ANNUAL ACTIVITY REPORT 2015

EURO-ARGO

Research Infrastructure

Annual Activity Report 2015

CONTENTS

PREFACE

Welcome to the 2015 annual report of the Euro-Argo ERIC! In its second year of operation, the Euro-Argo ERIC organized and started to implement a substantial long-term contribution to the international Argo programme. Long-term and quality in-situ observations, by means of Argo floats, are crucial to better quantify climate change, understand and predict the role of the oceans and seas on climate, and help decision-makers to wisely act in mitigating and in adapting to climate change. Since the turn of the Century, the data provided by Argo floats have made an outstanding contribution to ocean and climate change research and to operational oceanography. The sustainability of the Argo network, and its evolution, i.e. to respond to new operational and scientific needs, are, however, important challenges. The main goal of the Euro-Argo ERIC is to address these challenges and to play a prominent and unified European role in the Argo international programme.

As you can read in this report, numerous activities have been conducted by the Euro-Argo ERIC member states in 2015. Contributions to the Argo global array have significantly progressed towards the planned target and, in addition, European partners have been active in the development of the new phase of Argo with extensions to marginal seas, the deep ocean, the Polar Regions and to biogeochemical variables, following guidelines set forth in a European long-term strategy document. Euro-Argo partners have also continued to be major actors in the Argo data processing and dissemination business. The Euro-Argo ERIC participation in projects funded by the European Commission and the hiring of personnel for its Central Research Infrastructure that is hosted by Ifremer in Brest have been instrumental for all these activities. The increased Europe-wide visibility of Argo has resulted in a significant enhancement in data use and scientific production in Europe. The Euro-Argo ERIC has been and will further remain a major in-situ observational network in support of the Copernicus Marine Environment Monitoring Service (CMEMS) and the European Marine Observations and Data Network (EMODnet).

Thanks to the continued support of the Member States and of the European Commission, the Euro-Argo ERIC has started to significantly improve the European contribution to Argo. We feel confident that this effort will further develop in the future and will strengthen European excellence in ocean and climate change research.

We hope that you will enjoy reading this annual report.

Pierre-Marie Poulain
Chair of the Euro-Argo ERIC
Management Board

Hartmut Heinrich
Vice-Chair of the Euro-Argo ERIC
Management Board

EXECUTIVE SUMMARY

This second annual report describes the main achievements of the Euro-Argo ERIC community in 2015 through four themes:

a) Main operational outcomes in 2015

In 2015, **Grigor Obolensky** joined the team of the ERIC Central Research Infrastructure (C-RI) on September 1st, 2015 as a Project scientist. Two Council meetings and three Management Board meetings were held to accompany the ERIC in its main activities of management, communication and outreach actions. It helped to decide about Euro-Argo deployments, float monitoring activities, development of a long-term roadmap for Euro-Argo, and to search for new EU projects contributions.

Grigor Obolensky

The **preparation of the floats**, shipment and deployment was still organised at national level, with coordination regarding planning and deployment opportunities managed at Euro-Argo ERIC level. During the year 2015, the deployment plans for 2015 and 2016 were reviewed.

Published in December 2015, a new document on the **"Strategy for the Evolution of Argo in Europe"** presents a strategic plan for a European initiative for the future development of this international Argo programme for the 10 coming years. The primary goals of the strategic plan are to keep the Argo "Core mission" as the global +/-60° array (T&S) but with systematic acquisition of near surface measurements of salinity and temperature, and a progressive implementation of extensions into marginal seas and high latitudes, alongside an implementation of O2 and Bio-Argo parameters both in marginal seas and global ocean in addition with a strategy for Deep-Argo.

Concerning the Argo Data Management, the main focus of the Euro-Argo RI in 2015 has been the **transition to the V3.1 new format** that allows managing all the types of floats that are deployed by the Europeans. For the Delayed-Mode (DM), Euro-Argo partners contribute with 4 DM operators (BSH, Coriolis, OGS and BODC) and the coordination of 3 Argo Regional Centres (ARCs). In 2015, the North-Atlantic ARC (NAARC) continued to ensure the coordination of float deployment in Atlantic. The Mediterranean and Black Seas ARC (Med-ARC) contributed to the deployment of 45 new floats in the Mediterranean and Black Seas. And BODC

(UK) worked to reinvigorate the activity of the Southern Ocean ARC (SOARC) covering the entire Southern Ocean, prioritising activities that can be supported with low-levels of resource alongside partners.

In March 2015, **the 5th Euro-Argo User Workshop** was held on the Ifremer premises with 80 registered participants and included 18 talks, 16 posters alongside the Euro-Argo ERIC inauguration. The three scientific sessions leaded to a high-quality review of major results obtained in last year with Argo data in Europe. The final round tables provided an opportunity for users to participate in discussions of how Argo should evolve within Europe and at global scale.

In September 2015, the first edition of a **new workshop GAIC 2015** called "Sustained Ocean Observing for the next decade" has been organized in Galway (Ireland), incorporating the 5th International Argo Science Workshop. The Euro-Argo ERIC had a booth at this Conference that allowed fruitful exchanges with the GOSHIP and IOCCP communities as well as a presentation where some collaboration on optimisation of the network, technology and sensor development, at sea activities, data management and data quality were discussed.

Figure 1: Euro-Argo ERIC Booth at GAIC Conference (© Euro-Argo ERIC)

b) Major scientific achievements in 2015

COP21 (United Nation Conference on Climate Change for the 21st Century) ended with a historical agreement to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C. This agreement was based on an unambiguous diagnostic on climate change supported by a century of ocean observations. Observing the ocean in a sustained manner is now mandatory and Argo plays an important role in this monitoring. In this context, the role of Euro-Argo in sustaining 1/4 of the Argo network is important and Euro-Argo partners have defined a strategy for the next decade and are presently working on an implementation plan.

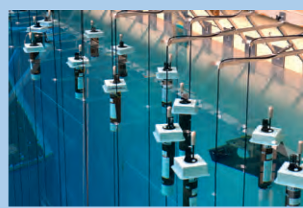
In 2015, the European ERIC scientific community has delivered significant and innovative results from Argo measurements and the Euro-Argo network. Most of the European teams working in physical oceanography perform **R&D activities with Argo and about 1/3 of Argo publications are made by EU scientists.**

Ending in year 2015, the **E-AIMS FP7 project** demonstrated that procurement, deployment and processing of new Argo floats (e.g. Bio-Argo, Deep Argo, polar seas) for Copernicus Marine Service can be organized at European level. The impact on the Copernicus Marine Service was clearly evidenced. Thanks to these comprehensive and very successful R&D activities, the Euro-Argo ERIC is now in an excellent position to agree on and start implementing the new phase of Argo that will be highly beneficial to the Copernicus Marine Service (CMEMS).

Innovative scientific results have been obtained thanks to **Bio-Argo floats**. For example, Czeschel et al., 2015 demonstrated that new profiling floats with oxygen sensors deployed in OMZs (Oxygen Minimum Zone) and eddies in the tropical oceans areas allow observing long-term trends and mean circulation as also registering the water mass and oxygen changes of an eddy when trapped in one. Sauzède et al., 2015 make use of the global Bio-Argo network to build global and regional 4D views of Chlorophyll (Chl), phytoplankton community size indices and particulate backscattering (bbp) which represent a new way to assess seasonal and inter-annual variability in the vertical distribution of phytoplankton biomass and community composition at a global scale.

2015 has been also a ramp-up year for the EURO-Argo ERIC team in terms of **participation to European projects:**

In 2015, the Euro-Argo ERIC made a proposal to DG-MARE called MOCCA (Monitoring the Ocean Climate Change with Argo) for the procurement and deployment of 150 floats, and the processing of collected data as a contribution towards the European effort under the international Argo programme. The floats will be delivered to the ERIC in 2016 and deployed in 2016-2017.



The **AtlantOS** (Atlantic Ocean Observing System) proposal (H2020 project 2015-2019), integrating the Euro-Argo ERIC contribution for the progressive extension of the Argo core mission towards the deep ocean and biogeochemistry, and the development of long-term plans, was accepted in December 2015.

A first **ENVRI+** meeting (ENVIronmental Research Insfrastructure) has been attended by the Euro-Argo ERIC staff in fall 2015. Some collaboration within the data management tasks have already been initiated, due to the known expertise of Euro-Argo partners concerning the Marine domain data. The Euro-Argo ERIC is about to open a fixed research engineer position to fulfil the important goals of this transverse project.

c) Financial Status

The Euro-Argo ERIC 2015 budget was presented during the 2nd Council Meeting. As Bulgaria and Spain were not able to contribute as candidate members, the income was 240 k€ (7x30 k€ + 3x 10k€). The expenditures were mainly related to personnel costs and services to set up and run the ERIC and for travel related to the User Workshop, project meetings, Council and Management Board meetings.

In 2015, Grigor Obolensky joined the team but the secondment procedure was a bit longer than planned and therefore the personal cost was lower than planned. It was agreed by the Council in November that the surplus from 2015 will be carried forward to 2016 and provide funds to run the ERIC during early 2016 as the members fees will be received in March-April 2016. This surplus will also provide the ERIC with enough cash to cover the MOCCA and AtlantOS floats purchases for which the EC pre-funding does not cover the complete float purchase cost.

d) Key Performance Indicators

The novel and enhanced role of the EU in the international Argo programme, and the enhanced Europe-wide visibility of the research will be monitored each year through KPIs (Key Performance Indicators) in three areas:

- *Regarding floats:* their procurement, deployment and coordination of operational activities;
- *Regarding users:* the access to data, the use of Argo data by European Operational users and the impact of Argo observations for the Copernicus Marine Service;
- *Regarding the financial sustainability* of the Euro-Argo RI and collaboration with the EU for additional sustained funding.

Those KPIs elaborated for the year 2015 clearly show three major performances:

- The European Argo array progressively approaches its objective of ¼ of the total Argo network;
- The data access and their use by operational European users and the scientific community are growing;
- The European scientific community thanks to Argo measurements is making significant scientific achievements; the European contribution is 28% of the total Argo bibliography.

Those KPIs will be updated each year to monitor the performance of Euro-Argo ERIC activities.

1 Main operational outcomes

1.1 What is the value-added of Euro-Argo research infrastructure

Argo is a global ocean observing system based on a network of more than 3,500 profiling floats which measure temperature and salinity throughout the deep global oceans, down to 2,000 metres and deliver data both in real time for operational users and after careful scientific quality control for climate change research and monitoring. Argo success could be achieved only through a very high degree of international cooperation. In this context, Euro-Argo is the European contribution to the international Argo float array. Each year, around 800 new floats must be deployed globally to maintain the Argo array in the coming decades. Euro-Argo develops and progressively consolidates the European component of the global network. Specific European interests also require increased sampling in some regional seas (e.g. Nordic Seas, Mediterranean Sea, Black Sea). Overall, the Euro-Argo infrastructure should comprise around 800 floats in operation at any given time. The maintenance of such an array would require Europe to deploy about 250 floats per year.

Euro-Argo ERIC is strengthening European excellence and expertise in ocean and climate research and will be an essential component Copernicus Marine Service.

Euro-Argo ERIC is, in particular, necessary:

- for ocean and climate monitoring and research,
- to strengthen and structure the European Research Area,
- to reduce fragmentation of efforts,
- to guarantee an effective access,
- to contribute to mobility of knowledge and/or researchers,
- to disseminate and optimise the results,
- to open new areas in technology.

The specific benefits from building a European infrastructure for Argo include:

- Greater efficiency in float procurement as the smaller countries are able to rely on Euro-Argo for specifying and procuring their floats and potentially benefit from price reductions associated with larger orders.
- A central capability for float testing and preparation (e.g. mission programming, installation of lithium batteries) and storage, which will mean that new participants do not have to invest in technical staff or storage facilities.
- Stronger European coordination of float deployments ensures that certain areas are not overpopulated at the expense of others of the global array. This is critical to Argo and important for the credibility of Europe.
- Strengthened European Argo data processing centres so that they are (i) able to process all European floats and ensure the data are delivered to users, and (ii) ensure that Europe

is able to fulfil its data processing commitments to the global programme.
- Delivery of a stronger and more coherent European contribution to float technology development and preparation of the new phase of Argo, with particular emphasis on European needs (e.g. sampling under ice, bio-geochemical sensors, deep floats).
- Close collaboration with the European Argo Users' Group in order to ensure that users' needs are articulated and that the best scientific and technical advice continues to feed into Euro-Argo.
- Outreach activities (website, brochures, educational materials etc.) needed to explain to schoolchildren and the general public the importance of observations from the Argo network.
- Leading role in extending float coverage into the Nordic Seas and Arctic Ocean which have a significant impact on the Atlantic circulation and climate change impacting Western Europe.

