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Comments	

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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): …
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): Countries surrounding the Atlantic Ocean
Is this deliverable a success story? If yes, why? **If not, why?**	☒ Yes, because the report shows the action taken at European level within the Euro-Argo ERIC in partnership with Argo International to sustain the fund on the long term for the Argo new missions ☐ No, because …..
Will this deliverable be used? **If yes, who will use it?** **If not, why will it not be used?**	☒ Yes, by in-situ observation data system managers, by users of in-situ Atlantic Ocean observation data, by data providers ☐ 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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1 Executive summary/ Abstract

In September 2018, a major milestone was achieved when the Argo programme delivered its two millionth profile of physical and chemical data from the world's oceans, quadrupling the number collected by ships over the previous 100 years. Across the globe, about 4,000 Argo floats continuously collect data on the physical state of the ocean. The project has been revolutionising oceanography for nearly 20 years.

First designed to acquire temperature and salinity profiles from 2000m to the surface in open ocean, it has been extended to marginal seas in the past decade and is presently extending to high latitudes, greater depth (4000 to 6000m depth) and biogeochemical parameters (Dissolved Oxygen, Chlorophyll, particulate Backscattering, Radiometry, Nutrients and pH).

The 2030 Argo design aims at maintaining a network of 4700 floats (2500 core mission, 1200 deep floats, 1000 BGC floats) with a global coverage including marginal seas and high latitudes. The foreseen density of the network is planned to have a higher spatial sampling in the marginal seas but also in the equatorial regions and western boundary currents. Euro-Argo aims at maintaining ¼ of this new Argo design. The Euro-Argo strategy for the next decade has been developed along those lines with more precise objectives in term of spatial of geographical coverages for the European seas to be able to fulfil the members countries requirements as well as European ones such as supporting the Copernicus Marine and Climate Services. The planned evolutions as well as the scientific and operational rationales are described in the document "The Euro-Argo Strategy for next decade" https://doi.org/10.13155/48526 . Presently all Euro-Argo ERIC countries are working on the implementation of this strategy that requires additional funding to be found.

The funding of the extensions of Argo in Europe will require:

- ***To enhance the reliability of the existing technology in order to increase the lifetime of the floats.***
- ***To reduce the capital and operating cost of the platform by integrating new sensors for the same variable.***
- ***To involve new countries that will contribute to the network.***
- ***To involve new communities that will contribute to the network in particular for the BGC network.***
- ***To work with the European Commission to develop additional European funding mechanism in particular in support of the Copernicus services.***

2 Introduction

2.1 Scope

This deliverable describes how Euro-Argo aims at sustaining the European contribution to Argo and extending its capacities taking into account both the overall Argo International Strategy and also the European Strategy for an Atlantic Ocean Observing System – AtlantOS by 2030.

2.2 Rationale

Europe has developed a strategy to support the implementation of AtlantOS in order to advance the utility of ocean observations to meet the following goals:

1. Support scientific research to understand the earth system, including measurements of ocean heat content, regional sea level monitoring, ocean circulation changes and climate feedbacks, as well as changes that affect ocean life, such as regional pH and oxygen levels.
2. More effectively sustain biodiversity and ecosystem health in European seas including the use of marine resources, maximization of sustainable food management, and habitat characterization.
3. Improve operational ocean and weather forecasts and prediction of climate change and their effects on European regional and coastal seas and nations including an effective mitigation of effects caused by natural hazards.
4. Support the Copernicus programme.
5. Support European Directives such as the Marine Strategy Framework Directive, Maritime policy, Water Framework Directive, Maritime Spatial Planning.
6. Support Blue Growth including improved maritime safety and efficiency, identification of renewable energy options, advanced seafloor mapping.

It is planned that, by 2030, the European component of the Atlantic Ocean Observing System will be fully coordinated and fit-for-purpose. Common strategic priorities have been set out and accompanied by national and regional implementation plans and voluntary commitments, contributing to the system's sustainability. The European component will be fully integrated in AtlantOS. To achieve this vision, Euro-Argo has prepared its strategy to sustain Argo ocean observation efforts.

