French National Report on Argo - 2014

Present status and future plans

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G. Maze, C. Cabanes, T. Carval, C. Coatanoan, F. D'Ortenzio, N. Lebreton, S. Le Reste, P.Y. Le Traon, S. Pouliquen and V. Thierry

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1 BACKGROUND, ORGANIZATION AND FUNDING OF THE FRENCH ARGO ACTIVITIES

1.1 Organization

Argo France[1] gathers all the French activities related to Argo and its extension toward deep and biogeochemical measurements. Argo France is the French contribution to the Euro-Argo[2] European research infrastructure (ERIC) that organizes and federates European contribution to Argo. Ministries from 12 European countries have agreed to form a new legal European entity to organize a long-term European contribution to Argo. The ERIC was set up in May 2014. The Euro Argo infrastructure is made up of distributed national facilities and a central infrastructure based in France (Ifremer, Brest), which is owned and controlled by the Euro-Argo ERIC. The distributed national facilities operate with direct national resources. As part of the Euro-Argo research infrastructure, they agree to a multi-annual commitment of resources (in particular in terms of floats to be deployed and for the data system), and to coordinate their activities through the Euro-Argo ERIC.

Euro-Argo and its French component (Argo France) is part of the Ministry of Research national roadmap on large research infrastructure (TGIR). Argo France is organized through the Coriolis[3] partnership (IFREMER, SHOM, INSU, IRD, Météo France, CNES and IPEV) and its governance bodies. Two research laboratories are leading the Argo France scientific activities: the "Laboratoire de Physique des Océans[4]" (LPO, Brest, France) and the "Laboratoire d'Océanographie de Villefranche[5]" (LOV, Villefranche, France). Argo France has been recognized in January 2011 as a long-term observing service. The agreement is valid for 10 years. Coriolis and Argo France have strong links with Mercator Ocean[6] (the French ocean forecasting center).

1.2 Funding

Argo France is mainly funded by the ministry of Research through Ifremer as part of national roadmap on large scale infrastructures and contribution to Euro-Argo (TGIR). This is a long term commitment. Argo France is also funded through SHOM (ministry of defense), CNRS/INSU and other French institutes involved in oceanography (CNES, IRD, Météo-France). At regional scale, Argo France is supported by the IUEM OSU[7] and funded by the CPER of the Brittany region.

The French contribution to the Argo global array is at the level of 60 to 65 floats per year with funding from Ifremer (50 floats/year) and SHOM (about 10 to 15 floats/year). Together with its European partners, Ifremer also works with the European commission to set up a long term direct EU funding for Argo.

Since 2000, around 892 French floats have been deployed in a number of different geographic areas. Deployments have been focused on meeting specific French requirements while also contributing to the global array.

To complement Argo, the NAOS[8] project (Novel Argo Ocean observing System, 2011-2019) has been funded by the Ministry of Research to consolidate and improve the French contribution to Argo and to prepare the next scientific challenges for Argo**.** The project provides an additional funding of 10 to 15 floats per year from 2012 to 2019, which

allows Ifremer to increase its long-term contribution to Argo from 50 to 60-65 floats/year. NAOS will also develop the new generation of French Argo floats and set up pilot experiments for biogeochemical floats (Mediterranean Sea, Arctic) and deep floats (Atlantic). An European Research Council (ERC) advanced grant has also been obtained by LOV to work on the development of a biogeochemical component for Argo, the REMOCEAN[9] project (REMotely sensed biogeochemical cycles in the OCEAN, 2010-2015)**.** Overall, as part of the NAOS and REMOCEAN projects, 150 additional floats should be deployed before 2019.

The level of support, additional to float purchase, is as indicated in Tableau 1 (man power for coordination activities, float preparation, deployment and data management activities).

Year	**Funding**	**Man/Year**	**French floats**	**Co-funded EU floats**	**Total**
2000	300k€		11		11
2001	633k€	3	12		12
2002	980k€	6	7	4	11
2003	900k€	9	34	20	54
2004	1400k€	15	85	18	103
2005	450k€	15	89	11	100
2006	900k€	12	51	14	65
2007	900k€	12	36		36
2008	1200k€	12	90		90
2009	1200k€	12	35	8	43
2010	1400k€	12	55		55
2011	1400k€		53		53
2012	1400k€	12	82		82
2013	1400k€	12	81		81
2014	1400k€	12	96		96
Total (2000-2014)			***817***		**892**
2015	**1400k€**	**12**	**95**		**95**

Tableau 1: (*Man/year* column) Man power dedicated to Argo for coordination activities, float preparation, deployment and data management activities (GDAC, DAC, NAARC, DMQC) within Argo-France. (*French floats* column) French floats contributing to Argo deployed by year. (*Co-funded EU floats* column) EU floats are the additional floats co-funded by European Union within the Gyroscope, Mersea and MFSTEP projects. Estimated value is given for 2015.

