Project	AtlantOS – 633211
Deliverable number	D9.4
Deliverable title	Report on the performance of AtlantOS observing system
Description	A report providing an assessment of the adequacy of the current observing and information system (with results from five pilot countries) will be determined and properly documented. Key findings, experiences and recommendations will be formulated to evolve the Integrated Atlantic Ocean Observing System (AtlantOS).
Work Package number	WP9
Work Package title	System evaluation and sustainability
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Submission data	21 March 2019 (revised date on agreement with AtlantOS Project Coordination Unit)
Due date	30 September 2018 (PM42)
Comments	The final delivery and review of this deliverable (D9.4) was postponed on agreement with the AtlantOS Project Coordination Unit. This allowed to get more input from the pilot countries (Brazil, Canada, France, Germany, and Spain). Most of the meetings within the pilot countries were held in November and December 2018. The meetings and subsequent interactions with AtlantOS provided important input on the adequacy of ocean observing activities and ocean information in the Atlantic.

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*

WHO are your most important stakeholders?	☐ Private company If yes, is it an SME ☐ or a large company ☐? ☒ National governmental body ☒ International organization ☐ NGO ☒ others Please give the name(s) of the stakeholder(s): Scientific community
WHERE is/are the company(ies) or organization(s) from?	☒ Your own country ☒ Another country in the EU ☒ Another country outside the EU Please name the country(ies): Brazil, Canada
Is this deliverable a success story? If yes, why? **If not, why?**	☒ Yes, because ….. it is the first time that ocean observing actors from different countries assessed their ocean observing activities and ocean information products in the Atlantic Ocean. These information and experiences can be used for updating the process and further assessment rounds. ☐ No, because …..
Will this deliverable be used? **If yes, who will use it?** **If not, why will it not be used?**	☒ Yes, by …… different scientific communities within each pilot country to showcase e.g. their perspectives and plans to their national and regional funders of ocean observing activities. Additionally, the information and results from this report can be useful for the 'All-Atlantic Ocean Observing System High-level Strategy' (AtlantOS BluePrint Process) as example mechanism for its ideas on implementing AtlantOS. Moreover, it can be used by regional and international organizations and systems (such as IOC, WMO, GOOS, EOOS,..) for their future plans. ☐ No, because …..

NOTE: This information is being collected for the following purposes:

1. To make a list of all companies/organizations with which AtlantOS partners have had contact. This is important to demonstrate the extent of industry and public-sector collaboration in the obs community. Please note that we will only publish one aggregated list of companies and not mention specific partnerships.
2. To better report success stories from the AtlantOS community on how observing delivers concrete value to society.

*For ideas about relations with stakeholders you are invited to consult D10.5 Best Practices in Stakeholder Engagement, Data Dissemination and Exploitation.

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Executive Summary

Atlantic Ocean observation is currently undertaken through loosely-coordinated, in-situ observing networks and systems, satellite observations and data management arrangements of heterogeneous international, national and regional design to support science and a wide range of information products. Thus, there is a compelling need to develop an integrated basin-scale ocean observing system to support an adequate management of the ocean. The All-Atlantic Ocean Observing System (AtlantOS) is an integrated 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 is consistent with the 'Framework of Ocean Observing' (FOO).
Effective strategies for a sustained, multidisciplinary and integrated ocean observing system need to be developed and promoted, to better connect user communities, observers, and the funders of ocean observing activities. End user communities include operational users, national and local authorities, as well as researchers, from the public and private sectors.

Why is an assessment of the adequacy of the Atlantic Ocean observation system and its ocean information products important for implementing AtlantOS? Annual investment costs in Atlantic Ocean observing and related downstream services are substantial in many countries. Integrated data is crucial for timely actions, decisions, and responses for everyone. The Atlantic Ocean Observing System delivers data and information products needed to increase the understanding of the Atlantic Ocean and its coastal waters.
The purpose of the assessment process was to evaluate the adequacy of AtlantOS and to develop a report that displays the results, experiences, and feedback which should serve as orientation for the ocean observing community.

Taking into account some of the work and information products that have already been developed within the AtlantOS project (e.g. D1.4, D.9.1, D9.2, D9.3), this process is timely and the reports fits perfectly the overarching target of the project - to deliver an advanced framework for the development of an integrated Atlantic Ocean Observing System that goes beyond the state-of–the-art, and leaves a legacy of sustainability after the life time of the project. A comprehensive and fit-for-purpose AtlantOS would increase (1) sustainable resource management, (2) informed and supported decision-making processes for end-users and stakeholder groups, as well as (3) knowledge hubs and observing networks in the context of sharing scientific data, best practices and general expertise.

This report describes why substantial national engagement in coordinated ocean observing activities in the Atlantic Ocean is needed. Specific aims are:

- To provide a first pan-Atlantic view on current national Atlantic Ocean observing activities conducted by different actors in five pilot countries (Brazil, Canada, France, Germany, and Spain);
- To identify the needs for ocean information provided by the Atlantic Ocean observing systems;
- To identify long-lasting and sustainable contributions to societal, economic and scientific benefits;
- To identify the future ambitions of countries and observing communities in the context of an All-Atlantic Ocean Observing System and ocean information;
- To develop background material for national authorities in order to facilitate decision-making processes regarding resource mobilizations for observations in the Atlantic Ocean;
- To strengthen pan-Atlantic views on current (and future) national Atlantic Ocean observation activities.
- To highlight results, experiences and feedback of the assessment process.

The following questions were taken into account in developing the AtlantOS assessment of the adequacy process:

- Is the system addressing its expected needs for ocean information?
- Where are the most significant gaps in the information chain?

- How could these gaps be closed by improved observations, more effective data flows and improved information product delivery?
- Is the current list of Essential Ocean Variables (EOVs) still adequate?

The results of this review process will serve as useful information, not only for national authorities; it will be interesting for international and trans-Atlantic cooperation and initiatives:

- Galway Statement on Atlantic Ocean Cooperation (2013),
- Belém Statement on Atlantic Research and Innovation Cooperation (2017),
- Tsukuba Communiqué from the 'G7 Science and Technology Ministers' (2016) to support an ocean observation initiative,
- United Nation's (UN) Decade of Ocean Science for Sustainable Development (2021-2030),
- Global Ocean Observing System (GOOS), Group on Earth Observation's (GEO) Blue Planet Initiative, and European Ocean Observing System (EOOS).

Based on the results and experiences from the AtlantOS assessment of the adequacy process the following conclusions and recommendations for further evaluation processes and the future implementation of AtlantOS could be drawn:

Recommendation #1 – National and international coordination: The results and experiences of the AtlantOS assessment of the adequacy process could help the GOOS National Focal Points by fostering and improving a consistent and fit-for-purpose assessment process for ocean observing activities and information products in the Atlantic Ocean at national level. The ocean observing communities and in particular the existing national coordination groups within the different pilot countries would like to work closely with their GOOS National Focal Point.

The AtlantOS assessment process indicates that most countries that conduct ocean observing activities already have a coordination group and most people within the scientific communities are aware of the GOOS National Focal Point process. Taking into account the responsibilities of the GOOS National Focal Point and ocean observing coordination groups (that have different mandates), it is important that they work together to assess the activities and information products in the Atlantic Ocean (and other basins). Currently, the GOOS National Focal Point process is not officially launched yet.

Recommendation #2 – Societal Benefit Areas: It is important to regularly evaluate requirements and user needs in the different ocean zones (coastal, regional, and open ocean) as orientation for Societal Benefit Areas (SBAs). Thus, (1) changes in priority levels, and (2) accompanying effects which might result in adapting ocean observing activities as well as ocean information products could be identified. The time interval for this evaluation needs to be identified by the international ocean observing community.

The results of the assessment process show that the relative priority levels of SBA's (in this case: the ocean's environmental status, scientific discovery, operational and real-time services, and ocean economic activities) slightly differ between countries, communities and ocean zones. Nevertheless, almost all SBAs are important for guiding the ocean observing activities at coastal, regional, and open ocean level. Since priorities depend on geographical, societal, economical, and political conditions, it is important to assess the SBAs regularly – (user) needs can change in the future due to different reasons (e.g., climate change adaptation). If the priority level of SBAs changes, ocean observing activities and information product development need to be adapted in the long-term.

Recommendation #3 – Essential Ocean Variables: It is fundamental that the ocean observing communities (1) evaluate and confirm the importance of EOVs for the development of ocean information products and general understanding of the Atlantic Ocean and (2) give feedback to the GOOS Expert Panels (Physics and Climate, Biogeochemistry, and Biology and Ecosystems) on requirements for existing EOVs (space/time resolution, accuracy) and articulating new EOVs. It might be important to add the evaluation of key phenomena

to an assessment of the adequacy process. This information would give information about which EOVs are important to measure.

Taking into account the results from the five pilot countries regarding the current list of EOVs, it can be determined that (1) the list seems adequate, (2) the detailed relevance level of each EOV differs due to its geographical location and the respective requirements, (3) more time is needed to inform the different communities about the important set of biological variables for their daily work, and (4) more variables (e.g. seafloor and microplastic requirements) need to be added to the current list of EOVs.

Recommendation #4 – Data systems: Ensure that the FAIR-principles are the basis for each data system and that all data is available (free and open access) through well-funded data management systems. By promoting and enhancing the interoperability of (international) data systems, an integrated Atlantic Ocean Observing System can be built to serve the user needs, e.g. for developing (information) products.

By analysing the results from the five pilot countries, one can determine that international data has been poorly used with regard to the development of (information) products considering all SBAs. Regional data systems have been used occasionally to develop products for (1) the ocean's environmental status, (2) scientific discovery, and (3) operational and real-time services. National data systems are often used to develop products in the SBAs of the ocean's environmental status and scientific discovery. The scientific community does not seem too much interested in developing (information) products for ocean economic activities. In addition, some data systems (e.g. WIS for pilot country Canada) are not available for some (scientific) departments.

Recommendation #5 – AtlantOS Monitoring tools: The monitoring tools should be made available in the future and help to improve the integration of ocean observing activities from other data systems to the AtlantOS tools. The issue of providing real-time data needs to be solved to improve the Atlantic Ocean Observing System. The compilation of ocean observing activities is important for defining national perspectives and (future) plans.

The AtlantOS monitoring tools received good feedback from the ocean observing actors participating in the assessment process. The tools are important for compiling and assessing ocean observing activities. Nevertheless, (1) they do not cover all ocean observing activities to provide an overview of the activities conducted by each country (e.g. lander, crawler, animal-borne sensors) and (2) deviations exist between the information received from the monitoring tools and the answers from the different observing actors (e.g. profiling floats, moorings, radar, gliders). Thus, it is important to improve and update the data systems in general. If monitoring tools or portals exist, where information about ocean observing activities can be submitted and which are easily accessible for all ocean observing actors, the Atlantic Ocean Observing System is fit-for-purpose and sustainable.

Recommendation #6 – Ocean Observing Activities: An assessment of the adequacy process can be the basis for discussion within each country to clarify which ocean observing activities and information products need to be sustained over the next years and what is missing to reach the status 'sustained' (e.g. considering personnel, technological developments, financial resources). National perspectives and plans are important for funders of ocean observing activities who do not know which activities and information products need to be sustained in the long term. It is important to classify each kind of observing activity/platform and information product. In addition, other initiatives exist which have developed tools to compile ocean observing activities. Thus, it might be useful to compare existing processes so that assessment procedures could benefit from each other.

While some ocean observing communities are satisfied with their ocean observing activities, most actors within the pilot countries do not indicate a specific level of satisfaction. The contributions of the different

actors of one pilot country are displayed in different formats; the ocean observing community needs to identify how these ocean observing activities should be counted (e.g. number of gliders or glider missions).

Furthermore, ocean observing actors are confused by the terms 'ocean observing system' and 'ocean observing network'. With the AtlantOS assessment process awareness of the difference was raised. These terms should be defined even more clearly (e.g. with regard to their focus area, characteristics, foundation, working structure) in the near future by the international ocean observing community. In the high-level strategy for 'An Integrated All-Atlantic Ocean Observing System in 2030' (de Young et. al, 2018) the meaning of these terms is already discussed. One possibility to further discuss this issue could be at the OceanObs'19 Conference taking place in September 2019 in Hawaii (U.S.). Many ocean observing experts from different countries and research fields are expected to participate.

Recommendation #7 – Ocean information products: A regular assessment of ocean information products by product developers and users is important to identify gaps and needs from both sides that will guide improvements in the Atlantic Ocean Observing System.

The AtlantOS assessment process indicates that concerns regarding (1) ineffective data flows, (2) inappropriate quality control, (3) inappropriate coverage of sampling areas, (4) insufficient sampling of important variables, (5) missing synergies for modelling and data assimilation, as well as (6) missing partnerships of academic, industrial, civil society, and governmental areas need to be addressed in the future. The observing communities can solve the issues by e.g. (1) improved observation infrastructures and technical developments, (2) fostering cooperation between countries, observing networks, and systems, (3) a comprehensive data management system, and (4) aligning with satellite community and adjacent communities.

Recommendation #8 – Future plans/voluntary commitments: The AtlantOS assessment process indicates that almost all pilot countries have specific plans for the next five years and that they prefer to submit their plans for the Atlantic Ocean at global level. The community could think about establishing a portal where actors/countries could upload their future activities and (voluntary) commitments. Thus, cooperation could be fostered and forces could be joined for activities and products that might not be sustained but are important for the ocean observing community, end-users, and stakeholder groups. Clearly, this might not be possible for all countries due to governmental regulations.

The pilot countries participating in the first AtlantOS assessment process identified a number of issues that need to be solved in future review processes:

- To define the terms coastal, regional, and open ocean.
- To define which activities should be taken into account (deployments and/or recoveries) for the different ocean observing platforms.
- To agree on a consistent format for the compilation of ocean observing activities.
- To update the list for ocean observing activities and data systems. For example lander, crawler, and cable observing activities need to be added to the list of observing platforms.
- To take into account satellite observations and provide an assessment of the contribution of present/future satellite systems.
- To assess the impact of observations (in-situ, satellite) in integrated modelling and data assimilation systems.
- To revise and strengthen the role of GOOS national focal points to make sure that they are empowered to represent national ocean observing activities.

This assessment process was carried out for the first time, so it is unlikely that all important ocean observing actors from each pilot country were included. Therefore, the answers are anonymized. The responses from some pilot countries cannot be seen as the official national perspective. Interested individuals can contact the GOOS National Focal Points of the pilot countries and request to see the whole analysis.

1. Introduction

The Atlantic Ocean plays a vital role in the global climate system and biosphere, providing crucial resources for humanity. Ocean observations are currently undertaken through loosely-coordinated, in-situ observing networks and systems, satellite observations and data management arrangements of heterogeneous international, national and regional design to support science and a wide range of information products. There is a compelling need to develop an integrated basin-scale ocean observing system to support sustainable ocean management. The All-Atlantic Ocean Observing System (AtlantOS) is an integrated 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 is consistent with the 'Framework of Ocean Observing' (FOO).
The vision of the European Union (EU) Horizon 2020 project AtlantOS[1] is to improve and innovate Atlantic observing to obtain an international, more sustainable, more efficient, more integrated, and fit-for-purpose system. Hence, the AtlantOS project will have a long-lasting and sustainable contribution to the societal, economic and scientific benefit arising from this integrated approach.

