

16<sup>th</sup> meeting of the  
International Argo Steering Team



Brest, France  
March 18-20, 2015

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## 1. Welcome and Introduction

Antoine Dosdat welcomed everyone to IFREMER and officially recognized the new JCOMMOPS Support Centre on the IFREMER campus.

**Action item 1:** Write letter of thanks to local host Antoine Dosdat, director of IFREMER Brittany. AST co-chairs

## 2. Objectives of the meeting

D. Roemmich opened the meeting by stating it was the largest Argo Steering Team meeting yet and thanked our host, IFREMER, for providing the room and support throughout the week.

The objectives of the meeting were as follows:

- Ensure that Core Argo remains healthy and continues to improve platform and sensor technology, data quality, coverage and utility
- Review the status and progress of Argo enhancements (Deep Argo, BGC-Argo, Equator, western boundary regions, marginal seas, high latitudes)
- Celebrate the opening of the JCOMM Observing Program Support Centre in Brest

Next, Roemmich listed several criteria that were found by a U.S. National Academy of Sciences 2015-2025 Decadal Survey of Ocean Sciences report to help make Argo successful. A free pdf of the report can be downloaded here: <http://www.nap.edu/catalog/21655/sea-change-2015-2025-decadal-survey-of-ocean-sciences>. The criteria are:

- Narrow, well-defined observational goals aimed at widely appreciated scientific and operational issues
- Broad international and multi-agency support based on meeting societal needs as well as science
- Tenacious championship within academia, industry and government agencies
- Commitment to publicly available data, which demands careful open data-quality control
- Sensors that are well matched to float capabilities and the demands of low-cost deployment
- Freedom for methods and technology to evolve, subject to clear performance requirements

A question to consider is how well Argo's enhancements can address these criteria. D. Roemmich reported that for the U.S. program, it now costs \$170 USD per profile. This statistic was reached by taking the total U.S. expenditure and dividing it by the total number of profiles per year. It is assumed that international partners have costs that are close to this per profile.

## 3. Action items from AST-15

M. Scanderbeg reported on action items from AST-15 that were still pending. Specifically she noted that H. Freeland had not had a chance to email float manufacturers requesting energy



budget simulator software. It was decided to carry this action item onto the list from the AST-16 meeting.

**Action item 2:** H. Freeland to email float manufacturers and suggest that they make energy budget simulator software available. H. Freeland

Feedback from B. Klein and Z. Liu stated that the Argo Wikipedia page was able to be transferred into German and Chinese. T. Suga said that a draft translation of the page into Japanese had been done, hopefully to be finalized and uploaded onto the Wikipedia site this year.

#### **4. Implementation issues**

##### **4.1 Update commitments table**

The commitments table was presented and updated for the coming year. Between Argo and Argo equivalent floats, it is estimated that over 850 floats will be deployed in 2015. The exact definition of an Argo equivalent float was questioned and it appeared to be different in different countries. Some countries call equivalent floats one that are purchased outside of the main Argo funding source while some countries call extension floats equivalent floats. In either case, Argo is continuing to try to deploy around 800 floats per year. See the Argo Status section for the exact number of floats deployed in the last year according to the AIC.

##### **4.2 Tracking progress on original mission**

##### **4.3 AIC funding**

During 2014, 10 national Argo programs made contributions in support of the Argo Information Centre. The funds contributed are used to support the salary of Mathieu Belbeoch, his requirements in his office and his travel funds. National programs contribute in different way, some transmitting money to the IOC, some to the WMO and some to a fund handled by CLS (Service Argos).

H. Freeland was disappointed that for the last 5 years he has been unable to reconcile accounts with the IOC/WMO accountants. This should not be hard and it is difficult to understand what the obstacles are. His private analysis is that sufficient money is being deposited each year, about 50% from the USA and the remainder from other nations and that Mathieu Belbéoch and the Argo Information Centre remain adequately funded within the JCOMMOPS office system. It seems very difficult to demonstrate this conclusively. The problem in reconciling accounts is the complexity of multiple sources in multiple currencies feeding money to three agencies each having different rules for the handling of funds.

After checking with the usual contributors, the prospect for contributions in 2015 looks good enough, but it is preferable that contributions be a little higher. Should any other country feel inclined to support the "Argo infrastructure" then please contact Howard Freeland for assistance. The easiest way to make a contribution is to send a small increment to your annual or monthly bill to CLS, as though it was a payment for Argos tracking, and ask them to re-direct the extra funds into the fund to support the Argo Information Centre. Money contributed through the IOC and WMO will be subject to a handling fee, 10% for the IOC and 7% for the WMO. CLS

does not charge a handling fee, but if money contributed through CLS is then moved to the IOC or WMO, it then becomes subject to the appropriate handling fee.

The Argo Director is also interested in receiving support should you determine that he serves a useful function. No salary support is needed, but travel does need to be covered. Support for travel could be provided through the AIC or by direct payment of travel.

**Action item 3:** H. Freeland to ask each national program when they would like to be invoiced for payments to the AIC.

#### **4.4 Bio-Argo/Biogeochemical Argo**

##### **Bio-Argo Report (Claustre)**

The terms of reference of the Bio-Argo Task Team were presented and discussed. In particular, a strategy for thinking of Bio-Argo more “globally” was requested. After an initial phase that has been mostly devoted to the development of regional pilot projects (e.g. Southern Ocean, North Atlantic sub-polar Gyre, Mediterranean Sea), it is time to begin to widen the scope of Bio-Argo towards the global Ocean. It is thus proposed that the Bio-Argo group propose some key messages to initiate the development of a science and associated implementation plan.

The contribution and expectation of various countries with respect to the acquisition and deployment of Bio-Argo float was then reviewed. The number of Bio-Argo floats and countries that are involved continues to expand.

