ANNUAL ACTIVITY REPORT 2014

EURO-ARGO
Research Infrastructure

Annual Activity Report 2014

CONTENTS

PREFACE

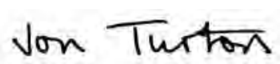
We are delighted to introduce the first annual report of the Euro-Argo ERIC. The setting up of the Euro-Argo ERIC in May 2014 was a major achievement for the development of a long term European contribution to the international Argo global array of profiling floats. Long-term global and high quality ocean observations are imperative to better characterize climate change, understand and predict the role of the ocean on climate, and also to make informed political decisions on how to attenuate and adapt to climate change. Argo has revolutionized global oceanography and has made in a few years only, outstanding contributions to ocean and climate change research and operational oceanography. Maintaining such a global ocean observing system on the longer run and making sure it can evolve to answer new scientific and operational needs are, however, major challenges that should not be minimized. We do expect that the Euro-Argo ERIC will be instrumental to address these challenges and will allow Europe to play a prominent role in the Argo international programme.

As can be seen in this report, Euro-Argo ERIC member states have been very active in 2014. Contributions to the global array are progressing and European partners continue to be major actors in the Argo data processing and dissemination system. They also are at the forefront of the development of the new phase of Argo with an extension to biogeochemical variables, the deep ocean and the polar seas. As far as users are concerned, the Euro-Argo research infrastructure has developed strong links with the European ocean and climate change research communities which are heavily relying on Argo observations. Euro-Argo is also a major in-situ infrastructure for the Copernicus Marine Environment Monitoring Service (CMEMS) and the European Marine Observation and Data Network (EMODnet).

While there are many challenges over the coming years, we are highly confident that thanks to a strong support from participating Member States and from the European Commission, Euro-Argo ERIC teams are in an excellent position to further improve European contributions to Argo and strengthen European excellence in ocean and climate change research.

We hope you will enjoy reading this first Euro-Argo ERIC annual report.

Pierre-Yves Le Traon
Chair of the Euro-Argo ERIC Council



Jon Turton
Vice-Chair of the Euro-Argo ERIC Council

EXECUTIVE SUMMARY

The Euro-Argo project began in 2008, with the main goal to ensure a long-term European contribution to Argo by developing an infrastructure for the European Argo activities. Since May 2014 and the birth of the new Euro-Argo Research Infrastructure Consortium (ERIC), 25 organisations from 12 countries are now involved with the first main objective to maintain and consolidate the global Argo array and regional coverage for European seas, by increasing the European contribution from 150-200 floats to 250 floats/year and consolidating the data processing system. Secondly, the Euro-Argo ERIC will prepare the evolution of Argo to address new scientific and operational challenges, and in particular start implementing the new phase of Argo with an extension towards biogeochemistry, the polar oceans, the marginal seas and the deep oceans.

This first annual report describes the main achievements of the Euro-Argo ERIC community in 2014 through 3 themes:

a) Main operational outcomes in 2014

In 2014, the Research Infrastructure was in the ramping up phase with a reduced budget funded by 7 Members and 2 Observers. The main part of 2014 was dedicated to setting up the Euro-Argo ERIC (Central RI) management. Most of the administrative, legal and economic issues have been addressed by the Central RI organization with the help of the ERIC governance and local host (IFREMER) support.

The Euro-Argo RI aims also at coordinating operations at sea and associated logistics. While the preparation of the floats, shipment and the deployment is organised at national level, the coordination regarding planning and deployment opportunities is managed at Euro-Argo ERIC level. During the year 2014, the deployment plans were reviewed for 2014 and 2015.

b) Major scientific achievements in 2014

The European ERIC scientific community has delivered significant and innovative results in 2014 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 publications are made by EU scientists.

The first two years of the European E-AIMS FP7 project (2013-2015) have demonstrated the feasibility and readiness for pre-operational monitoring and data processing of the new Argo floats (deep, bio, Iridium). Through E-AIMS, the Euro-Argo infrastructure has exhibited its ability to conduct R&D driven by GMES/Copernicus needs and that procurement, deployment and processing of floats for GMES/Copernicus can be organized at the European level. In 2015, design recommendations for the new phase of Argo will be elaborated on the basis of results from the E-AIMS project.

Global Ocean Indicators (GOIs) have been calculated (von Schuckmann et al, 2014) to gauge global warming and to assess the earth's energy and sea level budget. Estimations of the Global Ocean Heat Content (GOHC) and the Global

Steric Sea Level (GSSL) from temperature/salinity data from Argo reveals a positive change of 0.5±0.1 Wm^{-2} and 0.5±0.1 mm $year^{-1}$ during the years 2005-2012, averaged between 60°S and 60°N for the 10-1500m depth layer (von Schuckmann et al, 2014).

In 2014 the new generation of Bio-Argo floats have been improved thanks to the influence of the European teams, with Bio floats deployed by several European teams working in ecosystem oceanography. Bio-Argo floats are presently able to measure several essential variables for ecosystem studies (Chla, bbp, O2, Nitrate) and more variables are coming with the miniaturization of sensors. Moreover the European partners took a leading role in the Bio-Argo data system and the development of real time and delayed mode QC procedures.

c) Financial Status

The Euro-Argo ERIC 2014 budget was presented during the 1st Council Meeting. Bulgaria and Spain were not able to contribute as candidate members. The expenditures were mainly related to personnel cost and services to set up and run the ERIC and for travel related to the Inauguration, Council and Management board meetings.

For the fiscal year 2015, with a positive cash balance from 2014, and the fact that Spain and Bulgaria are likely to become Members in 2015 incomes should be between 240 and 300 k€. Also as the Euro-Argo ERIC is a partner in three H2020 project bids (AtlantOS, ENRI-plus, JERCICO-Next) that were successful, the Central RI should be reinforced and a Project Scientist position will be opened in 2015.

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/MyOcean;
- *Regarding the financial sustainability* of the Euro-Argo RI and collaboration with the EU for sustained funding.

Those KPIs elaborated for the year 2014 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;
- Significant scientific achievements are being made by the European scientific community thanks to Argo measurements, where 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 Set up and Management of the Euro-Argo ERIC

The Euro-Argo Research Infrastructure organizes and federates the European contribution to Argo (www.euro-argo.eu). It is part of the European ESFRI roadmap on large research infrastructures. From January 2008 to June 2011 Euro-Argo carried out a preparatory phase project, funded through the EU 7th Framework Research Programme, whose main outcome was to agree on the legal and governance framework under which to establish the research infrastructure, leading to the establishment of the Euro-Argo ERIC.

Ministries from 9 European countries (Finland, France, Germany, Italy, Netherlands, Greece, UK, Norway and Poland) have agreed to form this new European legal entity to organize the long-term European contribution to Argo. The Euro-Argo ERIC was set up by the Commission Implementing Decision (2014/261/EU) of 5th May 2014, and was inaugurated on the 17th July in Brussels, hosted by the French Permanent Representation in Brussels, in the presence of representatives of the European Commission and the Ministries of the signatory nations as well as the European institutes involved in Argo.

The Euro-Argo Research Infrastructure (RI) is illustrated in Figure 2 (next page). The infrastructure is made up of a Central Infrastructure (C-RI) based in France (IFREMER, Brest) which is owned and controlled by the Euro-Argo ERIC together with distributed national facilities.

The distributed national facilities operate with direct national resources. As part of the Euro-Argo RI, they agree to a multi-annual commitment of resources (in terms of floats to be deployed and

Figure 1: Official Euro-Argo ERIC inauguration in Brussels on 17th July 2014. (© Ifremer)

contributions for the data system) and to coordinate their activities through the ERIC. The Euro-Argo ERIC may subcontract some of its activities to the national facilities who have the relevant expertise (e.g. data management and quality control, float deployment) and according to their areas of responsibility.

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 (Central-RI)**, which includes a Programme Manager and a Programme Assistant, is responsible for the implementation of the decisions and programmes adopted by the Management Board.