1.3 Long term evolution of Argo

Euro-Argo has been working on a long term roadmap for the next phase of Argo and as part of the ERIC Euro-Argo countries will work on the implementation of a new sustained phase for Argo in Europe (see Strengthening International Dimension of Euro-Argo Research Infrastructure, SIDERI[10] project). At French level, the plan for the next 10 years is to continue deploying between 70 to 80 floats/years but to include Argo oxygen, bio-Argo, deep Argo long term components (from 2016/2017 after the NAOS pilot projects). A plan was submitted

in 2014 to the French Ministry of Research (TGIR). The goal is to contribute to 30 floats/year (T&S), 10 to 15 deep floats/year, 15 to 20 floats with oxygen sensors and 15 floats/year with biogeochemical sensors. This will require additional funding for floats, sensors and data processing.

2 FLOAT DEVELOPMENT

Since 2011, Ifremer together with NKE and CNRS has been working on PROVOR/ARVOR floats improvement in order to develop, validate and deploy the next generation of French Argo profiling floats. The new float capabilities include: longer life-time, more efficient design of the vehicle, improved transmission rates, integration of biogeochemical sensors, deeper measurements and under ice operations in the polar seas. In 2014, new prototypes have been achieved.

Firstly, the Arvor (for Argo core needs) has evolved to meet several requirements like reinforced self-tests, simplification of deployment protocol, securing the vector and the return of technical information and assistance for decoding the data. The works also include the improvements desired by users for Argos transmission system, including the mode to bind two missions each with different parameters. Two of these Arvor floats have been tested at sea in 2014 and demonstrated the easy way to deploy them. Three others will be deployed in early 2015.

The implementation of oxygen measurement on Arvor has been done. Two oxygen sensors have been tested on this float in order to compare their performance. This will continue in 2015 by deploying a 2nd float. Then, recommendations to improve oxygen measurements methodology should be done.

Improving Argos satellite transmission has continued. The ability to transmit Argo profiles (~100 samples) with Argos3 system has been tested in the Mediterranean Sea, which is an area known to be difficult for Argos transmission. Confirmation of this capabilities has been given by the transmission of whole profiles taking only few minutes, instead of several hours for Argos2 system.

The Deep-Arvor industrial phase has started. Two industrial prototypes (CTD + Oxygen) were realized, delivered, and then deployed in the North Atlantic Ocean during Geovide cruise in May 2014. The two floats start their profile at 4120 dbars (~4000m depth) and should demonstrate their stability during long immersion periods, their ability to cycle during a long time, and the quality of their measurements. By the end of December 2014, the 2nd float (2 days cycles) reached 100 cycles. A pilot experiment will start in 2015, which purpose is to deploy 12 Deep-Arvor in the same area.

Another main aspect of the development concerns the bio-geochemical applications. The Provor-CTS5 developed in 2013 is dedicated, i) to embed additional optical sensors, ii) to do other cycle schemes than Argo standard ones, iii) to modify its programmed mission itself depending on measurements or on results of mixed measurement computations. In 2014, this float has been adapted to be operated in Arctic area. In order to detect ice that covers the sea surface, the algorithm use temperature and salinity variations combined with an acoustic sounder. In case of detection, data transmissions are postponed. These floats will be deployed by Summer 2015.

3 THE STATUS OF IMPLEMENTATION

3.1 Floats deployed and their performance

96 floats have been deployed in 2014 (see map and table below). The deployment areas are chosen to meet French requirements in terms of research and operational activities (Atlantic, Indian and Southern Oceans) but also to contribute to establishing the global array (especially in the Southern Ocean) using AIC tools/map (see Figure 1).