Finally there was a recommendation to strengthen the link with other communities, as a way to attract new end-users and to work on the long-term sustainability of the Bio-Argo observation system. As a first step in this direction, some initiatives are mentioned. Several members of the Bio-Argo Task Team will give lectures at the summer school « instrumenting our ocean for better observation: a training course on autonomous biogeochemical sensors » which is organized by IOCCP (Kristinenberg, Sweden, June 23-July 1) . A “Bio-Argo” breakout session is planned as part of the second International Ocean Color Science (San Francisco (June 15-18) with the objective of developing synergies between both communities.

##### **SOCOM status (Johnson)**

Southern Ocean Carbon and Climate Observations and Modeling (SOCOM) is a new US Biogeochemical Argo program that will deploy some 200 profiling floats with pH, O<sub>2</sub>, NO<sub>3</sub>, and biooptical sensors into the Southern Ocean over the next 6 years. The program is led by Jorge Sarmiento at Princeton and executive team members include Lynne Talley, Joellen Russell, Heidi Cullen, Ken Johnson, and Steve Riser. Primary funding comes from the US National Science Foundation, Division of Polar Programs. The NOAA Climate Program will participate by providing half of the basic Argo floats. A NASA component, led by Emmanuel Boss, will provide the biooptical sensors. The program involves 23 senior researchers at 11 institutions. The web site for the program is <http://socom.princeton.edu>.

More than 20 SOCOM floats are already in the water and operating well. Float deployments began in March 2014 along the GO-SHIP P16S line. Additional floats were deployed from Polarstern along the Good Hope line in December 2014/January 2015. Deployments will continue at about 40 floats per year.

There is money in the budget to hire a person at the University of Washington to create V3.1 b-files for inclusion on the GDACs. The job announcement is currently open.

It is planned for the floats to usually go on a 10.25-day cycle. This means that the float will hit the surface at various times throughout the 24 hour day to get a variety of surfacing times. SOCCOM is also committed to making the technology available to everyone and is working with SeaBird to make NAVIS floats with the technology available.

SCOR Working Group 142 (Quality Control Procedures for Oxygen and Other Biogeochemical Sensors On Floats and Gliders) is charged with refining the quality control procedures for biogeochemical parameters observed by profiling floats. WG142 is co-chaired by Arne Kortzinger (GEOMAR) and Ken Johnson (MBARI). The website listing membership and terms of reference is at [http://www.scor-int.org/Working\\_Groups/wg142.htm](http://www.scor-int.org/Working_Groups/wg142.htm)

The initial efforts have focused on improving the accuracy of dissolved oxygen measurements. The first meeting of WG142 in Feb. 2014 identified air oxygen measurements as a very useful tool that could substantially remove the bias in instrument calibration. Subsequent investigations by working group members found that many floats are already making air oxygen measurements with minimal impact on float operations or energy budgets. Using these measurements can reduce the bias in oxygen measurements (relative to Winkler titrations) by some 10x, with an accuracy that approaches that of Winkler titrations. WG142 met prior to the Euro-Argo workshop and has agreed to write a recommendation to float manufacturers to the effect that air oxygen measurements should be made on all floats with oxygen sensors. The ADMT is already working to include air oxygen measurements in profile files.

### **XPRIZE (Johnson)**

The Wendy Schmidt Ocean Health XPrize is a competition with a \$2 million prize that is underway to find improved ocean pH sensors. This XPrize has the potential to intersect with Argo interests. Team DuraFET (MBARI, Scripps Institution of Oceanography, Honeywell, and Sea-Bird Scientific) has agreed that if they win, the prize money will be donated to provide pH sensors for the Argo program.

### **4.5 Euro-Argo update**

P.Y. Le Traon and S. Pouliquen gave a brief status of Euro-Argo update on behalf of all Euro-Argo partners. The Euro-Argo ERIC (a legal European entity owned by ministries) and its governance bodies (council, management board, programme manager, scientific and technical advisory group) is now in place to consolidate and improve the European contributions to Argo international. Thanks to the development of Euro-Argo ERIC, there have been major improvements of European contributions to the international programme (number of floats, data system, research and applications, new countries, sustainability). As far as European float deployment is concerned, between 150 to 200 floats have been deployed every year over the last couple of years. The Euro-Argo target of 250 floats/year should be reached in 2015/2016 thanks to new European Union funding from DG MARE that will complement what member states do. P.Y. Le Traon then recalled Euro-Argo views on the long term evolution of Argo. Euro-Argo needs to meet requirements from the research and operational (Copernicus Marine Service) oceanography communities. First priority is to maintain the global array and its regional extensions (marginal seas, high latitude). The second priority is the evolution of Argo to address new scientific and operational challenges. There is a strong interest of the European research community and Copernicus for extension to biogeochemical variables and deep Argo.

Several pilot experiments are ongoing or planned (e.g. Remocean, NAOS, E-AIMS, Atlantos). It will be important to agree soon on the long term strategy and targets for these extensions at the international level so that the different countries (including Europe) can develop long term implementation plans.

#### **4.6 UK Argo**

Following the pattern of inviting a national program to make a presentation, Jon Turton and Brian King reviewed the background and activities of UK Argo. Jon Turton described the genesis of the UK effort, through to the present partnerships and organizational responsibilities. Brian King described some science activities of the main partners. The British Oceanographic Data Centre, located within NOC Liverpool, is responsible for UK Real Time and Delayed-Mode data handling, and is active in many Argo data activities pursued between sessions of ADMT. The UK Met Office assimilates Argo data in its hierarchy of three forecast systems. Weekly (FOAM), Seasonal (GloSea) and Decadal (DePreSys). Results from NOC Southampton include combining Argo data with time-series moorings (at 26°N) and ship-based deep hydrography. An example of the latter is a study of temperature trends over the full depth of the NE Atlantic since 2000.