3 Current Situation

International programme: Euro-Argo is part of the Argo international programme, one of the networks endorsed by JCOMM under the Observation Program Area (OPA). Since 2018 temperature, salinity, oxygen, chlorophyll, backscatter, pH, nitrate and irradiance have been endorsed by IOC The Argo network is jointly maintained by 31 countries worldwide.

European engagement: The European contribution to Argo is managed through the Euro-Argo ERIC which has been set-up in 2014 by 9 countries and presently coordinates the contributions of 12 countries (see map).

Website: https://www.euro-argo.eu/

Contact email: euroargo@ifremer.fr

Current geographic coverage for measurement: The Argo network has a global scope aiming at sampling the ocean water column from 2000m to the surface in all the oceans with a spatial resolution of 3°x3° and higher resolution in marginal seas (Figure 1). The network coverage in December 2018 is shown in Figure 2 and the European contribution in Figure 3. While the Euro-Argo ERIC aims at contributing to the global network, about 80% of the European deployments are in the Atlantic Ocean (including high latitudes) and European marginal seas.

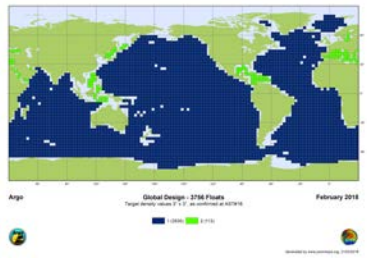

Figure 1 Current Argo Global Design for the Core mission

Figure 2 Present Argo network coverage

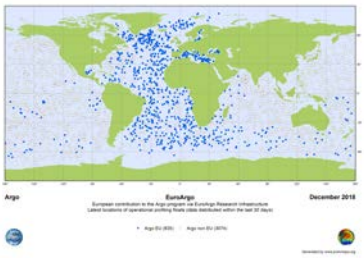

Figure 3 Euro-Argo contribution in blue

Present Argo landscape in the Atlantic Ocean (AtlantOS)	
Variables Measured	T&S (0-2000m) Deep T&S (below 2000m) BGC: O_2, Chl-a, b_{bp}, pH, NO_3, downwelling irradiance
Platform Type and #	**Operating Network** 900 operating floats including 20 deep and 30 BGC 10% of floats are equipped with O2 sensor **Deployment per year** Core 260 Deep 10 BGC: 15
Cost equipment (annual)	6 508 500 €
Cost data management (annual) 10% capital cost for Real time and Delayed mode processing	650 850€
European Share: 50% of the total cost (annual)	3 579 675 €

Present Argo landscape in the Atlantic Ocean (AtlantOS)	
Geographic Coverage (e.g., % of open ocean, focus on coastal or particular regions of interest)	Open ocean and marginal seas
Rationale (scientific questions addressed)	Explained in Euro-Argo Strategy for next decade https://doi.org/10.13155/48526
Benefits (societal benefit, SDG, etc.)	• Climate change monitoring • Operational oceanography • Ocean health monitoring • Research

The following table shows the Euro-Argo ERIC countries national contribution to the Argo network, not restricted to the Atlantic Ocean and the additional European funds that complemented the national contributions for the period (2014-2019) and are planned for 2019-2020.

European source	Amount	Capacity building **Outreach & training**	Materials **(sensors, platforms)**	Data Management	Other, please precise	Time period
Euro-Argo ERIC countries	≈5.5M€/year	X	From 200 core floats per year in 2014 to 250 (mainly core but 2% deep and 9% BGC) per year in 2018-on going	X		2014-ongoing
EMODnet MOCCA	≈4M€	X	120 Core floats (85% in the Atlantic)	X		2014-2020
H2020 AtlantOS	≈1.6M€	X	7 Deep 6 BGC	X		2015-2019
H2020 ENVRI+	≈500k€	X		X		2015-2019
H2020 Euro-Argo-RISE	≈4M€	X	17 floats (2 BGC, 3 DEEP, 12 core)	X	Testing new sensors on existing European float type	2019-2022
H2020 ENVRI-FAIR	≈1M€	X		X		2019-2022

At International level to maintain a global 3800-core float array of T&S floats (0-2000m) it is necessary to deploy more than 900 floats per year.