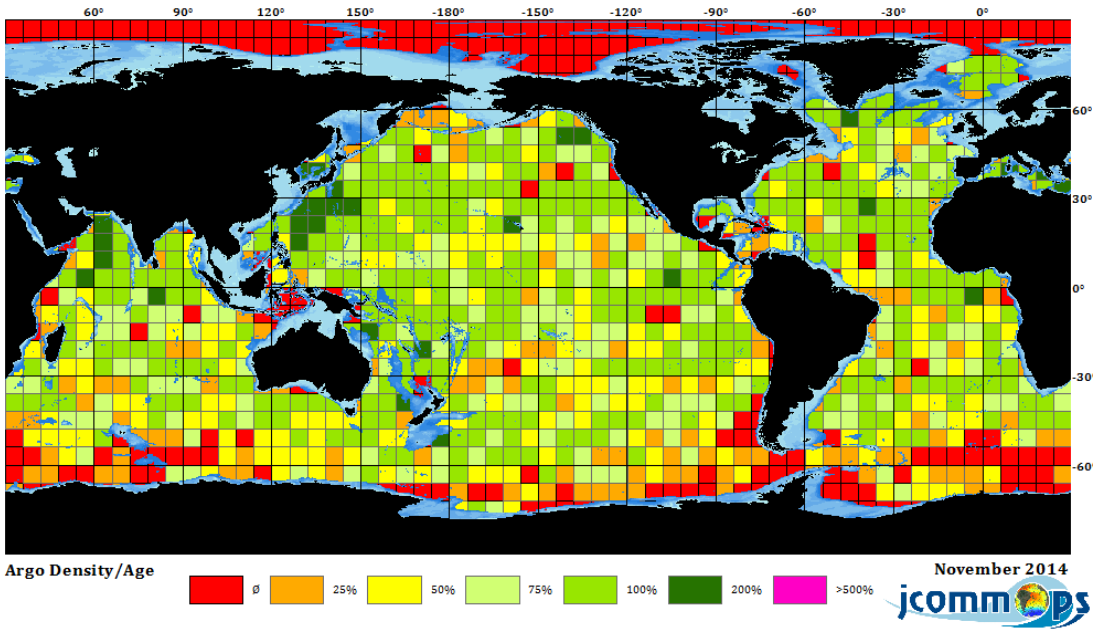
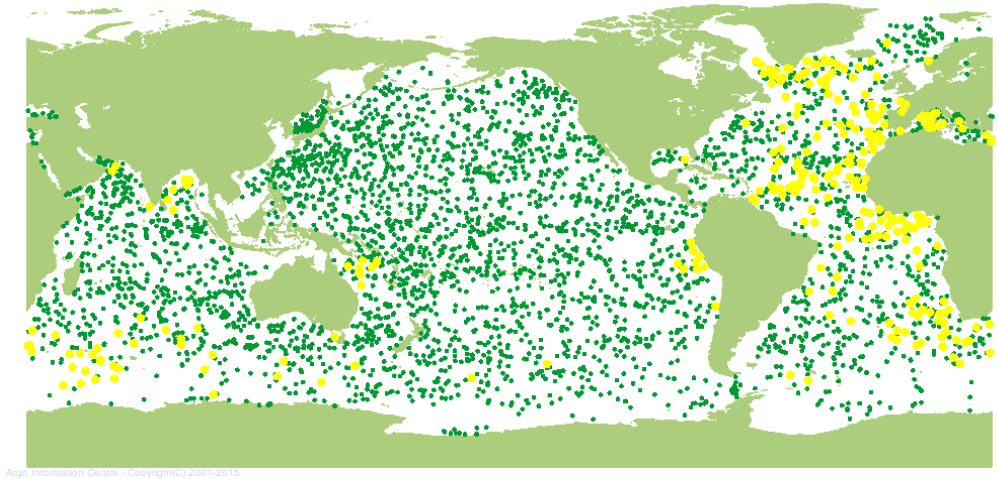
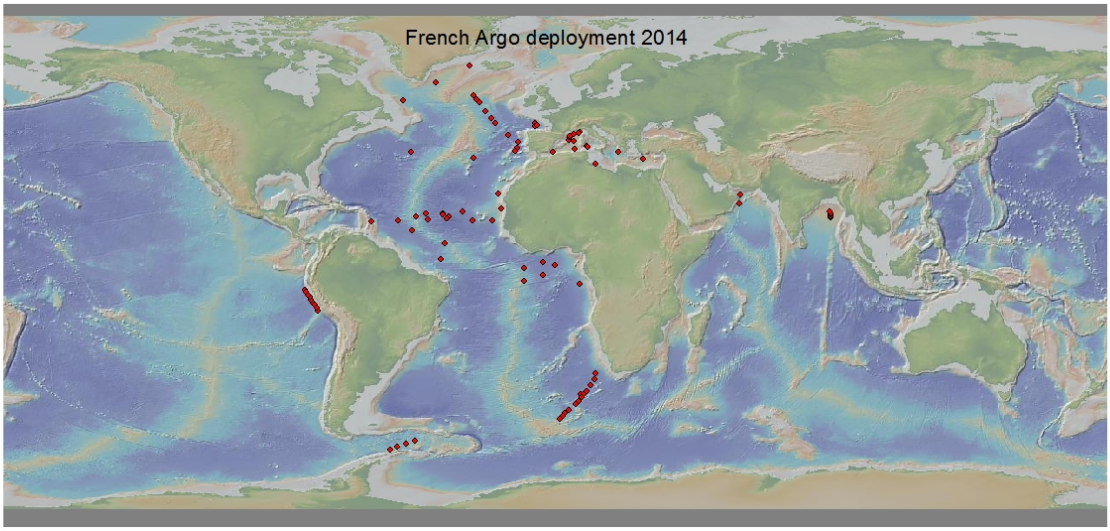


Figure 1 : Argo density/age 6°/6°



Positions (red marks) of the French active floats as of 05th February, 2015



2 ARVOR	**Oman / Persian Gulf**	**January**
11 ARVOR **2 APEX**	**North TransAtlantic**	**February** **October**
3 PROVOR DO **6 ARVOR**	**Perou AMOP**	**February**
6 ARVOR	**Guinea Gulf**	**May**
8 PROVOR DO	**Mediterranean sea**	**June**
2 PROVOR DO **8 ARVOR** **2 ARVOR DO**	**North Atlantic GEOVIDE**	**June**
10 ARVOR	**West Africa**	**Autumn**
6 ARVOR	**Sri Lanka**	**December**
2 ARVOR N	**Bay of Biscay**	**September**
3 ARVOR	**Falklands**	**October**
10 ARVOR	**Antarctic Goodhope**	**December**
15 PROVOR BIO	**North Atlantic** **Goodhope – Southern Ocean** **Mediterranean Sea** **Falklands**	

Deployment positions of the French floats for 2014

3.2 Technical problems encountered and solved

Problems encountered with the new ARVOR software in 2013 have been solved in 2014: we fixed the date bug and ensured good response from SBE sensors.

