# French National report on Argo – 2012
# Present status and future plans

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## 1. Background, organization and funding of the French Argo activities

Argo France gathers all the French activities related to Argo and its extension toward biogeochemical measurements. Argo France is the French contribution to the Euro-Argo European research infrastructure that organizes and federates European contribution to Argo. The European Commission has validated the Euro-Argo ERIC application and a final iteration was performed between the French ministry and the other ministries. The signature process started and the ERIC set-up is likely to happen in 2013. Together with its European partners, Ifremer also works with the European commission to set up a long term direct EC funding for Argo. France will host the Euro-Argo ERIC legal structure. Euro-Argo and its French component (Argo France) is part of the Ministry of Research national roadmap on large research infrastructures (TGIR).

### 1.1. Organization and funding

At national level, the Argo France activities are undertaken by Coriolis (CNES, Ifremer, INSU, IPEV, IRD, Météo-France et SHOM) as well as by two laboratories: the Laboratoire de Physique des Océans (LPO, Brest, France) and the Laboratoire d'Océanographie de Villefranche (LOV, Villefranche, France). Argo France has been recognized in January 2011 as a long-term observing service. The agreement is valid for 10 years.

Argo France is funded by the ministry of Research and by local administrations (Britanny region, Finistère department, city of Brest) mostly through Ifremer but also through other French institutes involved in oceanography (CNES, IRD, INSU, Météo-France) and in a lesser proportion by the ministry of Defense through SHOM. Until now, the French contribution to the Argo global array was at the level of about 65 floats per year with funding from Ifremer (about 50 floats/year) and SHOM (about 15 floats/year).

Since 2000, more than 640 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 France and Euro-Argo ERIC, the NAOS project has been recently 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 15 floats per year from 2012 to 2019, which allows Ifremer to increase its long-term contribution to Argo from 50 to 65 floats/year. A European Research Council (ERC) advanced grant has also been recently obtained by LOV to work on the development of a biogeochemical component for Argo**.** Overall, as part of the NAOS and REMOCEAN project, 150 floats should be deployed over the next 8 years in three pilot areas: Mediterranean Sea, Arctic and North Atlantic.

Overall 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 |
| ***Total (2000-2012)*** | | | ***640*** | | **715** |
| | | | | | |
| **2013** | **1400k€** | **12** | **65** | | |

**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 2012.**

### 1.2. Float development

Based on Ifremer expertise in acoustically tracked Lagrangian floats named "Marvor", Ifremer has developed the PROVOR profiling float in the late 90s and in collaboration with the NKE manufacturer has managed to provide to the Argo community a reliable instrument meeting the Argo requirements. PROVOR has now moved towards a « multi-sensors » utilization. The instrumental base has been modified in order to make the integration of new sensors easier. For example, Provor is fitted with an Aanderaa optode (Provor-DO). ProvBio (CTD and optical sensors) and ProCarbon (CTD, dissolved Oxygen, Particular Organic Carbon) have been developed and use Iridium system to transmit more data, to reduce time at surface and to modify some mission parameters by remote control. Developments are under way to provide an ARGOS3 version of these floats.

Ifremer, in partnership with NKE manufacturer, has developed the ARVOR float that aims to complete the float offer. When PROVOR leads toward a "multi-sensors" utilization, ARVOR tends to agree with the following criteria: performances improvement, easy deployment (lighter weight < 20kg) and costs reduction. Since 2010, ARVOR floats can be fitted with Iridium transmission capability.

Since 2011, Ifremer together with NKE and CNRS is working on PROVOR/ARVOR floats improvement within the NAOS project 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 2012, several prototypes have been completed.

Ifremer teams have been deeply involved in Argos-3 satellite transmission. The main objective is to transmit a complete profile on a single satellite pass and to remotely control the float. Two transmission types have been explored, the low and the high-rate. The interactive low-rate uses the same channel flow rates and power transmission as Argos-2. An Arvor-A3 has been successfully deployed in October in the Bay of Biscay. The float is able to transmit 150 points data per profile (about 1.5 times a typical Argo profile) in a single Argos-3 satellite pass (less than fifteen minutes) including margins. The high-rate transmission uses GMSK modulation on a dedicated channel, with increased power and at a theoretical speed of 4 800 bits/s. The transmission test results suffer from high variability. The best passages satellites can transmit more than 1 000 points, for the best cases to much less for the worst ones. This point is still under investigation.