A stronger European contribution to Argo will also be a major contribution towards sustaining the global float array, which has been shown to be an essential core element of our ability to run predictive climate models (e.g. on seasonal to decadal timescales) and to run operational models (e.g. for the Copernicus Marine Service) for ocean analysis and prediction.

1.2 Euro-Argo ERIC Team

In 2015, the ERIC Central Research Infrastructure (C-RI) is composed of three persons funded by the ERIC: a Programme Manager, a Project Assistant and a Project Scientist who joined the team on September 1st, 2015.

Figure 2: Euro-Argo ERIC Project Office with G. Obolensky (Project Scientist), F. Loubrieu (Project Assistant) and S. Pouliquen (Programme Manager) (© Euro-Argo ERIC)

1.3 Management of the Euro-Argo ERIC

The Euro-Argo ERIC and its governance bodies were set up in 2014, with the creation of:

- **The Council,** composed of one delegate per member, defines the broad strategic direction of the ERIC and its evolution.
- **The Management Board** supervises the operation of Euro-Argo ERIC 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 Central Research Infrastructure (C-RI) is responsible for the implementation** of the decisions and programmes adopted by the Management Board.

In addition, acting as a consultative body composed of independent experts, **the Scientific and Technical Advisory Group** (STAG) provides feedback to the Council on scientific or technical matters, including data management and instrumentation, relevant to the operation, development, evolution of the Euro-Argo ERIC and access to its data by research and operational users.

In 2015, main activities of the ERIC were focused on:

- Setting up and managing of the Euro-Argo ERIC,
- Enhancing communication and outreach (including scientific community),
- Coordinating Euro-Argo float deployment and float monitoring activities,
- Developing a long-term roadmap for Euro-Argo, including implementation issues,
- Organizing the work of the ERIC for new EU projects: MOCCA, AtlantOS and ENVRI+,
- Continuing seeking for additional funding with EC.

In 2015, two Council meetings were organized:

- *The first on the 29th April 2015 in Brest (France)* was dedicated to the approval of the 2014 financial and annual reports, to the evolution of the Euro-Argo staff for 2015-2019, to the preparation of Euro-Argo contribution to EU proposals and to the preparation of a strategy for the evolution of Argo for the next decade.
- *The second was in Paris (France) on 19th November 2015* and dedicated to a presentation of a draft annual activity and financial report for 2015 and the approval of the 2016 work plan and proposed budget. It included information on the accepted European projects and their progress, the presentation of a consolidated multi-year budget and cash flow plan for the Euro-Argo ERIC activities including EU projects and authorisation to open a long term position for an instrumental engineer and a fix term position for a research engineer on project funding.

In 2015, three Management Board meetings were held:

- *The first one was in Brest (France) on 16th March 2015* and dedicated to the review of 2015 activities, the preparation of the DG-MARE MOCCA proposal (see § 2.2) and the way forward to progress on the strategy document on the evolution of Argo in Europe.

Figure 3: Euro-Argo ERIC Management Board members in Utrecht (Netherlands).

- *The second one was in Hamburg (Germany) on the 24th - 25th June 2015* and dedicated to the review of 2015 activities, the finalization of the strategy document and the consolidation of the deployment plans for 2015-2017.

- *The 3rd one was in Utrecht (Netherlands) on the 13th - 14th October 2015.* It was dedicated to the MOCCA project activities and in particular the call for tenders for European float purchase, the preparation of the 2016 work plan and proposed budget and the implementation plan elaboration methodology.

1.4 Float procurement and deployment: status and plans

Autonomous profiling floats are the basic technology on which the Argo observing array is based. They represent one of the major costs of the infrastructure. Float procurement is mainly done at national level, although European Commission funded few floats through the FP7 E-AIMS project. In 2015-2016, more floats will be procured through European funding within the H2020 AtlantOS and the DG-MARE MOCCA projects.

Float deployments require adequate logistical support and easy access to information on research cruises for deployment opportunities. The Euro-Argo RI aims at coordinating operations at sea and their associated logistics. Floats can be deployed during research cruises or from other ships of opportunity, which must be identified. This requires regular contacts with ship operators, operations planning and training of personnel in charge of field work. A concerted international plan must be agreed upon. Float deployments also have to be notified through the Argo Information Centre (AIC) up to 6 months prior to deployment to meet the requirements of IOC Resolution XX-6. The Euro-Argo ERIC together with the Management Board facilitates such activities between the European partners and with the international programme.

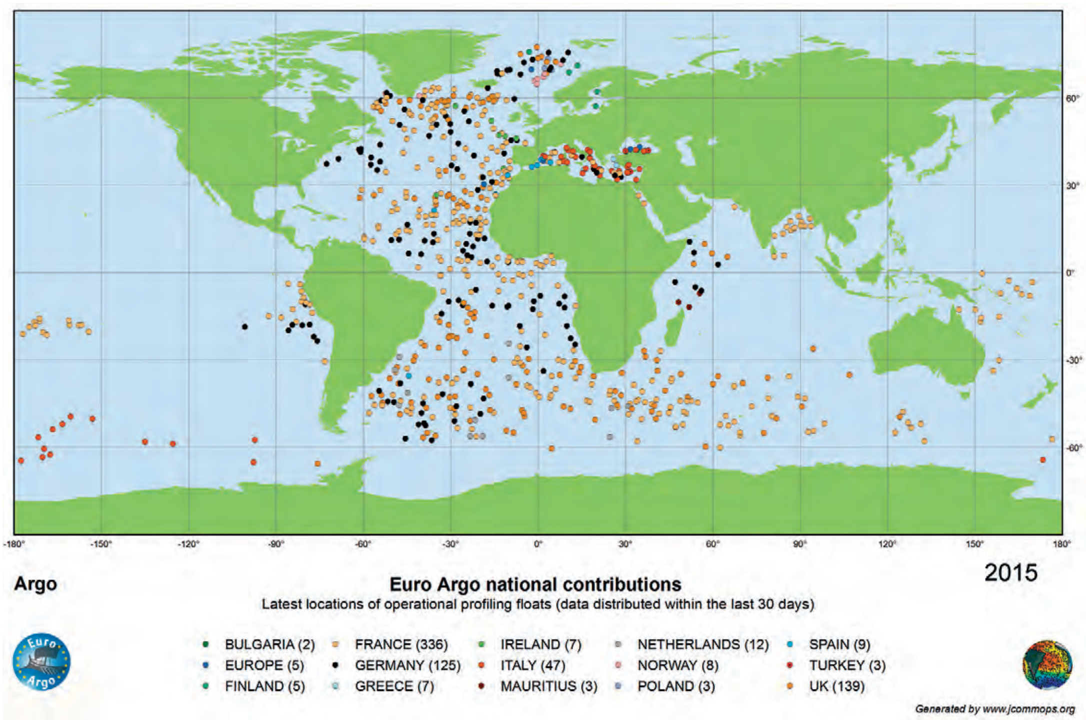


Figure 4: Euro-Argo national contributions per country (©JCOMMOPS/AIC). In 2015, Mauritius and Turkey contributions are deployment of float donated by Euro-Argo partners.

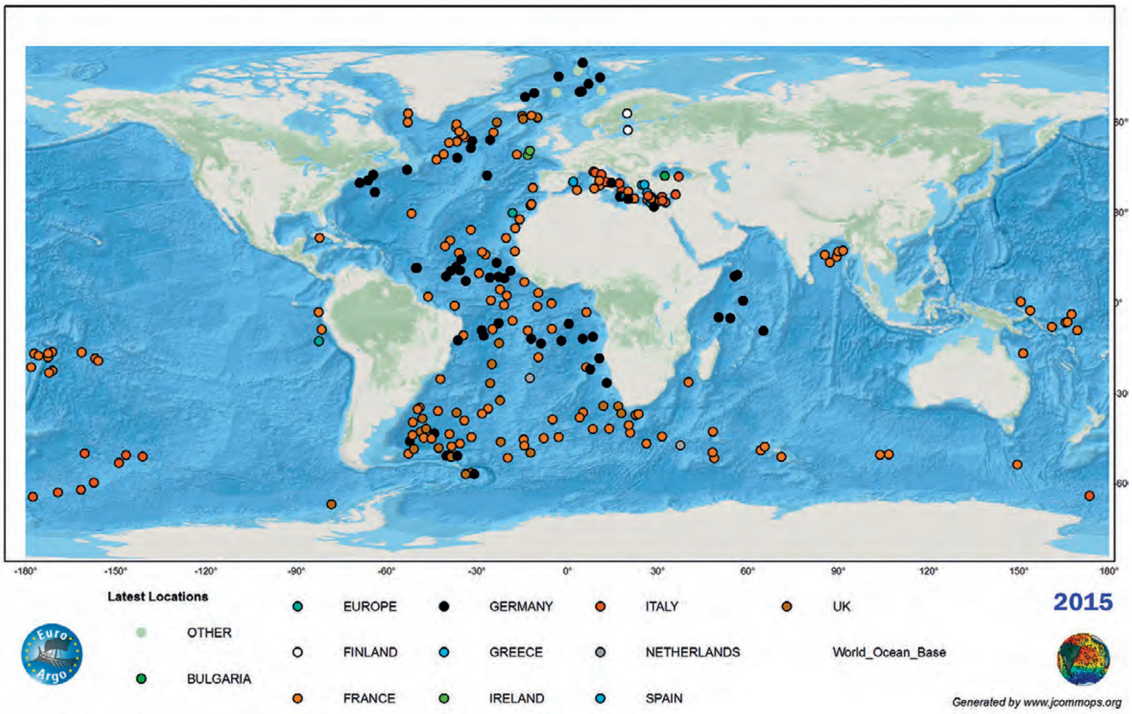


Figure 5: Euro-Argo partners' 2015 deployment (©JCOMMOPS/AIC).

	2013 deployed	2013 Argo extension	2014 deployed	2014 Argo extension	2015 deployed	2015 Argo extension	2016 estimated	2016 Argo extension	2017 estimated	2017 Argo extension	2018-2020 plans (per year)
European Union	2	2		7	2		60	7	70	6	80
Bulgaria		1	0	0		1					
Finland		4		5		2		3		3	3
France	65	16	87	10	101	20	65	15	65	15	80
Germany	31	7	58	15	66		50	6	50	25	40
Greece		2				5		5		5	5
Ireland	1		2		2		3		3		3
Italy		12		21		26	15	20	15	20	35
Netherlands	4		4		2		14		7		7
Norway	2	1	2	4	3		3		3		3
Poland					3		3		3		3
Spain	1		1		1		3	1	3		3
UK	34	2	48	2	32		25	23	34	6	40
Total	140	47	202	64	212	54	241	80	253	80	
		187		266		266		321		333	302

Table 1: Float procurement for 2013-2015 and plans for 2016-2018.

In 2015, the preparation of the floats, shipment and deployment was still organised at national level, with coordination regarding planning and deployment opportunities managed at Euro-Argo ERIC level. During the year 2015, the deployment plans for 2015 and 2016 were reviewed.

1.5 Development of an Euro-Argo Strategy for the next decade

A document on the "Strategy for the Evolution of Argo in Europe" published in December 2015 presents a strategic plan for a European initiative for future development of this international programme aiming for:

- **Strengthening** Europe's role in and contribution to the global Argo Programme,
- **Supporting** the implementation of the EU Marine Policy through the development and subsequent incorporation of biogeochemical sensors into the programme,
- **Extending** spatially the observations into the European and Polar Seas, as well as into the abyssal parts of the oceans,
- **Further developing** the existing data management system,
- **Maximising** the relevant knowledge of the Seas and Oceans, e.g. their role in a changing climate.

