control procedures building on existing initiatives like the US QARTOD and in Europe, JERICO. The provision of guidelines will form the base for developing global data products.</p> <p>*+***Support the implementation of common best practices across the Atlantic basin through leveraging the AtlantOS supported Ocean Best Practices System (Perlman <i>et al.</i> submitted) to facilitate interoperability and capacity building.</p> | <p>*+***Implement the All Atlantic Ocean Observing System Strategy (aka the BluePrint)</p> <p>*+***Ensure implementation activities are carried out in close collaboration with the GOOS RAs.</p> |
| Expected Outcome | <p>Increased communication within and between countries successfully help nations to address and act on global issues, e.g., implementation of the 2030 UN SDGs Agenda</p> <p>The Coastal Ocean Observing Community is informed and well connected with strengthen Atlantic alliances.</p> | <p>Forum for funders is established with good options available to choose from to sustain observations and ensure the coastal ocean observing infrastructure is fit-for purpose.</p> | <p>Atlantic Wide Access to facilities is achieved.</p> <p>The maturity of coastal ocean observing technologies has advanced significantly.</p> <p>Capacity is built and retained in each Atlantic partner country.</p> | <p>An optimised, Enhanced, Integrated fit-for-purpose observing system is achieved.</p> <p>Strong and productive alliances between Atlantic coastal ocean observing communities are realised.</p> |

* Addresses Strategic Focus Priority 1 “**Strengthen Atlantic Linkages with Coastal Communities**”

** Addresses Strategic Focus Priority 2 “**Sustained Observations**”

*** Addresses Strategic Focus Priority 3 “**Develop Best Practices**”

³ National Focal Point (GOOS)

11. References

- Anil, A., Guillaume, C., Cusack, C., Fernandez, V. and O'Conchubhair, D. (2018) [Gap analysis of links between coastal and open ocean networks](#). AtlantOS Deliverable, D4.5 AtlantOS, 24 pp. DOI [10.13155/57443](#).
- Barciela, R. and Tinker, J. (2018) Report on AtlantOS fitness to MSFD needs. ed. by Wood, R. AtlantOS Deliverable, D8.16 AtlantOS, 22 pp. DOI [10.3289/atlantOS_d8.16](#)
- Benedetti-Cecchi, L.; Crowe, T.; Boehme, L.; Boero, F.; Christensen, A.; Grémare, A.; Hernandez, F.; Kromkamp, J.C.; Nogueira García, E.; Petihakis, G.; Robidart, J.; Sousa Pinto, I.; Zingone, A.; Larkin, K.; Muñiz Piniella, A.; Kellett, P.; Heymans, S.J.J. (2018) Strengthening Europe's capability in biological ocean observations. Marine Board Future Science Brief, 3. European Marine Board: Ostend. ISBN 9789492043559. 76 pp.
- Bradshaw, E. (2017) Sea level observing site catalogue: Systematic documentation of South Atlantic tide gauge site data and benchmarks. AtlantOS Deliverable, D4.1 AtlantOS, 505 pp. DOI [10.3289/AtlantOS_D4.1](#).
- Bradshaw, E. and Rickards, L. (2018) *South Atlantic tide gauge data management plan*. AtlantOS Deliverable, D4.2 AtlantOS, 16 pp. DOI [10.3289/AtlantOS_D4.2](#).
- Buch, E., Palacz, A., Karstensen, J., Fernandez, V., Dickey-Collas, M. and Borges, D. (2017) [Capacities and Gap analysis](#), AtlantOS Deliverable, D1.3 AtlantOS, 105 pp. DOI [10.3289/AtlantOS_D1.3](#).
- Buch, E., Ketelhake, S., Larkin, K. and Ott, M. (2019) European Strategy for Atlantic Ocean Observing. AtlantOS Deliverable, D9.5 . AtlantOS (submitted).
- Cangialosi, J. P., Latta, A. S. and Berg R. (2018) National hurricane Center Tropical Cyclone Report Hurricane IRMA (AL112017) 111 pp., https://www.nhc.noaa.gov/data/tcr/AL112017_Irma.pdf.
- Coppola, L., Puillat, I., Aoustin, Y., Monbet, Ph., Nolan, G., Diamond, E., Ntomas, M. (2014) Assessment of FCT activities. Towards a Joint European Research Infrastructure network for Coastal Observatories D#1.8, [JERICO \(FP7\)](#), 24pp.
- De Young, B. *et al.* (2018): BluePrint Vision for an Integrated Atlantic Ocean Observing System in 2030, to be considered for publication in *Frontiers Marine Science*, section Ocean Observation.
- dos Santos, F.A., de Oliveira, A.L.S.C., Soares, F.L.M., Carvalho, G.V., São Tiago, P.M., Santos, N.G., Garção H.F., Pimentel, F.P., Boechat, A.C., Mariano, L.S., Bergman, C., Rinaldi, F.L., Miranda, T.C., Cabral, M.M., da Cruz, L.M.M., Pellegrini, J.A.C., Assad, L.P.F., Landau, L., and Fragoso, M.R. (2015) Projeto Azul: operational oceanography in an active oil and gas area southeastern Brazil. Em: Liu Y, Kerkering H, Weisberg RH (eds) *Coastal ocean observing systems*, 1st ed. Elsevier, London, pp 99–116. doi: [10.1016/B978-0-12-802022-7.00020-1](#)
- Heymans, J.J., Skogen, M., Schrum, C., Solidoro, C. (2018) Enhancing Europe's capability in marine ecosystem modelling for societal benefit. Larkin, K.E., Coopman, J., Muñiz Piniella, A., Kellett, P., Simon, C., Rundt, C., Viegas, C., Heymans, J.J. [Eds.] *Future Science Brief 4 of the European Marine Board*, Ostend, Belgium. 32 pp. ISBN: 9789492043580 ISSN: 2593-5232
- Ketelhake, S., Visbeck, M. *et al.* (2019) Report on the performance of AtlantOS observing system (submitted).