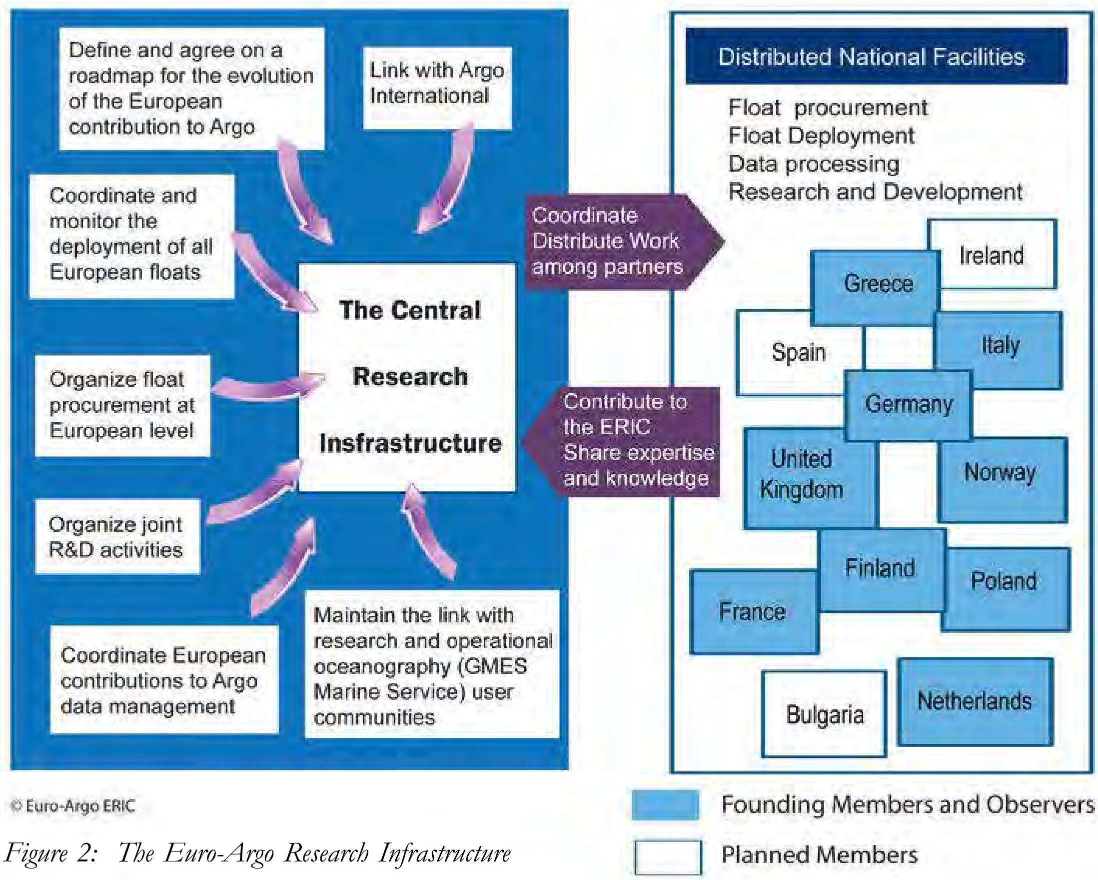


Figure 2: The Euro-Argo Research Infrastructure

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 2014, two Council meetings were held: the first in Brussels on 18th July 2014 and the second in Paris on 27th November 2014. The Euro-Argo ERIC Council will meet twice a year: in March/April to approve the annual accounts, and in November to approve the work plan and budget for the following year. The 1st Council meeting was dedicated to approval of the documents necessary to run the ERIC, the internal working procedures and financial rules, the proposal made by IFREMER to host the ERIC for the first five years as well as the 2014 budget and work plan. At the 2nd Council a draft annual activity and financial report was presented and the 2015 work plan and proposed budget was approved. It included information on the accepted European projects and authorisation to open a project scientist position.

In 2014, two Management Board meetings were held: the first in Brussels on 18th July to organize the Management Board activities and the second in Paris on 15th October to progress the actions identified at the 1st Council meeting. The Management Board will normally meet 3 times a year. In October to prepare the activity report and budget/work plan for the subsequent year. In March, to monitor activities, agree on deployment plans and prepare the European contributions to the Argo International Steering Team. In June, to analyse the Council and STAG recommendations and take appropriate actions.

In 2014, the Research Infrastructure was in the ramping up phase, with a central entity working with a budget funded by Members and Observers. The main part of 2014 was dedicated to the setting up of the Euro-Argo ERIC, where most of the administrative, legal and economic issues were addressed by the Central-RI organization with the help of the ERIC governance and local host (IFREMER) support.

1.2 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 a few floats were funded by European Commission through the FP7 EAIMS project. In 2015, more floats will be procured through European funding within the H2020AtlantOS 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

	2011 deployed	2011 Argo extension	2012 deployed	2012 Argo extension	2013 deployed	2013 Argo extension	2014 deployed	2014 Argo extension	2015 estimated	2015 Argo extension	2016-2020 plans (per year)
Bulgaria		3				1	0	0		3	3
European Union					2	2		9	40	14	80
Finland		2		3		4		5		3	3
France	53		82		65	16	85	15	65	15	80
Germany	48		72		31	7	48	18	40	12	40
Greece						2		5		5	5
Ireland	3		2		1		2		3		3
Italy		4	2	17		12		22		30	25
Netherlands	7		7		4		8		7		7
Norway						1	2	4	3		3
Poland			1			2			3		3
Spain	17		6		4		2		3		3
Turkey						4		2			
UK (Mauritius)	41 (4)		25	13	30 (2)	2	45(2)	2	50		40
Total	173	9	197	33	139	53	194	82	214	82	
	182		230		192		276		296		295

Table 1: Float procurement for 2011-2014 and plans for 2015.

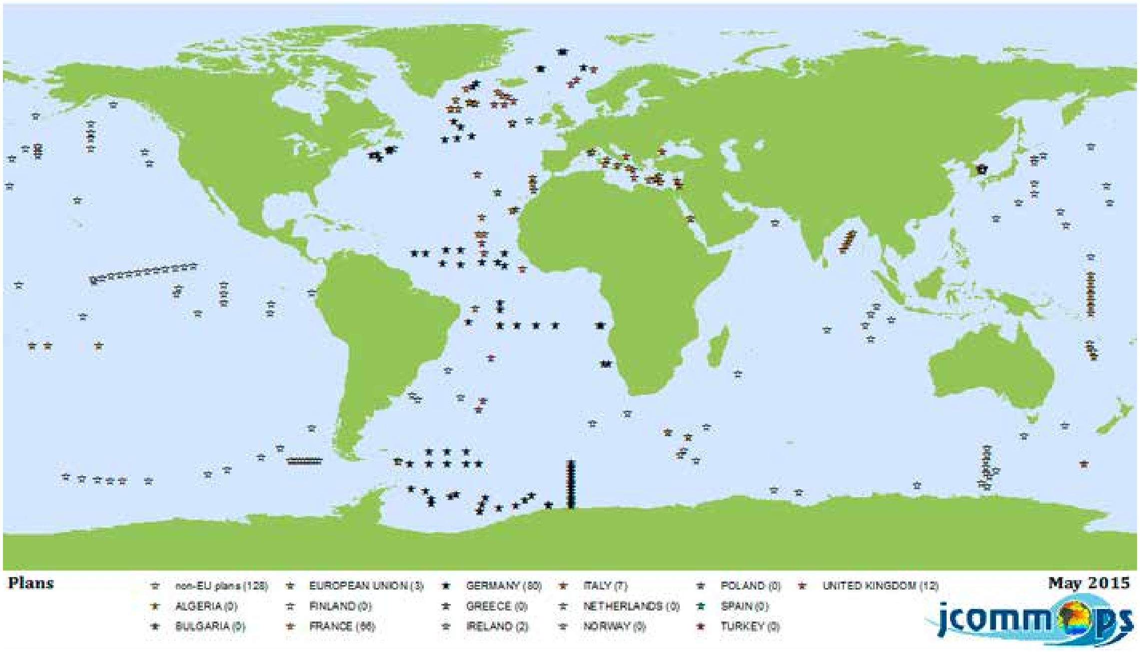


Figure 3: Euro-Argo partners deployment plans in colour, with Argo international plans in white (source: jcommops / AIC).

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 six 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.

In 2014, the preparation of the floats, shipment and deployment was organised at national level, with coordination regarding planning and deployment opportunities managed at Euro-Argo ERIC level. During the year 2014, the deployment plans for 2014 and 2015 were reviewed.

AT-SEA MONITORING

To maintain and improve the system, it is essential to continuously monitor the array at-sea from an engineering point of view, in order to assess instrumental performance and to detect early on any dysfunction. It is necessary to consider the sensors accuracy and stability (as well as all other performance indicators), mission parameters, energy budgets, transmission power, rate and causes of failure etc.

To achieve these objectives, a small group of national experts coordinated by the Program Manager worked together in 2014 to elaborate a proposal to identify how to improve the at-sea monitoring of the Euro-Argo fleet. The idea would be to use the monitoring tools developed by IFREMER on the whole EU fleet (see: http://www.coriolis.eu.org/Data-Products/At-sea-monitoring). This would be possible by loading the new technical files that are now provided for all the EU floats into the Coriolis database. The float behaviour will be periodically analysed and documented in a report listing the failures. The national experts of the RI help on in-depth analysis of failure in liaison with float and sensor manufacturers, especially when new modes of failures are identified. A rapid feedback about analyses of newly deployed floats is particularly important. Plans are to develop further this activity in 2015 within the DG-MARE MOCCA project.

Figure 4: Floats on the vessel ready for deployment (© LPO)

DEVELOPMENT OF A ROADMAP FOR FLOAT DEPLOYMENT

Within the FP7 SIDERI project a roadmap for Euro-Argo has been defined and in particular for its extensions. The goal now is to define an implementation plan that will take into account what can be done at national level and what needs to be complemented by European funding.

In summer 2014, each country was asked to make an inventory of what is done in their country with respect of the different topics identified in the Euro-Argo Roadmap, by filling a questionnaire on “Developing a roadmap for float deployment“. It comprised nine questions on deployment areas, types of floats, purposes for deployment and on scientific-technical preferences.