1.1 Scope and purpose of the report

Effective strategies for a sustained, multidisciplinary and integrated ocean observing system need to be developed and promoted, to better connect user communities, observers, and the funders of ocean observing activities. End user include operational users, national and local authorities, civil society, as well as researchers from the public and private sectors.

Why is an assessment of the adequacy of the Atlantic Ocean observation system and its ocean information important for implementing AtlantOS? Annual investment costs in Atlantic Ocean observing and related downstream services are substantial in many countries. Integrated data is crucial for timely actions, decisions, and responses for everyone. The Atlantic Ocean Observing System delivers data and information products needed to improve the understanding of the Atlantic Ocean and its coastal waters. This AtlantOS assessment of adequacy will enable the development of information products that have a societal benefit and will be used by different communities. Furthermore, international observing program performances could also be monitored more easily.
The purpose of the assessment process was to evaluate the adequacy of AtlantOS and to develop a report that displays the results, experiences, and feedback which should serve as orientation for the ocean observing community.

This report describes why substantial national engagement in coordinated ocean observing activities in the Atlantic Ocean is needed. Specific aims are:

- To provide a first pan-Atlantic view on current national Atlantic Ocean observing activities conducted by different actors in five pilot countries (Brazil, Canada, France, Germany, and Spain);
- To identify the needs for ocean information provided by the Atlantic Ocean observing systems;
- To identify long-lasting and sustainable contributions to societal, economic and scientific benefits;
- To identify the future ambitions of countries and observing communities in the context of an All-Atlantic Ocean Observing System and ocean information;
- To develop background material for national authorities in order to facilitate decision-making processes regarding resource mobilizations for observations in the Atlantic Ocean;
- To strengthen pan-Atlantic views on current (and future) national Atlantic Ocean observation activities.
- To highlight results, experiences and feedback of the assessment process.

Since one purpose of this exercise was to provide a first pan-Atlantic view on current (and future) national Atlantic Ocean observation activities, the aims were, in more detail:

[1] Within this report, the term 'AtlantOS project' refers to the EU H2020 project and the term 'AtlantOS' refers to the All-Atlantic Ocean Observing System.

- To compile Atlantic ocean observing activities conducted by different actors in five pilot countries;
- To identify the needs for ocean information provided by the Atlantic Ocean observing systems;
- To identify the perspective of countries and observing communities on the European Ocean Observing System (EOOS), the Global Ocean Observing System (GOOS), the Group on Earth Observations (GEO), and international partnerships;

A number of policy processes, that demand ocean information products to fulfil needs related to societal benefits and that would benefit from a review of ocean observing activities, were identified such as:

- United Nation's (UNs) Sustainable Development Goals (SDGs),
- UN Decade of Ocean Science for Sustainable Development (2021-2030),
- Paris Agreement on climate change [within the United Nations Framework Convention on Climate Change (UNFCCC) process], and
- Sendai Framework for Disaster Risk Reduction.

Furthermore, the results of this review process will serve as useful information material for some international and trans-Atlantic partnerships:

- Galway Statement on Atlantic Ocean Cooperation (2013),
- Belém Statement on Atlantic Research and Innovation Cooperation (2017),
- Tsukuba Communiqué from the G7 Science and Technology Ministers' (2016) to support an ocean observation initiative, and
- GOOS, GEO Blue Planet Initiative, and EOOS.

The outcomes enable an evaluation from the perspective of different actors within different countries regarding the relevance of ocean information products etc. The following questions should be taken into account to build a comprehensive and user oriented AtlantOS:

- Is the system addressing the expected needs for ocean information?
- Where are the most significant gaps in the information?
- How could these gaps be closed – by improved observations, more effective data flows and/or improved information product delivery?
- Is the current list of Essential Ocean Variables (EOVs) still adequate?

To answer these questions this report will (1) showcase the results of the assessment process (anonymized), (2) display the experiences and feedback that need to be considered for future review processes, (3) demonstrate which processes the ocean observing community could use as an orientation, and (4) provide a list of recommendations.

In 2019, the AtlantOS partners plan to present the findings of this report to European and international funders of ocean observing systems, and in particular to key contact points that are responsible for the mobilization of resources. Some elements of the assessment will serve as references for the scientific community and policy makers. This first assessment process will serve as a baseline for future updates of such a process.

1.2 Region of interest and background information

The region of interest is the Atlantic Ocean – from the North to the South (see figure 1). Ocean observing actors were also asked to state their activities in their marginal seas.

During and after the development of the AtlantOS assessment of the adequacy process, a number of other AtlantOS project reports and information products were taken into account such as:

AtlantOS D1.3 '[Capacities and Gaps analysis]' which identified sustainability issues that could be solved by developing national perspectives and plans after assessing ocean observing activities and ocean information products. The gaps that need to be solved are:

- The lack of sustained funding for ocean observations - about 70% of data in GOOS is funded by time-limited research projects;
- Observing networks suffer a lack of funding for coordination/management of the network (staff, travel);
- In-situ ocean observations are based on infrastructures supported mainly by national agencies.

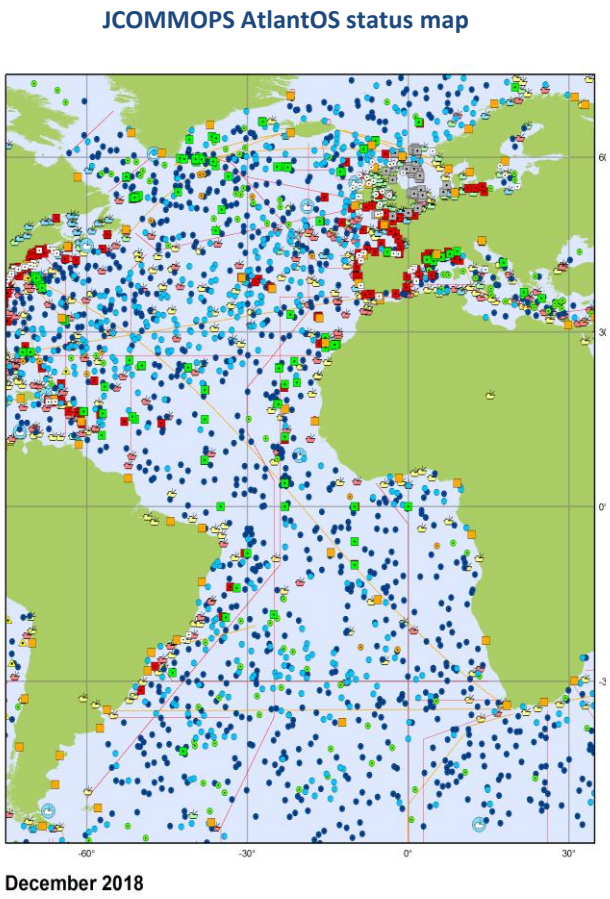

Figure 1 - Global Ocean Observing System status map of the integrated Atlantic Ocean Observing System for December 2018 showing the main in-situ elements (drifters, moorings, buoys, etc.) with onboard instruments collecting ocean observations (source: JCOMMOPS).

AtlantOS D1.4 '[Atlantic Ocean Observing Networks: Cost and feasibility study]'. The study provided - for the first time - an initial overview of the estimated running costs of selected ocean observing networks in the Atlantic. Thus, by linking the actual ocean observing activities with the amount of estimated costs, a first idea of the costs for ocean observing activities per country was given.

Within AtlantOS task 9.1 'System monitoring/evaluation' two online monitoring tools[2] have been developed. One tool focuses on international observing networks and their implementation in the Atlantic Ocean and is operated by JCOMMOPS (Joint Technical Commission for Oceanography and Marine Meteorology in-situ Observing Programme Support Center). The other tool focuses on users and data/platform availability including also national observing systems and is operated by EMODnet (European Marine Observation and Data Network) Physics and EuroGOOS. These tools are working towards monitoring the observing networks' effectiveness to meet their targets as well as the combined effectiveness of the overall system in measuring Essential Ocean Variables. The JCOMMOPS and EMODnet Physics/EuroGOOS monitoring tools will continue to improve as the networks evolve and as our understanding of ocean information and products is defined more clearly. To assess the adequacy of the current Atlantic Ocean observing system these monitoring tools have been used to identify the contributions of the different pilot countries. Thus, the results of this report will showcase (1) how these tools contribute to the current status of the overall monitoring system and (2) how effectively the observation system meets the needs of end users for ocean information and products.

[2] (1) A web-based monitoring tool of the Atlantic ocean observing system (international) developed by JCOMMOPS and (2) a web-based monitoring tool of the Atlantic ocean observing system (Europe) developed by EMODnet Physics.

In a further report on the assessment of the performance of AtlantOS (D9.3), an update of the monitoring status of the observing system in the Atlantic Ocean was provided by examining a number of representative observation programs.

Each of the above mentioned reports and information products noted that a comprehensive and fit-for-purpose AtlantOS would increase (1) sustainable resource management, (2) informed and supported decision-making processes for end-users and stakeholder groups, and (3) knowledge hubs as well as observing networks to share scientific data, best practices and know-how.
Taking into account the work and information products that have already been developed within the AtlantOS project, this report is timely and fits perfectly the overarching target of the project - to deliver an advanced framework for the development of an integrated All-Atlantic Ocean Observing System that goes beyond the state-of –the-art, and leaves a legacy of sustainability after the life of the project.

2. Methodology and Conceptualization

There are different engagement types with end-user communities including closer interaction to better address the needs for ocean observing and derived products for better informing management decisions. However, the engagement varies between countries and communities. Thus, the AtlantOS project assessment of the adequacy process oriented itself towards existing processes and built on different options to involve the scientific community and other stakeholders in this process.
The online questionnaire should serve as a help for compiling and assessing the current Atlantic Ocean Observing System (EOVs, observing activities, data accessibility, and information products). The survey is an initial step to set the scene for a more regular review process and thus the questionnaire need to be updated e.g. for another assessment round.

2.1 Global Climate Observing System - Learning from an existing assessment process in climate research and comparison with structures in the field of ocean observing

At international level, an assessment of the adequacy process was established for the climate observing system. This process was implemented through the Global Climate Observing System (GCOS) – this program is co-sponsored by the World Meteorological Organization (WMO), Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), United Nations Environment Programme (UNEP), and International Science Council (ISC) (GCOS 2019).

In 1992, GCOS was formed through a Memorandum of Understanding (MoU) as an international non-governmental organization to ensure that the observations and information needed to address climate-related issues are obtained and made available to all potential users. Like GOOS, GCOS provides an operational framework for integrating and enhancing the observational systems of participating countries and organizations into a comprehensive system focused on the requirements for climate issues (whereas GOOS focuses on maritime issues).

In 1998 and 2003, GCOS published its First and Second Adequacy Report – both addressed to the Parties to the UN Framework Convention on Climate Change. With its second report, GCOS established the scientific requirements for systematic climate observations [e.g. the concept of Essential Climate Variables (ECVs)] underlying the needs of the Parties to the UNFCCC and the Intergovernmental Panel on Climate Change (IPCC). Afterwards, the UNFCCC Conference of the Parties (COP) requested that GCOS should develop a 5- to 10-year implementation plan (decision 11/CP.9). To examine if the targets - set in the implementation plan - have been met by the countries' respective observing communities, GCOS has the mandate to regularly ask their members to assess the climate activities within their countries.

To facilitate the coordination and communication between GCOS and the national level, some countries have appointed a GCOS national coordinator and most countries have appointed a GCOS National Focal Point. This coordination structure leads to a very easy procedure regarding an assessment process. The outcome of the assessment processes is that:

- GCOS publishes an adequacy report that determines if the targets of the implementation plan have been met and provides guidance for improvements (e.g. update of the ECV list),
- The GCOS Implementation Plan is regularly updated and numerical targets associated with different observing networks can be set more reliable,
- Each country can develop an inventory report regarding their activities after assessing the adequacy of their activities and if they meet the ECVs – these reports are important for the scientific community, policy-makers as well as other stakeholder groups (like industry and civil society) for their decision-making processes (e.g. sustained funding of climate observing activities).

In general, it can be determined that GCOS provides - with its processes and mechanisms - an operational framework for integrating and enhancing the observational systems of participating countries and organizations into a comprehensive system focused on the requirements for climate issues. Therefore, the set of ECVs covers some EOVs. Nevertheless, the ECVs are not as detailed as the EOVs established under the Global Ocean Observing System Expert Panels (Physics and Climate, Biogeochemistry, and Biology and Ecosystems). Additionally, the observations supported by GCOS contribute to solving challenges in climate research and also underpin climate services and adaptation measures. Requirements and user needs are slightly different in the field of ocean observing.

In the following, the basic structures of the ocean observing community those of GCOS will be compared. GOOS was established in 1991 by the member states of IOC-UNESCO, with the WMO, UNEP, and ISC joining later as sponsors. Since 2012, the FOO sets the theoretical scene for conducting ocean observing activities within our ocean basins. The mandate of GOOS is to contribute to the UNFCCC and the UN Convention on Biodiversity (CBD). To fulfil these tasks, GOOS has the IOC/WMO mandates to provide operational ocean services. To better understand ocean climate and ecosystems, as well as human impacts and vulnerabilities, the coordination of a continuous and long-term system of ocean observations is needed (GOOS 2019). In addition, an assessment of the adequacy of EOVs, ocean observing activities and ocean information products - in more detail than it is done at GCOS level - is needed so that the scientific community, policy makers and other stakeholder groups have an overview of what has been done, how it fits their needs, and what needs to be improved to meet their targets. Such a process/mechanism does not exist in the field of ocean observing.

Fortunately, in 2018, GOOS National Focal Points were appointed by member states of IOC-UNESCO. The terms of reference are similar to those of the GCOS National Focal Points. Each national focal point is responsible for promoting GOOS and its strategies, for implementing a sustainable ocean observing system at national level, and for reporting on the status of national activities and capacity development needs to GOOS and IOC. Thus, the national GOOS focal points need to be communicated with GOOS itself, as well as national organizations and individuals involved in national ocean observing activities. With the establishment of this position, the aim is to sustain the ocean observing system infrastructure for research and/or operational needs in each country and on international level.

"The specific responsibilities of the national GOOS focal points are to:

1. Promote the work of GOOS and GOOS Regional Alliances at the national level by:
   a. promoting GOOS plans and documents where relevant,
   b. publicizing opportunities for engagement with GOOS structures and activities, including its panels, the JCOMM Observations Coordination Group, GOOS Regional Alliances, and GOOS Projects, and
   c. advocating for national investment in sustained ocean observing systems.
2. Report to IOC on the status of national ocean observing system activities that contribute to GOOS.
3. Promote regionally and nationally coordinated strategies and implementation for a sustained ocean observing system delivering the needed information to users, including suggesting pilot projects.