- Larkin, K. and Heymans, S. J. J. (2018) Strategic foresight paper on AtlantOS in the European context: Towards strengthened coordination and governance of ocean observing systems. Open Access AtlantOS Deliverable, D10.11 AtlantOS, 48 pp. DOI 10.3289/atlantOS_d10.11.
- Martínez, M.L., Intralawan, A., Vazquez, G., Perez-Maqueo, O., Sutton, P. and Landgrave, R. (2007) The coasts of our world: Ecological, economic and social importance. *Ecological Economics* 63(2-3), p 254-272.
- Morin, P., Krieger, M., Durand, D., Puillat, I. and Farcy, P. (2015) Achievements and Strategy for the Future. The joint European Research Infrastructure network for Coastal Observatories D#1.11, [JERICO \(FP7\)](#), 112pp.
- OECD (2016) *The Ocean Economy in 2030*, OECD Publishing, Paris. <http://dx.doi.org/10.1787/9789264251724-en>
- Palmer, M., Williams, C. and Horsburgh, K. (2018) Synoptic multi-variable multi-glider study. AtlantOS Deliverable, D4.3 AtlantOS, 25 pp. DOI 10.3289/atlantOS_d4.3.
- Palmer, M., Williams, C. and Horsburgh, K. (2018) Synoptic multi-variable multi-glider study. AtlantOS Deliverable, D4.3 . AtlantOS, 25 pp. DOI 10.3289/atlantOS_d4.3.
- Pearlman, J., Bushnell, M., Buttigieg, PL., Coppola, L., Pearlman, F., Barbier, M., Simpson, P., Munoz, C., Karstensen, J., Muller-Karger, F., Pissiersens, P., Hermes, J., Heslop, E., Jenkyns, R., Achterberg, E., Bittig, H., Bourles, B., Buck, J., Cusack, C., Delory, E., Garello, R., Hartman, S., Heitsenrether, R., Lara Lopez, A., Leadbetter, A., Manzella, G., Maso, J., McCurdy, A., Moussat, E., Petihakis, G., Pinaridi, N., Pouliquen, S., Przeslawski, R., Roden, N., Silke, J., Tamburri, M., Tanhua, T., Thomas, J., Waldmann, C., Whoriskey, F., Bensi M., Bozzano R., Blandin J., Cano D., Cardin V., Charcos Llorens M., Cianca A., Giovanetti G., Lanteri N., Ntoumas M., Pensieri S., Stasch C., Toma M., Tengberg A. (2019) *Evolving and Sustaining Ocean Best Practices and Standards for the Next Decade* (Submitted Ocean Obs'19 White paper to *Frontiers Marine Science*).
- Pike, A., Morris, A., Cardwell C., Connelly, D. and Mowlem, M. (2016) Sensors and Instrumentation Roadmap AtlantOS Deliverable, D6.1 AtlantOS, 24 pp. DOI 10.3289/AtlantOS_D6.1
- Sohou, Z. Bourles, B., Djiman, R., AMAN, A., Folorunsho, R., Armah, A. K., and Chuchla, R. Racape, V. (2014) PROPAO: a network of coastal temperature autonomous sensors in the north of the Gulf of Guinea, *Proceeding of the Colloquium in Physical Oceanography and Applications*, Cotonou, Republica of Benin, 7 November 2012, Ed. Hounkonnou, M.H. and duPenhoat, Y. ISBN 978-99919-1899-0.
- UNESCO (2005) An implementation strategy for the coastal module of the Global Ocean Observing System (GOOS), GOOS Report No. 148, United Nations Educational, Scientific and Cultural Organisation, Paris. pp. 142.
- Wang, M., and Hu, C. (2017) Predicting Sargassum blooms in the Caribbean Sea from MODIS observations. *Geophys. Res. Lett.*, 44 (7), pp. 3265-3273
- Wood, R., Tinker, J., Krijnen, J., Barciela, R. and Dye, S. (2017) Reanalysis for MSFD. AtlantOS Deliverable, D8.5 . AtlantOS, 8 pp. DOI 10.3289/AtlantOS_D8.5.