#### **4.7 Discussion items from National Reports**

Only a couple of items came up during the discussion. Both were reminders for AST members and their national programs. It was noted that all National Programs are expected to be archiving their raw data and it was suggested that programs investigate this and report back at the ADMT-16 meeting as to the status of this archiving. It was also requested that AST members check to make sure that their country has an active Argo float point for float notification purposes.

**Action item 4:** Ask National Programs to investigate how they are archiving their raw data and report on this at the ADMT-16 meeting. National Programs

**Action item 5:** Ask AST members to ensure their country has an active Argo focal point. AST members

#### **4.8 Argo DOIs**

The current status of Argo DOIs is that DOIs are applied to Argo documentation (User manual, Quality control manual, Trajectory DAC cookbook, etc), to the GDAC (grows and mutates), and to monthly snapshots of which we currently have 20 (to enable scientific reproducibility).

The approach for moving to a single Argo data DOI presented at AST-15 was shown three times at the March 2015 RDA workshop and it has been verbally agreed with publishers. We are awaiting NODC resources to mint the DOI and expose snapshots. This will hopefully happen this US fiscal year and resolving a particular snapshot via citation method is additional work for another fiscal year.

We have on-going discussions with major publishing houses on how to track the citations of Argo data within academic literature. All houses were unanimous in saying we need to get Argo data into a formal data paper. Users then cite data paper and snapshot DOIs, the data paper would automatically be indexed making tracking of citations simpler.

Further to this we need to investigate the indexing of Argo data DOIs and identify Argo DOI citations to test so issues can be raised with publishing houses, Datacite and Crossref as appropriate. Lastly, the Google “Custom Search API” may be a viable method for identifying citations but it may be limited to open access journals as the snapshot DOIs are usually embedded at the end of the main body of the paper.

**Action item 6:** Write Argo data paper for submission to a data journal. J. Buck, S. Pouliquen, H. Freeland, M. Scanderbeg, S. Wijffels, S. Jayne

**Action item 7:** Include citation information when data is downloaded from GDACs including FTP, HTTP, Data Selection Tools and rsync service. GDACs

#### **4.9 AIC Report on Status of Argo**

##### **4.10 Float deployment opportunities**

The JCOMMOPS Ship Coordinator, Mr. Martin Kramp, reported on activities and developments in JCOMMOPS regarding deployment opportunities and highlighted several items that may be of interest to the meeting.

JCOMMOPS gathers cruise and vessel information from different communities and has initialized new partnerships in the last inter-sessional period, with i) ship owners (e.g. Hamburg Süd, 45 owned / 58 chartered container vessels), ii) ship builders (e.g. STX, MSC liners / Queen Mary 2), iii) schedule coordinators (e.g. UNOLS) iv) ship operators (e.g. ProLarge) and v) event managers (e.g. Cornell Sailing). These agreements are established top-down, in general with the board of directors, and target long-term and wide-spread activities.

Synchronization mechanisms with key metadata sources from above organizations are currently set up by the new JCOMMOPS IT engineer. Tools to easily provide cruise information and operation or maintenance requests are also under construction. Deployments have been realized in the last inter-sessional period based on cruise information pushed by JCOMMOPS into the community, or indirectly by cruise plans made available through the JCOMMOPS Coordination for GO-SHIP, but with a number difficult to measure.

Mr. Kramp requested the meeting to submit more details on requirements. Many, and particularly free-of-cost opportunities, remain unused at the moment.

The Ship Coordinator reported that Sailing Vessel Lady Amber is still available in South Africa for substantial, cross-program and low cost operations. After training activities and some technical modifications (in particular a crane module is now available) the vessel has in the meantime also successfully proven its capacities in the deployment and recovery of larger instruments, such as wave gliders. The vessel will probably be involved in Spurs-2, and could already on its way to the operation zone transit under-sampled areas.

Regarding further progress with the sailing community, Mr. Kramp reported on deployments in the Barcelona World and Volvo Ocean Races. All boats deployed instruments in high-value positions. In addition to their willingness to deploy in remote areas, these events are also willing

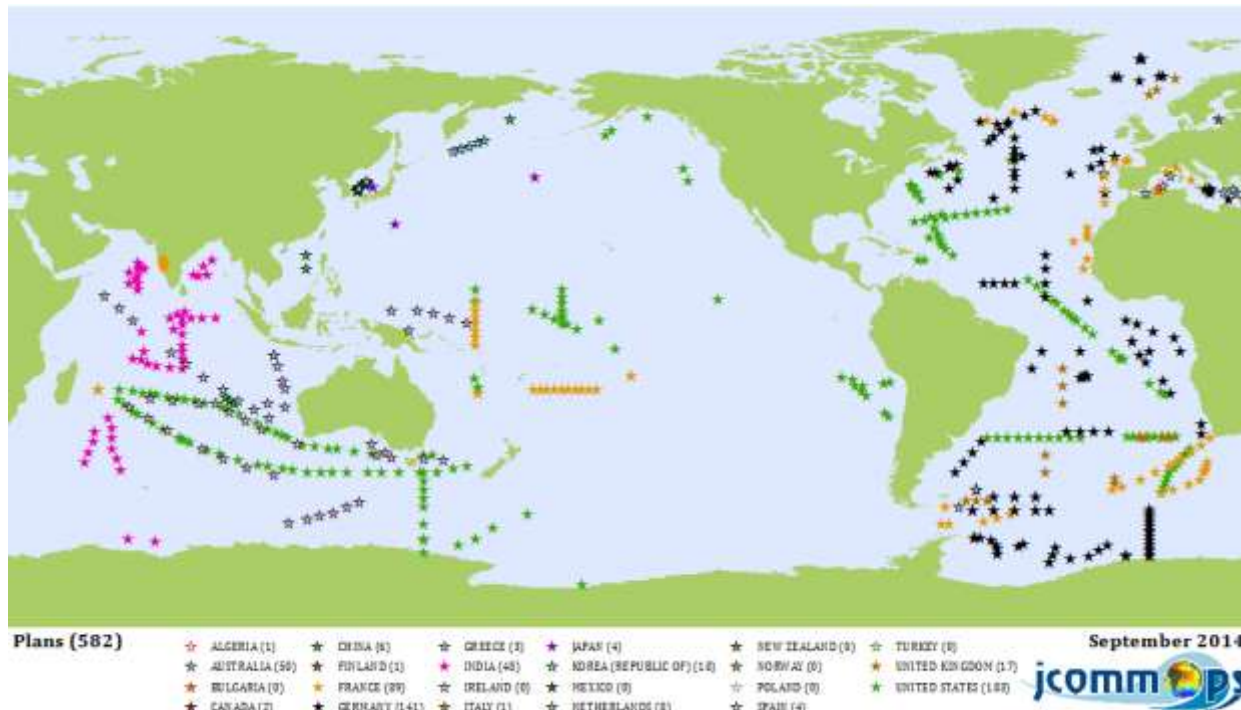
to co- or fully fund some instruments in the future. Such contributions would go beyond former in-kind contributions from volunteer ships, and these deployment operations also achieved good media coverage. Martin showed a video of a successful, but also rather violent deployment at 15kn boat-speed. He stressed that these are the only “free” deployments in the Southern Ocean with recurrent opportunities from non-research vessels.