4. Ensure that national needs and gaps related to sustained ocean observing systems are brought to the attention of the GOOS Programme; and to supply information to IOC on ocean observing capacity development needs in the context of the IOC Capacity Development strategy and plan." (IOC Circular letter 2666)

The second responsibility refers to the reporting of the status of national ocean observing system activities. This could include that the GOOS National Focal Point takes care of the evaluation of national ocean observing activities and information products within the respective country together with the most important actors (including governmental organizations, academic institutions, military, civil society, and service users in the private sector). Thus, this step can help to establish an assessment of the adequacy process to build a comprehensive integrated Atlantic Ocean Observing System. Each country needs to involve their ocean observing actors in such a process. By developing reports of national perspectives and plans (e.g. inventory reports), the ocean observing community could work more closely together and could exchange their views on solid statements.

By compiling information on how to develop an Atlantic Ocean assessment process, the GCOS assessment process served as a well-established example that could be implemented in the ocean observing community. AtlantOS can become more coordinated, sustained, and effective by assessing EOVs, data access, ocean observing activities, and information products regularly. Furthermore, such a process would help organizations at international level to fulfil their mandates.

2.2 Selection of Pilot Countries

Five pilot countries have been selected to test how an AtlantOS assessment of the adequacy process and (online) questionnaire could be carried out to receive the information that is needed. Brazil, Canada, France, Germany, and Spain showcase a heterogeneous group of countries conducting ocean observing activities in the Atlantic Ocean and developing information products. The contact points in the pilot countries differ but were mainly from the scientific community or governmental institutions.

2.3 Development of the online questionnaire

The online questionnaire was developed within the AtlantOS project Work Package 9 'System Evaluation and Sustainability' with contributions and comments from different project partners (e.g. EuroGOOS, GEOMAR, Ifremer, and IOC-UNESCO). The survey mainly consists of quantitative questions, although some questions ask for qualitative answers (e.g. 'Please specify your answer') - see Annex I. Double negation was avoided and the questions were asked as simple as possible. For most questions, the answer option 'no opinion' could be chosen so that ocean observing actors were not forced to an answer they cannot fully support.

The questionnaire was uploaded to a free online questionnaire tool – LimeSurvey. The link to the questionnaire was circulated via e-mail to the contact points of the pilot countries. Additionally, some countries (Canada, France, Germany) received the questionnaire in paper-based format to circulate it more easily in their community. The filled in paper-based questionnaires were transferred to the online tool after submission.

At the beginning, the scope and structure of the questionnaire, some background information, and important terms are explained and defined. The questionnaire consists of three different parts: (A) National organization of ocean observing activities, (B) Adequacy of the existing ocean observation system, and (C) Future ocean observation activities within the respective country. At the end of the survey, open-ended questions and comments could be stated. Part A and B asked for feedback on the adequacy of the current ocean observing networks and the information delivery for EOVs and the requirements, which are defined by the users (both based on D1.1 'Initial AtlantOS requirements report'. Part C asked for information about future ocean observing activities within the next five years (2019 to 2023).

To review the observational capability in the Atlantic, the information available in the main pan-European coordinated observations data portals, or integrators - like EMODnet - were collected. Moreover, we have collected the metadata information available in the international JCOMMOPS data portal, which gathers the data from ocean observing global networks in support of GOOS, GCOS and WMO, as well as other data portals

collecting biogeochemistry and biology/ecosystems observations like the Ocean Biogeographic Information System (OBIS) or the International Council for the Exploration of the Sea (ICES).

2.4 Analysis of the online questionnaire

The analysis was carried out via LimeSurvey and each pilot country received a document on which they could provide comments (e.g. send further information or missing answers). The assessment process in Germany and Spain involved more institutes than in the other countries. In this report, the average of the answers from German and Spanish actors were determined in different evaluation tables. However, the answers cannot be attributed to a specific pilot country to preserve the anonymity of the ocean observing actors.

This assessment process was carried out for the first time, so it is unlikely that all important ocean observing actors from each pilot country were included. Therefore, the answers are anonymized. The responses from some pilot countries cannot be seen as the official national perspective. Interested individuals can contact the GOOS National Focal Points of the pilot countries and request to see the whole analysis

2.5 General information about the first AtlantOS assessment of the adequacy process

The first assessment process with five pilot countries was carried out from June 2018 to January 2019 and took into account ocean observing activities and ocean information products in the period from 2015 to 2017. The number of respondents differed from country to country. In some countries, coordinating groups answered the questionnaire. In other countries, several different actors (e.g. institutions, universities, institutes) conducting ocean observing activities in the Atlantic Ocean and marginal seas answered the questionnaire.

In general, the communication between the AtlantOS assessment process team and contact points for each country was carried out via e-mail. Nevertheless, before or after filling in the questionnaire, the responsible groups of each country had the opportunity to meet the AtlantOS project assessment process team in-person or remotely to discuss open questions, the results of the questionnaire, and further steps; only some of the actors used this opportunity. In two pilot countries, the AtlantOS Task 9.2 team organized meetings with the ocean observing actors. In one country, the responsible group met in December 2018 because of their national ocean observing partnership program and discussed the AtlantOS project assessment process – scientists, who are working in the AtlantOS project and are part of WP9, organized this meeting. Two countries carried out the process in their community without asking for help.

3. Performance of the current ocean observing system

This chapter presents the results and experiences of the assessment process, as well as the process' feedback the AtlantOS assessment team received. As stated in chapter 2, the answers cannot be attributed to a specific pilot country to preserve anonymity. Some results are accumulated within this report whereas some results will be shown together. The latter present an overall status of the adequacy of EOVs, ocean observing activities, data portals, and information products, which might be helpful for national authorities, scientific communities, civil society, international organizations, and other interested stakeholders.

3.1 Coordination at national and international levels

The coordination of ocean observing activities is organized in different ways at national level. The most common used structures are:

- Coordinating body/strategic group, in which ocean observing actors from different research areas (physics, biogeochemistry, and biology) are members, and
- Cooperation on bilateral basis or with a group of just a few ocean observing actors.

The latter structure does not clearly lead to a national organization of ocean observing activities so that research activities and national coordination seem fragmented and hard to evaluate.

By analyzing the responses to the assessment process, the following detailed information regarding coordinating structures and opinions can be identified. In some countries:

- National coordinating partnerships/projects or national ocean observing systems covering a wide range of important ocean observing actors in the respective country (organized through a governance structure) coordinate and evaluate national ocean observing activities and related tasks (e.g. data management, technological developments, strengthening the links between research and operational oceanography, coordinating research infrastructure, resource mobilization);
- The ministerial or military level (policy makers) plays an important role for coordinating ocean observing activities;
- A GOOS National Committee exists in addition to the recently appointed GOOS National Focal Point;
- Most collaborations and cooperation of ocean observing activities are managed on bilateral basis or between a few partners so that no national ocean observing coordination group or a similar body exist.

At international level, the recently appointed GOOS National Focal Points will be responsible for the communication between countries and the GOOS (already stated in chapter 2). Experience shows that the national focal point process is not officially launched yet so that the appointed people cannot start their work.

One question in the AtlantOS assessment process addressed the GOOS National Focal Point and respective terms of reference. Most ocean observing actors responded that the responsibilities and tasks of this position are adequate. They noted that the terms of reference cover both - observations and services. The ocean observing actors have the following additional expectation:

- GOOS National Focal Point process (both at IOC and at national level) needs to be set up/officially launched,
- More support is needed for maintaining long-term observations,
- To improve coordination of national research activities,
- To disseminate latest developments on national level and feed national interest into the GOOS process, i.e. extension of the scope of GOOS on processes in the deep sea - the impact of climate variability on deep sea ecosystems should be investigated over longer time periods, and
- To gather enough information to organize a common observational strategy.

In addition, the different ocean observing actors identified the following issues regarding coordinating structures that need to be solved in the future:

- Some coordinating partnerships/projects are limited in time and resources;
- Marine research landscape is diverse and several groups and initiatives exist. In some countries, the ocean observing actors that took part in the AtlantOS assessment process do not know the coordinating groups or contact points within their country, since not every research community is involved;
- Ocean observing actors are not aware of the (planned) activities that the coordinating groups or focal points will pursue over the coming years due to lacks of communication (1) on international and national level, and (2) between pathways on national level.

Most ocean observing actors participating in the process liked the idea of the AtlantOS assessment of the adequacy for evaluating their ocean observing activities. Some actors indicated to meet again in one year at the latest to develop a community-based perspective that could be circulated and presented to important stakeholder groups. In one pilot country – where no coordination group exists - the ocean observing community decided to establish a national coordination group for promoting synergies, resources optimization, identifying requirements and promote sustainability of their marine observation system.

In general, the AtlantOS assessment process indicates that most countries conducting ocean observing activities already have a coordination group or will establish such a group in the near future. Unfortunately, not every scientist is aware of the coordinating structures in his/her country. Furthermore, in some pilot countries not all research fields (e.g. physical, biogeochemical, and biological) are part of the coordinating groups/bodies. In addition, all pilot countries appointed a GOOS National Focal Point and are waiting for a signal that these people will start their work under their mandate. Taking into account the responsibilities of the GOOS National Focal Point and national ocean observing groups (that have different mandates) it is essential that they work together by assessing the activities and information products referring to the Atlantic Ocean (and other basins). Interested individuals who would like to contact one of the National GOOS Focal Points to get a full image of the assessment of the adequacy analysis can find more information on the GOOS website.

Recommendation #1 – National and international coordination: The results and experiences of the AtlantOS assessment of the adequacy process could help the GOOS National Focal Points by fostering and improving a consistent and fit-for-purpose assessment process for ocean observing activities and information products in the Atlantic Ocean at national level. The ocean observing communities and in particular the existing national coordination groups within the different pilot countries would like to work closely with their GOOS National Focal Point.

3.2 Societal Benefit Areas

Taking into account the FOO and the AtlantOS value chain, ocean observing activities should consider Societal Benefit Areas (SBAs). SBAs are defined – in this regard - as domains in which ocean observations are translated into support for decision-making processes by developing solutions to societal challenges within these SBAs by mobilizing resources including observations, science, modelling and applications, to enable end-to-end systems and deliver services for users.

The first AtlantOS assessment process used SBAs that considered GOOS and GEO Blue Planet: Ocean's environmental status, scientific discovery, operational and real-time services, and ocean economic activities. In addition, in the questionnaire the option 'Others' was offered to reveal if the ocean observing community has other SBAs that are important for conducting ocean observing activities, gathering data, and developing ocean information products. Since the importance of SBAs might differ, actors were asked for a more concrete information on the priority level (high, medium, low priority) of each SBA at coastal, regional, and open ocean levels.

The results of the first AtlantOS assessment of the adequacy process identifies the following priority levels for the different SBAs within the different ocean zones per country:

Coastal Level

Table 1 - Societal Benefit Areas showing the importance for guiding the ocean observing activities at coastal level and respective priority level in more detail (source: own research).

Societal benefit areas	**Pilot country**	**Guiding the ocean observing activities** (answer 'yes' in %)	**Priority level** (in %)
Ocean's environmental status (e.g. sustainable ocean health; global and regional assessments of e.g. biodiversity issues; food security)	Country A	0.00	High (100.00)
	Country B	100.00	High (100.00)
	Country C	100.00	High (100.00)
	Country D	75.00	High (56.25)
	Country E	71.43	High (57.14)
	Country A	100.00	High (100.00)

Scientific discovery (e.g. scientific analysis regarding climate, ecosystem, biodiversity, pollution; forecasting; prevention of natural hazards)	Country B	100.00	High (100.00)
	Country C	100.00	High (100.00)
	Country D	81.25	High (56.25)
	Country E	71.43	High (57.14)
Operational and real-time services (e.g. marine hazard response)	Country A	100.00	Medium (100.00)
	Country B	100.00	Medium (100.00)
	Country C	100.00	High (100.00)
	Country D	68.75	Medium and low (both 31.25)
	Country E	28.57	Medium (57.14)
Ocean Economic activities (e.g. sustainable ocean management; assessing human impact on ocean)	Country A	0.00	Medium (100.00)
	Country B	100.00	High (100.00)
	Country C	100.00	High (100.00)
	Country D	56.25	Medium (31.25)
	Country E	28.57	High and medium (both 28.57)

Regional level

Table 2 - Societal Benefit Areas showing the importance for guiding the ocean observing activities at regional level and respective priority level in more detail (source: own research).

Societal benefit areas (SBAs)	Pilot country	Guiding the ocean observing activities (answer 'yes' in %)	Priority level (in %)
Ocean's environmental status (e.g. sustainable ocean health; global and regional assessments of e.g. biodiversity issues; food security)	Country A	0.00	Medium (100.00)
	Country B	100.00	Medium (100.00)
	Country C	100.00	High (100.00)
	Country D	75.00	High (50.00)
	Country E	71.43	High (57.14)
Scientific discovery (e.g. scientific analysis regarding climate, ecosystem, biodiversity, pollution; forecasting; prevention of natural hazards)	Country A	100.00	High (100.00)
	Country B	100.00	Medium (100.00)
	Country C	100.00	High (100.00)
	Country D	81.25	High (62.50)
	Country E	71.43	High (71.43)
Operational and real-time services (e.g. marine hazard response)	Country A	100.00	High (100.00)
	Country B	100.00	Medium (100.00)
	Country C	100.00	High (100.00)
	Country D	68.75	Medium (37.50)

	Country E	42.86	Medium (42.86)
Ocean Economic activities (e.g. sustainable ocean management; assessing human impact on ocean)	Country A	0.00	Medium (100.00)
	Country B	100.00	Medium (100.00)
	Country C	100.00	High (100.00)
	Country D	56.25	Medium and low (both 31.25)
	Country E	28.57	Medium (42.86)

Open Ocean Level

Table 3 - Societal Benefit Areas showing the importance for guiding the ocean observing activities at open ocean level and respective priority level in more detail (source: own research).

Societal benefit areas (SBAs)	**Pilot country**	**Guiding the ocean observing activities** (answer 'yes' in %)	**Priority level** (in %)
Ocean's environmental status (e.g. sustainable ocean health; global and regional assessments of e.g. biodiversity issues; food security)	Country A	0.00	Medium (100.00)
	Country B	100.00	Medium (100.00)
	Country C	100.00	High (100.00)
	Country D	75.00	Low (43.75)
	Country E	71.43	High and medium (both 42.86)
Scientific discovery (e.g. scientific analysis regarding climate, ecosystem, biodiversity, pollution; forecasting; prevention of natural hazards)	Country A	100.00	High (100.00)
	Country B	100.00	Medium (100.00)
	Country C	100.00	High (100.00)
	Country D	81.25	High (50.00)
	Country E	85.71	High (85.71)
Operational and real-time services (e.g. marine hazard response)	Country A	100.00	High (100.00)
	Country B	100.00	Low (100.00)
	Country C	100.00	High (100.00)
	Country D	68.75	Low (43.75)
	Country E	28.57	Medium (42.86)
Ocean Economic activities (e.g. sustainable ocean management; assessing human impact on ocean)	Country A	0.00	Medium (100.00)
	Country B	100.00	Medium (100.00)
	Country C	100.00	High (100.00)
	Country D	56.25	Low (43.75)
	Country E	14.29	Medium (28.57)

The results of the first AtlantOS assessment process show that the priority level of SBAs (ocean's environmental status, scientific discovery, operational and real-time services, and ocean economic activities) differ

slightly from country to country, community to community and between the ocean zones. However, almost all SBAs guide the ocean observing activities at coastal, regional, and open ocean level. The ocean observing actors of the different pilot countries identified no other SBA.