3.3 Status of contributions to Argo data management

Within Argo-France, Argo data management is undertaken by Coriolis, which play three roles: Argo Data Assembly Centre, Global Data Centre, and leader of the North Atlantic Argo Regional Centre. Coriolis is located within Ifremer-Brest and is operated by Ifremer with support of Shom. **More details on the Coriolis activities as DAC and GDAC can be found in Coriolis annual reports**[11] (French only).

We are developing a new data processing chain based on Matlab to manage data and metadata from Provor-Remocean floats. These are advanced type of floats performing bio-geo-chemical measurements. They will be available in real-time from Argo GDAC when the new version of the format checker will be deployed. In the mean time they are available in V3.1 format at:

ftp://ftp.ifremer.fr/ifremer/coriolis/argo/dac/

More information at: http://www.coriolis.eu.org/Data-Products/Data-Delivery/Argo-bio-floats-from-Coriolis

3.3.1 Data Assembly Center[12]

Coriolis processes in Real Time and Delayed Mode float data deployed by France and 7 European countries (Germany, Spain, Netherlands, Norway, Italy, Greece, Bulgaria). These last 12 months, a total of 30 753 profiles from 687 active floats was collected, controlled and distributed. Compared to 2013, the number of profiles increased by 40%, the number of floats increased by 5%. The increase in profile number is mainly explained by new bio-Argo floats that perform more vertical profiles than typical core-Argo floats. We also started to split in 2 profiles the floats having pumped/unpumped CTD samplings.

Transition to Argo NetCDF format V3.1: Since May 17th 2013, the new profile files from Coriolis DAC are distributed in Argo NetCDF version 3.0. On October 7th 2013, all the existing real-time profile files from Coriolis DAC where transformed into version 3.0 files (43 964 files resubmitted). Since September 2014, the Provor bio-Argo floats are distributed with Argo NetCDF V3.1 format: metadata, technical data, trajectory and profiles. Gradually, all Coriolis files will be converted in Argo NetCDF 3.1. The transition will be performed by float type: for a given type, all files will be converted. We want to avoid a combination of different formats for a given float.

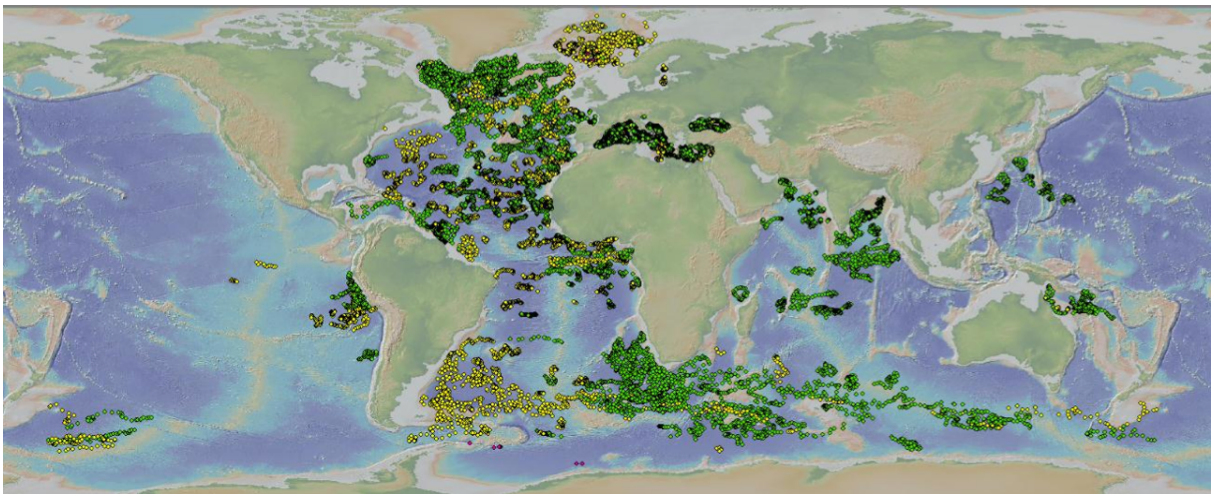


Figure: Maps of the 30 753 profiles from the 687 floats managed by Coriolis DAC in 2014.