The questionnaire was sent and answered by all national Euro-Argo contact points. Questions 1 to 3 dealt with deployments of members during the recent period

2010-2014. The remaining six questions 4 to 9 dealt with the future:

- **Q1**: What is your preferred region of interest?
- **Q2**: What type of floats did you/your country deploy?
- **Q3**: For what purposes do you/your country deploy floats?
- **Q4**: What is your preferred region you/ your country plan to deploy floats in the future?
- **Q5**: For what purposes do you/your country plan to deploy floats?
- **Q6**: On what in your opinion should the EuroArgo community focus its activities in the future?
- **Q7**: Do you think the Euro-Argo community should support a specific research theme?
- **Q8**: The Euro-Argo community should support research on…
- **Q9**: It is current understanding that Argo needs advancements in float technology.

The outcome of the questionnaire can be taken as representative for the participants in EuroArgo. In general, there was good agreement amongst the participants, where the results can be summarized in 4 points:

- The Atlantic Ocean, its neighbouring seas and the Southern Ocean will remain the priority regions for the ERIC's deployment activities;
- Grid completion within the framework of the "traditional" Argo programme is the most important reason for float deployment;
- From a scientific point of view, research on items related to climate change should have a priority. The most prominent point was the interest in relation to monitoring heat transport, especially in the Atlantic Ocean. At the moment, several countries have programs for the Nordic Seas, which are mainly ice-free, but no plans yet for the ice-covered Arctic proper ;
- With respect to technical float development, there is a clear focus on biogeochemical sensors, deep ocean capability and longer battery life.

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1.3 Data Processing

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) Delayed Mode 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 and Southern Ocean ARCs).

In 2014, Argo Data Management efforts focused on:

- **Monitoring and Improving the Real-Time system:** A survey on delays has been achieved by the Argo Information Centre (AIC) using the French GDAC catalogues. A large improvement in the past three years has been achieved and unnecessary delays due to GDAC and European DAC have been corrected. Most data are delivered within 24 h to the GDACs and the WMO Global Telecommunications System (GTS). A second focus has been on real time quality control procedures, in particular for surface un-pumped data, where the Real Time Quality Control procedure for un-pumped SST has been defined,

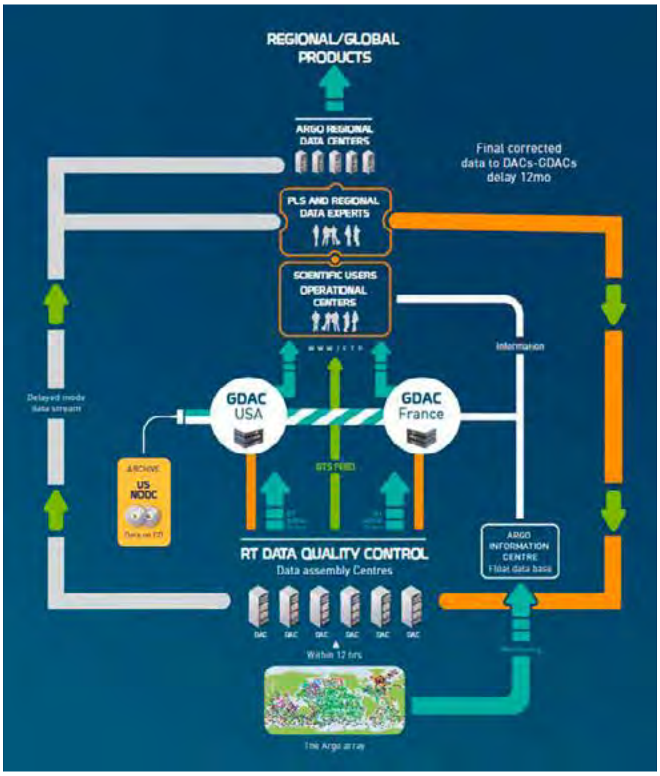

Figure 5: Argo Data Flow through the Argo Data System

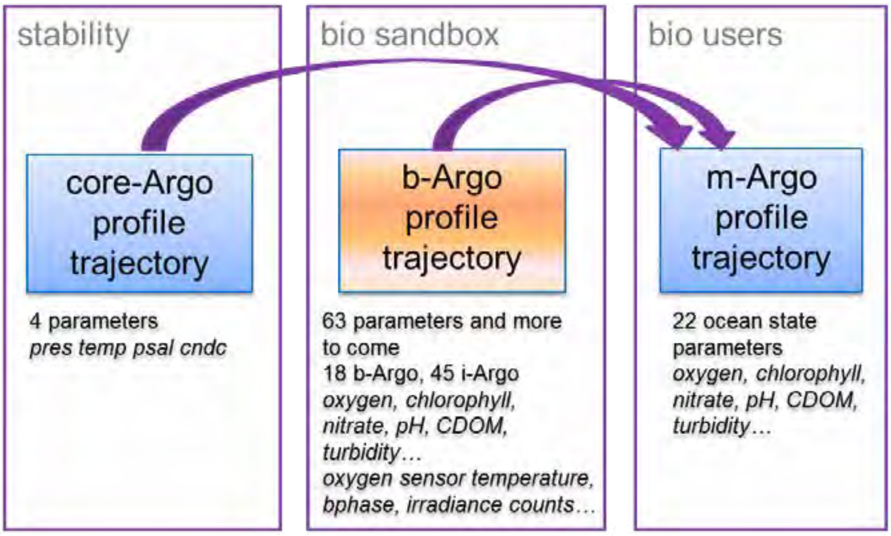

Figure 6: New V3.1 Argo Data Format, with separation of core-data and bio-data. More details in User's manual - chapter 2.6 "B-Argo profile and trajectory format additional features".

agreed with international partners and implemented at BODC and Coriolis. These data will be reprocessed and transmitted in 2015 to the GDACs in the new Argo V3.1 format.

- **Updating Data Format to V3.1:** Because of new technological developments in the past 5 years, a new Argo V3.1 format has been defined by the European partners and agreed with international Argo partners. This new V3.1 form allows separation between core-Argo Data (pumped temperature and salinity profiles) and additional Argo data collected within the extensions of Argo (mainly near-surface and biogeochemical data).

This new format allows to be able to *(i)* handle change in mission, especially for Iridium and Argos3 floats, *(ii)* to separate surface and sub-surface profiles, *(iii)* to enhance trajectory data, *(iv)* to have the capability to include new variables, especially new Bio-Argo parameters. The transition to V3.1 format has been implemented within the FP7 E-AIMS project and reprocessed files will be available at the GDACs in 2015.

REGIONAL CENTRES

The Atlantic ARC (NA-ARC)

http://www.ifremer.fr/lpo/naarc/

France is leading the NA-ARC, which is a collaborative effort between Germany (IFM-HH, BSH), Spain (IEO), Italy (OGS), Netherlands (KNMI), UK (NOCS, UKHO), Ireland (IMR), Norway (IMR), Canada (DFO), and USA (AOML). Within the NA-ARC, BSH and Hamburg University coordinate the activities in the Nordic Seas.

The NA-ARC produces maps and gridded products as well as some time series plots, all available on the web. It also provides a data-mining tool for North Atlantic Argo data. In 2014 an assessment of DMQC (Delayed Mode Quality Control) in the

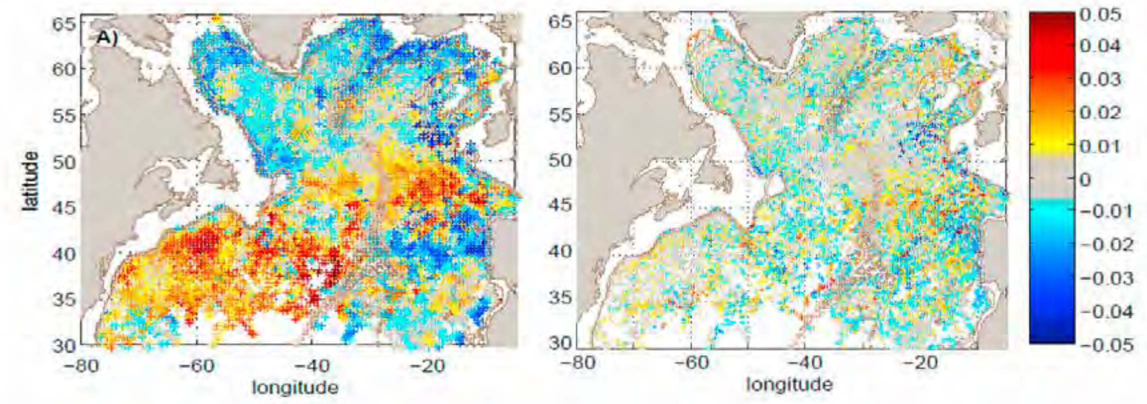

Figure 7: Spurious salinity corrections (in PSU) that can be obtained with the original OW method (left) are strongly reduced when the modified OW method is used (right).

Northern Atlantic was performed and led to the proposal for a modified OW method as described in the following paper: http://www.coriolis.eu.org/News-Events/Newsletters/Coriolis-10.

The modified OW (Owens-Wong) method better takes into account the large scale interannual variability that can be responsible of spurious corrections (see Figure 7). The new method was run on 578 floats, and for 26 floats the salinity correction proposed by the PI differs significantly from NA-ARC results. The PIs or DM operators of the 26 floats were informed and the DM corrections have been revised or are in process.