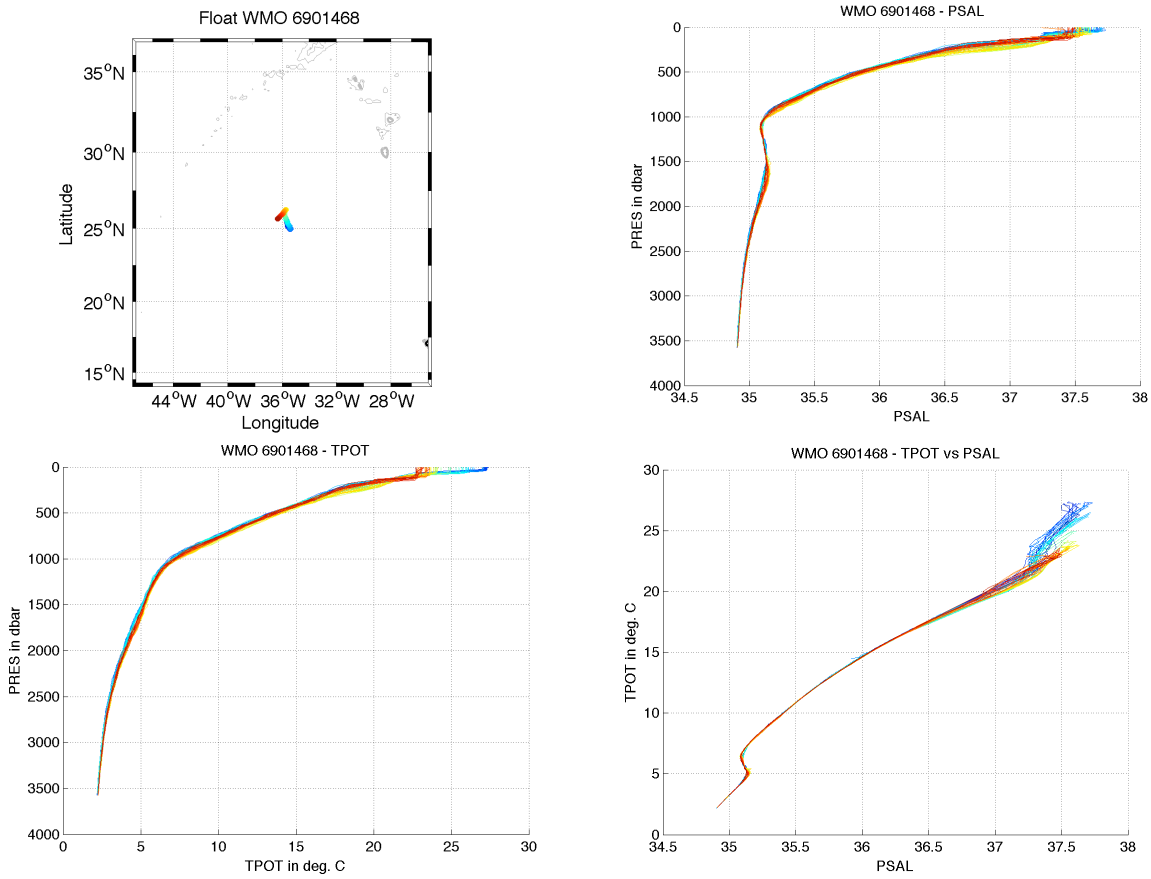


**Figure 1: Position, salinity and temperature profiles and θ/S diagram for the deep Arvor float (WMO 6901468). The color of each profile varies from blue (first profile) to red (last profile).**