3.3.2 Global Argo Data Centre[13]

Coriolis hosts one of the two global data assembly centres (GDAC) for Argo that contains the whole official Argo dataset. The Argo GDAC ftp server is actively monitored by a Nagios agent (see http://en.wikipedia.org/wiki/Nagios). Every 5 minutes, a download test is performed. The success/failure of the test and the response time are recorded (see Figure 2). We faced 2 bad events in November 2013 and in July 2014.

• In November 2013 (week 43), we cumulated 3 days, 2 hours and 28 minutes of interruption. This major problem was related a system instability on the linux cluster.

• In July 2014 (week 29), we cumulated 2 days of interruption. The Ifremer Internet service provider faced a router problem, somewhere between Brest and Paris.

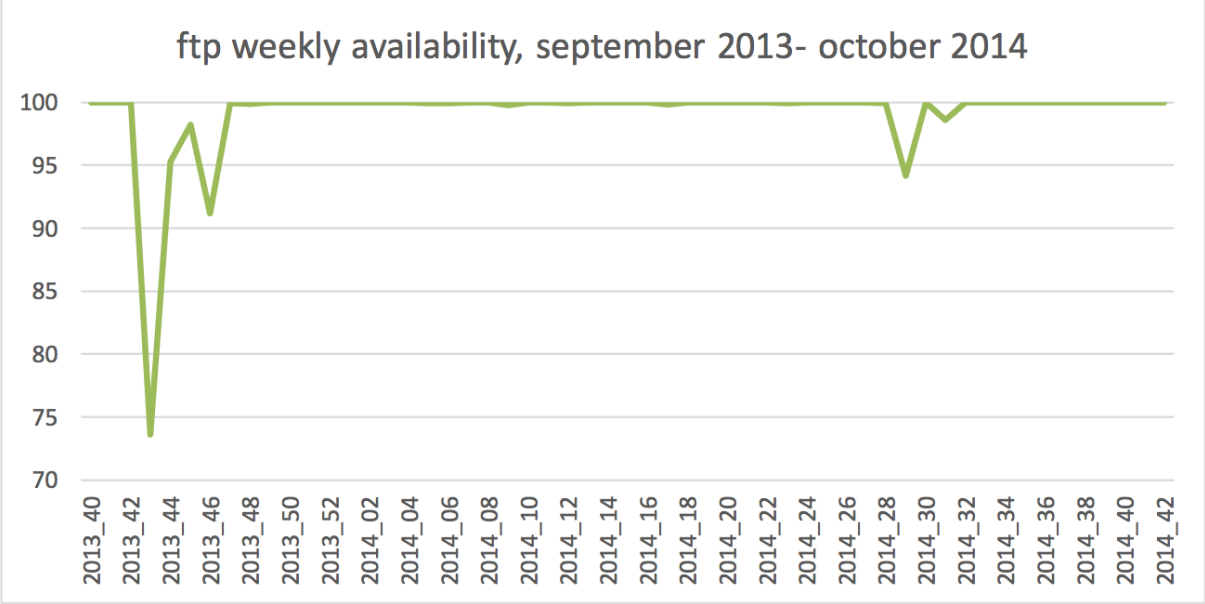


Figure 2 : Nagios monitoring: between October 2013 and September 2014.

3.3.3 North Atlantic Argo Regional Centre[14]

See section 5.4

3.4 Status of delayed mode quality control process

In 2014, a total of 6835 new delayed mode profiles where produced and validated by PIs. A total of 116 113 delayed mode profiles were produced and validated since 2005 (see Figure 5). In February 2015, 64% of the floats and 66% of the profiles processed by the Coriolis DAC were in delayed mode, compared to 71% and 74% last year, respectively (see Figure 6). Fewer profiles have been processed in delayed mode in 2014 but the decrease in percentage is also due to an increase of new floats with a lot of profiles (not yet in delayed mode).