The Mediterranean and Black Seas ARC (Med-ARC)

http://nettuno.ogs.trieste.it/sire/medargo/active/index.php

Italy (OGS) is leading the MED-ARC, which is a collaborative effort between Greece (HCMR), Spain (IEO), France (IFREMER, UPMC/LOV), Bulgaria (IOBAS, USOF). In 2014, the Med-ARC coordinated the float operations in the Mediterranean and Black seas, including deployments and the production of Argo products. It performed also DMQC on the Argo data from this region. The Med-ARC manages more than 250 floats, with more than 70 floats presently active and the involvement of 2 new countries (Lebanon and Turkey).

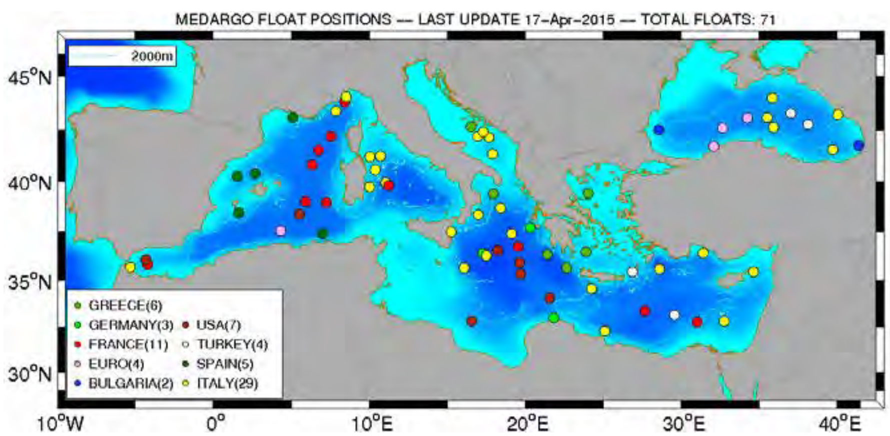

Figure 8: Positions of 71 Med-Argo Active Floats (source: Med-ARC, April 2015).

2 MAJOR SCIENTIFIC ACHIEVEMENTS

2.1 E-AIMS results

E-AIMS (Euro-Argo Improvements for the GMES/Copernicus Marine Service) is an FP7 Space R&D project dealing with the in-situ component of Copernicus (see: www.euro-argo.eu/E-AIMS).

E-AIMS is led by IFREMER and involves 16 institutions[1] from 9 different countries. The project started in January 2013 and will end in December 2015.

E-AIMS organises an end-to-end evaluation of new Argo floats (from float design down to the use of the data by GMES/Copernicus). WP3 is specifically dedicated to the impact and design studies from Copernicus Marine Service and seasonal/decadal modelling and forecasting. The main objective is to perform Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs) with the Copernicus Marine Service assimilation systems to assess the potential of Argo and its extensions. WP4 studies analyze the use of Argo float data to calibrate, validate and monitor the long-term stability of satellite observations and give present and future requirements for satellite cal/val activities.

IMPACT AND DESIGN STUDIES FOR COPERNICUS MARINE SERVICE MONITORING AND FORECASTING CENTERS

At global scale, 1-year OSEs were carried out with the Mercator Ocean ¼° global data assimilation system. A reference run where all data (satellite altimetry, sea surface temperature, Argo and other in-situ observations) were assimilated was compared to a run without Argo data assimilation or with only half of the Argo data assimilated.

A strong impact of Argo data assimilation was identified on temperature and salinity estimates at all depths, linked with an observation minus model forecast error (innovation) reduction both in term of variability and bias. Through Argo assimilation the differences between the observed and forecast fields is reduced by about 20% in the 0-300 m depth and from 20% to 65% in the 700-2000 m layers depth (Figure 9).

Argo floats are thus crucial in the system to control the model forecast water properties, from the surface down to 2000 m. Not all regions are equally impacted by the Argo observations. The performance of the system is also degraded if only half of the array is assimilated. Time series of the anomaly of heat and salt content for different depth ranges (not shown here) also reveal a strong sensitivity to the density of Argo data.

1 Ifremer, France; UKMO, UK; OGS, Italy; NERC/BODC, UK; KNMI, Netherlands; IEO, Spain; IMR, Norway; USOF, Bulgaria; IOPAS, Poland; Geomar, Germany; Mercator Océan, France; INGV, Italy; CLS, France; ACRI-ST, France; CSIC, Spain; IOBAS, Bulgaria.

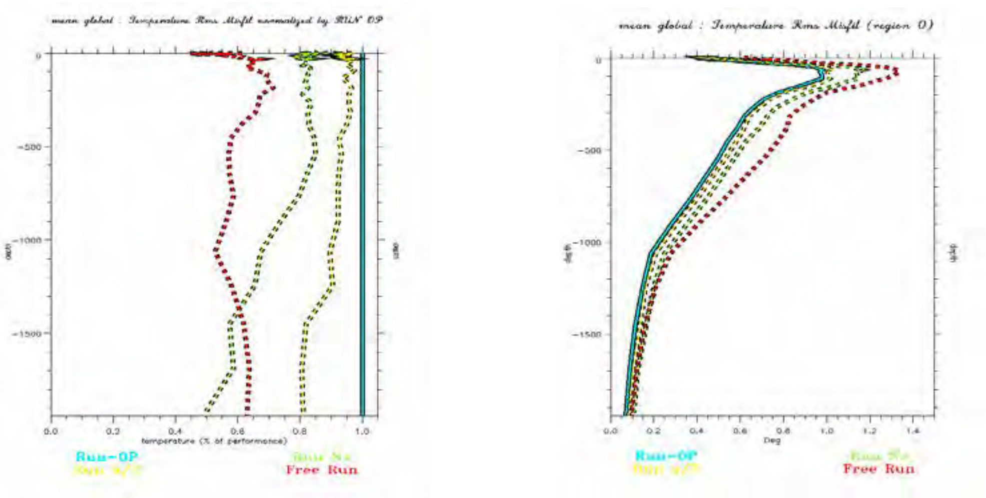

Figure 9: OSEs carried out with the Mercator Ocean global data assimilation system. Vertical structure of RMS of temperature innovations (left) and normalized RMS temperature innovations (right) from 0-2000m for Run-Ref (blue) (all observations assimilated), Run-Argo2 (yellow) (half of the Argo data assimilated), Run-NoArgo (green) (no Argo data assimilated) and Free Run (red). Innovations are defined as observation minus model forecast fields.

The denial of Argo observations from the Met Office coupled global data assimilation system caused a similar large degradation in ocean temperature and salinity innovation statistics, as shown in Figure 10. The greatest differences in the upper ocean built slowly over 6 to 12 months and future OSEs investigating the impact of Argo and other ocean observing systems should be run for between 6-months and 1-year.

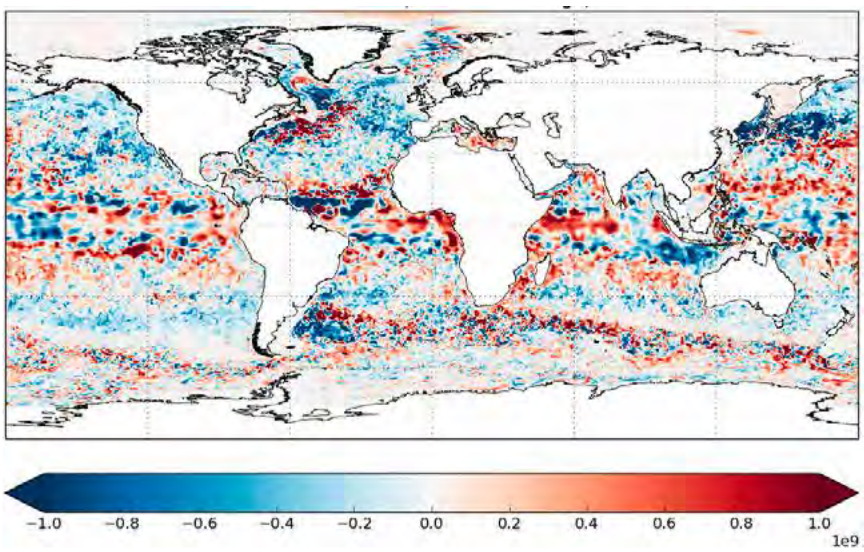

Figure 10: Upper-ocean heat content difference of top 300m, between the control analyses and the no-Argo analyses averaged over October 2012.

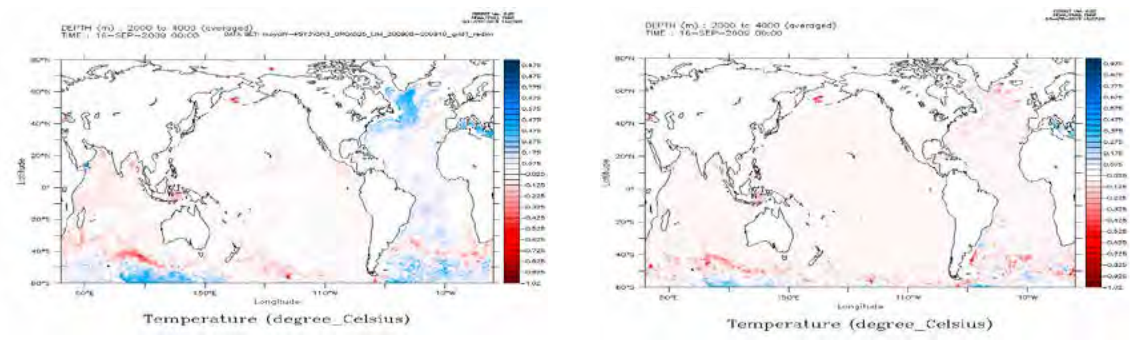

Figure 11: OSSE carried out with the Mercator Ocean global data assimilation model to analyze the sensitivity of results to the assimilation of deep (4000 m) Argo floats. Three month mean temperature difference between the analyzed and the simulated "truth" in the 2000m-4000m layer: on the left without any float diving below 2000 m and on the right with one third of the floats diving to 4000 m every third 10-day cycle (colour scale between -1 and 1°C).