In sailing rallies, which lead family crews on pleasure yachts around the world (such as the Blue Planet Odyssey), floats and drifters are continuously and successfully deployed, very smoothly, and ships even agreed to change their direct routes significantly, in order to sail through higher priority areas. As with races, these so-called rallies also take place regularly.

As alternative to “free” opportunities, Mr. Kramp presented missions organized in cooperation with the marine operator ProLarge. The new type of multihull survey vessel (OE43, based on the NOR-50 concept developed 15 years ago at Ifremer) is now under construction and allows for cost-effective deployments in perfect conditions and positions; the operator will agree to de-route the ship(s) on trans-ocean passages in order to get into under-sampled areas, and would only invoice the additional costs (extra ship-time, insurance etc.). A pilot project could take place at the end of the year.

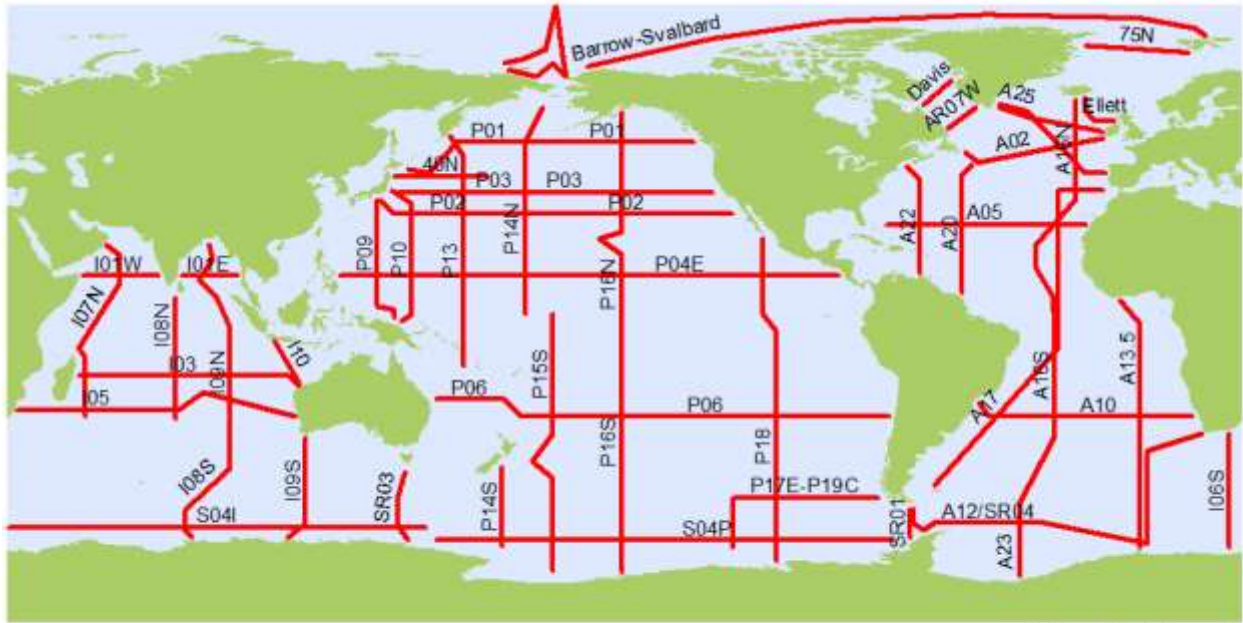
The team noted the good progress and agreed that JCOMMOPS is able to propose continuously deployment and other operation opportunities in all sea areas, both short and long term. From the new location in Brest, and with all staff members now reunited there, JCOMMOPS is in an excellent strategic position for the further development of an integrated Ship Coordination.

## BACKGROUND INFORMATION



The planning of Argo deployments through the AIC has proven its effectiveness. Deployment opportunities for other panels could also be identified here long enough in advance.