The deep Arvor model was successfully deployed during the Strasse campaign in August 2012 in the middle of the Atlantic Ocean (Figure 1). This was the last step of a work started in 2009 by Ifremer. This extension to Argo capabilities is needed to monitor deep water masses that play a key role in climate change studies. The targeted "depth" was achieved thanks to the use of composite materials that have the advantages of being light and cheap, the adaptation of engine technology and the

evolution of the CTD sensor. This deep-Arvor float is also equipped with an optode sensor and an Iridium satellite transmission in "sbd" mode. The on-board energy package is dimensioned to realize 150 cycles CTD02. Since its launch, the deep-Arvor reached sixty cycles at 3500 m depth (Figure 1) and transmitted both standard Argo sampling profiles and high-resolution profiles (1000 points). The float remained in the same area which allowed us to verify the good stability of the sensors over the first 6-month period. The achievement and maintaining a cycling Argo float at 3500 m depth is a performance. We are currently investigating the possibility to reach 4000 m depth.

## 2. The status of implementation (major achievements and problems in 2012)

### - floats deployed and their performance

**82 floats** have been deployed in 2012. 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).

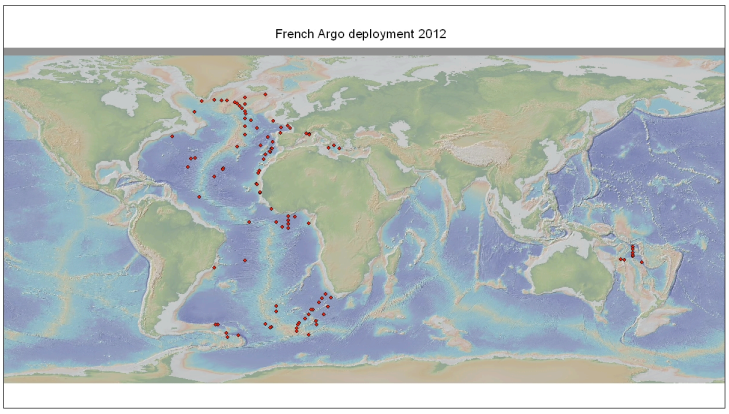


**Figure 2: Deployment position of the 82 French floats deployed in 2012.**

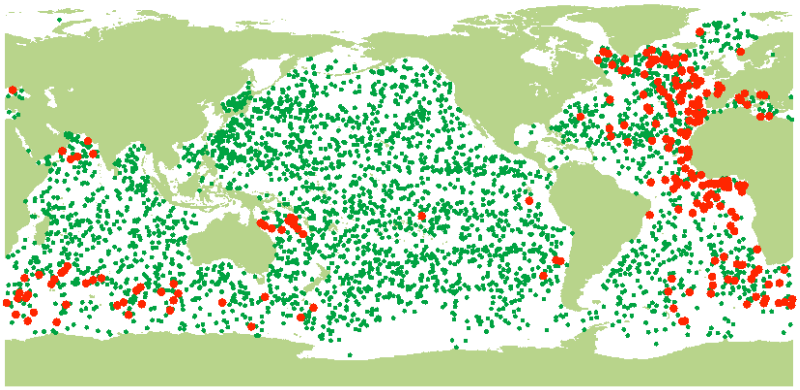

**Figure 3: (Lower panel) Actual position of the French active floats.**

### - technical problems encountered and solved

No major technical problems were encountered in 2012.

- **status of contributions to Argo data management**

Within Argo-France, Coriolis plays three roles in the Argo data management organization: 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.

*As Argo Data Assembly Center*, Coriolis processes in Real Time and Delayed Mode float data deployed by France, by 7 European countries (Germany, Spain, Netherlands, Norway, Italy, Greece, Bulgaria) Coriolis data center processes data coming from 1431 floats including 466 active floats in February 2013. Data are processed and distributed according to Argo recommendations.