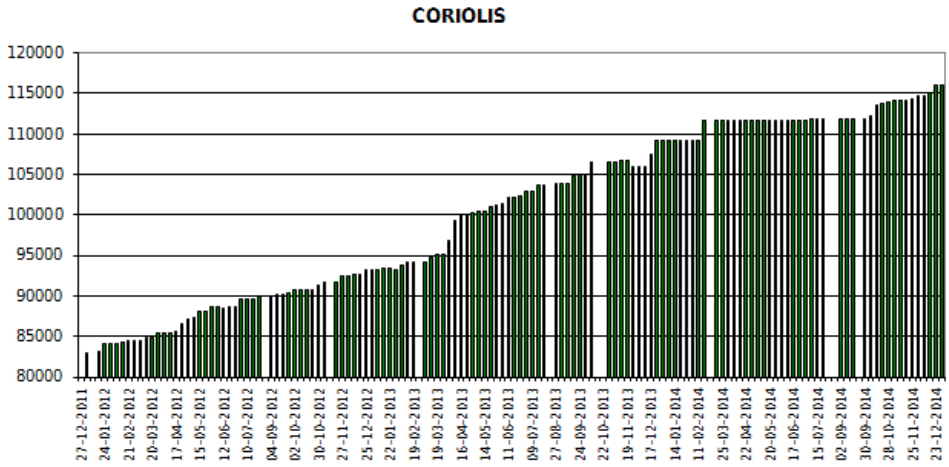


Figure 5: Evolution of the DM profiles' submission versus dates

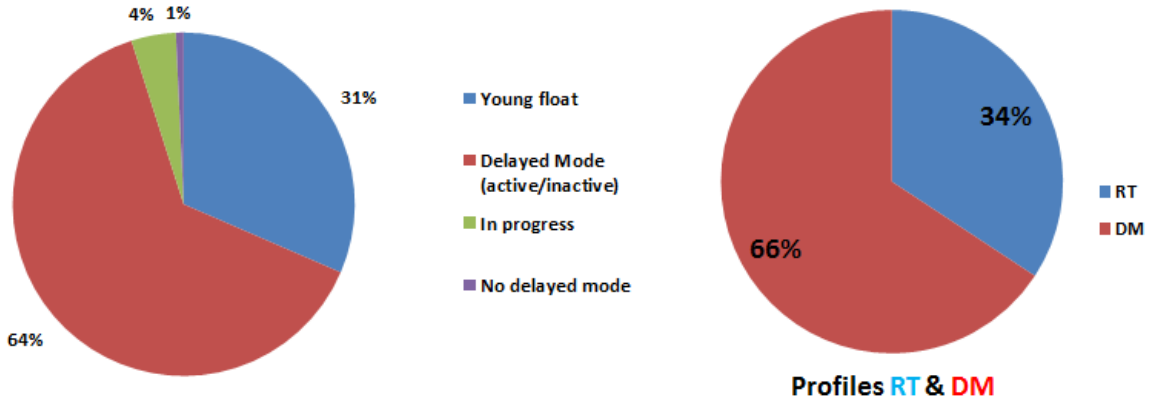


Figure 6. Status of the floats processed by Coriolis DAC. Left: in terms of float percent and right: in terms of profile percent (DM : delayed mode – RT : real time).

4 SUMMARY OF DEPLOYMENT PLANS* AND OTHER COMMITMENTS TO ARGO† FOR THE UPCOMING YEAR AND BEYOND WHERE POSSIBLE

According to the current deployment plan, 95 floats will be deployed in 2015. They will be deployed **in** the Mediterranean Sea, in Atlantic (North and South), in the Southern Ocean and in the Indian Ocean. During the following cruises:

6 ARVOR	**Opportunity Barcelona World Race South Atlantic**	**January**
2 ARVOR	**PROTEUS MED Mediterranean sea**	**January**
3 PROVOR T/S 5 ARVOR	**GMMC GOODHOPE South Atlantic**	**February**
10 ARVOR	**GMMC OUTPACE Pacific**	**February**
4 ARVOR	**Opportunity North TransAtlantic**	**February April**
6 ARVOR	**PIRATA Guinea Gulf**	**March**
9 ARVOR	**GMMC SCALOP Falklands**	**April**
7 ARVOR	**FALKLANDS Cooperation with Barcelona ICM/CSIC**	**March**
5 ARVOR	**BRAZIL Cooperation with Barcelona ICM/CSIC**	**April**
8 ARVOR 9 PROVOR DO	**GMMC REXX North Atlantic**	**May/June**
7 ARVOR	**GMMC CASSIOPEE New Caledonia**	**July**
6 ARVOR	**GMMC SAGAR Bay of Bengal**	**Summer**
2 ARVOR	**GMMC INDOMIX Indonesian Sea**	**Summer**
10 ARVOR	**Bay of Biscay and West Africa - VSF**	**Autumn 2015**

Coriolis will continue to run the Coriolis DAC and the European GDAC as well as coordinating the North Atlantic ARC activities. Within the Euro-Argo project, development will be carried out to improve anomalies detection at GDAC both in RT and DM, to monitor in real time the behavior of the European fleet and to improve data consistency check within NA-ARC.

France also contributes to the funding of the AIC.

* Level of commitment, areas of float deployment
† Data management

5 SUMMARY OF NATIONAL RESEARCH AND OPERATIONAL USES OF ARGO DATA AS WELL AS CONTRIBUTIONS TO ARGO REGIONAL CENTERS

5.1 Operational ocean forecasting

All Argo data (alongside with other in-situ and remotely sensed ocean data) are routinely assimilated into the MERCATOR operational ocean forecasting system run by the MERCATOR-Ocean[6] structure.

5.2 Support to the Mercator and Coriolis scientific activities

Coriolis has developed together with MERCATOR (The French operational oceanography forecast center) a strong connection with the French research community via the Mercator-Coriolis Mission Group (GMMC). It consists of about one hundred researchers (with some turnover each year) following a scientific announcement of opportunities and call for tender. Its task is to support the Mercator and Coriolis scientific activities and to participate in product validation. The call for tender proposes to the community "standard" Argo floats as well as floats equipped with oxygen and biogeochemical sensors. These new opportunities strengthen ties between the French scientific community and Coriolis with regard to the development of qualification procedures for "Argo extensions" floats.