Argo is now the major and only systematic source of quality-controlled oceanic data. However, there is an essential need for more data, especially for Polar Regions and the abyssal ocean. Together with satellite observations, Argo provides critical observations of the ocean that are required to constrain the Copernicus Marine Environment Monitoring Service (CMEMS) modelling and forecasting systems.

Euro-Argo needs to meet requirements from the research and operational (Copernicus) oceanography community in Europe with a focus on European Seas. This requires adaption of the "Core Argo" design to these needs and evolutions in array design float technology and data systems.

In the Euro-Argo Strategy document, the following upgrades of the Argo programme have been identified:

- Monitoring of marginal seas: Mediterranean, Baltic and Black Seas,
- Monitoring of high latitudes: Nordic and Arctic Seas, Southern Ocean,
- Monitoring of the near surface oceans,
- Monitoring of the abyssal oceans,
- Monitoring of ecosystem parameters.

Figure 6: Argo float deployment

With the following implementation, **guidelines have been defined:**

- Keep the Argo "Core mission" as the global +/-60° array (T&S) with systematic acquisition of near surface measurements of pressure and temperature,
- Implement an "extended mission" for marginal seas and high latitudes,
- Define a strategy for O2 and Bio Argo "extended mission" implementation, both in marginal seas and global ocean,
- Define a strategy for Deep-Argo.

This plan is built assuming that Euro-Argo will continue to maintain ¼ of the global Argo network including the deep and Bio extensions, which means maintaining a fleet of 1000 active floats and deploying 350 floats per year including 50 deep Argo and 50 Bio-Argo.

1.6 Data Processing

1.6.1 Argo Data Management

The Euro-Argo RI plays an active role in Argo data management, through 3 elements:

- **One Global Data Assembly Centre (GDAC),** Coriolis in France, proposing services to the operational and research communities.
- **Two Data Processing Centres (DACs)** in Europe: The French DAC (Coriolis) processes float data deployed by France and other European (Germany, Spain, Netherlands, Norway, Italy, Finland, Greece and Bulgaria) countries. The UK DAC (BODC) processes all UK, Irish and Mauritian float data.
- For the Delayed-Mode, Euro-Argo partners contribute with **4 DM operators** (BSH, Coriolis, OGS and BODC) and the coordination of **3 Argo Regional Centres (ARCs)**: the Atlantic ARC (NA-ARC), the Mediterranean and Black Seas ARC (Med-ARC) and the Southern Ocean ARC (SO-ARC).

Thanks to the Euro-Argo RI, the European Argo data system is strengthened to ensure it is able to process all European floats and deliver the data to users, and ensure that Europe is able to fulfil its data processing commitments to the global Argo programme (Coriolis GDAC, North-Atlantic ARC, Mediterranean and Southern Ocean ARCs).

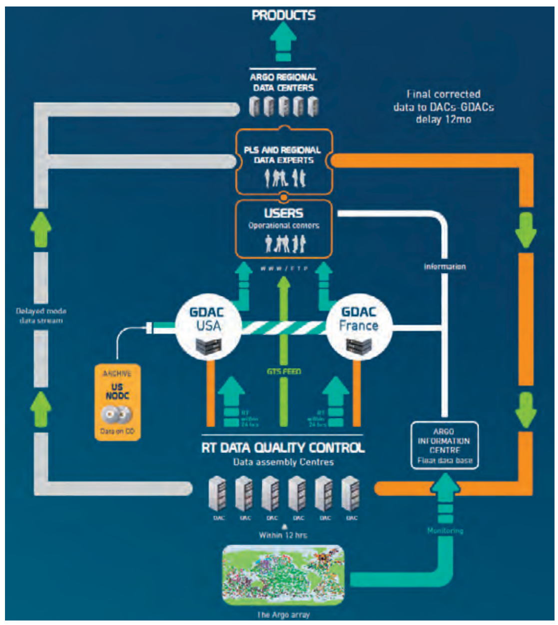


Figure 7: Argo Data Flow through the Argo Data System (© Euro-Argo)

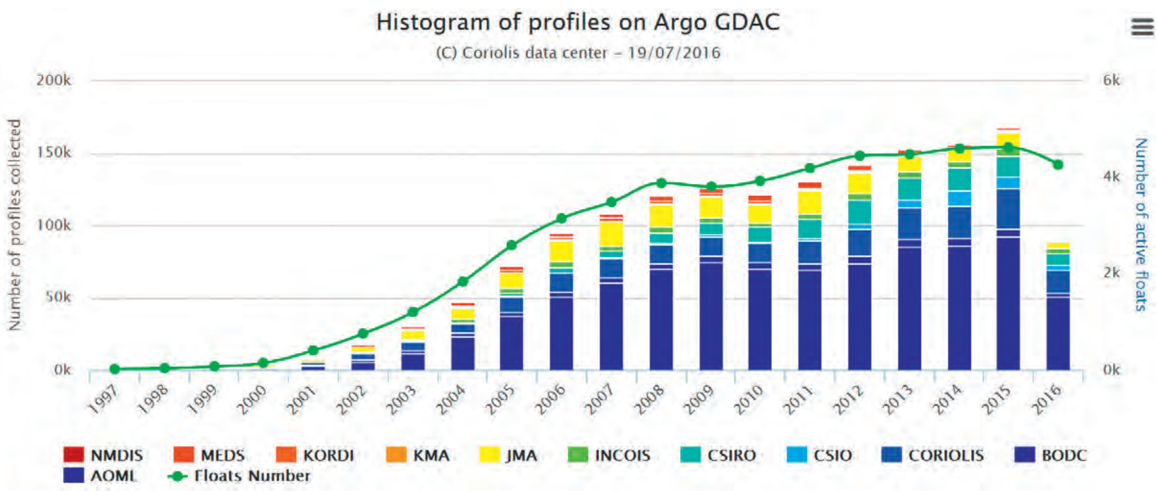


Figure 8: Histogram of profiles on Argo GDAC. Colors indicate the contribution of each National Data Centre (© Coriolis Data Centre)

In 2015, the main focus has been the transition to the V3.1 new data format that allows managing all the types of floats that are deployed by the European partners:

- **Floats with Iridium transmission** that allows changing mission configuration from shore after deployment,
- **Floats that acquire near surface measurements** useful for satellite calibration/validation activities. These data have a lower quality than the deeper ones and have to be stored in different profiles,
- **Floats that acquire new bio-geochemical parameters** that require the creation of specific additional profile files to store all the intermediate measurements acquired by these sensors.

To perform such transition both DACs have re-designed their Argo decoding chains. Such activity was mandatory to be able to upgrade the Argo Data System for the next decade and set up a reliable system. In 2015, both DACs have been turning the new system into operation and have started, early 2016, processing and distributing the Argo data in this new format.

1.6.2 Regional Centres

1.6.2.1 The Atlantic ARC (NA-ARC)

France has taken the lead in establishing the NA-ARC, which is a collaborative effort between Germany (IFM-HH, BSH), Spain (IEO), Netherlands (KNMI), UK (NOCS, UKHO), Ireland (IMR), Norway (IMR), Canada (DFO), and USA (AOML). France coordinates the North-Atlantic ARC activities, in particular the float deployment in the Atlantic.

The NA-ARC website *(http://www.ifremer.fr/lpo/naarc/)* provides information about format that allows float data and status in the North-Atlantic Ocean. NA-ARC also provides a web API to access to metadata about Argo profiles in the North Atlantic region *(http://api.ifremer.fr/naarc/v1)*. 627 floats have been processed in delayed-mode (DM) in the North Atlantic, north of 30°N. Among the 627 floats, 24 floats show

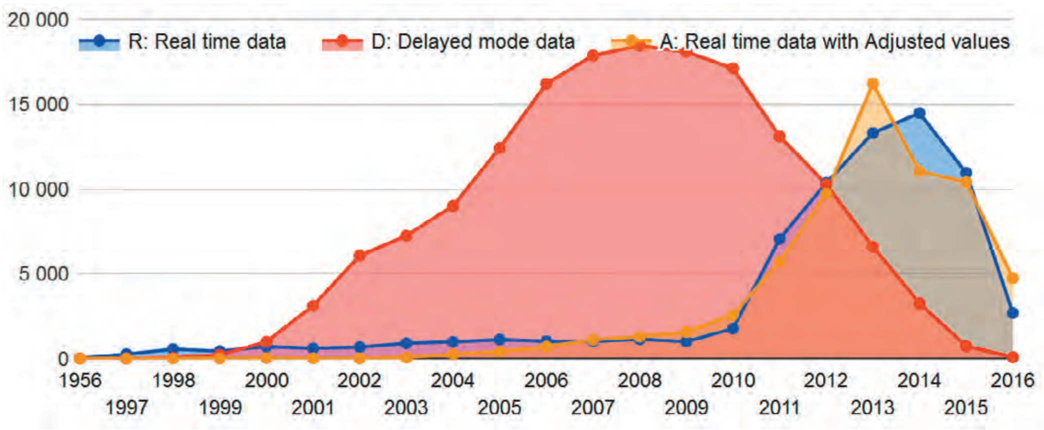


Figure 9: Evolution of the Data-Mode of Argo floats in the North-Atlantic (north 20°S) (©Argo-NAARC, 2016/3/23)

a significant salinity drift or bias and have been corrected according to the PI decision. Modification of the OW method has been proposed to account for the large interannual to decadal variability of the large-scale salinity field observed in the North Atlantic. A scientific article reporting the modified OW method is under revision in Deep-Sea Research Part I ("Improvement of bias detection in Argo float conductivity sensors and its application in the North Atlantic" by C. Cabanes, V. Thierry, C. Lagadec, 2016).

The modified OW method was used to check the consistency of the Argo salinity dataset available in delayed mode in the North-Atlantic Ocean. It was found that salinity corrections need to be reconsidered for 4.5% of the floats. Most of these were deployed in the early period of the Argo programme. This reflects the good overall quality of the Argo database and highlights the progress made by the Argo community for the delayed-mode adjustment of salinity since the beginning of the Argo programme. Consistency checks remain necessary to ensure the overall quality of the Argo dataset. It is planned to perform such checks annually on the North-Atlantic Argo fleet. Statuses of those checks are available online: *http://www.argodatamgt.org/Argo-regional-Centers/North-Atlantic-ARC/Overall-consistency-of-DM-corrections.*

1.6.2.2 The Mediterranean and Black Seas ARC (Med-ARC)

MedArgo is the Argo Regional Centre for the Mediterranean and the Black Seas. OGS Italy, who coordinates the MedArgo activities, established several collaborations with European and non-European countries (Algeria, Bulgaria, France, Spain, Greece, Germany, Turkey, Malta, Romania, Israel and Lebanon) in order to set the planning and the deployment coordination of floats. Future collaborations will be extended also to Tunisia in 2016 for operations in the Sicily Channel.

In 2015, MedArgo has started to collaborate with the International Seakeepers Society *(www.seakeepers.org)* to deploy floats from yachts of opportunity. Floats were successfully deployed south of Barcelona and in the Levantine Sea in fall 2015 by a super yacht transiting between Barcelona and Miami and by a sailing yacht navigating in the Mediterranean Sea.

Thanks to the above-mentioned co-operations, 45 new floats have been deployed in the Mediterranean and Black Sea during 2015 (see table 2). The float data are transferred in near real time to MedArgo and Coriolis GDAC where they are processed and made freely available.

As of March 2016, there were 72 active floats in the Mediterranean Sea and 10 in the Black Sea, including several floats equipped with biogeochemical sensors. It is expected that more than 30 floats will be deployed in 2016 with the contributions of several countries.

1.6.2.3 The Southern Ocean ARC (SOARC)

BODC (UK) is working to reinvigorate the activity of the Southern Ocean Argo Regional Centre (SOARC) covering the entire Southern Ocean. The recent work has focused on assessing the most beneficial ways to develop the activities of SOARC.