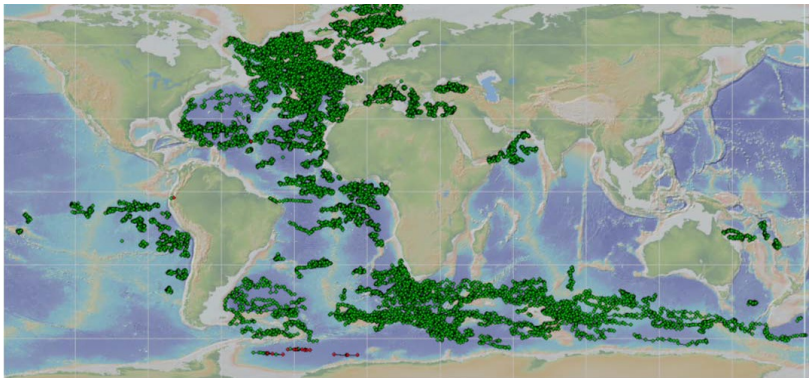

**Figure 4: Maps of the 18 841 profiles from the 1431 floats managed by Coriolis DAC this current year.**

*As Argo Global Argo Data Centre*, 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. From January to November 2012 the ftp server was available for 99,98% of the time. The 0.02% of failure represents 1 hour 52 minutes and 54 seconds of interruption (compared to 1 day 5 hours and 45 minutes last year). The main problems problem occurred on May 1st 2012. The ftp server failed down, but was automatically reactivated on another node of the cluster). Compared to last year, the new ftp server dramatically increased the files transfer time from 100ms to 4 ms: the files are downloaded up to 25 times faster.

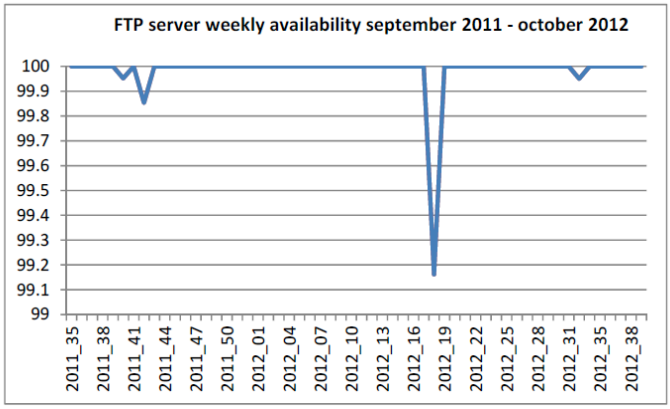


**Figure 5 : Nagios monitoring: between September 2011 and October 2012.**

*North Atlantic Argo Regional Centre (NA-ARC)* : 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 WWW site, http://www.ifremer.fr/lpo/naarc/ (also available through the Argo Data Mangement Web site: **http://www.argodatamgt.org/Argo-regional-Centers/North-Atlantic-ARC** under "More on NA-ARC floats".) provides useful information about float data and status in the North-Atlantic Ocean. For instance, it can be used to monitor the number of floats in the North-Atlantic as well as the number of floats equipped with an oxygen sensor (**Figure 6**).

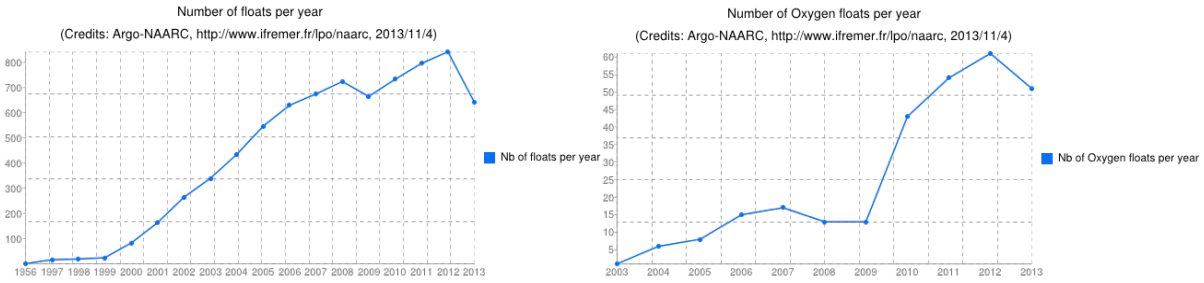


**Figure 6 Examples of viewing service available at http://www.argodatamgt.org/Argo-regional-Centers/North-Atlantic-ARC under "More on NA-ARC floats". The figures display the number of floats in the NA-ARC area (Atlantic ocean North of 20°S) and the number of floats equipped with .**

See also Section 4.