For future assessment processes, it is important to define the ocean zones in more detail to have a common understanding of coastal, regional, and open ocean level. Several ocean observing actors within the different pilot countries identified this issue.

Recommendation #2 – Societal Benefit Areas: It is important to regularly evaluate requirements and user needs in the different ocean zones (coastal, regional, and open ocean) as orientation for Societal Benefit Areas (SBAs). Thus, (1) changes in priority levels, and (2) accompanying effects which might result in adapting ocean observing activities as well as ocean information products could be identified. The time interval for this evaluation needs to be identified by the international ocean observing community.

3.3 Essential Ocean Variables

EOVs[3] are defined as a specific set of quantities identified by one of the three GOOS Expert Panels (Physics and Climate, Biogeochemistry, and Biology and Ecosystems). EOVs derived from observational data with high scientific value along with technological feasibility and suitability to provide routine estimations of the ocean state. In response to scientifically based observing approaches, the EOVs, in connection with relevant oceanic phenomena, define the time, space and parameter space for observing. In turn, the adequate mix of observing platforms can be evaluated and the ocean observing status can be estimated. The criteria on which EOVs are identified are: Relevance, feasibility, and cost effectiveness. Each EOV has a specification sheet that can be found on the GOOS website.

To assess EOVs properly, it is important to understand how well established the FOO and the concept of EOVs is within the scientific community and other stakeholders. Therefore, the knowledge level of the theoretical framework and concept as well as the use of those in the daily research was identified in the survey. The ocean observing actors could choose between 'yes', 'no', and 'partly'. Results can be found in the table below:

Table 4 – Showcase four questions and respective responses identifying the knowledge level and degree of use of the Framework for Ocean Observing and concept of Essential Ocean Variables by the ocean observing actors in the different pilot countries. (source: own research)

Question	Country A (in %)	Country B (in %)	Country C (in %)	Country D (in %)	Country E (in %)
Are you familiar with the Framework of Ocean Observing?	Yes (100.00)	Yes (100.00)	Yes (100.00)	Yes (18.75) No (50.00) Partly (18.75) No answer (12.50)	Yes (28.57) No (28.57) Partly (42.86)
Are you familiar with the concept of Essential Ocean Variables?	Yes (100.00)	Yes (100.00)	Yes (100.00)	Yes (43.75) No (25.00) Partly (18.75) No answer (12.50)	Yes (42.86) No (14.29) Partly (42.86)

[3] Note: The list of EOVs was updated so that the EOVs used in the first AtlantOS assessment of the adequacy process are not up to date. The most recent list can be found on the GOOS website.

Are your ocean observing activities oriented towards the FOO?	Yes (100.00)	Yes (100.00)	Partly (100.00)	Yes (12.50) No (31.25) Partly (43.75) No answer (12.50)	Yes (42.86) No (28.57) Partly (28.57)
Is the FOO observing context helpful for your observing system design and/or decision making processes?	Yes (100.00)	Yes (100.00)	Partly (100.00)	Yes (31.25) No (31.25) Partly (25.00) No answer (12.50)	Yes (42.86) No (14.29) Partly (28.57)

The results indicate that most ocean observing actors are (partly) aware of the Framework for Ocean Observing and concept of Essential Ocean Variables. One community seems to be an outlier regarding the FOO. In addition, most actors orient their ocean observing activities (partly) towards the FOO and find the FOO context helpful for observing system design and /or decision-making processes.

Nevertheless, some actors of different pilot countries noted, that there is a need to inform their ocean observing communities about these theoretical approaches. Especially the biological and ecosystem observing communities seem not that well informed about the FOO and EOV concept but would highly appreciate to be more informed about these approaches. Since the level of awareness varies, it might be helpful for future assessment processes to state these questions regarding theoretical frameworks and concepts again to promote these approaches within the different ocean observing communities.

With this information in mind, the following tables show the assessment of the set of EOVs (physical, biogeochemical, biological and ecosystem). First, the ocean observing actors identified which EOVs (according to GOOS) are of relevance for their ocean observing activities at coastal, regional and open ocean level. The results are displayed in different colors

- Red: EOV seems not relevant for actors in the pilot country (0 – 35 % answered with ‘relevant’),
- Yellow: EOV seems partly relevant for ocean observing actors in the pilot country (35 – 75 % answered with ‘relevant’)
- Green: EOV seems relevant for actors in the pilot country (75 – 100 % answered with ‘relevant’)

Afterwards, the actors identified in more detail how relevant the variables are within the different ocean zones. The displayed results show the option that most actors agreed on in the respective pilot country - sometimes options had the same amount of votes. The answers are allocated to following numbers and colors:

- 1 - Very relevant (green)
- 2 - Relevant (light green)
- 3 – Neutral (yellow)
- 4 - Irrelevant (red)
- 0 - No opinion (grey)

Table 5 – Relevance of physical Essential Ocean Variables at coastal, regional, and open ocean level for ocean observing communities in the five pilot countries. Red - EOV seems not relevant, yellow - EOV seems partly relevant, green - EOV seems relevant (source: own research).

		Sea State	Ocean Surface Stress	Sea ice	Sea surface height	Sea surface temperature	Subsurface temperature	Surface currents	Subsurface currents	Sea surface salinity	Subsurface salinity	Heat flux/ radiation
Coastal	Country A	100.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00	100.00	0.00	100.00
	Country B	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country C	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country D	43.75	31.25	31.25	37.50	43.75	43.75	43.75	43.75	31.25	31.25	31.25
	Country E	42.86	57.14	0.00	57.14	14.29	42.86	0.00	57.14	85.71	57.14	71.43
Regional	Country A	100.00	100.00	0.00	0.00	100.00	100.00	100.00	0.00	0.00	0.00	0.00
	Country B	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country C	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country D	50.00	31.25	43.75	43.75	56.25	56.25	56.25	56.25	43.75	50.00	31.25
	Country E	28.57	57.14	0.00	28.57	0.00	85.71	0.00	71.43	100.00	71.43	100.00
Open Ocean	Country A	100.00	100.00	0.00	0.00	100.00	100.00	100.00	0.00	0.00	0.00	0.00
	Country B	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country C	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country D	50.00	43.75	43.75	56.25	56.25	56.25	56.25	56.25	50.00	50.00	43.75
	Country E	14.29	42.86	0.00	14.29	71.43	57.14	85.71	71.43	85.71	71.43	71.43

Table 6 – Detailed relevance level of physical Essential Ocean Variables at coastal, regional, and open ocean level for ocean observing communities in the five pilot countries. 1 - very relevant (green), 2 – relevant(light green), 3 – neutral (yellow), 4 – irrelevant (red), 0 – no opinion (grey) (source: own research).

		Sea State	Ocean Surface Stress	Sea ice	Sea surface height	Sea surface tempera-ture	Sub-surface tempera-ture	Surface currents	Sub-surface currents	Sea surface salinity	Sub-surface salinity	Heat flux/ radiation
Coastal	Country A	1	1	4	1	1	1	1	1	1	2	1
	Country B	1	1	1	1	1	1	2	1	1	1	2
	Country C	1	1	0	1	1	1	1	1	1	1	2
	Country D	1 0	0	2 0	2	1	1	1	1	1 0	2 0	1 0
	Country E	1	1	0	1	1	2	2	2	1	2 3	2
Regional	Country A	2	1	4	1	1	1	1	1	1	2	2
	Country B	2	1	1	2	1	1	2	2	1	1	2
	Country C	2	1	0	1	1	1	1	1	1	1	2
	Country D	1 3 0	0	2	2	1	1	1	1	1	1	0
	Country E	2	2	0	1	1	1	1	1	1	1	1 2 3
Open Ocean	Country A	2	1	4	1	1	1	1	1	1	2	3
	Country B	3	2	2	3	2	2	3	3	1	2	2
	Country C	2	2	1	1	1	1	1	1	1	1	2
	Country D	1 3 4	1	2	2	1	1	1	1	1 2	1	1 0
	Country E	2	2	0	1	1	2	1	1	1	2	2

Table 7 - Relevance of biogeochemical Essential Ocean Variables at coastal, regional, and open ocean level for ocean observing communities in the five pilot countries. Red - EOV seems not relevant, yellow - EOV seems partly relevant, green - EOV seems relevant (source: own research).

		Dissolved Oxygen	Inorganic macro nu-trients	Carbonate System	Transient tracers	Suspended particulates	Nitrous oxide	Stable Carbon Isotopes	Dissolved organic carbon	Ocean Colour
Coastal	Country A	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00
	Country B	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country C	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country D	50.00	43.75	25.00	50.00	31.25	37.50	25.00	31.25	37.50
	Country E	85.71	85.71	71.43	0.00	57.14	14.29	14.29	57.14	57.14
Regional	Country A	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00
	Country B	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country C	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00
	Country D	43.75	13.75	37.50	31.25	31.25	37.50	43.75	43.75	43.75
	Country E	85.71	71.43	71.43	14.29	57.14	28.57	14.29	57.14	42.86
Open Ocean	Country A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Country B	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country C	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00
	Country D	62.50	50.00	43.75	43.75	43.75	43.75	43.75	43.75	43.75
	Country E	57.14	57.14	71.43	28.57	42.86	28.57	14.29	28.57	28.57

Table 8 - Detailed relevance level of biogeochemical Essential Ocean Variables at coastal, regional, and open ocean level corresponding to the five pilot countries. 1 - very relevant (green), 2 – relevant(light green), 3 – neutral (yellow), 4 – irrelevant (red), 0 – no opinion (grey) (source: own research).

		Dissolved Oxygen	Inorganic macro nutrients	Carbonate System	Transient tracers	Suspended particulates	Nitrous oxide	Stable Carbon Isotopes	Dissolved organic carbon	Ocean Colour
Coastal	Country A	1	1	0	0	0	0	0	1	1
	Country B	1	1	1	2	2	3	3	1	1
	Country C	1	1	1	2	1	1	2	1	1
	Country D	1	1	0	0	1 0	0	0	0	1
	Country E	1	1	2	3	3	2 3 4	3	1	1
Regional	Country A	2	2	0	0	0	0	0	2	2
	Country B	2	2	2	3	3	3	3	2	1
	Country C	1	1	1	2	0	2	2	1	1
	Country D	1	1	1	0	1 0	0	0	1	1
	Country E	1	2	1 2	2	2	2	2	2	1 2
Open Ocean	Country A	2	2	0	0	0	0	0	2	2
	Country B	2	3	3	3	3	3	3	3	2
	Country C	1	1	1	2	0	2	2	1	1
	Country D	1	1	2	1 0	1	0	0	2	1
	Country E	1	2	1	1	2	1	1 2 4	1	1 2

Table 9 - Relevance of biology and ecosystem Essential Ocean Variables at coastal, regional, and open ocean level for ocean observing communities in the five pilot countries. Red - EOV seems not relevant, yellow - EOV seems partly relevant, green - EOV seems relevant (source: own research).

		Phyto-plankton biomass and diversity	Zooplankton biomass and diversity	Fish abundance and distribu-tion	Marine tur-tles, birds, mammals abundance and distribution	Live coral	Seagrass cover	Macroalgal canopy	Mangrove cover	Microbe biomass and diversity (*emerging)	Benthic in-vertebrate abundance and distri-bution (*emerging)
Coastal	Country A	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Country B	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	n.a.	n.a.
	Country C	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country D	50.00	43.75	31.25	18.75	25.00	31.25	25.00	18.75	25.00	50.00
	Country E	57.14	28.57	42.86	28.57	0.00	14.29	0.00	0.00	14.29	28.57
Regional	Country A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Country B	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	n.a.	n.a.
	Country C	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country D	43.75	50.00	43.75	31.25	31.25	37.50	43.75	31.25	25.00	25.00
	Country E	57.14	28.57	28.57	28.57	0.00	14.29	0.00	0.00	14.29	28.57
Open Ocean	Country A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Country B	100.00	100.00	100.00	100.00	100.00	0.00	100.00	0.00	n.a.	n.a.
	Country C	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Country D	43.75	50.00	37.50	37.50	31.25	37.50	37.50	31.25	25.00	50.00
	Country E	57.14	14.29	14.29	28.57	14.29	14.29	0.00	0.00	14.29	14.29

Table 10 - Detailed relevance level of biology and ecosystem Essential Ocean Variables at coastal, regional, and open ocean level for ocean observing communities in the five pilot countrie. 1 - very relevant (green), 2 – relevant(light green), 3 – neutral (yellow), 4 – irrelevant (red), 0 – no opinion (grey) (source: own research).

		Phytoplankton biomass and diversity	Zooplankton biomass and diversity	Fish abundance and distribution	Marine turtles, birds, mammals abundance and distribution	Live coral	Seagrass cover	Macroalgal canopy	Mangrove cover	Microbe biomass and diversity (*emerging)	Benthic invertebrate abundance and distribution (*emerging)
Coastal	Country A	1	1	0	0	0	0	0	0	0	0
	Country B	1	1	1	1	2	1	2	0	n.a.	n.a.
	Country C	1	1	1	1	1	1	1	1	1	1
	Country D	1	1	0	0	0	0	0	0	0	0
	Country E	1	1	1 2 3	0	0	0	0	0	0	0
Regional	Country A	2	1	0	0	0	0	0	0	0	0
	Country B	1	2	1	1	2	2	3	0	n.a.	n.a.
	Country C	1	1	1	1	1	1	1	1	3	3
	Country D	1	1	1 3 0	0	0	2 3 0	3	4	0	0
	Country E	1	1	1	2	0	0	0	0	0	0
Open Ocean	Country A	2	2	0	0	0	0	0	0	0	0
	Country B	3	3	3	2	1	2	3	0	n.a.	n.a.
	Country C	1	1	1	1	1	2	1	1	3	3
	Country D	1	1	0	4	0	4	4 0	4	0	0
	Country E	2	1 3 0	2 3 0	0	2 4 0	0	0	0	0	0

Moreover, the ocean observing actors were asked which phenomena are not covered by the Essential Ocean Variables on coastal, regional, and open ocean levels and which EOVs would be useful to address those phenomena and are missing in the present list. The answers to these questions indicate that

- 'DF radar' is not included in the current EOV list;
- It should be taken into account that some EOVs are covered through satellite observations;
- Some EOVs enclose a very high degree of diverse aspects and particularities that cannot be summarized in a single variable. For instance, zooplankton biomass and diversity, encloses very different organisms (from protozoa to macrozooplankton) that cannot be observed by a single methodology and observing activities often only include certain groups;
- 'Subsurface (spectral) light' as a physical EOV could be added to the list of EOVs, since light availability is of relevance for physical, chemical and biological processes - 'ocean colour' is related, but a different kind of information;
- 'Sediments', 'sediment-water interface' as well as 'iron chemistry/bioavailability' could be added to the list of EOVs;
- Some EOVs referring to the seafloor and microplastics could be added to list of biogeochemical EOVs (seafloor (and water column) respiration, deep-ocean suspended particle fluxes / organic particle attenuation, seafloor organic matter quality and quantity, microplastics and marine litter abundance, mass, fluxes);
- The study of flux of material through the water column in all depths are of high importance for assessing biogeochemical processes;
- pCO2, dissolved inorganic carbon, total alkalinity and pH should be listed separately and not all combined as Carbonate System Parameters.