International source	Amount	Capacity building **Outreach & training**	Materials **(sensors, platforms)**	Data Management	Other	Time period
Argo participation countries	≈25M$ per year for the core mission	X	From 800 per year in 2014 to 900 floats per year in 2018	X	Float development is not included in these figures	On going
Projects	Deep and BGC are presently funded through R&D projects estimated to 2M€ for deep and 13M€ for BGC for this 4 year period			X for BGC	Not included : float and sensor technology development	2014-2018

4 Strategic Plan 2019-2030

The strategic development of Euro-Argo is managed with a governance mechanism that has been set up at the creation of the ERIC in 2014. The Euro-Argo European Research Infrastructure Consortium (ERIC) is composed of a Central Infrastructure (the ERIC Office) and distributed national facilities that jointly developed a strategy for the evolution of Euro-Argo for next decade.

The table below shows the Euro-Argo governance.

Decision-making process	The Euro-Argo ERIC is governed by the following bodies: • The Council is the body having ultimate decision-making authority. It is composed of one delegate per Member acting collectively. • The Management Board supervises the operation of the infrastructure and ensures that it operates and evolves in accordance with the strategic direction set by the Council, and the requirements set forth by the research and operational communities. • The Scientific and Technical Advisory Group (STAG), consisting of independent experts, is established to advise the Council on any scientific or technical matters (including data management and instrumentation) relevant to the operation, development, and evolution of the Euro-Argo ERIC • The Programme Manager is appointed by the Council, as the executive officer and legal representative of the Euro-Argo ERIC.
National commitment/ alignment with national priorities	Adherence to the Euro-Argo ERIC is done at ministerial level with an endorsement of the European Commission. The Euro-Argo Strategy and Implementation Plan is developed with the representative of the countries and take into account both the European and national requirements. Moreover, the chair of Argo international is the chair of the STAG which guaranty coherency with Argo international.
Related research infrastructure	Euro-Argo interacts with the other Marine Research Infrastructures in Europe with EUROGOOS AISBL and its regional alliances. The Euro-Argo ERIC has signed a MoU with EuroGOOS. Euro-Argo also collaborates with the European Environment Research Infrastructures within ESFRI and ENVRI community networking.

The evolution of ocean observation foreseen for Euro-Argo observing network has to be aligned with the strategic evolution of the Argo International programme as Euro-Argo is the European contribution to Argo.

The 2030 Argo design discussed at last Argo Science Workshop is summarised in the Figure 4. It aims at maintaining a network of 4700 floats (2500 core mission, 1200 deep floats, 1000 BGC floats) with a global coverage including marginal seas and high latitudes. The foreseen density of the network is planned to have a higher spatial sampling in the marginal seas but also in the equatorial regions and western boundary currents. The way the implementation of the extensions is planned is that the Deep and BGC floats will also contribute to the core mission (i.e. sampling the 0-2000m water column at least every 10 days).