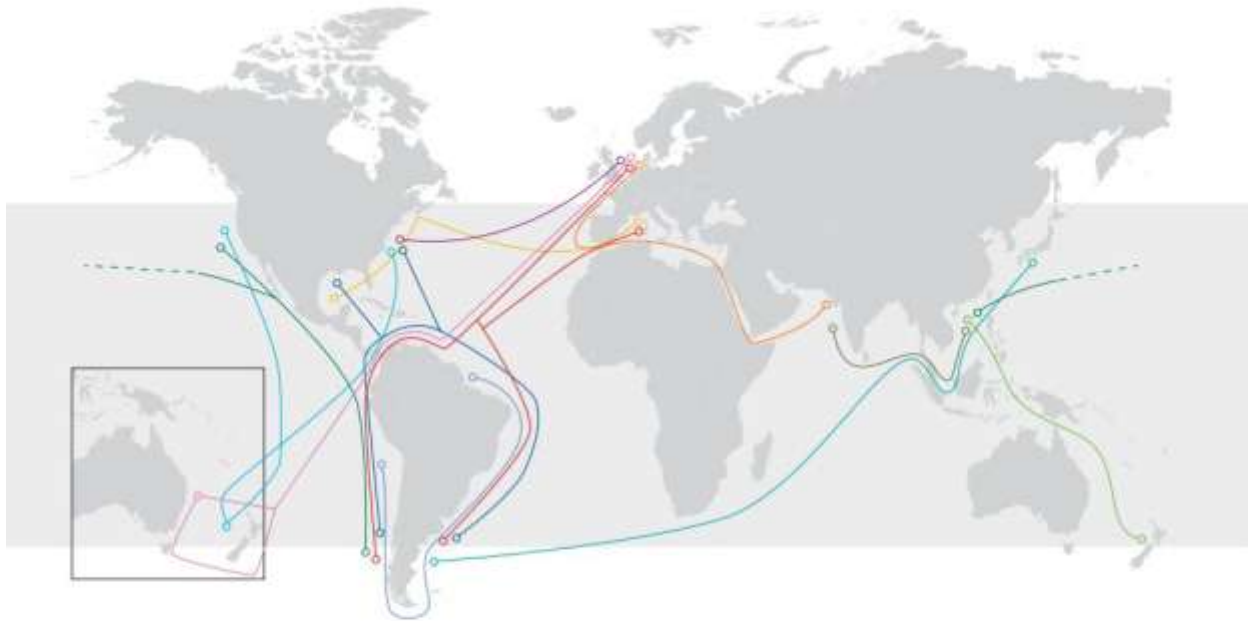


GO-SHIP Design Map  
2012-2023 Survey

Status September 2014



Synergies with research cruises, in particular GO-SHIP, are now better exploited, with new synchronization and cooperation agreements between JCOMMOPS and organizations such as UNOLS, POGO, IRSO, or individual operators.



**Main liner services of Hamburg Süd**

- |   |   |   |
|---|---|---|
| <span style="color: red;">■</span> Europe / Mediterranean – South America / Central America               | <span style="color: purple;">■</span> Europe – North America  | <span style="color: teal;">■</span> Asia – South Africa / South America                     |
| <span style="color: orange;">■</span> Europe – Mediterranean / Inner Med / Middle East / Pakistan / India | <span style="color: darkblue;">■</span> North America / Central America / Caribbean – South America | <span style="color: green;">■</span> Asia – Central America / North America / South America |
| <span style="color: yellow;">■</span> Mediterranean – Canada / Central America                            | <span style="color: blue;">■</span> Intra South America   | <span style="color: olive;">■</span> Asia – India / Pakistan                                |
| <span style="color: pink;">■</span> Europe – Central America / New Zealand / Australia                    | <span style="color: cyan;">■</span> North America – New Zealand / Australia / Pacific Islands       | <span style="color: lightgreen;">■</span> Asia – Australia / New Zealand                    |

Hamburg Süd has agreed to support the ocean observing system with its entire fleet, in a top-down approach with the board of directors. All JCOMM and associated programs, including rather difficult applications such as SOOP or ASAP, are welcome. The company will also supports logistics through its ship suppliers.



Lady Amber has established a self-training in deploying and recovering bigger instruments such as wave gliders. The vessel is still on stand-by in South Africa, could be mobilized within a few weeks but can wait no longer than spring 2015 for new missions. Third party funding is hoped to be achieved, but at least one more mission must be funded by the observing community before.