5.3 National Research

Argo data are being used by many researchers in France to improve the understanding of ocean properties (e.g. circulation, heat storage and budget, and mixing), climate monitoring and on how they are applied in ocean models (e.g. improved salinity assimilation, …). In section 8 a non-exhaustive list of 2014's publications involving Argo data and a scientist from a French laboratory is reported.

5.4 Argo-Regional Center: North Atlantic

France has taken the lead in establishing 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), Greece (HCMR) and Bulgaria (IOBAS). Coriolis coordinates the North-Atlantic ARC activities and in particular the float deployment in Atlantic.

The NA-ARC website provides information about float data and status in the North-Atlantic Ocean. NA-ARC also provides a web API to access metadata about Argo profiles in the North Atlantic region (http://api.ifremer.fr/naarc/v1).

We have checked 578 floats processed in delayed mode (DM) in the North Atlantic, North of 30°N. Among the 578 floats, 392 do not show a significant salinity drift or bias according to the PI decision and were not corrected in DM, the other 186 floats have been corrected by the PI.

For each of the 578 floats, we have run a slightly modified OW method. Compared to the OW original method, our configuration better take into account the interannual variability, that was shown to induce spurious corrections with the standard OW method settings and provides

an improved estimate of the error bars. The modified OW method has been described in more details in the following paper:
http://www.mercator-ocean.fr/content/download/2058/15810/version/1/file/Newsletter%2350-final.pdf

For each float, we have compared the original correction made by the PI and the result of the slightly modified OW method. We found 26 floats among 578 for which the salinity correction proposed by the PI differs significantly from our results. The 26 floats are listed on the NAARC web site:
http://www.argodatamgt.org/Argo-regional-Centers/North-Atlantic-ARC/Overall-consistency-of-DM-corrections

Pis or DM operators of the 26 floats have been informed and the DM corrections have been revised or revisions are in process. We plan to update these checks of the overall consistency of the delayed mode corrections in the NAARC region once a year.

6 ISSUES THAT YOUR COUNTRY WISHES TO BE CONSIDERED AND RESOLVED BY THE ARGO STEERING TEAM REGARDING THE INTERNATIONAL OPERATION OF ARGO.

These might include tasks performed by the AIC, the coordination of activities at an international level and the performance of the Argo data system. If you have specific comments, please include them in your national report.

Many format issues were reported when processing data downloaded from the CCHDO for the Argo reference database. Many files did not comply with the file format and naming convention. In some cases, data with a QC "good" were obviously "bad". Dealing with all those issues is time consuming and prevent updating more regularly the database or working on the DMQC of many floats. It also raises the issue of data quality: can we trust the data if the file format or QC values are not good? (See also next section)

7 CTD CRUISE DATA IN THE REFERENCE DATABASE

To continue improving the number of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include the number and location of CTD cruise data uploaded by PIs within your country to the CCHDO website in the past year. These cruises could be used for Argo calibration purposes only or could be cruises that are open to the public as well.

French PIs within France uploaded CTD cruise data to the CCHDO website in 2014 but the exact number is not known at this time. In December 2014, a new version of the Argo CTD reference database (2014V01) was made available on the ftp site (see Figure 11).

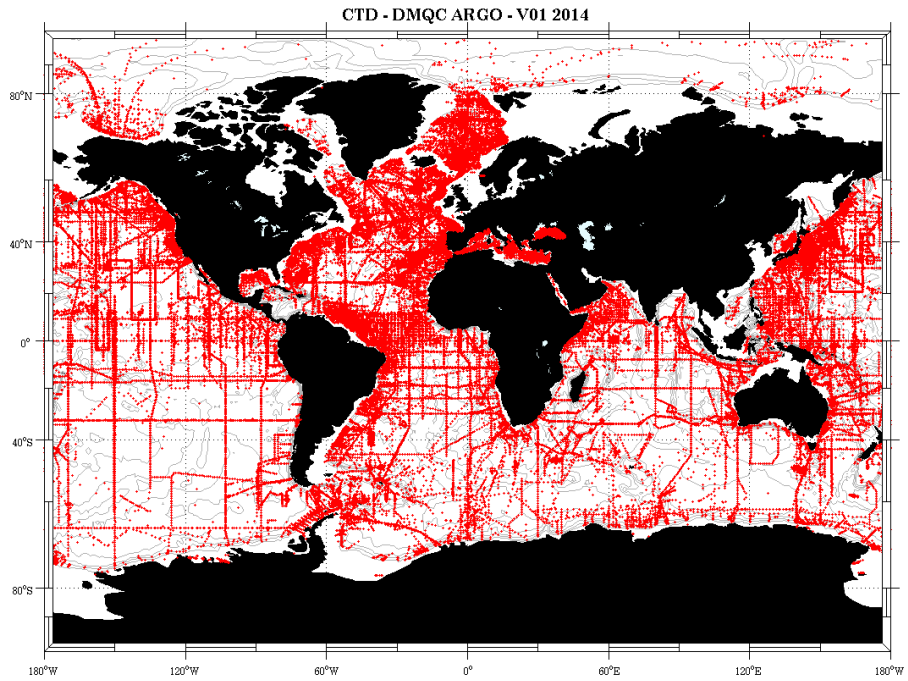


Figure 11: CTD reference database (2014V01)