Annex 1: Glossary

| Name/Acronym | Meaning |
|---------------------|--|
| Atlantic BluePrint | AtlantOS All Atlantic Ocean Observing System Strategy |
| C-IOOS | The emerging Canadian Integrated Ocean Observing System |
| CMEMS | Copernicus Marine Environment Monitoring Service |
| CTD | Conductivity, Temperature with Depth - a package of electronic sensors that measure seawater properties. |
| EC | European Commission |
| EU | European Union |
| EuroGOOS | European Global Ocean Observing System |
| FAIR | Findable, Accessible, Interoperable and Reusable |
| FCT | Forum for Coastal Technologies |
| FOO | Framework for Ocean Observing |
| G7 | Group of Seven (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States). |
| GOOS | Global Ocean Observing System |
| GOOS Africa | Global Ocean Observing System Africa |
| GRAs | Global Ocean Observing System Regional Alliances |
| IOC | Intergovernmental Oceanographic Commission of UNESCO |
| IOCARIBE | Intergovernmental Oceanographic Commission for the Caribbean and Adjacent Regions (GOOS) |
| IODE | International Oceanographic Data and Information Exchange |
| JERICO | Joint European Research Infrastructure for Coastal Observatories |
| MONGOOS | Mediterranean Operational Network for the Global Ocean Observing System |
| NANOOS | Northwest Association of Networked Ocean Observing Systems |
| NFP | National Focal Point (cf. GOOS) |

| Name/Acronym | Meaning |
|---------------------|---|
| OCEATLAN | The Regional Alliance for Oceanography in the Upper Southwest and Tropical Atlantic |
| ONC | Ocean Networks Canada |
| SWOT | Strengths, Weaknesses, Opportunities and Threats |
| TNA (TA) | TransNational Access (now referred to as TA) |
| UN SDG14 | United Nations Sustainable Development Goal 14 (life below water). |
| US ACT | United States Alliance for Coastal Technologies |
| US IOOS | US Integrated Ocean Observing System |

Annex 2: Environmental scan of existing coastal ocean observations in the Atlantic

SWOT results from Atlantic regions in the South & North, East & West

- Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis

(South America, North America, Europe and Africa)

The top two priorities in each region is presented from a SWOT Analysis exercise carried out on the existing Atlantic Ocean Coastal Observing System. This is followed by the SWOT results from the Atlantic regions: South America, North America, Europe and Africa.

SWOT result source: The 2017 AtlantOS 3rd General Assembly SWOT workshop held in Plocan, Gran Canaria. Representatives from the coastal and ocean observing communities in Brazil, Argentina, USA, Canada and several European countries (UK, Ireland, Italy, France, Germany, Belgium, Portugal and Spain) attended the workshop. Before the workshop information was provided for West Africa and the Gulf of Guinea.