An important general note is that it should be considered if observing activities of the above mentioned EOVs are carried out within an integrated system more or less independently. This is an important issue on the value of an observing system and if EOVs are covered in a sustainable way.

Taking into account the assessment from the five pilot countries for the current list of EOVs it can be determined that

- The list seems adequate - Most EOVs are relevant in the different ocean observing communities and for developing ocean information products.
- The detailed relevance level of each EOV differs due to the geographical location and the respective requirements - some EOVs (like 'sea ice') are very relevant for countries directly affected by significant changes of this EOV and irrelevant for countries not affected by significant changes.
- Some more time is needed for informing the different communities about the important set of biological variables for their daily work.
- There is a need to think about adding variables e.g. regarding seafloor and microplastics requirements to the current list of EOVs.

Recommendation #3 – Essential Ocean Variables: Essential Ocean Variables: It is fundamental that the ocean observing communities (1) evaluate and confirm the importance of EOVs for the development of ocean information products and general understanding of the Atlantic Ocean and (2) give feedback to the GOOS Expert Panels (Physics and Climate, Biogeochemistry, and Biology and Ecosystems) on requirements for existing EOVs (space/time resolution, accuracy) and articulating new EOVs. It might be important to add the evaluation of key phenomena to an assessment of the adequacy process. This information would give information about which EOVs are important to measure.

3.4 Data access and availability

For developing ocean (information) products, reliable data are needed. To get these data, access and availability need to be open and free. Thus, the FAIR-principles are becoming more and more important. To build

a comprehensive and sustainable Atlantic Ocean Observing System it is helpful to compile the information, which data systems are used by ocean observing actors and how accessible the data are. For the assessment process, different international, regional, and national data systems were taken into account. Different research areas use different data systems. Some of the data systems are already covered under the GOOS data systems. Since data systems differ from their information uptake we asked for which SBA the ocean observing actors use the respective data system. By getting all these information, the current status of data access and availability can be assessed and reviewed.
The following results can be determined (see tables below).

International Level

Table 11 – international data systems showing the amount of use (in %) by ocean observing actors in the respective pilot country in accordance to the different Societal Benefit Areas (source: own research).

Data System	Pilot country	Use of data system differentiated in Societal Benefit Areas (answer 'yes' in %)				
		Ocean's environmental status	Scientific discovery	Operational and real-time services	Ocean economic activities	Others
GTS/WIS	Country A	0.00	0.00	0.00	0.00	0.00
	Country B	100.00	100.00	100.00	0.00	0.00
	Country C	0.00	0.00	100.00	0.00	0.00
	Country D	12.50	6.25	0.00	0.00	0.00
	Country E	14.29	0.00	28.57	0.00	0.00
GEOSS	Country A	0.00	0.00	0.00	0.00	0.00
	Country B	0.00	100.00	0.00	0.00	0.00
	Country C	0.00	0.00	0.00	0.00	0.00
	Country D	6.25	0.00	0.00	0.00	0.00
	Country E	0.00	28.57	14.29	0.00	0.00
GDACs	Country A	0.00	0.00	0.00	0.00	0.00
	Country B	0.00	100.00	100.00	0.00	0.00
	Country C	100.00	100.00	100.00	0.00	0.00
	Country D	25.00	31.25	6.25	0.00	0.00
	Country E	28.57	42.86	14.29	0.00	0.00

Regional Level

Table 12 – Regional data systems showing the amount of use (in %) by ocean observing actors in the respective pilot country in accordance to the different Societal Benefit Areas (source: own research).

Data System	Pilot Country	Use of data system differentiated in Societal Benefit Areas (answer 'yes' in %)				
		Ocean's environmental status	Scientific discovery	Operational and real-time services	Ocean economic activities	Others
CMEMS INS TACs	Country A	0.00	100.00	100.00	0.00	0.00
	Country B	100.00	100.00	100.00	0.00	0.00
	Country C	100.00	100.00	100.00	100.00	0.00
	Country D	12.50	18.75	0.00	0.00	0.00
	Country E	28.57	28.57	42.86	0.00	0.00

EMODnet	Country A	0.00	0.00	0.00	0.00	0.00
	Country B	0.00	100.00	100.00	0.00	0.00
	Country C	100.00	100.00	100.00	100.00	0.00
	Country D	12.50	12.50	0.00	0.00	0.00
	Country E	28.57	28.57	28.57	14.29	0.00

National Level

Table 13 – National data systems showing the amount of use (in %) by ocean observing actors in the respective pilot country in accordance to the different Societal Benefit Areas (source: own research).

Data System	**Pilot Country**	**Use of data system differentiated in Societal Benefit Areas** (answer 'yes' in %)				
		Ocean's environmental status	**Scientific discovery**	**Operational and real-time services**	**Ocean economic activities**	**Others**
SeaDataNet / NODCs (e.g. Coriolis, PANAGEA)	Country A	0.00	100.00	100.00	0.00	0.00
	Country B	100.00	100.00	0.00	0.00	0.00
	Country C	100.00	100.00	0.00	100.00	0.00
	Country D	37.50	50.00	0.00	0.00	0.00
	Country E	42.86	42.86	14.29	0.00	0.00
ICES Data and Analytic Services (DAS)	Country A	0.00	0.00	0.00	0.00	0.00
	Country B	100.00	100.00	0.00	100.00	0.00
	Country C	100.00	100.00	0.00	100.00	0.00
	Country D	25.00	25.00	0.00	0.00	0.00
	Country E	14.29	28.57	0.00	14.29	0.00
OBIS	Country A	0.00	0.00	0.00	0.00	0.00
	Country B	100.00	100.00	0.00	0.00	0.00
	Country C	100.00	100.00	0.00	0.00	0.00
	Country D	6.25	12.50	0.00	0.00	0.00
	Country E	14.29	14.29	0.00	14.29	0.00
Others	Country A	0.00	0.00	0.00	0.00	0.00
	Country B	100.00	100.00	0.00	0.00	0.00
	Country C	0.00	0.00	0.00	0.00	0.00
	Country D	0.00	0.00	0.00	0.00	0.00
	Country E	0.00	0.00	14.29	0.00	0.00

In addition, the following table indicates the level of data availability in the different data systems. The displayed results show the option that most actors agreed on in the respective pilot country – sometimes, different options had the same amount of votes. The answers are allocated to following numbers and colors:

- 1 - Always (green)
- 2 - Mostly (light green)
- 3 – Sometimes (yellow)
- 4 - Never (red)
- 0 - No opinion (grey)

Table 14 – Data availability of the different data systems with regard to ocean observing actors in the five pilot countries. 1 - always (green), 2 – mostly (light green), 3 – sometimes (yellow), 4 – never (red), 0 – no opinion (grey) (source: own research).

Pilot / Country	International Level			Regional Level				National Level						
	GIS/WIS	GEOSS	GDACs	CMEMS INS TACs	EMODnet	SeaDataNet / NODCs (e.g. Coriolis, PA-NAGEA)	ICES DAS	OBIS	Others
Country A	2	0	0	2	0	2	0	0	0
Country B	1	0	1	1	1	1	1	1	1
Country C	3	4	2	2	2	2	2	3	n.a.
Country D	0	0	0	0	0	1	2	0	0
Country E	4 / 0	2	2	1 / 0	1 / 0	1 / 2	0	2 / 0	2 / 0

One of the guiding questions (see chapter 1) addresses the most significant gaps in information and how these gaps can be closed. Thus, the following responses showcase some issues/big concerns in the field of data systems (identified by the different ocean observing actors):

- Data systems are linked to the GEOSS portal but ocean observing actors do not use the GEOSS portal to access them;
- WIS is not available for some research departments;
- There is a need for better monitoring / curation of headings and codes used in GIS data.

One ocean observing actor refers to a step towards data integration in the GEOSS portal, which facilitates the access to environmental data on a global scale. Within the AtlantOS project, a new community portal had been set up. This portal makes sure that the data coming out of the Atlantic Ocean Observing System are only a couple of clicks away, and facilitate access to the vast amounts of online data resources provided by AtlantOS project partner. The AtlantOS community portal in the GEOSS portal demonstrates the concept of making use of existing data integrators for integration of the diverse data sources that are available from the Atlantic Ocean Observing System. With this measure, the discovery and access to ocean data will be significantly enhanced.

By analysing the results from the five pilot countries, it can be determined that international data systems (GIS, WIS, GEOSS, GDACs) have been poorly used with regard to data gathering for the development of (information) products for all SBAs. Regional data systems (CMEMS INS TACs, EMODnet) have been used sometimes in the fields of (1) ocean's environmental status, (2) scientific discovery, and (3) operational and real-time services. National data systems have been used very often for developing products in the SBAs ocean's environmental status and scientific discovery. The scientific community seems not that much interested in developing (information) products in the field of ocean economic activities. In addition, some data systems are not available for some ocean observing actors.

Recommendation #4 – Data systems: Ensure that the FAIR-principles are the basis for every data system and that all data are available (free and open access) through well-funded data management systems. By promoting and enhancing the interoperability of (international) data systems, an integrated Atlantic Ocean Observing System can be built to serve the needs of users, e.g. for developing (information) products.

3.5 Compilation of Ocean Observing Activities

The compilation of ocean observing activities in the different pilot countries is an important part of the assessment process. Currently, ocean observing communities do not evaluate their ocean observing activities. Nevertheless, this step is essential for determining which ocean observing activities need to be improved to meet the needs of the users and developing fit-for-purpose ocean observing products. Furthermore, it will become more visible which observations need to be sustained for the long-term and how much an integrated Atlantic Ocean Observing system would cost (considering the costs e.g. identified in AtlantOS project deliverable 1.4). Thus, the ocean observing actors were asked to indicate – as accurately as possible - which ocean observing activities they carried out in the period from 1 January 2015 to 31 December 2017 (or they should indicate a convenient period). By using the JCOMMOPS and EMODnet AtlantOS monitoring tools, the pilot countries received a table of ocean observing activities based on these tools to compare the information from the tools and the ones they have. The following table showcase the results that the pilot countries submitted:

Table 15 – Compilation of ocean observing activities carried out by ocean observing actors in the five pilot countries. The information were supplemented through the AtlantOS monitoring tools developed by JCOMMOPS and EMODnet physics. Considered period is: 1 January 2015 to 31 December 2017 (source: own research).

Platform Type (and example observing network)	**Characteristics**	**Country A**	**Country B**	**Country C**	**Country D**	**Country E**
Research Vessel (e.g. GO-SHIP)	Scientific Domain	XBT	Physical Biogeochemical Ecosystem	Physical Biogeochemical Ecosystem	Physical Biogeochemical Biology and ecosystem	Physical Biogeochemical Biology and ecosystem
	Location	-	Open Ocean Coastal	Open Ocean Coastal	Open ocean Regional (Mainly) Coastal	Open ocean Regional Coastal
	Depth	Surface to 800m	Surface Deep	Surface Deep	Surface Deep	Surface (water column) Deep 0 – 600m
	Contribution	**GO-SHIP**	**181 cruises (11843 CTD casts)**	**15 cruises**	**Between 16 and 22 cruises**	**>1000 CTD casts per year**
Floats (e.g. Argo, Deep Argo)	Scientific Domain	n.a.	Physical Biogeochemical	Physical Biogeochemical	Physical Biogeochemical	Physical
	Location	n.a.	Open Ocean	Open Ocean Coastal	Open ocean	Open ocean
	Depth	n.a.	Surface Deep	Surface Deep	Surface Deep	Surface Deep
	Contribution	n.a.	**65 profilers**	**423 profilers**	**272 profilers** (e.g. Bio-Argo, Hybrid Antarctic float observation system (HAFOS))	**16 profilers**
Moorings (e.g. Coastal: DBCP Open Ocean: OceanSITES, (PIRATA), EMSO)	Scientific Domain	n.a.	Physical Biogeochemical	Physical Biogeochemical	Physical Biogeochemical Biology and ecosystem	Physical Biogeochemical
	Location	n.a.	Open Ocean Coastal	Open Ocean Coastal Atmospheric	Open Ocean	Coastal Regional Open Ocean

	Depth	n.a.	Surface Deep	Surface Deep	Deep	Surface (water column) Deep
	Contribution	n.a.	**75 buoys**	**149 buoys**	**360 buoys** (40% deployed through German institutions) (e.g. LTER HAUSGARTEN / FRAM, strongly connected to OceanSITES)	**2 buoy deployments and recoveries by year** (several ADCP deployments and contribution to OceanSITES)
Gliders (e.g. OceanGliders)	Scientific Domain	n.a.	Physical Biogeochemical	Physical Biogeochemical	Biogeochemical Biology and ecosystem	Physical Biogeochemical
	Location	n.a.	Coastal	Open Ocean Coastal	Open ocean Regional Coastal	Open ocean Regional Coastal
	Depth	n.a.	Surface Deep	Surface Deep	Surface Deep	Surface (to 1000m)
	Contribution	n.a.	**6 gliders**	**7 gliders**	-	**20 missions**
Surface Drifters (e.g. DBCP)	Scientific Domain	n.a.	Physical	Physical	Physical Biogeochemical	Physical
	Location	n.a.	Open Ocean Coastal	Open Ocean Coastal	Coastal Open ocean	Open ocean
	Depth	n.a.	Surface	Surface	Surface	Surface
	Contribution	n.a.	**62 drifters**	**377 drifters**	**74 surface drifters** (e.g. Debris drifters)	**6 deployments**
Commercial ships (e.g. Ferrybox)	Scientific Domain	n.a.	Physical Biogeochemical	Physical Biogeochemical	Physical Biogeochemical	Physical Biogeochemical
	Location	n.a.	Coastal	Open Ocean Coastal	Coastal	Coastal Open ocean
	Depth	n.a.	-	-	Surface	Surface
	Contribution	n.a.	**1 route carried out**	**34 route carried out**	**2 routes**	**2 routes**
Commercial ships (XBT / TSG) (e.g. SOT, SOOP, VOS)	Scientific Domain	n.a.	Hydrography	Underway	Meteorological	Physical Underway
	Location	n.a.	Open Ocean Coastal	Open Ocean Coastal	-	Coastal Open Ocean