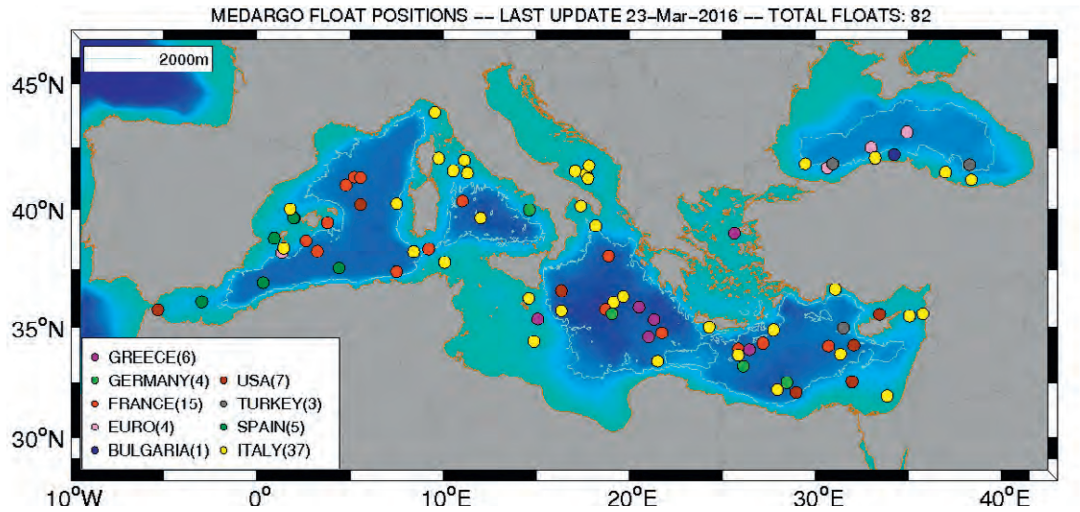


Figure 10: Positions of 82 active Argo floats in the Mediterranean and the Black Seas (© MedArgo, 03/23/2016)

Country	Number of floats	Model of floats
FRANCE	11	9 Provor-bio, 2 Arvor
ITALY	16	4 Arvor, 4 Provor-bio, 5 Apex, 2 NOVA, 1 DOVA
SPAIN	2	Apex
EURO-Argo RI	2	1 Arvor A3, 1 Provor-DO
USA	4	Apex
GERMANY	5	2 Arvor, 3 Apex
GREECE	5	2 NOVA, 2 DOVA, 1 Provor-DO
TOTAL	45	

Table 2: 2015 float deployments in the Mediterranean and Black Sea

This has resulted in four strands of development being identified, which can be supported with low-levels of resource:

- Improving discoverability of existing resources of use to delayed-mode operators. This can be achieved by enhancing access to data discover tools, links to other elements of the ocean observing system, links to plotted hydrographic observations and access to model outputs (e.g. UK MetOffice FOAM model). Matt Donnelly (BODC, UK) is now compiling a list of resources and seeking to arrange mutual links with relevant projects.
- Progressing with under-ice positioning techniques: SOARC (Birgit Klein, BSH) has begun investigating the potential for improving near-real time estimates of under ice positions. Alongside the NRT improvements, integration of improved positions into the delayed-mode workflow for the Weddell Sea enabled by the RAFOS array maintained by AWI (Germany) is being investigated. This activity is in support of the SOOS (Southern Ocean Observing System) under ice strategy and underpins any future extensions to under ice RAFOS positioning.
- Identifying additional SOARC partners and establishing an independent SOARC website. The current SOARC web presence is located on the UK Argo website *(http://www.ukargo.net/southern_ocean_argo_regional_centre)*, which only identifies UK and Australian contributions to the Southern Ocean, while there are other Argo contributors with interests, capabilities and activities in the Southern Ocean. SOARC is therefore welcoming expressions of interest for other potential collaborators in Argo Southern Ocean activities.
- The previous three strands will be assisted by the planned creation of the new SOARC website by BODC (UK), which will make use of existing content of the UK Argo website but establish a distinct SOARC identity. This will provide the portal for Southern Ocean float discovery, access to resources relevant to the community and help support improved collaboration in the Southern Ocean including Argo under ice.

Figure 11: Float launched into Arctic waters (© Argo UK)

1.7 User Workshop and GAIC 2015

1.7.1 Euro-Argo User Workshop 2015

About one hundred scientists met at Centre Ifremer Bretagne from 16th to 20th March 2015 for an "Argo week". The week started on March 16th with the 5th Euro-Argo User Workshop followed by the 16th Argo steering team meeting that meets once a year and coordinates the Argo activities and defines the objectives for the future.
The 5th Euro-Argo User Workshop included

18 talks, 16 posters and had 80 registered participants. There was also a Euro-Argo ERIC inauguration cocktail on Monday evening at Ifremer (120 persons invited).

The workshop included:

- **An opening session**, with reviews of:
  - Achievements and future challenges after a decade of global Argo.
  - Updates of Euro-Argo ERIC and the long-term European contribution to Argo.
- **Three Scientific Sessions:**
  - Ocean Circulation and water masses.
  - Bio-Argo.
  - Marginal Seas and high latitudes.
- **A final session** with a round table discussion on 4 following topics:
  - Implementation of Argo in European marginal Seas.
  - Thoughts about a Deep-Argo strategy.
  - Bio Argo.
  - What are the requirements on Argo Data System enhancements?

Figure 11: Poster Session during the Euro-Argo User Workshop (© Euro-Argo ERIC)

The User workshop brought together the users of Argo data and other complementary observations, for operational oceanography and studies of the circulation and physical and biogeochemical properties of the oceans. The three scientific sessions led to a high-quality review of major results obtained in last year with Argo data in Europe.

The round tables provided an opportunity for users to participate in discussions of how Argo should evolve within Europe and globally. The conclusions of the workshop were two folds. First one was the importance of sustaining the existing mission as Argo now provides a key dataset for global change studies, ocean research and operational forecasting, delivering more than 120,000 temperature/salinity profiles every year. The second one was that the coming decade will see Argo extended into the deep ocean, marginal and coastal seas, and seasonal ice zones, and including new biogeochemical sensors. An active European contribution is expected to help in evolving its new design to be scientifically rigorous, realistic (robust technology) and multi-application (value for investing nations).

1.7.2 GAIC 2015

The first edition of a new workshop GAIC 2015 called "Sustained Ocean Observing for the next decade" has been organized in Galway (Ireland) on Sept. 14-18 2015, incorporating the 5th International Argo Science Workshop.

Figure 13: About 100 Scientists at the 5th Euro-Argo User Workshop in Brest, France (© Euro-Argo ERIC)

GAIC 2015 was a combined GO-SHIP/Argo/IOCCP conference on physical and biogeochemical measurements of the water column. The three sponsoring programs (GO-SHIP/Argo/IOCPP) for this conference promote and coordinate sustained observations of the water column to reveal the changing physics, chemistry and biology of the ocean:

- Argo began with a focus on physical properties of the upper 2,000 metres of the ocean and is extending to abyssal and green Ocean,
- GO-SHIP covers the full water column, with repeat physical and biogeochemical measurements from research ships,
- The focus of IOCCP is on coordination of ocean carbon and marine biogeochemistry observations, including data from research ships and other platforms.

Each programme has established maturity in its own field. Studies combining data from these programs are addressing new research questions and adding value to the individual programs. New technology means there is growing overlap in the research questions that each programme can now address. It also presents challenges for how to implement and utilise new technology.

This conference brought together these programs that make sustained observations of the water column on global scales, showcasing the individual programs as well as the synergies among them. An additional focus of the conference was the future opportunities presented by these programs: in particular the technological development of Argo into the realms of Deep and Bio-Argo.

The Euro-Argo ERIC had a booth at the conference that allowed fruitful exchanges with the GO-SHIP and IOCCP communities as well as a presentation where some collaboration on optimisation of the network, technology and sensor development, at sea activities, data management and data quality were discussed.

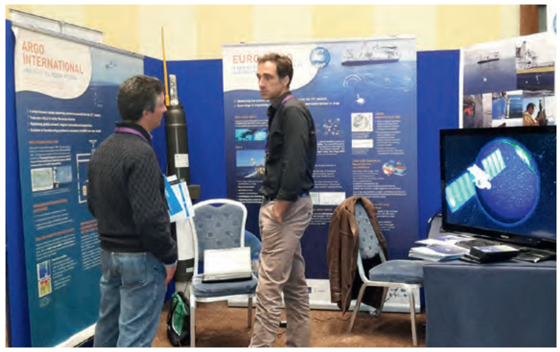
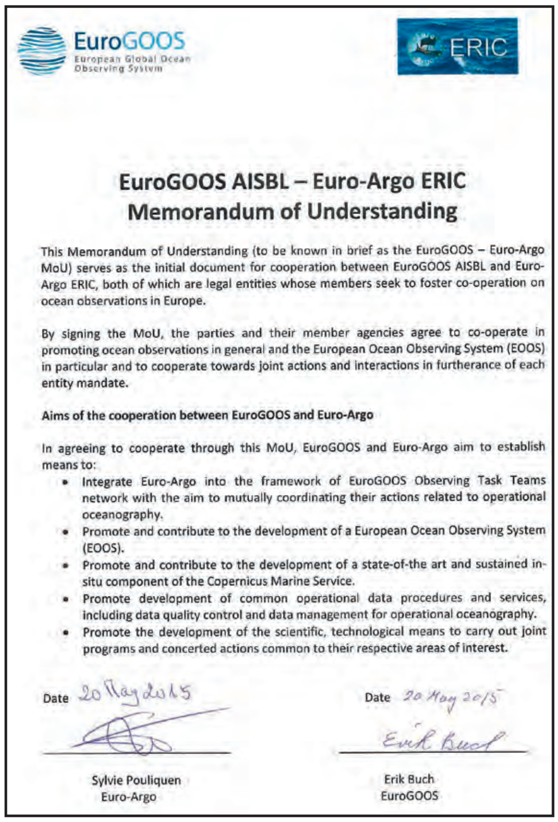


Figure 14:
Euro-Argo ERIC booth at GAIC in Galway, Sept. 2015.

1.8 Euro-Argo and other European Marine Research Infrastructures

The international ocean observing community has recognized a need for integration and coordination of interdisciplinary ocean observations. Furthermore, studies demonstrate that the economic benefit of the integration of the ocean observing efforts, with the necessary data analysis and product distribution, implemented at the global, ocean basin, and regional scales). Euro-Argo is part of this integrated observing system and need to coordinate with the other Research Infrastructures.

Therefore at the EuroGOOS annual meeting the Memorandum of Understanding was signed between EuroGOOS and Euro-Argo ERIC. By signing the MoU, EuroGOOS and Euro-Argo agree to co-operate in promoting ocean observations in general and the European Ocean Observing System (EOOS) in particular and to cooperate towards joint actions and interactions in furtherance of each entity mandate.



EuroGOOS
European Global Ocean Observing System

ERIC

EuroGOOS AISBL – Euro-Argo ERIC
Memorandum of Understanding

This Memorandum of Understanding (to be known in brief as the EuroGOOS – Euro-Argo MoU) serves as the initial document for cooperation between EuroGOOS AISBL and Euro-Argo ERIC, both of which are legal entities whose members seek to foster co-operation on ocean observations in Europe.

By signing the MoU, the parties and their member agencies agree to co-operate in promoting ocean observations in general and the European Ocean Observing System (EOOS) in particular and to cooperate towards joint actions and interactions in furtherance of each entity mandate.

Aims of the cooperation between EuroGOOS and Euro-Argo

In agreeing to cooperate through this MoU, EuroGOOS and Euro-Argo aim to establish means to:

- Integrate Euro-Argo into the framework of EuroGOOS Observing Task Teams network with the aim to mutually coordinating their actions related to operational oceanography.
- Promote and contribute to the development of a European Ocean Observing System (EOOS).
- Promote and contribute to the development of a state-of-the art and sustained in-situ component of the Copernicus Marine Service.
- Promote development of common operational data procedures and services, including data quality control and data management for operational oceanography.
- Promote the development of the scientific, technological means to carry out joint programs and concerted actions common to their respective areas of interest.