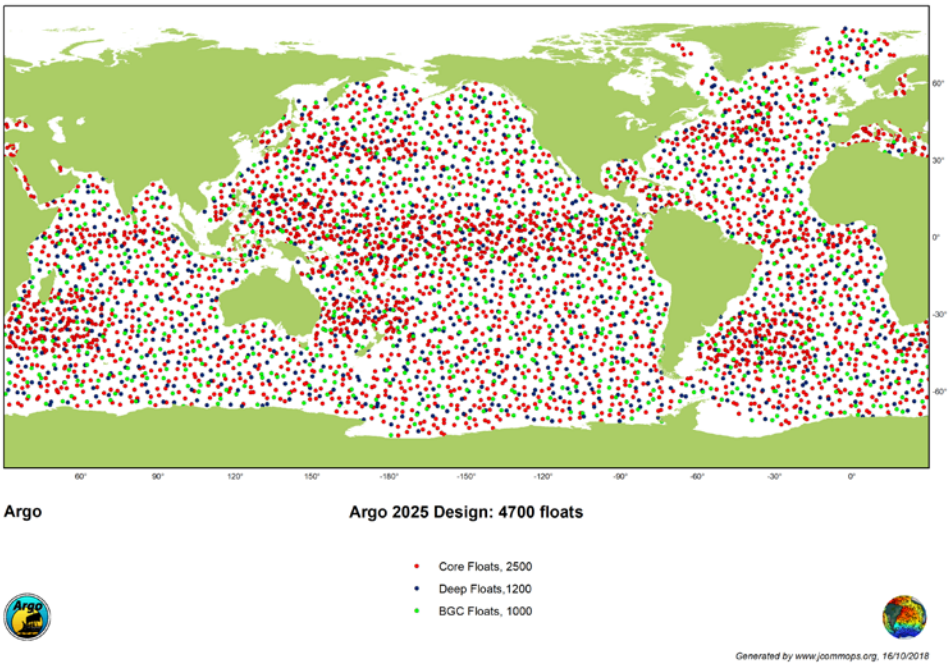

Figure 4 : Argo 2025-2030 design

Euro-Argo aims at maintaining ¼ of this new Argo design. The Euro-Argo strategy for the next decade has been developed along those lines with more precise objectives in the European seas to be able to fulfil the Members countries requirements as well as European ones such as supporting the Copernicus Marine and Climate Services.

The planned evolutions as well as the scientific and operational rationales are described in the document "The Euro-Argo Strategy for next decade" https://doi.org/10.13155/48526.

Presently all Euro-Argo ERIC countries are working on the implementation of this strategy that requires additional funding to be found.

Hereafter the improvement of the Argo network in the Atlantic has been defined in two steps. The first one considers that 10% of the Atlantic floats will go deeper than 2000m, and 10% will be full BGC floats. It also considers that 30% of the floats will be equipped with Oxygen sensors. Such improvement will require additional 1.5M€ fund. The second step that is the 2030 target considers that 25% of the floats will be deep ones and 25% full BGC, with 25% of the total network equipped with oxygen sensor. Such a target requires 3M€ in addition to the present Euro-Argo costs.

The funding of the extensions of Argo in Europe will require:

- ***To enhance the reliability of the existing technology in order to increase the lifetime of the floats***
- ***To reduce the capital and operating cost of the platform by integrating new sensors for the same variable***
- ***To involve new countries that will contribute to the network***
- ***To involve new communities that will contribute to the network in particular for the BGC network***
- ***To work with the European Commission to develop additional European funding mechanism in particular in support of the Copernicus services***

	Modest Improvement, outlook for a moderately positive funding environment,	**What is Needed** the system needed by the requirements
Variables Measured	T&S (0-2000m) Deep T&S (below 2000m) BGC: O_2, Chl-a, b_{bp}, pH, NO_3, downwelling irradiance	T&S (0-2000m) Deep T&S (below 2000m) BGC: O_2, Chl-a, b_{bp}, pH, NO_3, downwelling irradiance
Platform Type and #	**Operating Network** 900 operating floats including 100 deep and 100 BGC 20% of floats are equipped with O2 sensor **Deployment per year** Core floats 230 Deep float 35 BGC: 35	**Target Network** 900 operating floats including 225 deep and 225 BGC 25% of floats are equipped with O_2 sensor **Deployment per year** Core floats 150 Deep float 75 BGC:75
Accuracy (if this is the area for improvement)	Accuracy of the sensors below 2000m need to be assessed Stability of the BGC parameters over 5-year timeframe need to be assessed	
Cost equipment (annual)	8 667 500 €	11 964 000 €
Cost data management(annual)	866 750 €	1 196 400 €
European Share: 50% of the total cost (annual)	4 767 125 €	6 580 200 €
Geographic Coverage (e.g., % of open ocean, focus on coastal or particular regions of interest)	Open ocean and marginal seas	Open ocean and marginal seas
Benefits (societal benefit, SDG, etc.)	• Move towards better assessment of Climate change impacts over the whole water column • Move towards better constrain physical and ecosystem operational models • New fields in Research	• Better assess Climate change impacts over the whole water column • Constrain physical and ecosystem operational models • New fields in Research