	Depth	n.a.	High resolution Low resolution	High resolution Low resolution	-	Surface
	Contribution	n.a.	**791 CTD casts**	-	See platform type 'Meteorological'	**4 routes** (e.g. AtlantOS VOS)
Radar (e.g. HF-Radar)	Scientific Domain	n.a.	-		-	Physical
	Location	n.a.	-		Coastal	Coastal
	Depth	n.a.	-		Surface	Surface
	Contribution	n.a.	**2 antennas**	**2 antennas**	**3 antennas**	-
Animal-borne sensors (e.g. Ocean Tracking Network)	Scientific Domain	n.a.	-	-	-	-
	Location	n.a.	-	Open Ocean	-	-
	Depth	n.a.	-	-	-	-
	Contribution	n.a.	-	-	-	-
CPR /Plankton surveys (e.g. Continuous Plankton Recorder)	Scientific Domain	n.a.	-	-	Biogeochemical Biology and ecosystem	Biogeochemical Biology and ecosystem
	Location	n.a.	Open Ocean Coastal	Coastal	Open Ocean Coastal	Open Ocean Coastal
	Depth	n.a.	Surface Deep	Surface	Surface Deep	Surface Deep
	Contribution	n.a.	**1692 ship days**	-	**80 ship days** of surveys per year for different measurements	**6 monitoring programs**
Fish surveys (e.g. ICES Working Groups)	Scientific Domain	n.a.	-	-	Biology and ecosystem Sonar	Biology and ecosystem
	Location	n.a.	-	Open Ocean Coastal	(Mainly) Coastal Open Ocean	Coastal
	Depth	n.a.	-	Surface Deep	Surface Deep	
	Contribution	n.a.	-	**10 cruises**	**365 d/year**	**365 cruise days/year**
Tide Gauge (e.g. Global Sea Level Observing System)	Scientific Domain	n.a.	Physical	Physical	-	Physical
	Location	n.a.	Coastal	Coastal	Open Ocean	Coastal
	Depth	n.a.	Surface	Surface	-	Surface
	Contribution	n.a.	**22 stations**	**6 stations**	**38 stations**	**30 stations**

Meteorological (e.g. SOT)	Scientific Domain	n.a.	-	-	Physical Biological Biology and ecosystem	Atmospheric
	Location	n.a.	Open Ocean Coastal	Open Ocean Coastal	Open ocean (Mainly) Coastal	Open ocean Coastal
	Depth	n.a.	-	-	Surface Deep	
	Contribution	n.a.		-	**450 casts**	Automated continuous
Bathymetry / Sonar Signals (e.g. GEBCO, Seafloor Mapping)	Scientific Domain	n.a.	-	-	-	-
	Location	n.a.	-	Open Ocean Coastal	Coastal Open Ocean	(Mainly) Coastal
	Depth	n.a.	-	-	Deep	-
	Contribution	n.a.	**25 cruises**	**2 cruises**	**19 cruises** (125.760km); **4.600km long transect**	-
Marine Genomics	Scientific Domain	n.a.	-	-	Biogeochemical Biology and ecosystem	Biology and ecosystem
	Location	n.a.	-	Open Ocean Coastal	Coastal Open Ocean Wadden Sea	Coastal
	Depth	n.a.	-	-	Surface Deep Sediment Subsurface rock	-
	Contribution	n.a.	-	-	**>15 research cruises,** **>30 field trips**	Preliminary
Others (e.g. Sail drones, …)	Scientific Domain	n.a.	-	-	Physical Biogeochemical Biology and ecosystem	-
	Location	n.a.	-	-	Open ocean Coastal	-
	Depth	n.a.	-	-	Surface Deep	-
	Contribution	n.a.	-	-		-

Some countries carried out activities in marginal seas (e.g. in submersed volcano areas in the Canary Islands, Mediterranean Sea, etc.).

By analyzing the content of table 15 it can be identified that

1. The monitoring tools developed by JCOMMOPS and EMODnet physics are important for the compilation of ocean observing activities from different countries. Nevertheless, (1) they do not cover all ocean observing activities that need to be taken into account for creating an overall view of activities conducted by each country (e.g. animal-borne sensors), (2) deviations exist in the information we received from the monitoring tools and the answers from the different observing actors (e.g. profiling floats, moorings, radar, gliders), and (3) it is an issue to provide the needed metadata in real-time. Thus, it is important to improve and update the data systems in general. If monitoring tools or portals exist, where information about ocean observing activities can be submitted and which are easily accessible for all ocean observing actors, the Atlantic Ocean Observing System is fit-for-purpose and sustainable.
2. The contributions of ocean observing activities from different actors are displayed in a different format. It needs to be identified by the ocean observing community how the ocean observing activities should be counted (e.g. amount of gliders or glider missions).

During one in-person meeting, the ocean observing actors indicated that further ocean observing platform types need to be added to the AtlantOS assessment process. These are observations referring to lander, crawler, and cable. Furthermore, it need to be defined which kind of ocean observing activities need to be taken into account for the compilation (deployments and/or recoveries). Additionally, the ocean observing communities should consider if the compilation of ocean observing activities need to take into account the characteristic “sustained‘ to indicate if activities are secured for the long-term in terms of funding, personnel, and technologies.

Furthermore, the ocean observing actors are confused by the terms ‘ocean observing system’ and ‘ocean observing network’. With the AtlantOS assessment process the awareness of the difference was raised. These terms should be defined (e.g. with regard to their focus area, characteristics, foundation, working structure) in the near future by the international ocean observing community. A possible place for discussing this issue could be the OceanObs’19 Conference taking place in September 2019 on Hawaii (U.S.) with participation of a huge number of ocean observing experts from different countries and different research fields. The vision for ‘An Integrated All-Atlantic Ocean Observing System in 2030’ (de Young et. al, 2018) already discusses the meaning of these terms and should be taken into account.

The compilation of ocean observing activities does not indicate how satisfied ocean observing actors are with their contributions. Thus, the observing actors were asked to name the level of satisfaction for each ocean observing activity platform type. The table below showcase the responses and assessment. The displayed results points to the option that most actors agreed on in the respective pilot country; sometimes options had the same amount of votes. The answers are allocated to following numbers and colors:

- 1 – Very satisfied (green)
- 2 - Satisfied (light green)
- 3 – Neutral (yellow)
- 4 - Unsatisfied (red)
- 0 - No opinion (grey)

Table 16 Assessment of ocean observing activities by ocean observing actors of the five pilot countries (carried out in the period 1 January 2015 to 31 December 2017). 1 – very satisfied (green), 2 – satisfied (light green), 3 – neutral (yellow), 4 – unsatisfied (red), 0 – no opinion (grey) (source: own research).

Platform Type	Country A	Country B	Country C	Country D	Country E
Research Vessel (e.g. GO-SHIP)	2	n.a.	2	2	1
Floats (e.g. Argo, Deep Argo)	2	n.a.	2	0	1 / 2
Moorings (e.g. Coastal: DBCP Open Ocean: OceanSITES, (PIRATA), EMSO)	3	n.a.	2	1	2
Gliders (e.g. OceanGliders)	4	n.a.	2	3	2
Surface Drifters (e.g. DBCP)	3	n.a.	2	0	2
Commercial ships (e.g. Ferrybox)	0	n.a.	2	0	3
Commercial ships (XBT / TSG) (e.g. SOT, SOOP, VOS)	0	n.a.	2	0	3
Radar (e.g. HF-Radar)	4	n.a.	2	0	2
Animal-borne sensors (e.g. Ocean Tracking Net-work)	0	n.a.	2	0	0
CPR /Plankton surveys (e.g. Continuous Plankton Recorder)	0	n.a.	3	2 / 3 / 0	1 / 3

Fish surveys (e.g. ICES Working Groups)	0	n.a.	2	0	1	3
Tide Gauge (e.g. Global Sea Level Observing System)	4	n.a.	2	0	1	3
Meteorological (e.g. SOT)	3	n.a.	2	0	3	
Bathymetry / Sonar Signals (e.g. GEBCO, Seafloor Mapping)	0	n.a.	2	0	2	3
Marine Genomics	0	n.a.	2	0	3	4
Others (e.g. Sail drones, …)	0	n.a.	n.a.	0	3	0

In general it can be determined that

- Some ocean observing communities are satisfied with their ocean observing activities contribution (country C), but most actors of the other pilot countries do not indicate a specific level of satisfaction. Four platform type contributions got the grade ‘unsatisfied’ by ocean observing actors but the reasons behind that were not given.
- Ocean Observing actors are confused by the terms ‘ocean observing system’ ‘and ocean observing network’. With the AtlantOS assessment process the awareness of the difference was raised. These terms should be defined in the near future by the international ocean observing community.

Recommendation #5 – AtlantOS Monitoring tools: The monitoring tools should be made available in the future and help to improve the integration of ocean observing activities from other data systems to the AtlantOS tools. The issue of providing real-time data needs to be solved to improve the Atlantic Ocean Observing System. The compilation of ocean observing activities is important for defining national perspectives and (future) plans.

Recommendation #6 – Ocean Observing Activities: An assessment of the adequacy process can be the basis for discussion within each country to clarify which ocean observing activities and information products need to be sustained over the next years and what is missing to reach the status 'sustained' (e.g. considering personnel, technological developments, financial resources). National perspectives and plans are important for funders of ocean observing activities who do not know which activities and information products need to be sustained in the long term. It is important to classify each kind of observing activity/platform and information product. In addition, other initiatives exist which have developed tools to compile ocean observing activities. Thus, it might be useful to compare existing processes so that assessment procedures could benefit from each other.

3.6 Ocean Information Products

To get an overall picture of the current Atlantic Ocean Observing System, the ocean information products need to be evaluated by ocean observing end-users and actors who develop(ed) products and are in contact with the end-users (ideally). By taking into account the availability and adequacy of observational data, the following table displays if ocean information products - the actors developed or contributed to - are adequate in addressing the expected user needs within the different Societal Benefit Areas. The results are displayed in different colors

- Red – the ocean information products are not adequate,
- Green - the ocean information products are adequate, and
- Grey – the ocean observing actors have no opinion if the ocean information products are adequate.

Table 17 – Adequacy of ocean information products based on the different Societal Benefit Areas. Red – the ocean information products are not adequate, green - the ocean information products are adequate, grey – the ocean observing actors have no opinion if the ocean information products are adequate (source: own research).

Pilot Country	Ocean information products addressing the following societal benefit areas			
	Ocean's environmental status (e.g. Oil spill hazard mapping)	**Scientific discovery** (e.g. NW European Shelf Seas (NWS) reanalysis and forecasting)	**Real-time services** (e.g. ship route hazard mapping)	**Ocean economic activities** (e.g. fish stock assessment, offshore aquaculture siting)
Country A	No opinion	Yes	Yes	No opinion
Country B	Yes	Yes	Yes	Yes
Country C	No	No	No	Yes
Country D	No opinion	Yes	No opinion	No opinion
Country E	Yes	Yes	No opinion	No opinion

Furthermore, the ocean observing actors should indicate the most significant gaps in the information chain and how the gaps could be closed (e.g. improved observations, more effective data flow, etc.). Indeed, general gaps and solutions were identified for the development and adequacy of information products within the different Societal Benefit Areas:

General issues involve

- Insufficient sampling and missing data in specific coverage areas (for e.g. resolving seasonal changes of physical, biogeochemical, and biological characteristics at/in the seafloor and of the uppermost water layer during times of ice cover),
- Lack of biogeochemical and biological observations and missing information about impacts of physics and chemistry on the biology,

- Missing strategies and procedures for a comprehensive data management for real-time data from marine observatories,
- Heterogeneous and intransparent data flows and quality control,
- Missing tools for the integration and analysis of e.g. biodiversity data including provision of reference data to facilitate more consistent biodiversity assessments,
- Lack of high-resolution oceanography e.g. in the deep ocean (below 2000 m).

Solutions include

- Improved observations/observational methods and technical solutions for autonomous sampling, sample fixation, and seafloor measurements (e.g. crawler technologies),
- Expanded partnerships between academic, industrial, civil society, and governmental sectors, including international partnerships,
- Secured funding of long term observations,
- Synergies with satellite observations and improved (coupled) modelling and data assimilation capabilities (e.g. in physics and biogeochemistry as well as physics and biology),
- Contribution to the development of national observatory infrastructures for the assessment of the short term effects of events compared to long term trends,
- An integrated Atlantic Ocean Observing System with integrated data policies, initiating national consortia for the development of comprehensive data management strategies
- Installation of more observation infrastructures that provide year-round observations of main hydrographic and biological variables in coastal zones,
- Collection of continuous environmental data from coastal environments focusing on the effects of global change phenomena (e.g. increasing extreme hydrological events) on biota and the ecosystem as a whole, and
- Collection of environmental data as part or fishery data collection and developments of bio-sensors for monitoring the contaminant parameters,

In general, it can be determined that the integrated Atlantic Ocean Observing System can be improved by evaluating the (information) products and determining their main issues. The assessment process indicates that concerns regarding (1) ineffective data flows, (2) inappropriate quality control, (3) inappropriate coverage of sampling areas, (4) insufficient sampling of important variables, (5) missing synergies for modelling and data assimilation, as well as (6) missing partnerships of academic, industrial, civil society, and governmental areas need to be solved in the future. The observing communities can solve the issues by e.g. (1) improved observation infrastructures and technical developments, (2) fostering cooperation between countries, observing networks, and systems, (3) comprehensive data management system, and (4) aligning with satellite community and adjacent communities.

Recommendation #7 – Ocean information products: A regular assessment of ocean information products by product developers and users is important to identify gaps and needs from both sides that will guide improvements in the Atlantic Ocean Observing System.

4. Future Ocean Observing Activities

The third part of the assessment of the adequacy of the Atlantic Ocean Observing System process addressed future ocean observation activities for the next five years (2019 – 2023). The focus was on following eight topics: Coordination at national level, EOV assessment, ocean observing activities, data management, information product delivery, open access to (information) products, capacity building at the national level and beyond, and resource mobilization. The following general future activities can be identified – detailed responses can be found within the analyses of the pilot countries (GOOS National Focal Point need to be contacted).

4.1 Coordination within the pilot countries

One pilot country had recently implemented a national ocean observing system which will evolve in the next years to represent e.g. the national perspectives and plans on issues of ocean observing (including most important national ocean observing actors).
Another pilot country will develop and organize its ocean observing activities around Research Infrastructures (RIs) which should be important for building blocks on a future ocean observing system coordination (including e.g. recommendations for an AtlantOS).
A further pilot country will establish a coordinating body for ocean observation activities and possibly another coordination group on data management – both groups will work on a national ocean observing strategy.
Most countries already have a national coordination group that does not cover the full spectrum of ocean observing activities in the respective pilot countries. Thus, most groups will strengthen the national integration of ocean observing activities involving all relevant institutions (universities, research institutions, governmental bodies and connect to other important observing communities (including e.g. IPBES).
Several pilot countries will include the GOOS National Focal Point within their national coordination process.

4.2 EOVs assessment

Some actors would like to establish an information process for the observing communities within their country so that the whole community is aware about the theoretical concept of EOVs and the Framework for Ocean Observing.
One pilot country will include a community wide review process of 11 EOVs that are important for their ocean observing activities within their national ocean observing system.
One pilot country community refer to EOV assessment processes that are regularly done at the level of observing network, regional observing activity, or research infrastructure. Their national observing actors will discuss how to use those processes for national perspective and planning processes.
Some actors would like to establish an EOV review process at the international level that is open for all interested people and would be conducted every few years.