- **status of delayed mode quality control process**

In 2012, 10327 new delayed mode profiles where produced and validated by PIs. A total of 93299 delayed mode profiles where produced and validated since 2005. In February 2013, 72% of the floats and 73.3% of the profiles processed by the Coriolis DAC are in delayed mode.

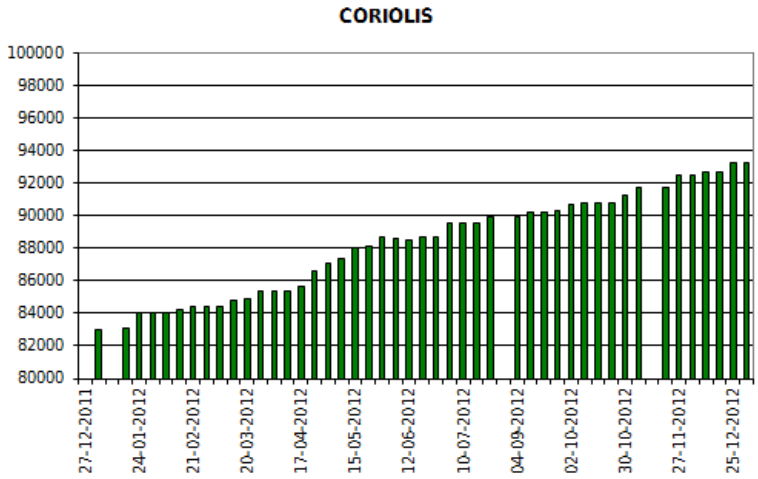


**Figure 7: Evolution of the DM profiles' submission versus dates**

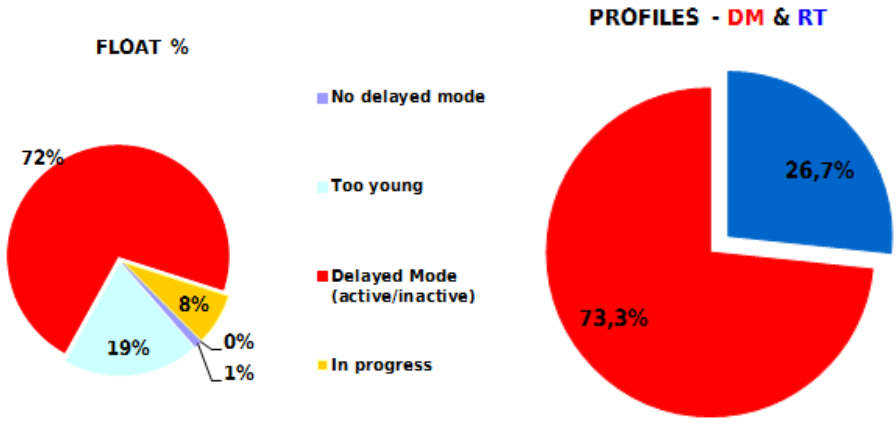


**Figure 8 Status of the floats processed by Coriolis DAC. Left: in terms of float percent and right: in terms of profile percent (DM : delayed mode – RT : real time).**

**Status of pressure corrections, technical files :** For APEX floats, the real-time pressure correction has been implemented at the Coriolis data center and it is operational. The implementation of the pressure correction of NEMO floats is still on-going

## 3. Summary of deployment plans (level of commitment, areas of float deployment) and other commitments to Argo (data management) for the upcoming year and beyond where possible.

According to the current deployment plan, 65 floats will be deployed in 2013. They will be deployed in 2013 in the Mediterranean Sea, in the North and the South Atlantic Oceans, in the Southern Ocean and in the Indian Ocean (Figure 5).