Date 20 May 2015 | Date 20 May 2015

Sylvie Pouliquen
Euro-Argo

Erik Buch
EuroGOOS

2 PROJECTS WHERE EURO-ARGO IS INVOLVED IN 2015

2.1 E-AIMS recommendations

Today, two main challenges are facing to Argo and Euro-Argo community:

- to maintain the global array and ensure its long-term sustainability,
- to prepare the evolution of the operational network for the next decade, that means an extension of the network towards biogeochemistry, the deep ocean, the polar areas and the marginal seas.

In this context, the E-AIMS project organized during three years (2013-2015) an end-to-end evaluation of several new Argo floats (oxygen sensors, bio-geochemical floats, deep and Arctic floats). European Argo data centres were, in parallel, adapted so that they can handle them. Observing System Evaluations and Simulation Experiments were conducted to provide robust recommendations for the next phase of Argo and quantify the impact on CMEMS (Copernicus Marine Environment Monitoring Serivce). A real time demonstration of the utility of these new floats for the CMEMS was finally successfully carried out.

Ending in year 2015, the E-AIMS project thus demonstrated that procurement, deployment and processing of these new floats for Copernicus can be organized at European level. The maturity/feasibility of new float technology (Oxygen, Bio-Argo, Deep Argo and Arctic), instruments/sensors, data processing, data quality control, use/uptake by CMEMS) as demonstrated and the impact on the CMEMS was clearly evidenced.

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Main recommendations from E-AIMS project are:

- To maintain at least the present density of global Argo, with possibly an improved coverage of specific regions such as western boundary currents,
- To maintain Euro-Argo efforts for the Mediterranean Sea, Black Sea and Nordic/Arctic Seas and start implementing Deep Argo and Bio-Argo,

- To strengthen the Argo and Euro-Argo data system,
  Argo proposed extensions will have a high impact for the CMEMS, and are also essential for Copernicus Climate Service.

Thanks to the comprehensive and successful R&D activities carried out as part of E-AIMS, the Euro-Argo ERIC is now in an excellent position to agree on and start implementing the new phase of Argo that will be highly beneficial to the CMEMS.

2.2 MOCCA Progress DG-MARE (European Maritime Affairs and Fisheries)

In February 2015, the Euro-Argo ERIC has been invited to submit an application for a grant for the implementation of the action "Monitoring the Oceans - Action 1.2.1.1 of the EMFF Work Programme 2015". The purpose of the tender was for the procurement and deployment of 150 floats, and the processing of collected data as a contribution towards the European effort under the international Argo programme.

The Euro-Argo ERIC submitted a proposal on the 10th April 2015. The proposal was accepted on the 11th June and the project started on the 24th of June 2015. The main activity of 2015 has been to issue a tender for the float procurement that was issued on the 4th August. Three manufacturers applied and after evaluation by a section committee, NKE was selected and the contract notified end of October. The floats will be delivered to the ERIC in 2016 and deployed in 2016-2017.
With this EC contribution, Euro-Argo will demonstrate the capability to operate ¼ of the Argo network in 2016-2017 but will need to continue working with the EC for the sustainability of this contribution.

Dedicated website to MOCCA:
http://www.euro-argo.eu/EU-Projects-Contribution/MOCCA

2.3 AtlantOS H2020 project (2015-2019)

AtlantOS, coordinated by the GEOMAR Helmholtz Centre for Ocean Research Kiel (Germany) is a project responding to the Horizon 2020 call BG-8-2014 for "Developing in-situ Atlantic Ocean Observations for a better management and sustainable exploitation of the maritime resources". AtlantOS is a research and innovation project that proposes the integration of ocean observing activities across all disciplines for the Atlantic.

The overarching goal of AtlantOS is the integration of the so far loosely coordinated set of existing ocean observing activities to a sustainable, efficient, and fit-for-purpose Integrated Atlantic Ocean Observing System (IAOOS). The IAOOS is to form the ocean in-situ observing backbone of the Copernicus Marine Monitoring system, which is the marine part of the European Earth Observation Programme.

One task which will be led by the Euro-Argo ERIC, with contributions from

Ifremer, LOV, GEOMAR and Euro-Argo ERIC partners, is to contribute to the progressive extension of the Argo core mission towards the deep ocean and biogeochemistry, and develop long-term plans:

- Deploy 7 deep-oxygen Argo floats in the North Atlantic, complementing 30 floats already funded at national and European level;
- Deploy 6 Bio-Argo floats in the Atlantic Ocean to enhance the actual network of 52 floats funded at national level in various biogeochemical provinces of the Atlantic;
- Work on improving Bio-Argo float capabilities, especially to adapt novel optode-based sensors for CO2 and O2 partial pressure and new pH sensors;
- Refine Delayed-Mode QC processing, and achieve the objective to deliver a consistent Argo and Bio-Argo dataset for the Atlantic;
- Work on the long-term sustainability issues for Bio-Argo and Deep Argo after the AtlantOS pilot project. Longer-term targets for Europe will be defined and the Euro-Argo ERIC will seek agreements at ministerial level and with EU for their implementation, in liaison with international partners

The overall task budget is 1,650 M€ and the Euro-Argo ERIC has a budget of 888 k€ for the 4-year duration of the project and a large part of this will be used to cover float purchases (7 Deep Argo and 7 Bio-Argo floats for 580 k€) in 2015 and to organize their deployment. The AtlantOS proposal, integrating the Euro-Argo ERIC contribution, was accepted in December 2015.

The 7 deep floats have benefitted from the recent manufacturer's developments; these floats funded through AtlantOS budget will be delivered during the 2016 summer, the first deployment are scheduled for the end of the 2016 year.

The 7 biogeochemical floats' sensor configuration is in accordance with the Bio-Argo community requirements, enhancing the efforts developed during the last years to uniform and organize the biogeochemical extension to the core Argo program. Their delivery will occur by the end of the year 2016 and deployed in spring 2017.

In parallel, Euro-Argo ERIC partners have developed their partnership in developing of the new optode-based sensors. A prototype of the CO2 partial pressure sensor has been tested, enhances on this thematic are foreseen for the next reporting period.

Dedicated website to AtlantOS:
https://www.atlantos-h2020.eu/

2.4 ENVRI+

ENVRI+ is a cluster of Research Infrastructures (RIs) for Environmental and Earth System sciences, built around the ESFRI roadmap and associating leading e-infrastructures and Integrating Activities together with technical specialist partners.

The objectives on the ENVRI+ proposal is to increase synergies between the infrastructures by removing barriers for cross-disciplinary collaboration and fostering a holistic scientific understanding of the Earth System, and by creating new innovative technical solutions for observational and data management challenges.

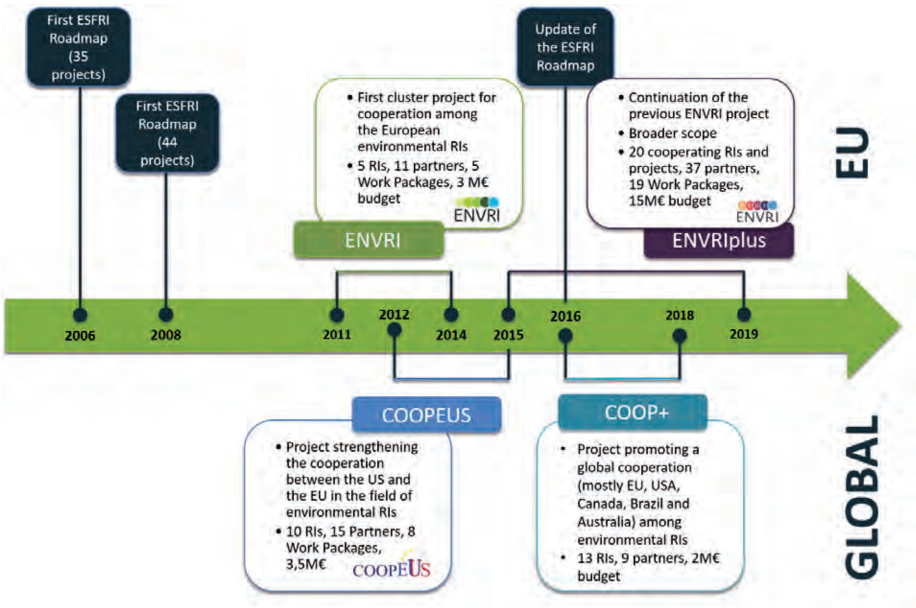
The ENVRI+ proposal deals with technology, data management and enhancing communication and outreach. The Euro-Argo ERIC is involved in the Marine contribution especially for the link with Glider (GROOM) and ICOS-RI for CO2/pCO2/pH measurements, and the homogenization of data processing and reprocessing between Euro-Argo, GROOM and EMSO/FixO3. The funding for the Euro-Argo ERIC is mainly for coordination and attending meetings, although Euro-Argo ERIC members will undertake some scientific tasks. The proposal was accepted in early 2015 and started in May 2015.

A first ENVRI+ meeting has been attended by the Euro-Argo ERIC staff in fall 2015. Some collaboration within the data management tasks have already been initiated, due to the known expertise of Euro-Argo partners concerning the Marine domain database building and data fluxes survey.

The scientific and technical use cases in which Euro-Argo will have an active role have been refined; they will concern the continuum between the Atmospheric-Marine and Marine-Sea ground domains, through the valorisation of the Argo floats data in link with data available from Atmospheric and Sea ground Research Infrastructures.

Euro-Argo ERIC is about to open a fixed research engineer position to fulfil the important goals of this transverse project.

Dedicated website to ENVRI+ :
http://www.envriplus.eu/



History of the development of ENVRI Cluster of Research Infrastructures (© ENVRI+)

3 SCIENTIFIC HIGHLIGHTS

In 2015, Argo data have being used by many researchers in Europe to improve the understanding of ocean properties (i.e. circulation, heat storage and budget, mixing and convection), climate monitoring and application in ocean models. The Euro-Argo community reached its target with 104 papers published (that is 28% of the total Argo bibliography) and the existing Euro-Argo's bibliography has been updated in December 2015 (see § 5.2) through *http://www.euro-argo.eu/Bibliography.*

To further enhance these research activities conducted by the Euro-Argo community, a selection of twenty scientific results were highlighted on the website at *http://www.euro-argo.eu/Main-Achievements/European-Contributions/Scientific-Results*, classified into 3 categories according to the scale ocean circulation and topics that they address:

- **Global Ocean Circulation and Climate Change:** von Schukmann et al., 2014 uses Argo data to quantify the consistency of the current global ocean observing systems from an Argo perspective thanks to its new Global Ocean Indicators. Sterl et al., 2011 uses Argo data in modelling to understand the reasons behind a climate model's failure to reproduce observed SSTs in the Southern Ocean.
- **Basin-Scale Oceanic Circulation:** ocean circulation patterns and process studies are performed from Argo data by the Euro-Argo community, with particular focus in Equatorial Atlantic Ocean and Pacific Ocean. Accurate Argo data are useful to better analyse the variability of ocean at different depths and from seasonal to inter-annual scales.
- **Regional-scale Oceanic Circulation:** using Argo and/or Bio-Argo floats, some European research activities study the subpolar North Atlantic and its adjacent Nordic Seas and Arctic Ocean to better understand the dynamics of high latitude water mass transformation. Other scientists deal with the Mediterranean Sea and its sub-basins (Adriatic, Ionian, Black Seas) using new bio-Argo floats to analyse links between physical and biogeochemical processes.

Thereafter, we detail two of those significant results:

- A study by Czeschel et al., 2015 presents new features of the mid-depth circulation of the eastern tropical South Pacific thanks to Argo profiling floats, and demonstrates how profiling floats are helpful tools in many ways to monitor and analyse changes within the oxygen minimum zones.
- A study by Sauzede et al., 2016 makes use of the global Bio-Argo network and highlights one of the potential of sampling with high spatio-temporal resolution bio-optical properties from Bio-Argo profiling floats at a global scale.

3.1 Observational tools for long-term trends and mesoscale variability:

Float measurements in oxygen minimum zones and eddies

In all tropical oceans areas of extremely low oxygen exist. Selected tropical time series reveal an oxygen decrease in 300-700 m depth and a vertical expansion of the oxygen minimum zones (OMZs) during the last 50 years (Stramma et al. 2008). Should the observed decrease in oxygen continue, this could lead to habitat compression, shifts in animal distribution and a loss of biodiversity with impact on fisheries and economics.