Argo - SOT - DBCP

Contributions from MEROCEANS Ships

2013



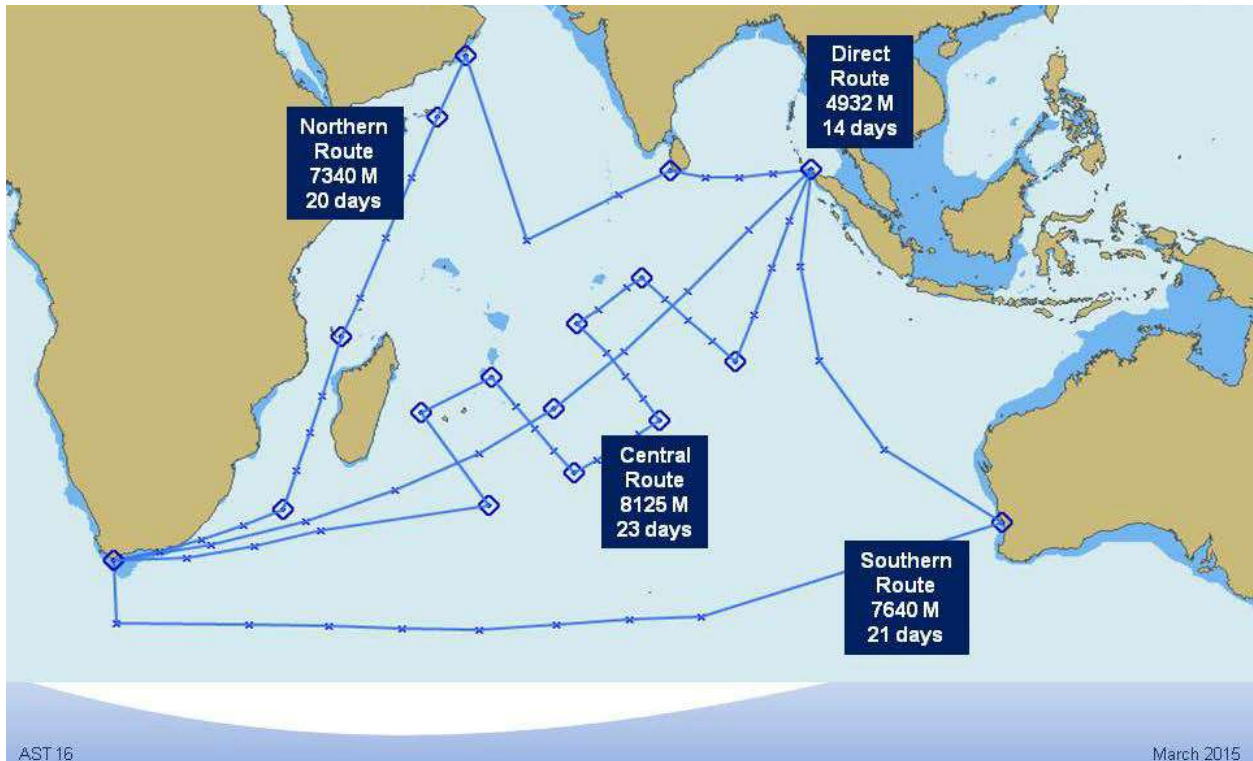
- in-situ data from Bark Europa
- in-situ data from NAVOSE Boogaloo
- in-situ data from non-MEROCEANS Ships

Deployments

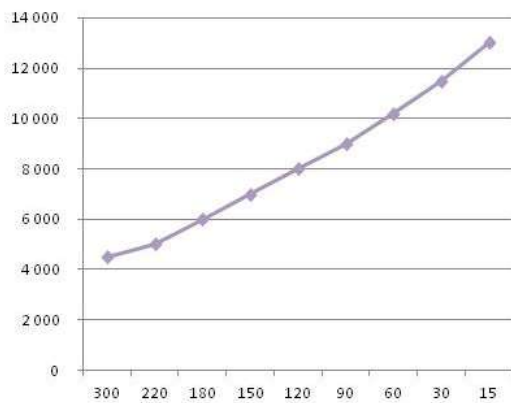
- ★ Argo
- DBCP



Organized sailing events, with clear schedules, routes, and numerous participants, with either family crews (no competition, called ocean rallies) or professional racing yachts and crews give recurrent access to some difficult ocean areas and have proven their feasibility. Formal cooperation agreements with pilot partners have been signed with IOC. In remote areas, it can also be efficient to work with individual sailing ships. Beyond deployment opportunities, another pilot project is underway with instruments being co- or fully funded by third parties.



In low risk area :



High Risk Area : +5 600€ /D  
 Difficult navigation Area : +2 500€ /D

2- Examples of opportunity mission:

	Distance	Duration	$\Delta t$	HRA or DNA	ROM Price (€)
Direct Route	4932 M	13,7 days	0	0,0	0 €
North Route	7340 M	20,4 days	+7 days	12 days	152 800 €
South Route	7640 M	21,2 days	+7,5 days	9 days	111 600 €
Central Route	8125 M	22,6 days	+9 days	0	115 300 €

*Direct Route is a transit between Cape Town and Banda Aceh*

AST 16

March 2015

Exemplary ROM prices for dedicated, cost-effective deployment missions, in perfect conditions and positions, from the OE43 survey vessel in ocean transit, in cooperation with ProLarge. High risk (piracy) and difficult navigation areas (ice) are possible, also CTDs (1 ton A-frame)

#### 4.11 JCOMM Observing Program Support Centre

## 5. Data Management Issues

### 5.1 Feedback from ADMT-15

S Pouliquen presented a summary of the Argo Data Management activities since last the AST meeting. A complete report can be found in the ADMT15 meeting report at <http://www.argodatamgt.org/Data-Mgt-Team/Meetings-and-reports>.

Current ADMT efforts focus on:

- Monitoring the Real Time system and the delays
- Updating Data Formats to V3.1 to be able to handle changes in mission for Iridium and Argos3 floats, to separate surface and sub-surface profiles, to enhance real-time trajectory data and to have the capability to include new variables especially Bio-Argo new parameters
- Improving data consistency and completeness through improvement of some real-time tests such as density inversion tests; monitoring data quality through OA and altimetry analyses; improving mandatory metadata, standardization of format-ID
- Implementation of a new format checker at the GDACs that will not only check data format but also perform some consistency checks in the contents; it will be turned operational on 30 March 2015
- Monitoring DMQC processing
- Feedback on ARC activity
- Ramping-up of the Bio-Argo data management activity with the organization of the 3<sup>rd</sup> Bio-Argo meeting before ADMT-15
- 

S Pouliquen in particular highlighted statistics computed annually by S Guinehut comparing Argo with Altimetry that could be used as indicators to inform users on Argo data quality. B. King mentioned that he had been tasked to work on quality indices last year and had been unable to make much progress, but would be interested in trying to do so this year. The idea of making two sets of indices, one for internal use and one for the general public was discussed.

**Action item 8:** Working group to collect Argo indices/metrics/ quality plots, decide how frequently to make them and where they will be stored. Could be two groups of metrics – one for internal use and one for general public. B. King, S. Wijffels, S. Pouliquen, M. Belbeoch

**Action item 9:** Send out an email to general Argo list about the rsync service at the GDACs. M. Scanderbeg

She also mentioned a new service set up at the GDACs that allow a synchronization service between the "dac" directory of the GDAC with a user mirror. It is described at <http://www.argodatamgt.org/Access-to-data/Argo-GDAC-synchronization-service>

A lot of DAC activity is focused presently on moving to V3.1 for RT and also historical data and we are confident that most of the DACs will have switched to V3.1 by ADMT-16 that will be hosted by BIOS in Bermuda.