4.3 Ocean observation activities

Within some pilot countries, governmental actors have the mandate for coordinating ocean observing activities. Those actors indicate that the mandate needs to be implemented through partnerships with the academic and private sectors in the near future.
In some pilot countries, the national system or coordination groups will be responsible for reviews of ocean observing activities/ocean observing system.
One actor refers to the start of a monitoring location in the tropics with several partner institutions.
In general, the different ocean observing actors will

- promote the process of establishing the Bio-Argo observations of bio-optical EOVs,
- continue the long-term observations in the Atlantic with a particular focus lies in the regions of West Africa and the Mid-Atlantic Ridge,
- contribute to seagoing activities that include deployment of moorings,
- promote and carry out physical, biogeochemical, and biological observing as well as seabed mapping activities,

- contribute and get funds for be a member of the European Research Infrastructure Consortium (ERIC), and
- focus on keeping the time series and progressing in particular observations according the research and social necessities.

The future ocean observing activities differ from country to country and community to community. By compiling all these activities and future goals, partnerships could be improved and resources could be brought together (ideally), to work on the activities that lie in the interest of several actors or countries.

4.4 Data management

For some actors the focus lies on the development of strategies and procedures for a comprehensive data management system for real-time data from marine observatories. Some actors will promote data integration policies within their respective country and at regional/international level.
The strengthening of data management and data access is a central subject for one pilot country since significant national funding as well as funding from funders of ocean observing are expected.
Almost all actors participating in the assessment process will contribute to the data systems that already exist.
Ocean Observing Actors will

- work on better integration and implementation of their national data policies and sustainable data structures, better integration of biological observations, and integration of satellite and in-situ ocean observation data,
- promote open access to data as a principle endorsed by governments and academic sectors,
- implement the FAIR principles,
- improve data quality control, and
- improve the quality assessment and data management of e.g underway measurement systems on research vessels and ferries.

4.5 Information product delivery

The national ocean observing system in one pilot country has the mandate and is presently funded to build a sustainable system to provide ocean data for information product delivery.
In general, ocean observing actors will

- develop a monitoring time series in the tropics,
- develop assessment and mitigation strategies for vulnerable coasts,
- support PANGAEA which is involved in a number of national and European projects that aim at development of data products aiming at biodiversity studies,
- work on concepts dealing with producing data products that enhances maritime safety,
- increase the availability of products through web servers, and
- contribute to the international existing products to avoid duplications.

4.6 Open access to (information) products

The national ocean observing system of one pilot country will provide open access to ocean data to allow greater accessibility, discoverability and interoperability of data and information and associated visualization products.
Other ocean observation actors will (1) enable and support open access to data products through databases and (2) work on the improvement of data availability based on e.g. INSPIRE-requirements.
In some countries, the open access to (information) products already exists.

4.7 Capacity building at national level and beyond

All ocean observing actors participated in the assessment process will continue with educational training through

- Increased amount of data that are openly available,

- Summer schools (e.g. on coastal observatories), and
- Dedicated training for ocean observing techniques.

Actors have formed national partnerships through programs and others opportunities to enhance and support capacity building. Some actors will support capacity building and foster e.g. student education based on bilateral cooperation. Within one pilot country, the focus is on increasing the cooperation between institutes and universities to allow university students a detailed access to scientific and monitoring surveys.

4.8 Resource mobilization

Two pilot countries could already give details regarding the amount of monetary resources that the federal government has committed to specific ocean observing network activities, ocean observing national programs or politically- motivated activities (e.g. UN Decade of Ocean Science for Sustainable Development). Within some pilot countries, new programs will be supported through monetary governmental contributions in the coming years. Some actors monitor e.g. full time equivalent people of specific programs to give an estimate of running costs to their funders. Actors identify that it is important to evaluate the ocean observing activities every few years to develop a sustainability plan.

It was difficult that ocean observing actors indicated an estimate of monetary resources that they would need to sustain their most important ocean observing activities. Within the AtlantOS 'Cost and Feasibility Study' figures provide estimated cost calculations for some ocean observing networks (e.g. Argo, GO-SHIP, PIRATA) that might be useful for actors for calculating the monetary resources for ocean observing activities.

In addition, actors within the pilot countries were asked if information about their future ocean observing activities are available for the public and if they are interested to register their future ocean observing activities for the Atlantic Ocean at international level.
Some actors indicated that their sustainability or implementation plans as well as ocean observing strategies can be found on their websites. Unfortunately, more than the half indicated that their future plans are not displayed publically. Fortunately, almost all actors indicated that they would like to register their plans (on a voluntary basis) for the basin at international level.

Recommendation #8 – Future plans/voluntary commitments: The AtlantOS assessment process indicates that almost all pilot countries have specific plans for the next five years and that they prefer to submit their plans for the Atlantic Ocean at global level. The community could think about establishing a portal where actors/countries could upload their future activities and (voluntary) commitments. Thus, cooperation could be fostered and forces could be joined for activities and products that might not be sustained but are important for the ocean observing community, end-users, and stakeholder groups. Clearly, this might not be possible for all countries due to governmental regulations.

5. Lessons learned from the first AtlantOS assessment of the adequacy process

The pilot countries' respective ocean observing actors that took part in the first AtlantOS assessment process, identified some issues need to be solved for future review processes:

- Define the terms coastal, regional, and open ocean,
- Define - for some ocean observing platforms - which activities should be taken into account (deployments and/or recoveries), and
- Update the list for ocean observing activities and data systems. For example, lander, crawler, and cable observing activities need to be added to the list of observing platforms.

When contacting the different ocean observing communities, it was difficult to identify the most important ocean observing actors needed for this process in some pilot countries. Especially in the ones where no coordination existed in that moment or the coordinating groups did not cover all research areas. Thus, the GOOS National Focal Point might play an important role for future assessment processes.

In addition, it is important to consider processes/initiatives that are already in place (e.g. from the Partnership for Observation of the Global Oceans). Those processes could help assessing ocean observing activities and information products within the Atlantic Ocean as well. It might be an advantage if the Atlantic Ocean observing community would agree on a format for the assessment process questionnaire.

6. Conclusion and outlook

The development of a standardised assessment process methodology would enable an optimal evaluation of national ocean observing coordination, societal benefit areas, EOVs, data systems, ocean information products, ocean observing activities, and future activities. This process would help the ocean observing actors to develop national perspectives and plans that are important for funders of ocean observing activities – national governments, as well as international organizations, industry, and civil society. This report is a first step to create a consistent adequacy process for the Atlantic Ocean. The methodologies developed in this study provide a starting point for the development of a common methodology. This will help to strengthen the knowledge acquired in this study and prevents the potential duplication of effort in future studies.

This was the first time that the AtlantOS assessment process was carried out, so it is likely that not all important ocean observing actors in each country were reached. Countries and ocean observing actors would like to track and evaluate how they are performing in conducting ocean observing activities in the Atlantic Ocean and developing ocean information products compared to other countries and actors. An AtlantOS assessment process would allow such comparisons in all research domains of ocean observing at the basin-scale scale level.

To foster cooperation and join forces it might be important to develop a portal at international level (such as GOOS) where all countries could submit their future ocean observing activities (voluntarily). Duplications of ocean observing activities could be prevented and resources (money, ship time, personnel, technologies) could be used for other important activities.

Considering the AtlantOS D9.3 'Report on assessment of the performance of AtlantOS observing system', the JCOMMOPS and EMODnet Physics monitoring tools will continue to evolve as networks and the coordination among them mature, as work progresses to harmonise some of the features between the two tools, and as, for example, some EOV-based metrics will be developed. Thus, these tools can serve as a basis for compiling ocean observing activities for future assessment processes. Ocean observing actors need to indicate and add ocean observing activities that are not included in these tools and – more importantly – how satisfied they are with their contributions.

This study was limited by time and resources and as such it is viewed as a first step in developing an assessment of the adequacy process for AtlantOS taking into account the ocean observing communities in five pilot countries conducting observing activities in the Atlantic and its marginal seas. The study relied on the significant goodwill, effort and contribution of the actors from the pilot countries, which was provided as a courtesy. Adequate resources and funding are required to build on the data gathered in this initial study. Future work should focus on addressing the limitations of this study and help to enhance the provision of more accurate data provided by the AtlantOS monitoring tools and participating ocean observing actors.

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List of Abbreviations

Argo	Broad-scale global array of temperature/salinity profiling floats that is a major component of the ocean observing system and exemplifies international collaboration, with 31 nations contributing floats (2017) and a data management system that delivers consistent quality controlled data streams.
AtlantOS	All-Atlantic Ocean Observing System [and European Union Horizon 2020 funded project is called 'AtlantOS - Optimizing and Enhancing the Integrated Atlantic Ocean Observing Systems (2015-2019)]
CBD	Convention of Biological Diversity
CMEMS INS TAC	Copernicus Marine Environment Monitoring Service In Situ Thematic Centre
COP	Conference of the Parties
CPR	Continuous Plankton Record
DAS	Data and Analytic Services
DBCP	Data Buoy Cooperation Panel
ECV	Essential Climate Variable
EMODnet	European Marine Observation and Data Network
EMSO	European Multidisciplinary Seafloor and water-column Observatory
EOOS	European Ocean Observing System
EOV	Essential Ocean Variable Essential Ocean Variables are a set of quantities derived from observational data that have a high scientific value, and measuring them is technologically feasible. EOVs are suited to providing routine estimates of the ocean state (physical, biogeochemical, ecosystem)
ERIC	European Research Infrastructure Consortium
EU	European Union
EuroGOOS	European Global Ocean Observing System
FAIR-principles	Findable, Accessible, Interoperable and Reusable principles
FOO	Framework for Ocean Observing
GCOS	Global Climate Observing System
GDAC	Global Data Assembly Centre
GEBCO	General Bathymetric Chart of the Oceans
GEO	Group of Earth Observation
GEOSS	Global Earth Observation System of Systems
GLOSS	Global Sea Level Observing System
GOOS	Global Ocean Observing System
GO-SHIP	Global Ocean Ship-based Hydrographic Investigations Program GO-SHIP is a globally coordinated network of sustained hydrographic sections that aims to bring together scientists with interests in physical oceanography, the carbon cycle, marine biogeochemistry and ecosystems, and other users and collectors of hydrographic data.
GTS	Global Telecommunication System
HF	High Frequency
ICES	International Council for the Exploration of the Sea
IOC	International Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change

IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
ISC	International Science Council
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
JCOMM OPS	Joint Technical Commission for Oceanography and Marine Meteorology in-situ Observing Programs Support Center
MoU	Memorandum of Understanding
OBIS	Ocean Biogeographic Information System
OceanSITES	The mission of OceanSITES is to collect, deliver and promote the use of high-quality data from long-term, high-frequency observations at fixed locations in the open ocean. OceanSITES typically aim to collect physical, biogeochemical, and biology/ecosystem data worldwide using open-ocean, full-depth water column as well as the overlying atmosphere
OTN	Ocean Tracking Network
PANGAEA	Data Publisher for Earth & Environmental Science
PIRATA	Prediction and Research Moored Array in the Tropical Atlantic
QA/QC	Quality assurance and quality control
RI	Research Infrastructure
SBA	Societal Benefit Area
SDG	Sustainable Development Goal
SOOP	Ship-of-Opportunity Programme
SOT	Ship Observations Team
TSG	Thermosalinograph
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VOS	Voluntary Observing Ship (Programm)
WIS	WMO Information system
WMO	World Meteorological Organization
XBT	XBT (eXpendable BathyThermograph) is a probe that is dropped from a ship and measures the temperature as it falls through the water. In a joint effort between research and government institutions and the private industry, XBTs are usually launched from cargo, research, or cruise ships.

Annex

Adequacy of ocean observation systems and ocean information – National Position on the Atlantic Ocean Observation System (AtlantOS) - Questionnaire (paper-based version)

Scope of the questionnaire
To collect the information needed to assess the contribution of your country to the existing Atlantic Ocean Observing System.

Why is an assessment of the adequacy of the Atlantic Ocean observation system and its ocean information important?
Annual investment costs in Atlantic Ocean observing and related downstream services are substantial in many countries. This assessment will provide for the first time a pan-Atlantic view on current (and future) national Atlantic Ocean observation activities. Elements of the assessment will serve as references for ministries and agencies within your country. This first assessment will serve as a baseline for future updates e.g. every three to five years.

Questionnaire structure
Part A: National Organization of ocean observing activities
Part B: Adequacy of the existing ocean observation system
Part C: Future ocean observation activities within your country

Background information
Atlantic Ocean observation is currently undertaken through loosely-coordinated, in-situ observing networks, satellite observations and data management arrangements of heterogeneous international, national and regional design to support science and a wide range of information products. Thus, there is tremendous opportunity to develop the systems towards a fully integrated Atlantic Ocean Observing System (AtlantOS) consistent with the developed 'Framework of Ocean Observing' (FOO).
The vision of AtlantOS is to improve and innovate Atlantic observing to obtain an international, more sustainable, more efficient, more integrated, and fit-for-purpose system. Hence, the AtlantOS initiative will have a long-lasting and sustainable contribution to the societal, economic and scientific benefit arising from this integrated approach. Additionally, effective strategies for such a sustained, multidisciplinary and integrated ocean observing system need to be developed, to better connect user communities and observers. End user communities include operational users, national and local authorities, as well as researchers, from the public and private sectors. Engagement with user communities within one nation can take diverse forms, including closer interaction to better target their needs for ocean observing networks and derived products while better informing management decisions.

Definition of important terms

- **Capacity Building** – Activities related to educational and technical training for operation and use of ocean observing platforms, data exploration, data archiving, use of ocean observing downstream services (e.g. Copernicus Marine Environment Monitoring Service) with the aim to overcome geographical, economic or political limitations and to enhance international collaboration.
- **Essential Ocean Variables (EOVs) –** A specific set of quantities derived from observational data with high scientific value along with technological feasibility and suitable to provide routine estimation of ocean state (physical, biogeochemical, ecosystem). In response to scientifically based observing approaches the EOVs, in connection with relevant oceanic phenomena, define the time, space and parameter space for observing. In turn, the adequate mix of observing platforms can be evaluate and the ocean observing status estimated.
- **Observing network** - A formal or loose grouping of scientists and/or agencies that operate observing platforms (e.g. Argo or GO-SHIP).
- **Societal Benefit Areas (SBAs)-** Societal Benefit Areas are the domains in which ocean observations are translated into support for decision-making by developing solutions to societal challenges within these SBAs by mobilizing resources including observations, science, modelling and applications, to enable end-to-end systems and deliver services for users.
  The SBAs we are using within this questionnaire orient towards the GOOS SBAs but were extended on ocean economic activities.

If you have any further questions before our meeting, please contact Sandra Ketelhake (GEOMAR Helmholtz Centre for Ocean Research Kiel, e-mail: sketelhake@geomar.de, phone: +49 431 600 4287).

Part A - National Organization of ocean observing activities

Question 1 – Ocean Observation Activities Coordination

Within your nation, do you have a person or a group of people who is/are supporting your ocean observing activities (e.g. a GOOS focal point)?