<u>Long-term trends</u>: Oxygen time series from historical measurements augmented with float data reveal a significant negative trend at a rate of -1.23 ± 0.67 µmol/kg/yr during 1976-2012, averaged in the Pacific region of the westward flowing South Equatorial Current and the South Equatorial Intermediate Current between 2-5°S, 84-87°W (Figure 15). GEOMAR studies are focussing on the factors controlling the long-term trend and variability of dissolved oxygen which might be linked to climate modes such as the Interdecadal Pacific Oscillation, El Niño and the Shallow Tropical Cell.

<u>Mean circulation</u>: As the OMZs are situated at the eastern boundaries of the tropical oceans, eastward currents are a major path of oxygen into OMZs it is important to gain knowledge about the circulation and its variability to understand the on-going changes in OMZs. Floats with a parking depth at 400 m show fast westward propagation in the equatorial channel and sluggish flow in the low ventilated centre of the OMZ (Figure 16).

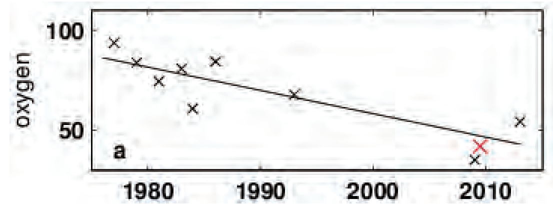


Figure 15: Oxygen trend since 1976 for the layer 50-300 m depth between 2 and 5°S and 84 and 87°W in µmol/kg/yr. The red cross is the mean oxygen value for 2009 from profiling floats with oxygen sensors (from Czeschel et al., 2015)

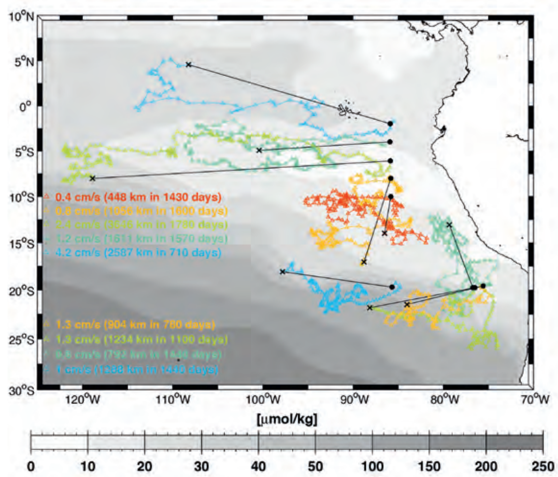


Figure 16: Floats drifting at 400 dbar with mean velocity information (from Czeschel et al., 2015).

<u>Mesoscale variability</u>: In the OMZ the mean flow is strongly overlaid with eddy activity on the poleward side of the OMZ. Eddies have been identified as major agents for the exchange between coastal waters and the open ocean. Coherent/isolated mesoscale eddies can exist over periods of several months, even years. Propagating generally westward after formation in the coastal regions, eddies are particularly important for the transport of properties into the OMZs, which are located at

the eastern boundaries of the tropical oceans. In addition to such transport, the local eddy dynamics can create distinct biogeochemical anomalies within these eddies. In order to understand the local processes as well as the large-scale impact of the mesoscale eddies, interdisciplinary field studies were carried out in the Atlantic and in the Pacific Ocean using Argo float data. Floats with oxygen sensors clearly show the passage of eddies with oxygen anomalies. One float stayed for more than half a year in a cyclonic eddy showing two cyclonic loops. The cyclonic rotation leads to an uplift of isopycnals and thus colder and more saline water as well as low oxygen is uplifted into the upper ocean (Figure 17) which might have an impact on the biological productivity. The strongest oxygen anomalies can be seen in 300 m depth.

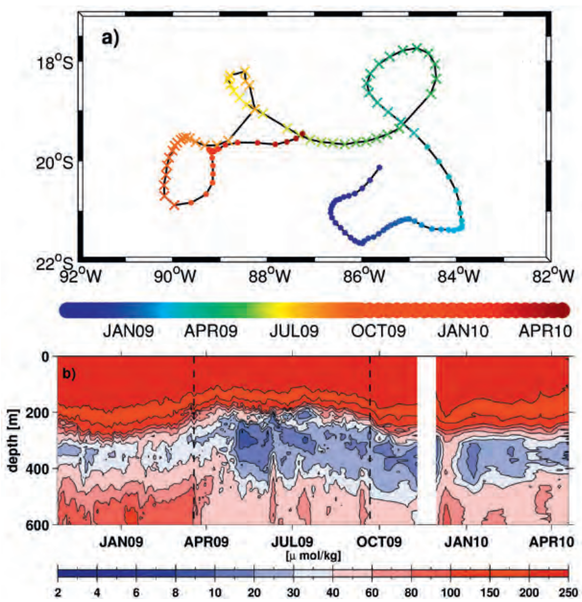


Figure 17: Measurements of a float in the tropical eastern South Pacific showing the float path (a) and the oxygen distribution versus time in the upper 600 m. The residence time of the float in the eddy is marked by Xs (a) and dashed black lines (b).

Profiling floats are helpful tools in many ways to monitor and analyse changes within the OMZs as they are ideal for continuous sampling of data especially in regions where data density is scarce. Besides profiles of temperature, salinity and pressure, additional parameters such as oxygen can be measured to fill the gaps in time series or to extend them. Floats are able to register the water mass and oxygen changes of an eddy when trapped in one.

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3.2 Bio-Argo: a 4D view of phytoplankton biomass from merged ocean colour and physical Argo data

Several bio-optical properties are estimated quasi-synoptically from remote sensing of ocean colour radiometry. However, these estimates only represent approximately one fifth of the productive layer. Therefore, this information appears to be insufficient for biogeochemical studies involving primary production or carbon export. Several bio-optical properties are now measured in situ with a high spatio-temporal resolution thanks to Bio-

Argo profiling floats. The ~5000 Bio-Argo profiles available in May 2015 provided the frame to consider the development of a new parameterization of bio-optical properties that could be used to derive a four dimensional view (i.e. according to x, y, z and t) of several bio-optical proxies of the phytoplankton biomass for the global ocean.

Neural network-based methods that merge ocean colour and Argo data to extend surface bio-optical properties to depth.

Two neural networks were developed to merge ocean colour observations with temperature and salinity profiles acquired by Argo profiling floats with the aim of modelling the vertical distribution of (1) the chlorophyll a concentration (Chl) associated to the total phytoplankton biomass and to three phytoplankton size classes (i.e. the micro-, the nano- and the pico-phytoplankton) and (2) the particulate backscattering coefficient (bbp), a widely used proxy of the particulate organic carbon and phytoplankton carbon in the open ocean.

The developed methods are referred as SOCA for "Satellite Ocean Colour merged with Argo data to infer the vertical distribution of bio-optical properties" [see Sauzède, 2015; Sauzède et al., 2016]. The inputs of these neural networks are composed of three main components: (1) the satellite estimates, (2) the vertically-resolved physical properties derived from physical Argo profiles and (3) the day of the year of the considered matchup. These methods were trained and validated using a large database of 4 725 concurrent profiles of temperature, salinity and bio-optical properties measured from Bio-Argo profiling floats concomitant with the satellite products. Independent datasets composed of (1) 20% of the initial database chosen randomly, (2) "independent" Bio-Argo floats profiles and (3) oceanographic cruises samples were used to evaluate the performance of these methods (see Figure 18).

The results appear to be very promising (~21% of global error), with a good representation of the vertical seasonal distribution of bio-optical properties (see the results for the retrieval of the vertical

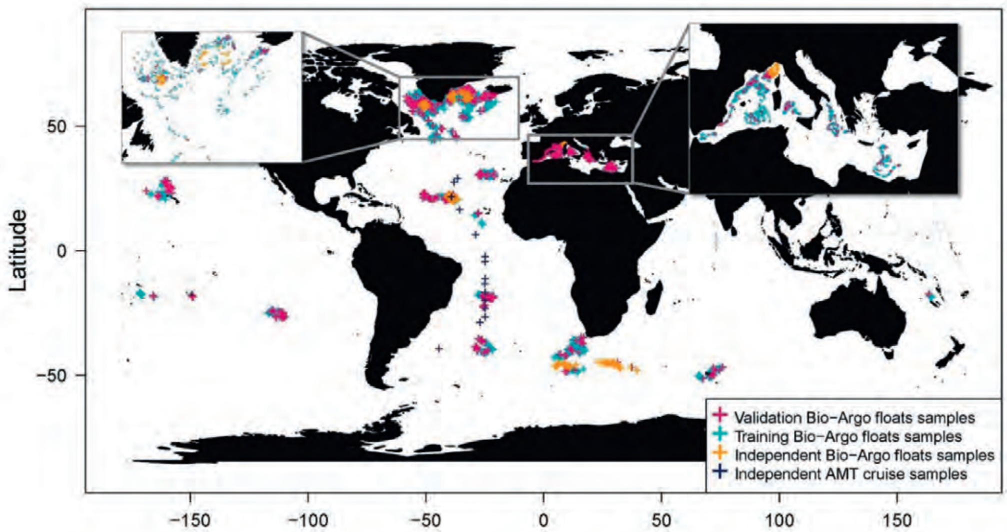

Figure 18: Geographic distribution of the 4725 stations sampled by the Bio-Argo floats and the 16 stations sampled during an oceanographic cruise used for the training and the validation of the SOCA method that estimates the vertical distribution of bbp from merged ocean colour and Argo data

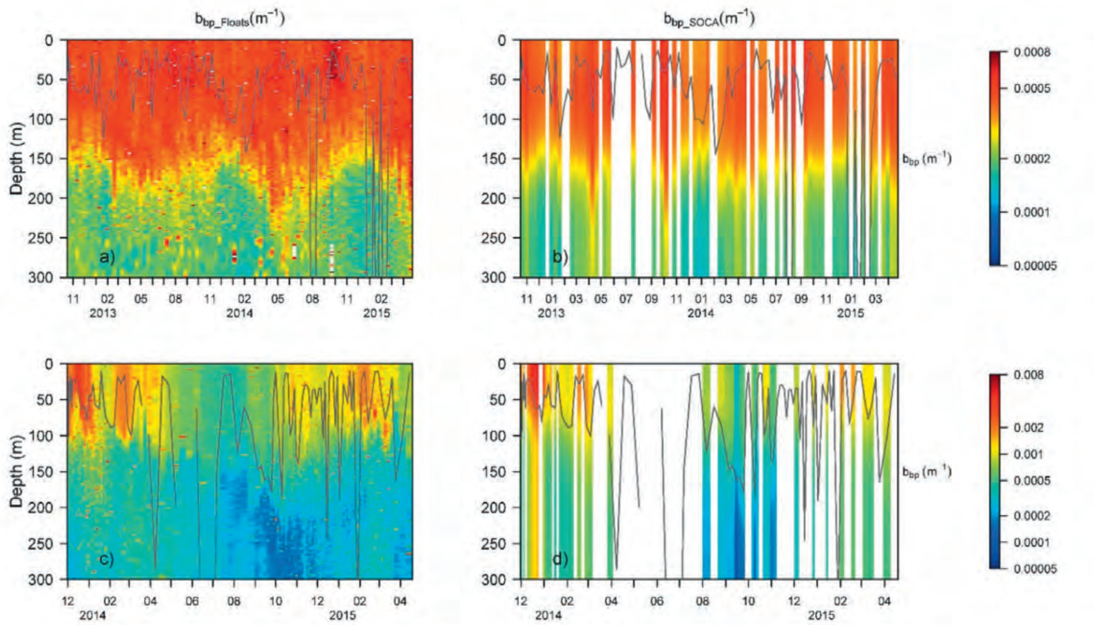

Figure 19: Comparison of the reference bbp measurements acquired by Bio-Argo floats, bbp_Floats (a and c) with the values predicted by SOCA, bbp_SOCA (b and d), modelled from merged ocean colour and Argo data. Time series for the Bio-Argo floats deployed in the North Atlantic Subtropical Gyre (a-b) and in the Southern Ocean (c-d). The grey line in each panel indicates the mixed layer depth.

distribution of bbp from SOCA compared to the reference in situ bbp measurements acquired from two "independent" Bio-Argo profiling floats in Figure 19.