SWOT Analysis of Coastal Ocean Observations in the Atlantic

Top two for South America, North America, Europe & Africa

Strengths

- South America**
- Educational level/long term tradition of high quality ocean observations
 - Ship time availability
- North America**
- Existence of US IOOS & emerging C-IOOS
 - Technological capacity for physical & BGC measurements
- Europe**
- High state of readiness in EU regarding structures & technology
 - EU funding pushing towards coordinated activities
- Africa**
- Several local/regional initiatives
 - Potential human resources and capacity building

Weaknesses

- South America**
- Lack of research infrastructure
 - Lack of effective Research Alliance for the South Atlantic
- North America**
- Communication with industry
 - Biological measurements
- Europe**
- Lack of connectivity
 - GAPS! (biological, geographical)
- Africa**
- Lack of funding
 - No regional coordination

Opportunities

- South America**
- Ongoing projects
 - Belém Statement
- North America**
- Increased coordination between US IOOS & emerging C-IOOS
 - Philanthropic funding e.g X-Prize
- Europe**
- Policy drivers, national priorities
 - Blue economy sectors
- Africa**
- High need for operational products
 - Regional networks in place of scientists and students

Threats

- South America**
- Lack of sustained funding
 - Human resources/infrastructure
- North America**
- Identify success - return on investment
 - Loss of trust in community and governance
- Europe**
- Political issues (Brexit) leading to loss of funding
 - Long term financial support (beyond AtlantOS)
- Africa**
- Severe lack of funding
 - Issue with coastal fishing activities (vandalism) for buoy maintenance



SWOT Analysis of Coastal Ocean Observations in the Atlantic - South America

Strengths

- Long term tradition of high quality ocean observing
- Ship time availability and RVs from different sources (scientific, Navy, fisheries)
- Open data policy
- Strong bilateral co-operations within the regions
- High level of education
- Long term cooperation with European institutions and the EU
- Good history of international collaborations
- Net integration
- Capacity building and transfer of knowledge management
- Good cooperation of countries with international sea level programme (GLOSS) including data sharing
- South Atlantic as a 'zone of peace and cooperation' by UN resolution

Weaknesses

- Tide gauge networks primarily for national needs, better global/regional cooperation needed
- Need for treatment(?) of available data information
- Lack of sustained funding for long term multidisciplinary measurements
- Lack of research infrastructure
- Data dispersion
- Weak biological data set integration (fisheries)
- Rotation of personnel (mainly technicians)
- Tide gauges not always included in coastal observing systems - maybe lack of linkage with other systems?

Opportunities

- Tradition of high quality ocean obs
- Ship time availability and RVs from different sources (scientific, Navy, fisheries)
- Open data policy
- Strong bilateral co-operations within the regions
- High level of education
- Long term cooperation with European institutions and the EU
- Good history of international collaborations
- Net integration
- Capacity building and transfer of knowledge management
- Good cooperation of countries with international sea level programme (GLOSS) including data sharing
- South Atlantic as a 'zone of peace and cooperation' by UN resolution

Threats

- Lack of research infrastructure
- Regional coordination
- Lack of effective regional alliance for the South Atlantic
- Lack of a strategy for market development on sensors and equipment for local manufacturers.
- Too few local producers selling sensors (customs are expensive and can be problematic)
- Lack of sustained funding
- Human resources



SWOT Analysis of Coastal Ocean Observations in the Atlantic - North America

Strengths

- Strong connections with N-S programmes and technology sharing e.g HF radar
- Institutional users are well connected
- C-IOOS is being developed
- IOOS is well in place and funded sustainably
- Strong connections to coastal users e.g HABS
- Well advanced technology regarding physical & biogeochemical measurements
- Significant committed funding for large scale infrastructure eg. OOI
- Full open and data policies for public data is strong

Weaknesses

- Funding is level - that leads to degrading of systems as equipment gets old
- US is large and many institutes provide ocean observing
- Communication with industry
- Biological Measurements - expensive and poor coverage
- Many people outside of the IOOS who also interact on a global basis.
- Shifting roles for partners and lack of understanding
- Pan Atlantic coordination

Opportunities

- Shifting roles public, private, new markets
- Philanthropic funding - Marine X-prize
- Increased coordination between US IOOS & emerging C-IOOS
- Opportunity for large scale funding
- Citizen science and private sector

Threats

- Identifying success - value, return on investment
- Loss of trust within Oceans Obs community - linked to governance
- Participants of ocean observing community 'feel' disenfranchised from governance
- Lack of transparency of governance model for large infrastructure
- Sustained funding because ocean observing as a public good needs to be funded.
- US climate is anti-climate
- Data control e.g with private sector



SWOT Analysis of Coastal Ocean Observations in the Atlantic - Europe

Strengths

- High state of readiness in EU regarding structures and technology
- EU funding pushing towards coordinated activities
- Long track record/heritage of EU projects
- Synoptic view at data derived from various ocean observing systems
- Shared infrastructure