## 5.2 Status of trajectory V3.1 files

M. Scanderbeg presented on the status of the V3.1 trajectory files and the Trajectory Cookbook. She reminded the AST that the goal of the cookbook was twofold: (1) to inform DACs on how to match measurement codes to the data that the various float types send back and (2) to make it clear to manufacturers what timing information Argo would like floats to send back.

Currently there are V3.1 files on the GDACs, but not many. A new version of the cookbook will be coming out shortly that includes a simpler APEX float section and a clearer separation of real time and dmode tasks. Work still needs to be done on the Standard Format ID and Argo Data Formats Table. There is an action on this from the ADMT-15 meeting which is being worked on.

DACs were asked to make the transition to V3.1 files so that timing information sent by newer floats can be sent out to the Argo users. It was noted that the users must also be educated on the new files and the website for this was included in the presentation: <http://www-argo.ucsd.edu/Traj3files.html>.

Finally, M. Scanderbeg discussed the possibility of delayed mode quality control of trajectory files. There are still many questions surrounding this topic including who will do it (float owners, float experts, outside scientists, etc) and what will need to be done (some will be float specific; some will not be). This topic is beginning to percolate through the data management team, but first the real time trajectory files need to be in V3.1.

**Action item 10:** Add short document to website about what cycle timing information Argo would like all float types to send back. Circulate to manufacturers and PIs. M. Scanderbeg

## 5.3 Argo BUFR enhancements

Jon Turton gave an update on progress since AST-15 towards enhancing the BUFR format for exchange of Argo data on the GTS. He noted the WMO timescale for migration to TDCF (Table Driven Code Formats), originally 2012 was subsequently delayed to November 2014 and had now been extended to “the summer of 2015”, as in September 2014 it was obvious that not all National Met Services would be ready for full transition by November 2014. Advantages of BUFR over the Traditional Alphanumeric Codes were that it can include quality flags, associated metadata and the messages (or files) are highly compressed. However, Argo is in pretty good shape in terms of distributing data in BUFR (TM 3-15-003) as shown by the status report at ADMT-15.

However, as the Argo NetCDF format develops to allow for the inclusion of additional profiles (e.g. un-pumped near-surface, bio-geochemical) it is important the Argo BUFR evolves to provide matching capability. A BUFR message has 6 sections, however the sections of key interest were Section 3 (the data description section) and Section 4 (the data section). Section 3 gives the data descriptors, sequences or templates that define the data that follows in Section 4 as a continuous bit stream (padded at the end to ensure it is an integer number of octets/bytes in length). Sequence 3-15-003 defines the primary core-Argo CTD profile. This can be followed by additional sequences that define any additional data, e.g. 3-06-037 for dissolved oxygen profiles – this is already approved for operational use and so can be used on GTS.

Additional sequences for secondary temperature (3-06-017), secondary temperature and salinity (3-06-018) profiles are presently being validated by UKMO and MEDS, who have both successfully encoded and decoded BUFR messages using the new sequences. However, during this process some improvements to the proposed templates have been identified (i) to permit supplementary profiles with more than 255 levels (now allows as many as 65,335 levels) and (ii) to modify code table 0-08-034 to map against the vertical sampling schemes defined for the Argo NetCDF (reference table 16). This should make it easier to generate a BUFR message from the NetCDF file. The next step is to repeat the 2-way validation with the above changes implemented and to document the results for approval by the WMO IPET-DRMM who are expected to meet summer 2015. The BUFR enhancements could then become operational by November 2015.

Looking further ahead a new BUFR class (41) has been agreed to allow for the specification of bio-geochemical variables, which are not presently included in BUFR Master Table 0. This will allow up to 255 bio-geochemical parameters (chlorophyll, CDOM, irradiance, backscattering etc.) to be specified as required for use with future ecosystem prediction models. In discussion it was anticipated that the JMA software to generate BUFR files from the NetCDF would be updated and made available to DACs. Also the Met Office will be developing a NetCDF to BUFR converter in Python, which could also be made available.

#### 5.4 Quality of the Argo reference database from CCHDO data

An overview of what has been done for the reference database for the past 10 years was presented. First, it was decided there was a need for Argo to have a common reference database, to have only high quality data in the reference database, **to get data in an 'impulsive' manner** and to get data in one format. To do that, Argo decided to ask CCHDO to collaborate because of its ability to guaranty high quality data and its experience in managing CTD data. At the ADMT-6 meeting in 2005, we agreed to set up a common Reference database for Argo in collaboration with CCHDO. The structure that was approved is the following:

- ARCs will help in identifying the cruises that would be of interest for Argo delayed mode Data Management activities and encourage PIs/National Data centers to send their CTD to CCHDO office
- CCHDO will quality control these data according to Clivar procedures described here: <http://cchdo.ucsd.edu/information.html>
- CCHDO will then transmit back the qualified data to Coriolis who will update the central reference database that will be available on an FTP site protected by password

A brief history of what happened after the ADMT-6 discussion was presented and focused on these main issues:

- 2006 (April - June: CCHDO disk sent to Coriolis )
- 2007 (September : list of CTD available at Coriolis sent to CCHDO / October : first CTD data sent from CCHDO to Coriolis)
- 2008 (July : first version delivered from Coriolis based on WOD2005 / October : updated version to move on ITS90 to match with the new version of OW method / November : CCHDO & Coriolis to send messages to ARC & EuroArgo partners to ask them to submit data to CCHDO)
- 2009 (few CTD provided by CCHDO from website access with login/password)
- 2010 (Coriolis new version with WOD2009)
- 2011 (December : first zip dataset provided by CCHDO – 10 cruises)

- 2012 (Coriolis new version with OCL updates, CCHDO dataset and data from ICES database)
- 2014 (data downloaded from CCHDO website in occasional connections).
- In 2013, Coriolis proposed to work on index lists generated in each main source providers (US-NODC, CCHDO & Coriolis) to easily exchange and synchronize CTD data.