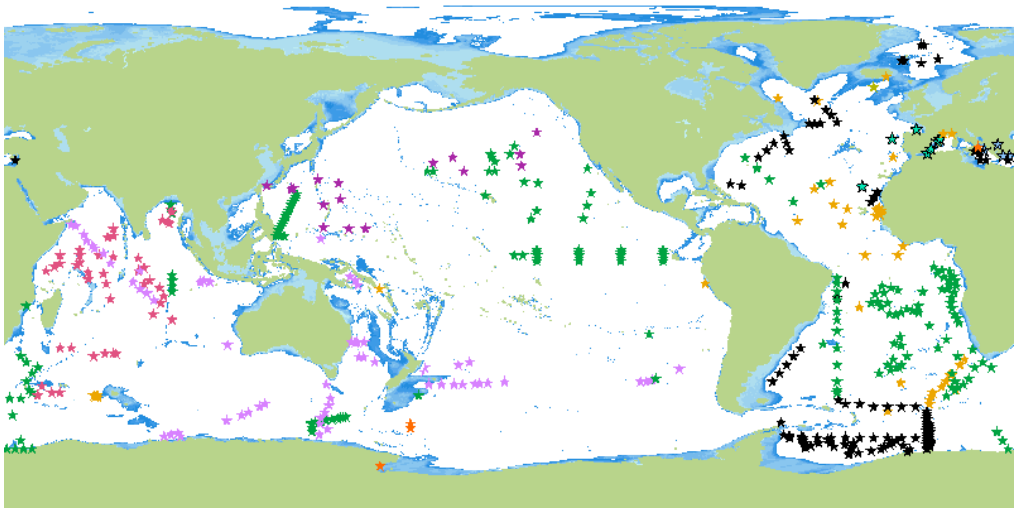

**Figure 5: Deployment plan. The orange stars represent the French deployment plan for 2013.**

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.

## 4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers

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 structure.

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.

Ocean science. 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, …). List of scientific publications is available trough the Argo web site: http://www-argo.ucsd.edu/FrBibliography.html and through the French Argo web site: http://wwz.ifremer.fr/lpo/SO-Argo-France/Publications. About 125 peer-reviewed papers using Argo-data have a leading author based in a French laboratory.

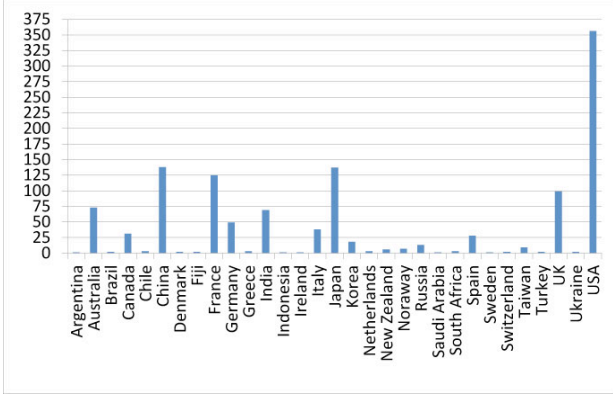


**Figure 9: Number of paper using Argo data as function of the country of the lead author.**

French-Argo meeting: The French Argo Users' Group provides a forum for engagement between these scientists and the French Argo program. The last meeting of the user group was scheduled the 20-21 June 2012 in Brest. In 2013, French Argo Users will meet as part of the 4th Euro-Argo Science Meeting that will be held in Southampton 18-20 June 2013.

Argo-Regional center: We are currently investigating the performance of the OW method in the North-Atlantic. Our objective is to propose a kind of cookbook on how to use OW to detect and correct salinity sensor bias or drift in the North-Atlantic. We have first selected all floats in the Subpolar gyre region that have been processed in delayed mode and for which no correction for

salinity bias or drift was necessary according to the PI's decision. We have then used this subset of "unbiased" floats to test the OW method in the Subpolar gyre region.
Figure 10A shows the correction proposed by the OW method for this subset of floats when the CTD reference database is used for calibration. One would expect that the corrections proposed by OW would be distributed around zero. However this is not the case, particularly along the Reykjanes Ridge and the topography in the Labrador sea were negative corrections are systematically proposed (-0.02 to -0.03PSU).