OSSEs, where observations are simulated, were also carried out to simulate the extension of the future deep Argo network and its impact on the Mercator Ocean global ocean data assimilation system. The analysis quality at depth greatly benefits from observations deeper than 2000 m, even with a sparser spatial coverage than the surface layers, deep ocean bias (Figure 11) could then be corrected for. The oceans deeper than 2000 m are mainly unobserved at present even though they represent more than 50% of the total ocean volume. Given the role of the deep ocean on the earth's climate it is essential to set up a global, long term monitoring system for depths deeper than 2000 m. The E-AIMS results show that such deep measurements will be crucial to validate and constrain Copernicus Marine Service models at depth.

USE OF ARGO FOR SATELLITE VALIDATION

The satellite validation studies carried out in E-AIMS have focused on sea level from satellite altimetry, ocean colour, sea surface temperature (SST) and sea surface salinity (SSS). All those satellite missions require to be validated with in-situ measurements and Argo provides unique observations for such a validation. Analyses carried out as part of E-AIMS confirm the high potential of Argo observations for the validation of satellite observations. For some missions (e.g. SSS) they are already the main source of information to validate and monitor the quality of satellite observations.

SUMMARY OF E-AIMS RESULTS

The main findings of the E-AIMS project for its first two years are:

- The feasibility and readiness for pre-operational monitoring of the new Argo floats (deep Argo, O2, Bio-Argo, two way telecommunication) has been demonstrated through the deployment of 18 floats tested at sea.
- The Argo data system (European DACs and GDAC) has been updated to handle new types of Argo floats including their real time/delayed mode QC.

- Interfaces with the Copernicus Marine Service monitoring and forecasting centres (global and regional) have been enhanced.
- Major impacts of past and future Argo data for satellite validation activities (ocean colour, altimetry, SST, SSS) and for the Copernicus Marine Service (data assimilation, validation) have been highlighted.
- Improvements of Argo (Deep, Bio) are expected to have a large impact on the Copernicus Marine Service. Bio-Argo profilers are already a unique source of observations for the validation of ocean colour satellites. Development of this new capability will require to optimise the match-up strategy, to program high-frequency profile cycles when floats are located in a biologically stable area and to develop capabilities to recover and redeploy bio-argo profilers whenever possible in order to decrease the cost of the network maintenance.

In 2015, design recommendations for the new phase of Argo will be elaborated and provided to the Euro-Argo ERIC. These recommendations will address the importance of:

- Increasing the depth of the vertical sampling;
- Increasing sampling in regions of high variability;
- Increasing the number of measurements in the upper four meters of the ocean;
- Enlarging network coverage in the Atlantic Ocean and at high-latitudes;
- Extending the number of parameters measured to monitor biogeochemical variables.

E-AIMS has demonstrated the capability of the Euro-Argo infrastructure to conduct R&D driven by GMES/Copernicus needs and that procurement, deployment and processing of floats for GMES/Copernicus can be organized at the European level. These are key aspects for the long-term sustainability of GMES/Copernicus in-situ component. At the end of E-AIMS, Euro-Argo will agree on and start implementing the new phase of Argo.

2.2 Global Ocean Indicators (GOIs)

Variations in the world's ocean heat storage and its associated volume changes are a key factor to gauge global warming and to assess the earth's energy and sea level budget. Global Ocean Indicators (GOIs) are estimated with the method of von Schuckmann and Le Traon (2011).

Estimating Global Ocean Heat Content (GOHC) (Figure 12) and Global Steric Sea Level (GSSL) with temperature/salinity data from the Argo network reveals that the ocean gains heat at a rate of 0.5±0.1 Wm^{-2} (applied to the surface area of the ocean) and and that sea level rose by 0.5±0.1 mm $year^{-1}$ during the years 2005-2012, averaged between 60°S and 60°N (von Schuckmann et al, 2014).

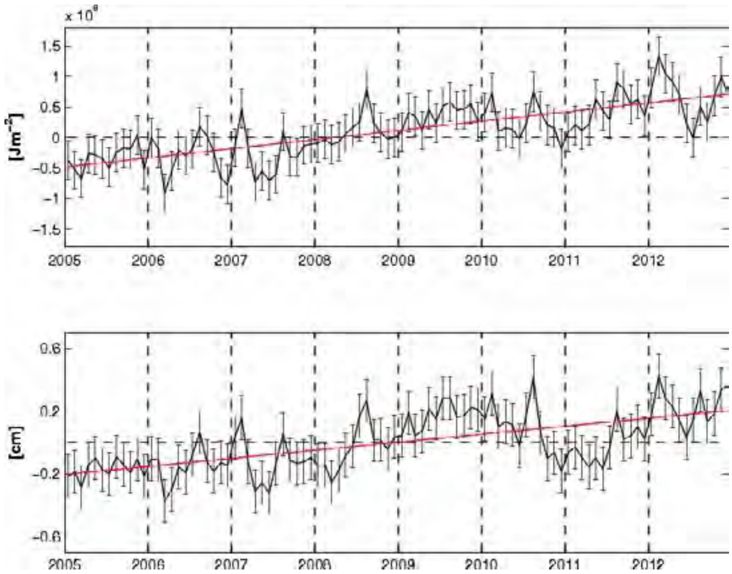

Figure 12: Global ocean (60 S–60 N) heat content (upper, GOHC) and steric sea level (lower, GSSL) during the period 2005–2012 from Argo according to the method of von Schuckmann and Le Traon (2011). The 8-year trends (red line) of GOHC/GSSL account for 0.5 ± 0.1 W m^{-2}, and 0.5 ± 0.1 mm $year^{-1}$ for the 10–1500 m depth layer, respectively. Error bars include data processing and climatology uncertainties, but not systematic errors (from von Schuckmann et al, 2014).

Argo salinity measurements in the upper 1500 m of the global ocean are also used to evaluate freshwater content FW, and a new GOI called GOFC (Global Ocean Freshwater Content). Owing to a lack of direct salinity observations, previous discussions on signatures of ocean hydrographic changes have concentrated on the temperature field but the salinity effect cannot be neglected. Ocean freshwater content is averaged globally following the method of von Schuckmann and Le Traon, 2011.

The first GOFC's estimation (Figure 13, from von Schuckmann and Le Traon, 2011) shows the dominance of inter-annual changes, while there are no significant trends. A study is in progress to further analyze changes of GOFC, as well as to update this GOI.

Work is also in progress to develop a method for the estimate of Regional Ocean Indicators for the Mediterranean Sea (von Schuckmann et al, 2014b) and will be presented soon. The Mediterranean area is one of the main "hot-spots" of climate change, with great demographic growth and overexploitation exerting exceptional pressure on the Mediterranean environment, its ecosystems, services and resources.

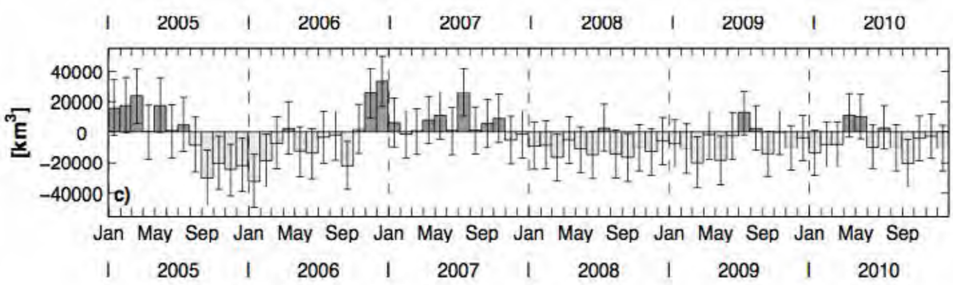

Figure 13: Estimation of GOFC for the period 2005-2010 from Argo measurements. The 6-yr trend is −80 ± 90 km^3 yr^{-1} (from von Schuckmann and Le Traon, 2011).

These first results show that GOIs derived from Argo measurements allow monitoring of the state of the global ocean. The estimation of GOIs based on this method was developed as part of the monitoring system in the frame of the European Commission project MyOcean (www.myocean.eu/) and within the Research and Development group of Coriolis.

References:

- Von Schuckmann, K. and P.-Y. Le Traon, 2011: How well can we derive Global Ocean Indicators from Argo data?, Ocean Science, 7, 783-791, 2011, www.ocean-sci.net/7/783/2011/, doi:10.5194/os-7-783-2011.
- Von Schuckmann, K., J.-B. Sallée, D. Chambers, P.-Y. Le Traon, C. Cabanes, F. Gaillard, S. Speich, M. Hamon, 2014: Consistency of the current global ocean observing systems from an Argo perspective, Ocean Science, 10, 547-557, doi:10.5194/OS-10-547-2014.