The data management strategy: The Argo data management is defined and maintained by the Argo Data Management team and procedures are updated on a yearly basis. All documentation is available at http://www.argodatamgt.org/Documentation**.** All Argo data and its extensions are processed by the National Data Centres according to commonly agreed procedures and are distributed to the community through the Argo Global data centres, one of them being operated in Europe by Ifremer. Argo data policy is free and open. All data are available within 12 hours from acquisition and are archived in the Global Argo Data repository operated by NCEI/USA. The extension to BGC-Argo will require to involve new expertise in the data management teams in particular for the delayed mode processing of the new variables. The extension to Deep ocean will require to enhance the delayed mode QC procedures as the amplitude of the signal at depth is smaller.

The services that will be supported by 2030:

Operational forecasting	Argo is essential for Copernicus Marine Service both for physical and ecosystem models and close collaboration will be established with CMEMS to enhance the network to take into account their requirements
Information product	Data services and products will be enhanced to take into account new user requirements and benefit from new capabilities that will be provided by the development of Big Data technology. In Europe in particular services through the European Open Science Cloud probably in partnership with other Environment Research Infrastructures or DIAS within Copernicus will be developed.
Ocean climate observing & prediction	Sustainability of Argo is essential for the re-analysis services provided by Copernicus Climate and Marine Services. With the development of BGC extensions, it is anticipated that Argo will also play a key role for the ecosystem climate monitoring and prediction service in close link with Satellite observations

The research will be supported

Global warming and climate variability	Argo and its extension toward the deep ocean are a fundamental monitoring program for the world climate as they facilitate understanding of climate variability and change with increased certainty and more precise attribution. The Argo and deep Argo dataset will facilitate assessment of the variability and trends in ocean heat content, freshwater distribution, steric sea level rise, as well as intermediate depth and deep ocean circulation. In particular, deep Argo will reduce the uncertainties in decadal deep ocean heat uptake estimates, while providing data for a broad range of scientific investigations of deep variability such as deep circulation or water mass mixing.
Acidification	Through the progressive implementation of pH sensors on the BGC-Argo fleet the new Argo mission will progressively fill the gap in monitoring ocean acidification.
Ocean Health	Measuring in a sustained way key environmental oceanic variables (O_2, NO_3, pH, particles, phytoplankton, light) will allow developing and monitoring health indicators for the Atlantic Ocean.
Biodiversity	Combining bio-optical BGC-Argo measurements together with their ocean color satellite counterparts will allow to progressively developing a 3D/4D vision of phytoplankton functional types for the AtlantOS domain.

Deoxygenation	The generalization of highly accurate O_2 measurements onboard of BGC-Argo float will help in cost-effectively monitoring ocean deoxygenation.
Noise	Although noise measurements are not yet considered as core Argo variables, there are some pilot projects highlighting the potential in progressively such measurements (wind and rain, anthropogenic noise including maritime traffic, marine mammals).

5 List of acronyms

BGC	Biogeochemistry
CMEMS	Copernicus Marine Environment Monitoring Service
DAC	Data Assembly Centre
EMODnet	European Marine Observation and Data Network
EuroGOOS	European Global Ocean Observing System
GDAC	Global Data Assembly Centre
GOOS	Global Ocean Observing System
INS TAC	In-Situ Thematic Assembly Centre
IOC	Intergovernmental Oceanographic Commission
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
JCOMMOPS	JCOMM in-situ Observing Programmes Support Centre
NRT	Near Real Time
QC	Quality Control
ROOS	Regional Ocean Observing System