Weaknesses

- Lack of connectivity/funding with non-EU partners
- GAPS! (biological, geographical)
- Lack of, or could be improved, coordination, standardisation, DOOS/SOOS synergies
- How to connect local coastal stations (systems) to 'OOS's
- Formal links ROOSES and OSPAR etc

Opportunities

- National/international legislation & policy drivers
- Blue economy sectors
- Stakeholder/users
- Internationalisation of ocean observing
- Opportunities for international exchange (PhD, post doc programmes)
- Improve coordination between ROOSES and RSCs (EU Directives)
- Setting up Marine Protected Areas
- Technical autonomy can bring capacity development outside EU

Threats

- Political issues (Brexit) leading to loss of funding
- Long term financial support (beyond AtlantOS)
- Technology driving but measuring less
- Beguiled by technology e.g remote sensing/modelling



SWOT Analysis of Coastal Ocean Observations in the Atlantic - Africa

IMPORTANT NOTE: More interaction with colleagues from this region is required for a comprehensive list

Strengths

- Several local/Regional coastal initiatives in West Africa & the Gulf of Guinea
- Workforce ready - lots of well educated graduates
- Local potential exists, thanks to capacity retention - competencies
- Regional coastal data bank at Institut de Recherches Halieutiques et Océanologiques du Bénin (IRHOB)

Weaknesses

- Too isolated with little resources (human, material, funding)
- Lack of funding to support long term observing
- Lack of regional communication & coordination

Opportunities

- High need for operational products
- Regional networks in place of scientists and students
- Get support through a regional consortium
- local recruitment is essential for efficient contributions to observing systems
- Key geographical area (coastal upwellings, Atlantic Cold Tongue & climaterelated issues -African Monsoon)
- Lot of potential for collaboration
- Regional network of farmers, students & scientists (Benin, Côte d'Ivoire, Ghana, Nigeria, Cameroon, Senegal...).
- Strong relationships with EU & France and with Brazil

Threats

- Severe lack of funding
- Issue with coastal fishing activities (vandalism) for buoy maintenance

Template used for the SWOT analysis

SWOT Analysis Template
Assessing the Existing Atlantic Coastal Ocean Observing System
 [Criteria can apply to more than one quadrant. Identify missing criteria appropriate to the Existing Coastal Ocean Observing System]
 Strengths and Weaknesses are generally internal while Opportunities and Threats are usually external influences.

Criteria examples

Advantages? Capabilities? Location and Geographical? Distribution? e.g. activities over a wide geographic distribution. Competitive advantages? e.g. world class collaborative research, collaborative procurement. Unique Selling Points? e.g. Best practices. Resources, Assets, People? Research Infrastructure? Data Infrastructure? Experience, Knowledge, Data? Outreach & Dissemination, Awareness? Informs Policy? Public? Science? Innovative Aspects? Cultural, attitudinal, behavioural – Public awareness, ocean literacy? Value and quality? Accreditations, Best Practices? Processes, systems, IT communications? Management? Mission and Values? Open Data Policy?

Strengths

Weaknesses

Criteria examples

Disadvantages? Gaps in capabilities? Lack of competitive strength? E.g. too few companies selling sensors (not enough diversity in the market). Funding? Unknown vulnerabilities? Continuity, supply chain robustness? Silo Research? Unfocused research? Reliability of data? Project plan? Community commitment and leadership? Accreditations, etc.? Processes and systems? Continuity post project? Bureaucracy? Mission and Values? Open Data Policy?

Criteria examples

Market Developments? e.g. cost of batteries drops, new cheap sensors etc. Industry trends? e.g. competitiveness and availability of sensors. Technology Development & Innovation? Global influences? Niche target markets? New Unique Selling Points? e.g. services, sensors, data etc. Developing Medium to long term Strategy Business and Product Development? Information and Research? Partnerships, Agencies, International?

Opportunities

Threats

Criteria examples

Political effects? Legislative effects? Environmental effects? IT developments? Competitor intentions - various? Market demand? New technologies, services, ideas? Vital MOUs and partners? Sustaining internal capabilities? Obstacles faced? Insurmountable weaknesses? Loss of key personnel? Sustainable funding? Economy - home, abroad? Seasonality, weather effects?

AtlantOS GA WP4, T4.4 Round Table workshop: Five minute intro, Ten minute per box, Ten minutes wrap-up. Organise participants to join one of the five tables; each table is designated to one of the five regions/zones 1. NW Atlantic (U.S. IOOS, Canada); 2. Caribbean; 3. S America (Atlantic); 4. W Africa – Atlantic; 5. NE Atlantic .