2.3 Bio-Argo

Two profiling floats, equipped with nitrate concentration sensors were deployed in the north-western Mediterranean from summer 2012 to summer 2013 (d'Ortenzio et al., 2014). Satellite ocean colour data were extracted to evaluate surface chlorophyll concentration at float locations. Time series of mixed layer depths and nitrate and chlorophyll concentrations were analyzed to characterize the interplay between the physical-chemical and biological dynamics in the area (Figure 14).

Deep convection (mixed layer depth > 1000 m) was observed in January–February, although high-nitrate surface concentrations could be already observed in December. Chlorophyll increase is observed since December, although high values were observed only in March. The early nitrate availability in subsurface layers, which is likely due to the permanent cyclonic circulation of the area, appears to drive the bloom onset. The additional nitrate supply associated with the deep convection events, although strengthening the overall nitrate uptake, seems to be decoupled from the December increase of chlorophyll.

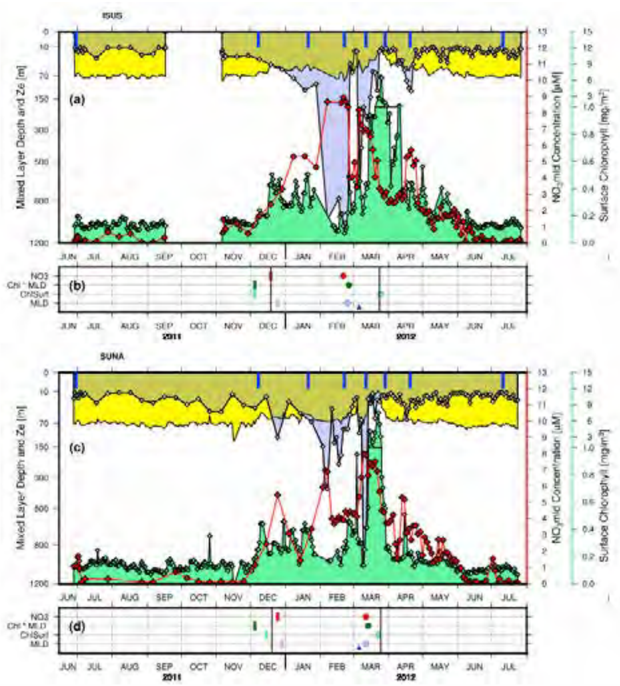

Figure 14: Time series and metrics of the PROVOR float with Nitrate sensor and satellite observations for the (a and b) ISUS sensor and for the (c and d) SUNA sensor. In Figures 14a and 14c, grey diamonds represent MLD, red diamonds NO3mld, yellow points Ze, and green diamonds CHL. The blue marks on the upper x axis of Figures 14a and 14c indicate the date of the satellite images. In Figures 14b and 14d, vertical short colored lines indicate the dates of parameter increasing (red for NO3, dark green for CHL × MLD, light green for CHL, and grey for MLD); circles indicate date of absolute maximum (same color code); and black lines indicate the dates of the first and the last occurrences of the MLD = Ze condition.

A new study from Wing et al., 2014 has demonstrated the ability of bio-Argo floats to measure and better understand the seasonal variability of 3 bio-optical properties (Chla, bbp(532) and cp(660)) in the North-Atlantic between June 2008 and May 2010, and their inter-correlations.

Another study published by Mignot et al, 2014 addresses the seasonal phytoplankton dynamics in the euphotic layer and explores its dependence on light regime dynamics. The bio-optical mechanisms and their relationship to light regimes that are revealed by the time series appear to be generic and potentially characteristic of all of the areas where a deep chlorophyll maximum forms, which is 50% of the open ocean.

References:

- D'Ortenzio F., H. Lavigne, F. Besson, H. Claustre, L. Coppola, N. Garcia, A. Laës-Huon, S. Le Reste, D. Malardé, C. Migon, P. Morin, L. Mortier, A. Poteau, L. Prieur, P. Raimbault and P. Testor : "Observing mixed layer depth, nitrates and chlorophyll concentrations in the North Western Mediterranean: a combined satellite and NO3 profiling floats experiment", Geophysical Research Letters, 41, 6443–6451, doi:10.1002/2014GL061020, 2014.
- Mignot, A., Claustre, H., Uitz, J., Poteau, A., D'Ortenzio, F. and X. Xing : "Understanding theseasonal dynamics of phytoplankton biomass and DCM in oligotrophic environments: a Bio-Argo float investigation".Global Biogeochemical Cycles, doi: 10.1002/2013GB004781, 2014.
- Xing, X., Claustre, H., Uitz, J., Mignot, A., Poteau, A. and H. Wang : " Seasonal Evolutions of Bio-optical Properties and Their Inter-relationships Observed by Bio-Argo Floats in the Sub-polar North Atlantic" , Journal of Geophysical Research - Ocean, 119, doi:10.1002/2014JC010189, 2014.

Figure 15: Bio Argo float deployment (© LOV)

3 FINANCIAL STATUS

3.1 Finances 2014

The Euro-Argo ERIC 2014 budget was presented during the 1st Council Meeting. As Bulgaria and Spain were not able to contribute as a candidate members, the income was 240 k€ (7* 30k€ + 3* 10k€). The expenditures were mainly related to personnel costs and services to set up and run the ERIC and for travel related to the Inauguration, Council and Management Board meetings.

As most of the contributions were provided in October and November 2014, it was difficult to set up subcontracts or hire new personal. It was agreed by the Council in November that the surplus from 2014 will be carried forward to 2015 and provide funds to run the ERIC during early 2015 as the members fees will be received in March-April 2015.

SUMMARY 2014 – GRAND TOTAL

Type	Code	Debit	Credit	Balance
Initial Balance				0
GC: Grants & contracts MF: Memberships fees II: Interest income VA: VAT reimbursement	GC MF II VA		240 000,00	240 000,00
PE: Personnel costs	PE	100 243,17		-100 243,17
TV: Travel Costs	TV	1 584,49		-1 584,49
MA: Materials Costs	MA	203,39		-203,39
AC: Accounting fees	AC	3 800,00		-3 800,00
BS: Bank services	BS	145,25		-145,25
SC: Other subcontracts	SC			0,00
				0,00
XX: Unknown, not yet categorized	XX			0,00
TOTAL FLOWS		105 976,30	240 000,00	134 023,70
END BALANCE				134 023,70

4 KEY PERFORMANCE INDICATORS

The EC set up a High Level Assessment Expert Group (AEG) to assess ESFRI RIs such as Euro-Argo. According to its 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 3 types of indicator:

- ***KPI 1*** : Regarding floats
- ***KPI 2*** : Regarding users
- ***KPI 3*** : Regarding financial aspects

4.1 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 2014, the deployment plans were reviewed for 2014 and 2015. In 2014 276 European floats were deployed, with at January 2015 a total of 694 active floats as shown in Figure 16. This is still below the target of 250 new floats/year and 800 operating floats, but has increased in recent years, as shown in Figures 17 and 18, where the percentage of European floats is approaching the 25% mark.

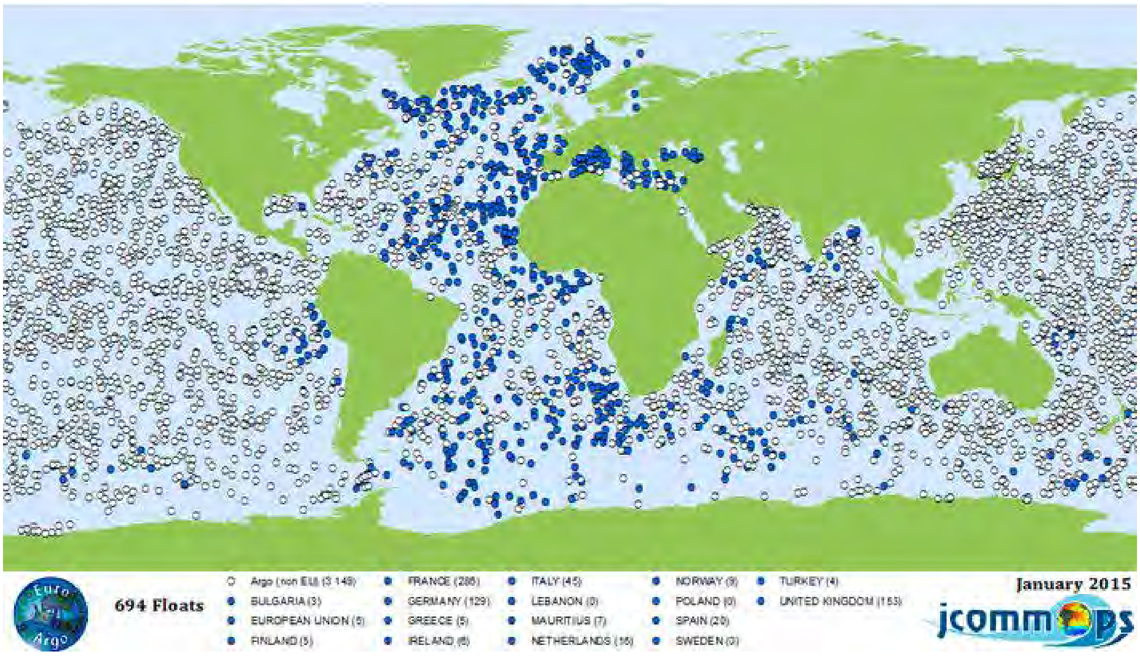

Figure 16: Argo (white points) and Euro-Argo RI (blue points) active profilers in January 2015 (source: jcommops/AIC).