This version takes into account few updates with new CTDs downloaded from the CCHDO website, data from OCL updates or coming directly from scientists. Some corrections have also been done after checking quality on the deep water to remove bad data. This work of correction has been done for the boxes with WMO number started with 1 and in progress for the others areas.

Concerning the data provided from the CCHDO, we are still waiting for a clear participation mainly for getting information of availability of new CTDs with homogeneous format of the CTD files.

8 BIBLIOGRAPHY

List of publications in which a scientist from a french laboratory is involved

In 2014, at least 31 articles with a French scientist as a coauthor have been published in peer reviewed journals. The list is reported hereafter. Note that the list of all publications in which a scientist from a French laboratory is involved is available on the Argo France website[15] and on the Argo Bibliography[16] webpage. To date, around 200 articles have been listed (see Figure 3).

In May 2013, we setup an online form dedicated to the French community to report as easily as possible PhDs and Master internships using Argo data. So far, 29 PhDs have been reported. The form is available here: http://goo.gl/XjBxC0.

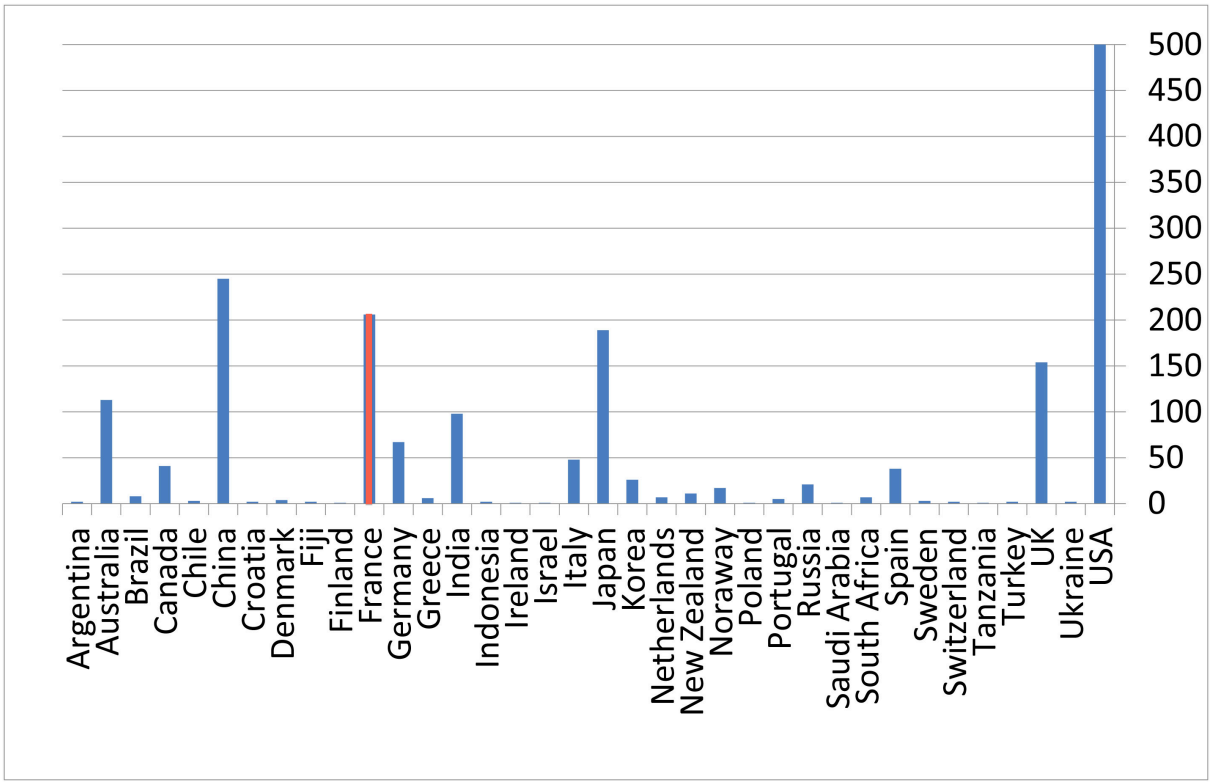


Figure 3: Number of paper using Argo data as function of the country of the lead author. France contribution is highlighted in red (Feb/2015).

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Footnotes

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[4] Laboratoire de Physique des Océans: http://wwz.ifremer.fr/lpo
[5] Laboratoire d'Océanographie de Villefranche: http://www.obs-vlfr.fr/LOV
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