Finally, this study makes use of the global Bio-Argo network and the results have highlighted one of the potential of sampling with high spatio-temporal resolution bio-optical properties from Bio-Argo profiling floats at a global scale. In fact, using the global array of Bio-Argo profiling floats for training neural networks, it becomes now possible to estimate using physical properties measured from Argo floats merged with ocean colour observations, the vertical distribution of key bio-optical proxies of the phytoplankton biomass in the global ocean. The global and regional 4D views of Chl, phytoplankton community size indices and bbp that could be obtained from SOCA methods represent a new important tool to assess seasonal and inter-annual variability in the vertical distribution of phytoplankton biomass and community composition at a global scale.

REFERENCES:

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4 FINANCIAL STATUS

The Euro-Argo ERIC 2015 budget was presented during the 2nd Council Meeting. As Bulgaria and Spain were not able to contribute as candidate members, the income was 240 k€ (7x30 k€ + 3x10 k€). The expenditures were mainly related to personnel costs and services to set up and run the ERIC and for travel related to the User Workshop, project meetings, Council and Management Board meetings. For 2015, as a host, Ifremer contributed in kind with 21,713.00 € (2 offices with all facilities, no overhead charged to the ERIC for the secondment of personal, financial and legal support).

In 2015 Grigor Obolensky joined the team. As the secondment procedure was a bit longer than planned and therefore the personal cost was lower than planned. It was agreed by the Council in November that the surplus from 2015 will be carried forward to 2016 and provide funds to run the ERIC during early 2016 as the members fees will be received in March-April 2016. This surplus will also provide the ERIC with enough cash to cover the MOCCA and AtlantOS floats purchases for which the EC pre-funding doesn't cover the complete float purchase cost.

SUMMARY 2015 - GRAND TOTAL (Euros)

Type	Code	Debit	Crédit	Solde
Initial balance				134 024
GC: Grants & contracts	GC		35 995	35 995
MF: Membersships fees	MF		240 000	240 000
II: Interest income	II			0
VA : VAT reimbursement	VA			0
PE: Personnel costs	PE	85 207		-85 207
TV: Travel costs	TV	25 558		-25 558
MA: Matérials costs	MA	985		-985
AC: Accounting fees	AC	4 000		-4 000
BS: Bank services	BS	143		-143
SC: Other subconstracts	SC	24 940		-24 940
XX: Unknow, not yet categorized	XX			
TOTAL FLOWS		140 833	275 995	
END BALANCE				269 186

5 KEY PERFORMANCE INDICATORS

The EC set up a High Level Assessment Expert Group (AEG) to assess ESFRI RIs such as Euro-Argo. According to their recommendations, a series of Key Performance Indicators (KPIs) have been defined to allow future evaluation of the performance of Euro-Argo activities. The novel and enhanced role of the EU in the international Argo programme and the enhanced Europe-wide visibility of the research will be monitored each year through two types of indicators:

- KPI 1: Regarding floats.
- KPI 2: Regarding users.

5.1 Regarding floats

The overall objectives of the Euro-Argo ERIC are to provide, deploy and operate an array of around 800 floats contributing to the global array - a European contribution of ¼ of the global array with enhanced coverage in the European regional seas.

During 2015, the deployment plans were reviewed for 2015 and 2016. In 2015, 266 European floats were deployed including 54 floats on the extension to marginal seas, biogeochemical and deep oceans. In January 2016 a total of 710 floats were active as shown in Figure 20. This is still below the target of 250 new floats/year and 800 operating floats for the core mission, but the number of European Argo floats has increased in recent years, as shown in 21 and Figure 22, where the percentage of European floats is approaching the 25% mark.

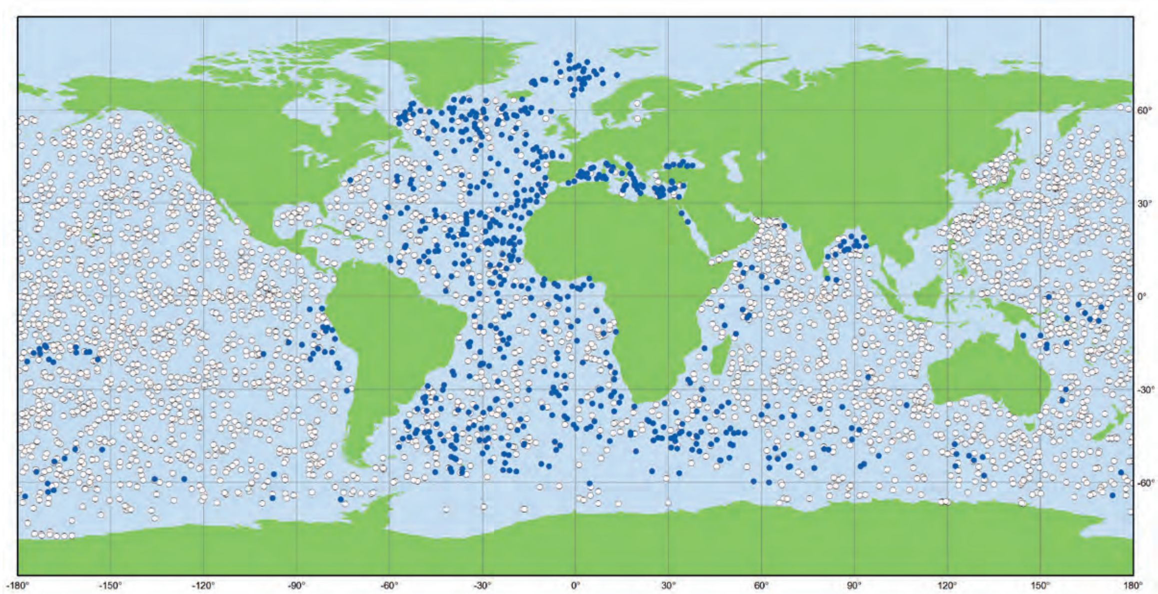

Figure 20: Argo (white points, 3142 floats) and Euro-Argo RI (blue points, 710 floats) active profilers in February 2016 (© JCOMMOPS/AIC).

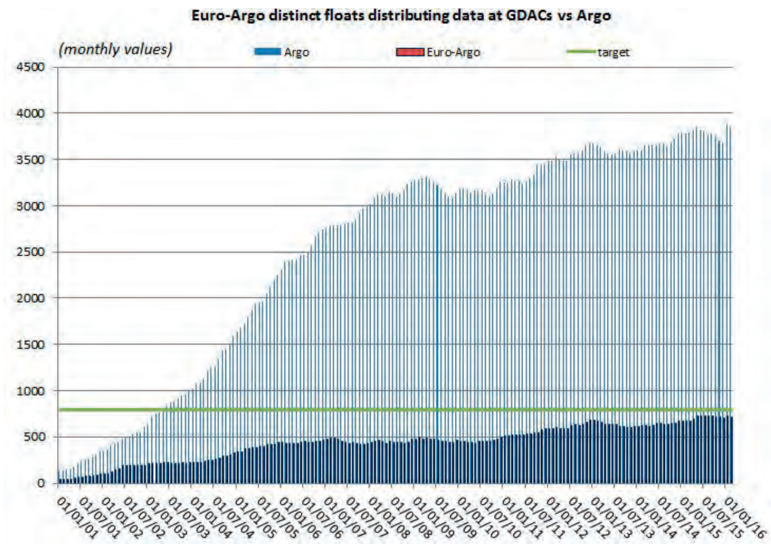

Figure 21: Euro-Argo (dark blue) vs Argo (light blue) distinct floats distributing data at GDACs, per month since 01/01/2001, progressing towards the initial target of 800 active floats (green line, about 700 floats).

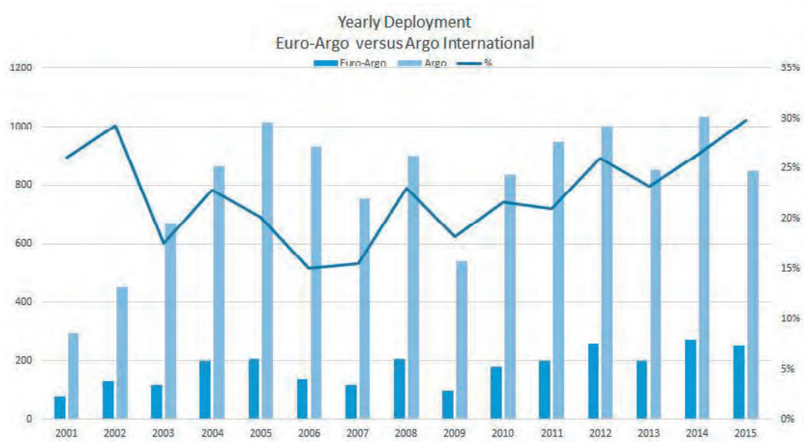

Figure 22: Number of Argo float deployed (light blue) and number of Euro-Argo floats (dark blue) per year, % Euro-Argo versus Argo (blue line).

In terms of float operating lifetime, as shown in Figure 23, the target is for 4 to 5 years, around 150 cycles.

Figure 23: Average number of profiles per year provided by the Euro-Argo fleet. In the recent years the floats are not old enough to have performed 150 cycles as a float makes 36 cycles per year.

5.2 Regarding users

The overall objectives of the Euro-Argo ERIC are to provide quality-controlled data and access to the data sets and data products to the research (climate and oceanography) and operational oceanography (e.g. Copernicus Marine Service) communities.

5.2.1 Euro-Argo bibliography

A new Euro-Argo bibliography has been created to monitor each year the number of publications using Argo observations from EU users. This bibliography was built on the base of the international Argo bibliography maintained by the Argo Project Office. It includes peer-reviewed articles and books that include Argo and Argo equivalent float data along with a few articles on floats that were precursors to Argo. Details from 1998 to 2015 are illustrated in Table 3 below.

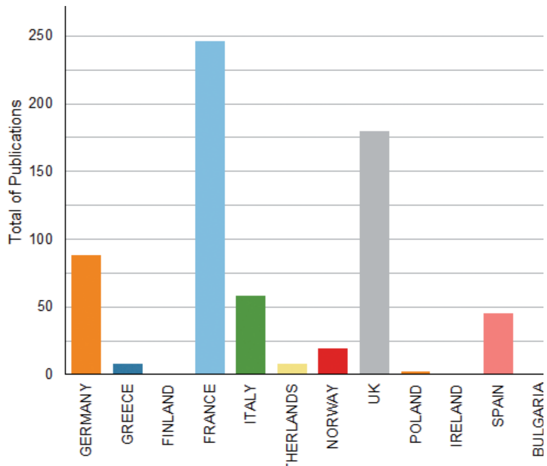

Figure 25: Number of publications by Euro-Argo participating countries since 1998.

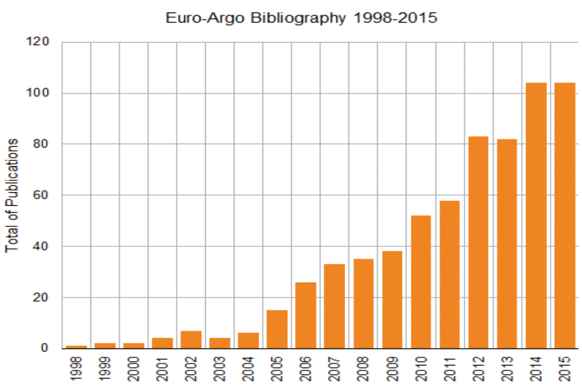

Figure 24: Number of Argo publications from Europe per year since 1998.

Figure 24 and Figure 25 represent the partition by year and by country respectively. France and UK are the main European contributors to Argo publications and are in the top 7 countries contributing to the Argo bibliography, with over 100 papers each. Just below, Germany, Italy and Spain contribute with about 150 papers since 1998.