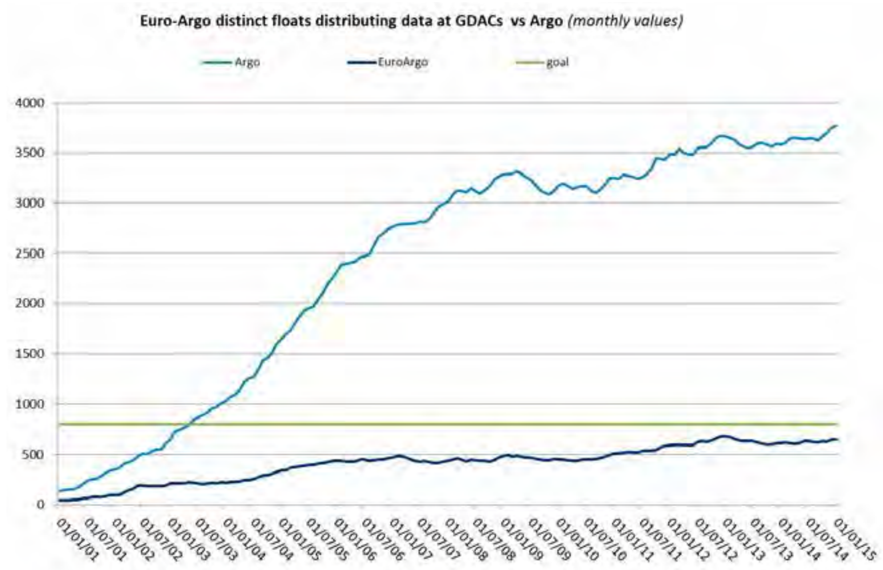

Figure 17: Euro-Argo (dark blue) progressing towards the initial target of 800 active (green) floats about 700 floats.

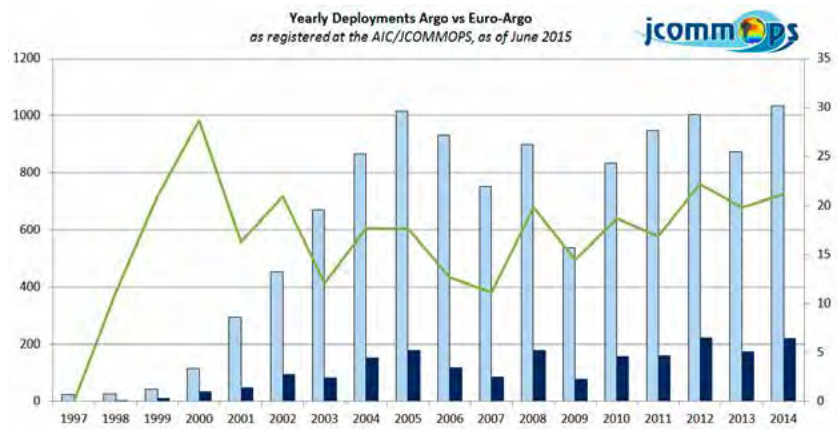

Figure 18: Number of Argo float deployed (light blue) and Number of Euro-Argo floats (dark blue) per year % Euro-Argo versus Argo (green).

In terms of float operating lifetime, as shown in Figure 19, the target is for 4 to 5 years, around 150 cycles.

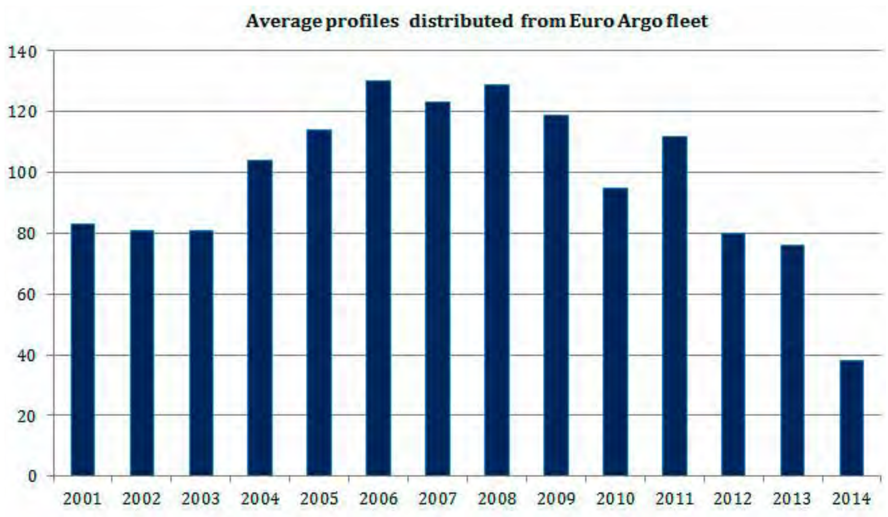

Figure 19: Average number of profiles per year provided by the Euro-Argo fleet. In the recent years the floats are not old enough to have performed 150 cycles as a float makes 36 cycles per year.

4.2 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.

A NEW 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 2014 are illustrated in Table 2 below. Figures 20 and 21 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 beneath, Germany, Italy and Spain contribute with about 150 papers since 1998.

A total of 349 Argo papers were published in 2014, which is the highest number since 1998. Argo publications from the Euro-Argo ERIC community also reach a high with 103 papers published in 2014. Since 1998, the European contribution has been 28.8 % of the total number, which is better than the initial target of 25%.

	Total (since 1998)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
GERMANY	*70*					2		1	3	4	3	7	5	6	9	9	12	9
GREECE	*7*										1		1	1	1			3
FINLAND	*1*																1	
FRANCE	*208*		1	1	1	3	1	2	3	6	8	16	17	17	23	31	30	48
ITALY	*47*									5	6	4	3	7	5	7	5	5
NETHERLANDS	*7*													1	1	2	2	1
NORWAY	*17*											1		1	3	4	3	5
UK	*154*	1	1	1	3	2	3	2	6	7	14	6	8	12	13	24	24	27
POLAND	*1*																	1
IRELAND	*1*													1				0
SPAIN	*37*							1	3	4	1	1	3	6	3	6	5	4
BULGARIA	*0*																	
TOTAL EURO-ARGO	*550*	*1*	*2*	*2*	*4*	*7*	*4*	*6*	*15*	*26*	*33*	*35*	*37*	*52*	*58*	*83*	*82*	*103*
ARGO Bibliography	*1910*	*4*	*4*	*8*	*16*	*20*	*21*	*26*	*53*	*81*	*94*	*102*	*117*	*226*	*230*	*264*	*295*	*349*
% EU Bibliography vs Argo	*28,80*	*25,00*	*50,00*	*25,00*	*25,00*	*35,00*	*19,05*	*23,08*	*28,30*	*32,10*	*35,11*	*34,31*	*31,62*	*23,01*	*25,22*	*31,44*	*27,80*	*29,51*

Table 2: Number of publications using Argo from EU users, and percentage versus Argo publications, per year since 1998.

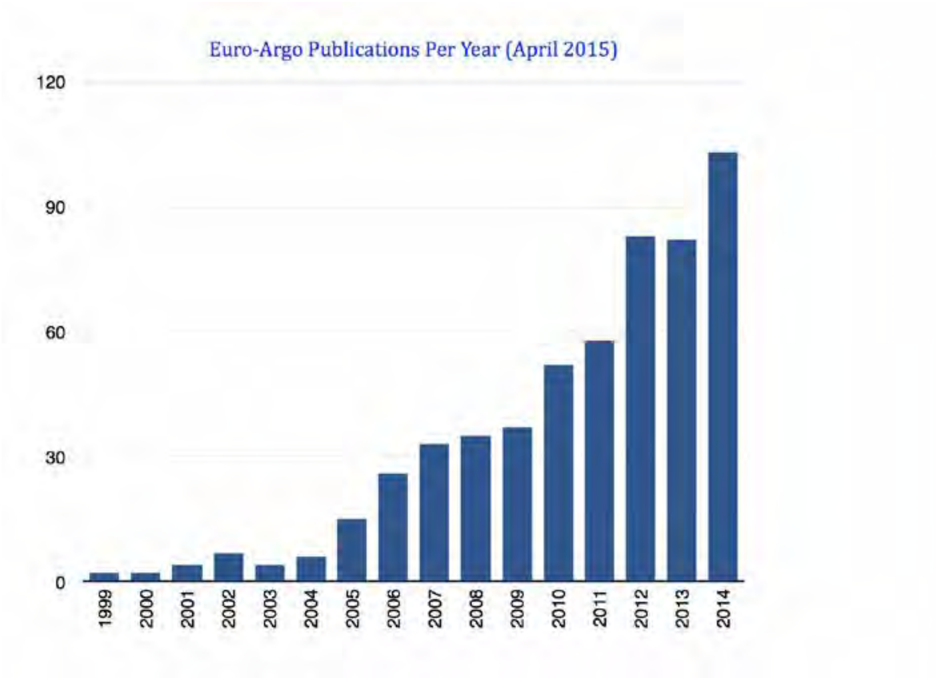

Figure 20: Number of Argo publications from Europe per year since 1998.