☐ Yes ☐ No

Who is/are your contact person(s) (including employment information) and what are they doing?

Are you planning to establish such a position in the future?

☐ Yes ☐ No

Question 2 – GOOS Focal Point

Within the Global Ocean Observation System it was agreed that every member state should nominate a GOOS National Focal Point for communication between GOOS and the national organizations and individuals involved in the country's sustained ocean observing system infrastructure for research and/or operational needs.

If your country already has a GOOS Focal Point, are you aware of the (planned) activities this person will pursues over the coming years?

☐ Yes

Could you briefly summarize the (planned) activities:

☐ No

Why are you not informed about the (planned) activities?

What are your expectation from the GOOS Focal Point process? Are the GOOS terms of reference sufficient respectively adequate?

Part B – Adequacy of the existing ocean observation system

This questionnaire part addresses current ocean observing activities within your country. Additionally, we would like to ask you if the existing Essential Ocean Variables are adequate for your needs.
For your reference, we generated a list of ocean observing activities associated with your country from the JCOMMOPS and EMODnet monitoring tools.

Question 3 – Societal benefit areas (SBAs)

What are the societal benefit areas that guide your ocean observing activities on the coastal, regional and open ocean level? Please indicate the priority level (high, medium, low) for each societal benefit area.
If you would like to define the societal benefit area in more detail, you are welcome to do so.

Societal benefit areas (SBAs)	More detail (optional)	Coastal Level	Regional Level	Open ocean Level
Ocean's environmental status (for more detail, e.g. sustainable ocean health; global and regional assessments of e.g. biodiversity issues; food security)		High Priority☐ Medium Priority ☐ Low Priority ☐	High Priority☐ Medium Priority ☐ Low Priority ☐	High Priority☐ Medium Priority ☐ Low Priority ☐
Scientific discovery (for more detail, e.g. scientific analysis regarding climate, ecosystem, biodiversity, pollution; forecasting; prevention of natural hazards)		High Priority☐ Medium Priority ☐ Low Priority ☐	High Priority☐ Medium Priority ☐ Low Priority ☐	High Priority☐ Medium Priority ☐ Low Priority ☐
Operational and real-time services (for more detail, e.g. marine hazard response)		High Priority☐ Medium Priority ☐ Low Priority ☐	High Priority☐ Medium Priority ☐ Low Priority ☐	High Priority☐ Medium Priority ☐ Low Priority ☐
Ocean Economic activities (for more detail, e.g. sustainable ocean management; assessing human impact on ocean)		High Priority☐ Medium Priority ☐ Low Priority ☐	High Priority☐ Medium Priority ☐ Low Priority ☐	High Priority☐ Medium Priority ☐ Low Priority ☐

Others:		High Priority☐ Medium Priority ☐ Low Priority ☐	High Priority☐ Medium Priority ☐ Low Priority ☐	High Priority☐ Medium Priority ☐ Low Priority ☐

Question 4 – Essential Ocean Variables

Are you familiar with the Framework of Ocean Observing (FOO)? ☐ Yes ☐ No[4] ☐ Partly

Are you familiar with the concept of Essential Ocean Variables (EOVs)? ☐ Yes ☐ No[4] ☐ Partly

Are your ocean observing activities oriented towards the FOO? ☐ Yes ☐ No[4] ☐ Partly

Is the FOO observing context helpful for your observing system design and/or decision making processes? Please, briefly explain your answer.

☐ Yes ☐ No ☐ Partly

[4] Please continue with question 5.

Which **Essential Ocean Variables** (according to GOOS) are of relevance for your ocean observing activities at the coastal, regional and open ocean level?

a) Physics

Essential Ocean Variables	Comments (optional)	Very relevant	Relevant	Neutral	Irrelevant	No opinion
☐ Sea state		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Ocean surface stress		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Sea ice		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Sea surface height		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Sea surface temperature		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Subsurface temperature		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Surface currents		☐ Coastal ☐ Regional	☐ Coastal ☐ Regional	☐ Coastal ☐ Regional	☐ Coastal ☐ Regional	☐ Coastal ☐ Regional

		☐ Open ocean	☐ Open ocean	☐ Open ocean	☐ Open ocean	☐ Open ocean
☐ Subsurface currents		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Sea surface salinity		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Subsurface salinity		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Heat flux/radiation		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean

b) Biogeochemistry

Essential Ocean Variables	**Comments (optional)**	**Very relevant**	**Relevant**	**Neutral**	**Irrelevant**	**No opinion**
☐ Dissolved Oxygen		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Inorganic macro nutrients		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Carbonate System		☐ Coastal ☐ Regional	☐ Coastal ☐ Regional	☐ Coastal ☐ Regional	☐ Coastal ☐ Regional	☐ Coastal ☐ Regional

		☐ Open ocean	☐ Open ocean	☐ Open ocean	☐ Open ocean	☐ Open ocean
☐ Transient tracers		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Suspended particulates		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Nitrous oxide		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Stable Carbon Isotopes		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Dissolved organic carbon		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Ocean Colour		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean

c) Biology and Ecosystems

Essential Ocean Variables	Comments (optional)	Very relevant	Relevant	Neutral	Irrelevant	No opinion
☐ Phytoplankton biomass and diversity		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Zooplankton biomass and diversity		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Fish abundance and distribution		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Marine turtles, birds, mammals abundance and distribution		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Live coral		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Seagrass cover		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Macroalgal canopy		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean
☐ Mangrove cover		☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean	☐ Coastal ☐ Regional ☐ Open ocean

Which phenomena is/are not covered by the Essential Ocean Variables in your opinion (coastal, regional, open ocean level)? Please specify your answer and indicate which EOV(s) would be useful and is/are missing in the present list.

Question 5 – Data access

Where does your institutions get data to work on ocean observing (information) products for the different societal benefit issues (taking into account GOOS data networks)?

Level	Data System	Societal benefit area	Availability of the data	Biggest concern or recommendation (optional)
International	**Global Telecommunication System (GTS)/ WMO Information System (WIS)**	☐ Ocean's environmental status ☐ Scientific discovery ☐ Real-time services ☐ Ocean economic activities ☐ Others:	☐ always ☐ mostly ☐ sometimes ☐ never ☐ no opinion	
	Global Earth Observation System of Systems (GEOSS)	☐ Ocean's environmental status ☐ Scientific discovery ☐ Real-time services ☐ Ocean economic activities ☐ Others:	☐ always ☐ mostly ☐ sometimes ☐ never ☐ no opinion	
	Global Data Assembly Centres (GDACs)	☐ Ocean's environmental status ☐ Scientific discovery ☐ Real-time services ☐ Ocean economic activities ☐ Others:	☐ always ☐ mostly ☐ sometimes ☐ never ☐ no opinion	
Regional	**Copernicus Marine Environment Monitoring Service In-situ Thematic Centres (CMEMS INS TACs)**	☐ Ocean's environmental status ☐ Scientific discovery ☐ Real-time services ☐ Ocean economic activities ☐ Others:	☐ always ☐ mostly ☐ sometimes ☐ never ☐ no opinion	

	EMODnet	☐ Ocean's environmental status ☐ Scientific discovery ☐ Real-time services ☐ Ocean economic activities ☐ Others:	☐ always ☐ mostly ☐ sometimes ☐ never ☐ no opinion	
National	**SeaDataNet / National Ocanography Data Centres (NODCs) (e.g. Coriolis, PANAGEA)**	☐ Ocean's environmental status ☐ Scientific discovery ☐ Real-time services ☐ Ocean economic activities ☐ Others:	☐ always ☐ mostly ☐ sometimes ☐ never ☐ no opinion	
	ICES Data & Analytic Services (DAS)	☐ Ocean's environmental status ☐ Scientific discovery ☐ Real-time services ☐ Ocean economic activities ☐ Others:	☐ always ☐ mostly ☐ sometimes ☐ never ☐ no opinion	
	Ocean Biogeographic Information System (OBIS)	☐ Ocean's environmental status ☐ Scientific discovery ☐ Real-time services ☐ Ocean economic activities ☐ Others:	☐ always ☐ mostly ☐ sometimes ☐ never ☐ no opinion	
	Others:	☐ Ocean's environmental status ☐ Scientific discovery ☐ Real-time services ☐ Ocean economic activities ☐ Others:	☐ always ☐ mostly ☐ sometimes ☐ never ☐ no opinion	

Question 6 – Ocean observation activities

Within the last two years (2015 to 2017 – or us a convenient period, e.g. one year) which kind of ocean observing activities have you carried out within the different research institutions in your country? Please answer as accurately as possible.
Are you satisfied with your country's contribution?
Note: JCOMMOPS and EMODnet Physics developed web-based monitoring tools with which we could track the real-time and persistent Atlantic Ocean observing activities. Please look at the table below, prefilled with information from the above-mentioned monitoring tools.

a) National/Regional/International Level

Platform Type	Ocean Observing Network (your examples)	Scientific Domain	Environment (location)	Environment (depth)	Country's contribution (2015-2017)	Very Satisfied	Satisfied	Neutral	Unsatisfied	Very Unsatisfied
Research Vessel (CTD) (e.g. GO-SHIP)		☐ Physical ☐ Biogeochemical ☐ Ecosystem	☐ Open ocean ☐ Coastal	☐ Surface ☐ Deep	In 'casts' **x** (x cruises)	☐	☐	☐	☐	☐
Floats (e.g. Argo, Deep Argo)		☐ Physical ☐ Biogeochemical ☐ Ecosystem	☐ Open ocean ☐ Coastal	☐ Surface ☐ Deep	In 'profiler' **x**	☐	☐	☐	☐	☐
Moorings (e.g. Coastal: DBCP Open Ocean: OceanSITES, (PIRATA), EMSO)		☐ Physical ☐ Biogeochemical ☐ Ecosystem	☐ Coastal ☐ Open Ocean ☐ Atmospheric	☐ Surface ☐ Deep	In 'amount of buoys' **x**	☐	☐	☐	☐	☐
Gliders (e.g. OceanGlider)		☐ Physical ☐ Biogeochemical ☐ Ecosystem	☐ Open ocean ☐ Coastal	☐ Surface ☐ Deep	In 'amount of gliders' **x**	☐	☐	☐	☐	☐
Surface Drifters (e.g. DBCP)		☐ Physical ☐ Biogeochemical ☐ Ecosystem	☐ Open ocean ☐ Coastal ☐ Atmospheric	☐ Surface ☐ Deep	In 'amount of drifters' **x**	☐	☐	☐	☐	☐
Commercial ships (e.g. Ferrybox)		☐ Physical ☐ Biogeochemical	☐ Open ocean ☐ Coastal		In 'Routes carried out' **x**	☐	☐	☐	☐	☐

Commercial ships (XBT / TSG) (e.g. SOT, SOOP, VOS)		☐ Hydrography ☐ Underway	☐ Open ocean ☐ Coastal	☐ High resolution ☐ Low resolution	In 'casts' **x**	☐	☐	☐	☐	☐
Radar (e.g. HF Radar)					In 'amount of antennas' **x**	☐	☐	☐	☐	☐
Animal-borne sensors (e.g. Ocean Tracking Network)			☐ Open ocean ☐ Coastal		In 'equipped marine mammals' **x**	☐	☐	☐	☐	☐
CPR /Plankton surveys (e.g. Continuous Plankton Recorder)			☐ Open ocean ☐ Coastal	☐ Surface ☐ Deep	In 'ship days' **x**	☐	☐	☐	☐	☐
Fish surveys (e.g. ICES Working Groups)			☐ Open ocean ☐ Coastal	☐ Surface ☐ Deep	In 'ship days' **x**	☐	☐	☐	☐	☐
Tide Gauge (e.g. Global Sea Level Observing System)		☐ Physical ☐ Biogeochemical ☐ Ecosystem	☐ Open ocean ☐ Coastal	☐ Surface ☐ Deep	In 'stations' **x**	☐	☐	☐	☐	☐
Meteorological (e.g. SOT)			☐ Open ocean ☐ Coastal		In 'casts' Manual: **x** Automatic: **x**	☐	☐	☐	☐	☐
Bathymetry / Sonar Signals (e.g. GEBCO, Seafloor Mapping)			☐ Open ocean ☐ Coastal	☐ Surface ☐ Deep	**x cruises** Single Line (km): Swath Line (km):	☐	☐	☐	☐	☐

Marine Genomics			☐ Open ocean ☐ Coastal	☐ Surface ☐ Deep	In 'amount of samples' **x**	☐	☐	☐	☐	☐
Others (e.g. Sail drones, …)			☐ Open ocean ☐ Coastal	☐ Surface ☐ Deep		☐	☐	☐	☐	☐

Question 7 – Information product delivery

Taking into account the availability and adequacy of ocean observational data, are the ocean information products you are developing and/or contributing to adequate in addressing the expected user needs within the different societal benefit areas?

Where do you see the most significant gaps in the information chain and how the gaps could be closed (e.g. improved observations, more effective data flows, etc.)?

Ocean information products addressing the following societal benefit areas	Adequate	Significant gaps	Solution for closing the gaps
Ocean's environmental status (e.g. Oil spill hazard mapping)	☐ Yes ☐ No ☐ No opinion		
Scientific discovery (e.g. NW European Shelf Seas (NWS) re-analysis and forecasting)	☐ Yes ☐ No ☐ No opinion		
Real-time services (e.g. ship route hazard mapping)	☐ Yes ☐ No ☐ No opinion		
Ocean Economic activities (e.g. fish stock assessment, offshore aquaculture siting)	☐ Yes ☐ No ☐ No opinion		
Others:	☐ Yes ☐ No ☐ No opinion		

Part C - Future ocean observation activities within your country

Within this questionnaire part, we would like to ask you to describe your future activities within your country in the field of sustained ocean observing activities.

Question 8 – Future Ocean Observing Activities

Please briefly specify in the boxes below your **future ocean observation activity goals** for the next 5 years within your country.

Coordination within your country (e.g. nomination of a specific group or person (GOOS Focal Point) to take care of gathering all ocean observation activities in your country and promote stakeholder engagement as well as cooperation within the scientific community)	
EOVs assessment (e.g. establishment of a review process)	
Ocean observation activities (e.g. establishment of a review process)	
Data management (e.g. data standardization, data quality control, open access of data) (e.g. orient activities towards FAIR-principles, implementing a data quality control mechanism)	
Information product delivery (e.g. improvement of existing products, development of specific products, sustained use of products)	
Capacity building within your country and beyond (e.g. educational training, sharing of research infrastructure)	

Open access to (information) products (e.g. specific policy issues)	
Resource mobilization (e.g. monetary, technical, personnel)	

Are the information about your future ocean observing activities available to the public (e.g. implementation plan or equivalent)?

☐ Yes
Please insert the needed information to find your plan (weblink, etc.):

☐ No
Are you planning to make your plan/strategy available to the public?
☐ Yes ☐ No

Are you interested to register your future commitments to the basin at global level?
☐ Yes ☐ No

Question 9 - Other issues

If you have any other comments or suggestions please state them here:

Thank you very much for your participation!