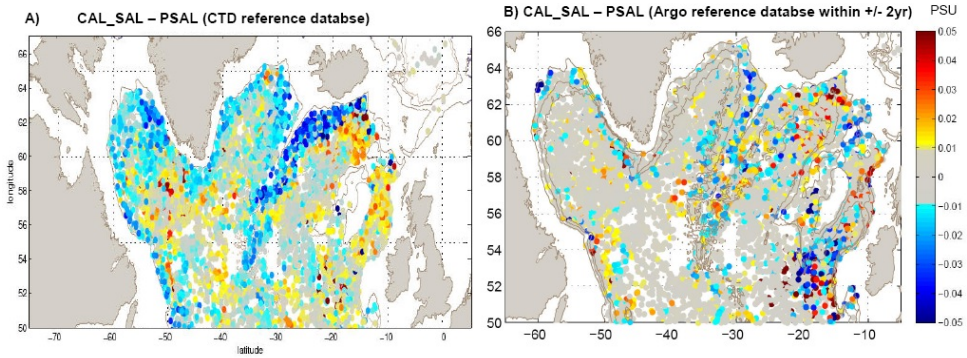


**Figure 10: Corrections proposed by the OW method for all floats for which no salinity correction was judged necessary by the PIs. A) CTD reference database is used for calibration. B) Argo reference database is used for calibration and reference profiles are selected within +/- 2 years of the analysed Argo profile.**

We have checked that these results were not strongly related to the choice of configuration parameters and $\theta$ levels. Instead, the systematically negative corrections proposed along the topography in the Labarador and Irminger seas are mainly explained by a large decadal variability that is not well captured in the CTD reference database. In consequence, salinity corrections estimated with OW and using the more recent Argo reference database seem to be more reliable. It is even necessary to select reference data within +/-2yr of the date of the profile in the Labrador Sea region because of large interannual variability (>0.01 PSU) (see Figure 10B).

Finally, we have checked the corrections made on Argo profiles on the GDAC. Figure 11 shows the delayed mode salinity corrections actually applied to all the floats in the North Atlantic region. Some floats in the subpolar gyre have been corrected for positive salinity biases (negative corrections) that are comparable to the values shown Figure 10A. Therefore, we counted 8 floats in this region that may have been over-corrected and that should be checked again (on-going work).

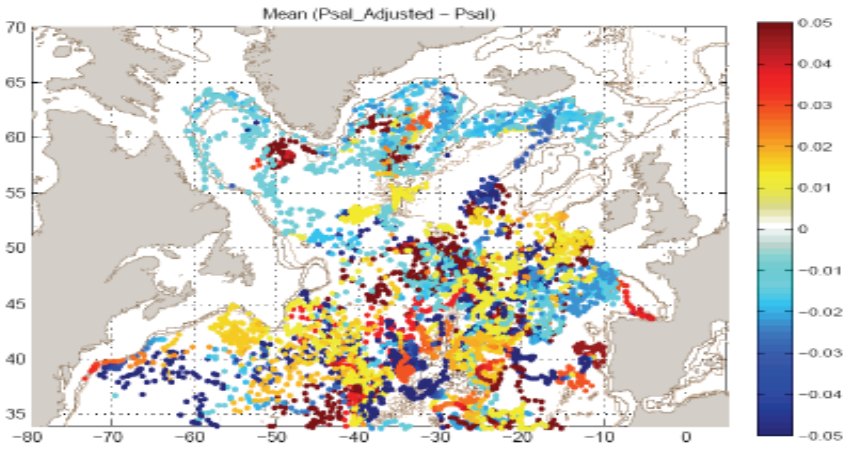


**Figure 11: Salinity corrections made on Argo profiles**

Owens, W. B. and Wong, A. P. S.: An improved calibration method for the drift of the conductivity sensor on autonomous CTD profiling floats by 2-S climatology, Deep-Sea Res.-Pt. I, 56, 450–457, 2009.

**5. 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**

None.

**6. 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**

The number of CTD cruise data uploaded by PIs within France in 2012 to the CCHDO website is not known.

The Coriolis reference database has been updated with new NODC data acquired since the release of the WOD 2009 and until October 2012, as well as ICES CTD data. Some CTD from CCHDO have been also integrated in this version provided in November 2012. An updated version of the reference database will be provided to the Argo community mid-March 2013.

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

This list is available on the following web site: http://wwz.ifremer.fr/lpo/SO-Argo-France/Publications. The missing publications on the Argo Bibliography page web have been reported to Megan Scandeberg.