	TOTAL	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GERMANY	88					2		1	3	4	3	7	5	6	9	9	12	10	17
GREECE	8										0		1	1	1			3	2
FINLAND	1																1		
FRANCE	246		1	1	1	3	1	2	3	6	8	16	17	17	23	31	30	48	38
ITALY	58									5	7	4	4	7	5	7	5	5	9
NETHERLANDS	8													1	1	2	2	1	1
NORWAY	19											1		1	3	4	3	5	2
UK	180	1	1	1	3	2	3	2	6	7	14	6	8	12	13	24	24	27	26
POLAND	2																	1	1
IRELAND	1													1				0	
SPAIN	45							1	3	4	1	1	3	6	3	6	5	4	8
BULGARIA	0																		
TOTAL EURO-ARGO	656	1	2	2	4	7	4	6	15	26	33	35	38	52	58	83	82	104	104
ARGO Bibliography	2282	4	4	8	16	20	21	26	53	81	94	102	117	226	227	264	295	353	371
% EU Bibliography vs Argo	28,75	25,00	50,00	25,00	25,00	35,00	19,05	23,08	28,30	32,10	35,11	34,31	32,48	23,01	25,55	31,44	27,80	29,46	28,03

Table 3: Number of publications using Argo from EU users, and percentage versus Argo publications, per year since 1998.

A total of 371 Argo papers were published in 2015, which is the highest number since 1998. Argo publications from the Euro-Argo ERIC community also reach a high with 104 papers published in 2015. Since 1998, the European contribution has been about 28.8 % of the total number, which is better than the initial target of 25%.

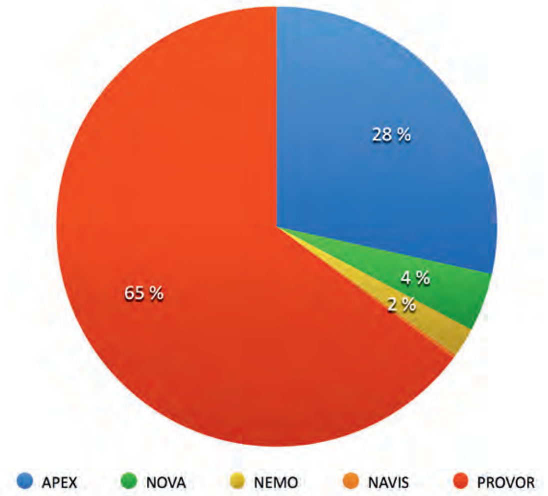

Figure 26: Repartition of active European float types in 2015.

5.2.2 Access to data

• USE OF GDAC PORTAL

In 2015, 25,568 vertical profiles collected from 745 active Euro-Argo floats were collected, controlled and diffused. Comparing to 2014, the number of collected profiles increased in 2015 of about 18% and the number of floats of about 14%. Those 745 active floats were equipped with 54 different versions, which increase the difficulty for decoding by the DAC. Figure 26 details the repartition by instrument types in 2015.

The number of users that access, visualize and download Argo data sets is monitored each year from the Coriolis GDAC portal, as shown in Figures 27 and 28.

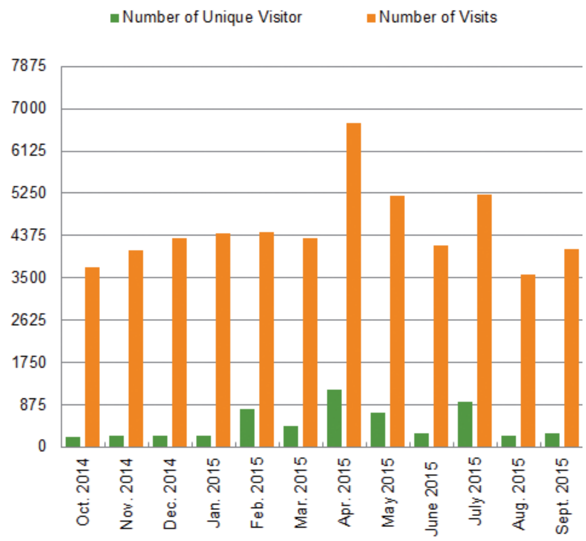

Figure 27: Number of Users and Visits on Coriolis GDAC in 2015.

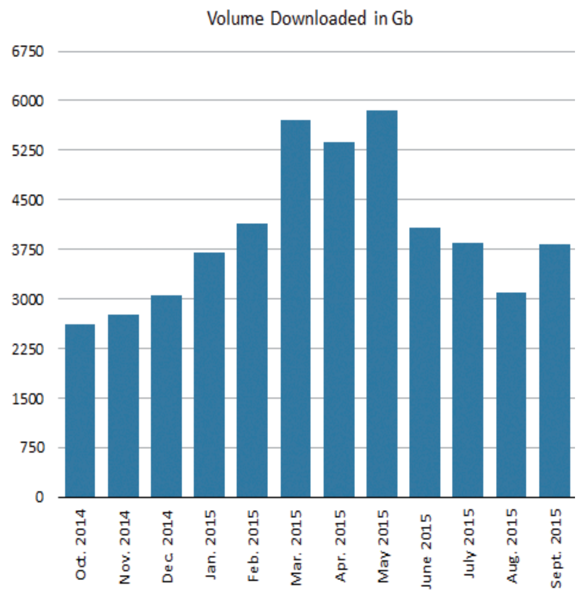

Figure 28: Volume of Data (in Gb) downloaded from Coriolis GDAC in 2015.

• <u>FTP SERVER MONITORING</u>

From October 1st 2014 to September 30th 2015, statistics on the Argo GDAC ftp server *(ftp://ftp.ifremer.fr/ifremer/argo)* show a monthly average of 483 unique visitors, performing 4518 sessions and downloading 4 Teraoctets of data files. The Argo GDAC ftp server is actively monitored by a Nagios agent. Every 5 minutes, a download test is performed. The success/failure of the test and the response time are recorded *(see http://en.wikipedia.org/wiki/Nagios)*.

From October 1st 2014 to September 30th 2015, the weekly average performance was 99.84%. The 0.16% of poor performances represents 15 minutes for a week. For this period, the cumulative poor performances period is of 24 hours. 3 Significant events arrived during this period:

- First week of January: 8 hours of Internet poor performances,
- Last week of January: disk storage instability, 7 hours and 35 minutes of poor performances of ftp,
- Mid-August 2015: 4 hours of poor internet performances.

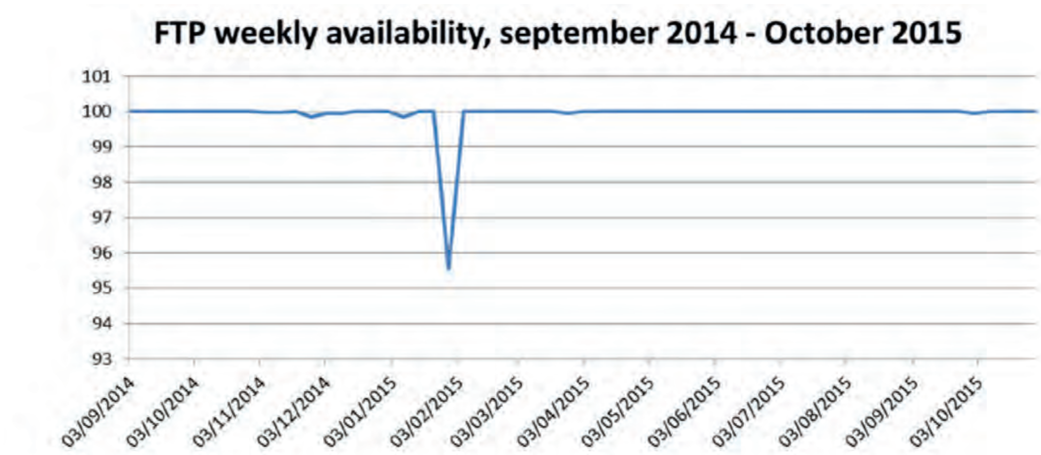

Figure 29: Nagios ftp monitoring at Coriolis GDAC between September 2014 to September 2015

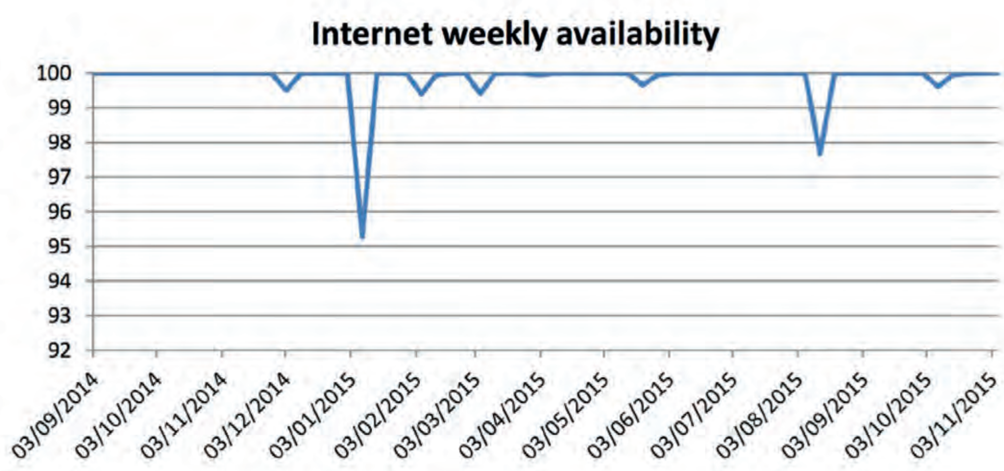

Figure 30: Nagios Internet monitoring at Coriolis GDAC between September 2014 to September 2015

Annex 1: Partners of Euro-Argo ERIC

COUNTRY	STATUTE	REPRESENTATING ORGANISATION *
Germany	Member	BSH
Greece	Member	HCMR
France	Member	IFREMER
Italy	Member	OGS
Netherlands	Member	KNMI
Finland	Member	FMI
United Kingdom of Great Britain and Northern Ireland	Member	Met Office
Norway	Observer	IMR
Poland	Observer	IOPAN
Spain	Candidate	SOCIB, IEO, Spanish Ministry of Economy
Ireland	Candidate	MI
Bulgaria	Candidate	IOBAS - USOF

** The listed institutes represent the Member States, but other institutes can also participate.*

Annex 2: Composition of Euro-Argo ERIC governance bodies

COUNCIL MEMBERS	
Pierre-Yves Le Traon	*Chair* - IFREMER France
Jon Turton	*Co-Chair* - UK Met Office
Bernd Brügge	BSH Germany
Vasilios Lykousis	HCMR Greece
Bart van den Hurk	KNMI Netherlands
Mikko Strahlendorff	FMI Finland
Alessandro Crise	OGS Italy
Dariusz Drewniak	Ministry of Science and Higher Education Poland
Roar Skalin	Research Council of Norway
MANAGEMENT BOARD MEMBERS	
Pierre-Marie Poulain	*Chair* - OGS Italy
Hartmut Heinrich	*Co-Chair* - BSH Germany
Virginie Thierry	IFREMER France
Gerasimos Korres	HCMR Greece
Andreas Sterl	KNMI Netherlands
Jon Turton	UK Met Office
Jari Haapala	FMI Finland
Walczowski Waldemar	IOPAN Poland
Kjell Arne Mork	IMR Norway
Euro-Argo ERIC Central Research Infrastructure	
Sylvie Pouliquen	Programme Manager - IFREMER France
Francine Loubrieu	Programme Assistant - IFREMER France
Grigor Obolensky	Programme Technical coordinator - CNRS France
Scientific & Technological Advisory Group (STAG)	
Glenn Nolan	EuroGOOS - EOOS
Susan Wijffels	CSIRO Australia - Argo International
Johnny Johannessen	NERSC Norway - Copernicus Marine Service
Arne Körtzinger	GEOMAR Germany - Research
Magdalena Balmaseda	ECMWF UK - Seasonal Prediction
Two Euro-Argo ERIC experts assist the STAG	
Birgit Klein	BSH Germany - Research with Core-Argo
Hervé Claustre	LOV France - Bio-Argo


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