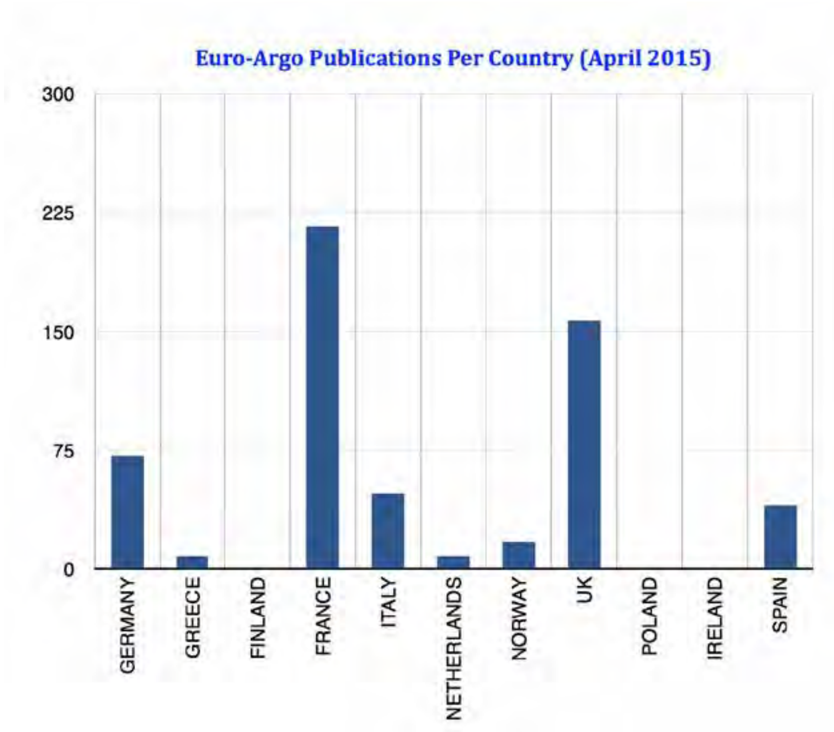

Figure 21: Number of publications by Euro-Argo participating countries since 1998.

ACCESS TO DATA

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 22 to 24.

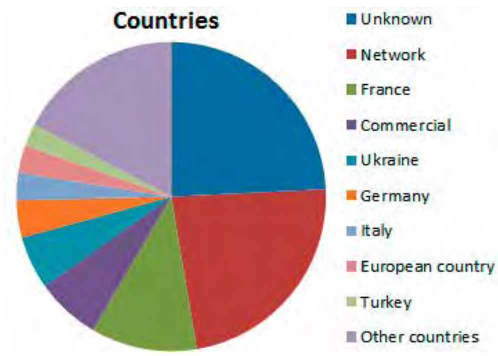

Figure 22: Origin of Users of the Coriolis GDAC portal by countries in 2014.

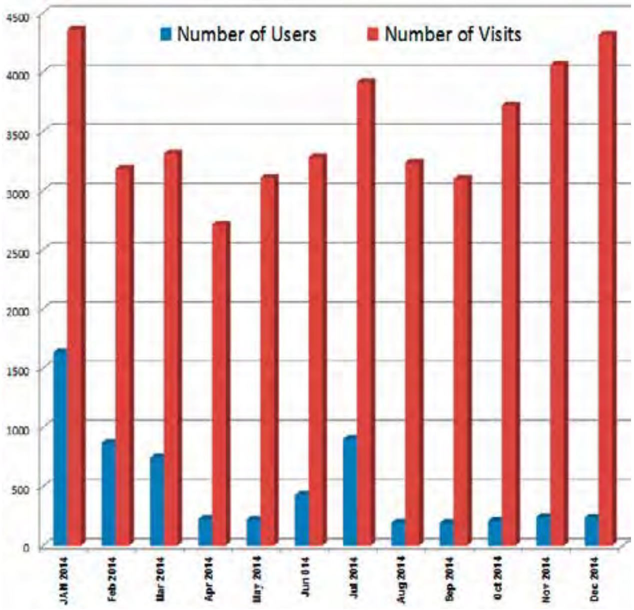

Figure 23: Number of Users and Visits on Coriolis GDAC in 2014.

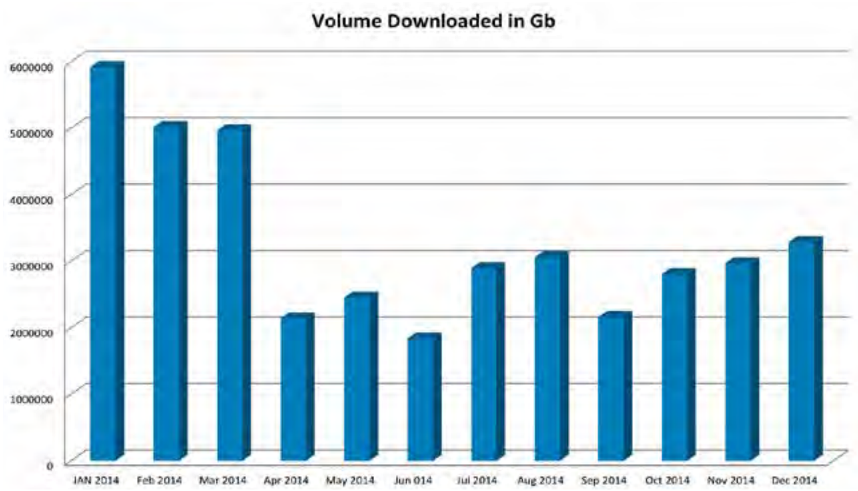

Figure 24: Volume of Data (in Gb) downloaded from Coriolis GDAC in 2014.

4.3 Regarding "Funding Sustainability"

Through the setting up of the Euro-Argo ERIC, funding from member states has been secured. This funding is estimated to be about 5 M€/year. Since 2008 Euro-Argo has also been working on complementary funding from the EU. The Central RI, in collaboration with the ERIC partners, worked in 2014 on several short-term opportunities to integrate the Euro-Argo ERIC contribution in new proposals.

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 7 Bio-Argo floats in the North-Atlantic to enhance the actual network of 60 floats and 60 O2-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 2014.

DG-MARE (EUROPEAN MARITIME AFFAIRS AND FISHERIES)

Since 2012, Euro-Argo partners have been discussing with DG-MARE on supporting the Euro-Argo infrastructure and to contribute funding for 100 floats per year including deployment and data processing. A draft Euro-Argo DG-MARE proposal was prepared in August 2013, discussed at the Euro-Argo Management Board meeting in January 2014 and revised in March and October 2014.
The target is that DG-MARE will contribute 4M€ and the ERIC with its members will add an additional 20% (i.e. 1M€) that will generate a total of 5M€ over a two year period. The details of costs and splitting activities between the Euro-Argo ERIC and its members would be as follows:

- Year 1: 40 floats DG-MARE + 10 floats Members.

- Year 2: 80 floats DG-MARE + 20 floats Members.

The funding would allow Euro-Argo to purchasing those (standard temperature and salinity) floats, arrange their deployment in 2016-2017 including at sea monitoring and their processing (2015-2019) in real-time and delayed mode. The Euro-Argo ERIC would demonstrate its capacity to manage such an activity, and continue to work with EC towards sustaining such a contribution in the future.

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ISOPOD

ISOPOD (« Infrastructure Support for Oceanography: Preparation, Operation and Development ») proposal addresses the H2020 work programme on the European Research Infrastructure (INFRASUPP-6-2014) and addresses the general challenge of international coordination and cooperation in sustained ocean observations for ocean research, focussing on the challenges of large-scale, open ocean in situ observations that are on the cusp of research and operations. ISOPOD proposal included the development of *(i)* Euro-Argo activities in the international context, *(ii)* the extension of the Euro-Argo cooperation in Mediterranean and Black sea, towards key third countries in the European neighbourhood (North Africa, Middle East, Russia etc.) and *(iii)* the Euro-Argo cooperation in the sub-polar North Atlantic, Baltic and Arctic seas. The proposal was submitted in September 2014 but was not successful.

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 of cross-disciplinary collaboration and 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.


Planned members
and observers

Annex 1 : Partners of Euro-Argo ERIC

Country	Statute	Representing 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	
Member	**Profession/Position**
Pierre-Yves Le Traon	*Chair*- IFREMER France
Jon Turton	*Co-Chair* – Met Office UK
Bernd Brügge	BSH Germany
Vasilios Lykousis	HCMR Greece
Bart van den Hurk	KNMI Netherlands
Mikko Strahlendorff	FMI Finland
Alessandro Crise	OGS Italy
Walczowski Waldemar	IOPAN 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	Met Office UK
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
Scientific & Technological Advisory Group (STAG)	
Glenn Nolan	EuroGOOS – EOOS
Susan Wijfels	CSIRO Australia – Argo International
Johnny Johannessen	NERSC Norway – Copernicus Marine Service
Arne Kortzinger	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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