Most of the data downloaded from CCHDO was in different formats (NetCDF, csv), with different parameter names for the same variable (for instance temperature and CTDTEMP), with no QC or different QC scales, and different fill values.

A table showing actions, who is responsible for those and what has actually done is presented (see below).

Action	Who ?	What is actually done ?
To get CTD files	CCHDO	Not a lot of CTD provided by ARCs ? Not a lot of CTD provided to Coriolis
To provide CTD files	CCHDO	CCHDO website but last time where files were available specifically for Argo DMQC = end of 2011
- access from a specific site	CCHDO	Push method or updated dataset like US-NODC
- regularly basis of diffusion	CCHDO	
To control file format	CCHDO	Several format : control of format at CCHDO ?
- Unique format (netcdf)	CCHDO	Different names
- Convention parameters name	CCHDO	Coriolis only takes netcdf files and need to change program in order to load the different names
To check quality control	CCHDO	??
- QC on data	CCHDO	??
- Good quality	CCHDO	??
- Default value (NaN, -999,..)	CCHDO	Most of the checks are doing at Coriolis level (QC Missing for few files - With good QC – bad data – Default Value Can be different from a cruise to an other one)
To load the CTD files in box files	Coriolis	After few checking (plot of data, BS ...)
To provide a new version of reference database	Coriolis	Once a year, expected twice a year

To conclude, a summary of what Coriolis would prefer for the reference database was presented:

- To get new CTD data on a regular basis (at least 2 weeks before AST & ADMT) from a secure site
- For all files to have the same format (easier for Reference Database and for CCHDO users)
- To have the same convention format for the parameters and QC value scale
- To have qualified QC data (do not add a good QC flag for datasets which have been not been checked)

In the discussion following the presentation, it was noted that there is quite a bit of lower quality data in the reference database and it would be helpful to have an easy way for delayed mode

quality control operators to be able to select the quality of data to use. In some areas, there is no recent high quality data, so there is not a choice, but this is not always true. It was decided there needs to be an action item to fully document how data is included in the reference database, including the quality of it (for example the profiles might be considered GOSHIP quality, taken with bottles, okayed by an expert, etc). It is also important to work with the delayed mode community to find out the most useful way to implement this quality indicator.

## 5.5 CTD reference data & API

**Action item 11:** Document how CTD reference database is made and report to ADMT-16. Work with dmode community to find a way of adding metadata on quality of CTD data in ref db. S. Diggs, C. Coatanoan, T. Carval

**Action item 12:** Ask M. Kramp & S. Diggs to monitor through time of GOSHIP data on CCHDO site.

**Action item 13:** Add more details into the CTD request in national reports. Would like to know names of PIs who submitted data, when CTD cruises will occur and names of those PIs. M. Scanderbeg, S. Diggs

## 6. Technical issues

### 6.1 Float technology progress

Zenghong Liu from CSIO introduced the HM-2000 profiling float which has been in development by Qingdao Hisun Ocean Equipment Corporation Limited (HSOE) since 2010. This kind of float uses BeiDou System (BDS) for data transmission and is able to switch between BDS and GPS for positioning. The HM-2000 float is unable to be deployed globally because of the limited coverage of BDS. The float has the advantages of two-way communication, grounding protection, automatic data retransmission and so on. Through two cruises, 5 floats were deployed for testing in the SCS and northwestern Pacific Ocean during October-November 2014. The comparisons between the HM-2000 (installed SBE41/SBE41CP CTD), shipboard CTD, an APEX float and historical Argo profiles show that the TS data from the HM-2000 floats are reliable. However, improvements are still needed to extend lifetime of each float making it possible to obtain more profiles.

### 6.2 Report on Tangaroa/Deep Argo deployment and CTD validation cruise

P. Sutton reported on the 2014 Tangaroa Deep Argo voyage whose principal aim was to test the SBE61 sensor package. The shipboard CTD included freshly-calibrated dual T and S sensors and 3 SBE61s were integrated into the shipboard system along with an SBE35 reference thermometer. Aspirational T, S, P accuracies for Deep Argo are  $\pm 0.001\text{C}$ ,  $\pm 0.002$  and  $\pm 3$  dbar respectively.

Provisional analysis of the temperature results indicates that even the freshly-calibrated shipboard sensors had a 1mC difference. The primary shipboard sensor was found to be consistent with the SBE35 reference thermometer, and so could be used as a reference. Comparing the three SBE61s with the SBE9 primary and the SBE35 at the bottle stops shows deep temperature differences of 1mC.

For salinity, bottle data were analyzed by 3 labs: NIWA (on board), SBE and CSIRO. Unfortunately, the CSIRO samples were damaged in transit and the quality of the CSIRO data suffered. Comparing the bottle data with the shipboard primary indicates that the primary sensor is accurate to better than  $0.5e-3$ . The secondary shipboard sensor is again different to the primary, showing a pressure-dependent difference from the primary. Two of the SBE61s were fresh 0.0 to -0.004, while the 3<sup>rd</sup> was salty to 0.001-0.005. All three SBE61s showed a pressure-dependent change of decreasing salinity with depth similar to that of the secondary SBE9 sensor.

The pressure comparison between the SBE61s and SBE9 shows differences of  $\pm 4.5$  dbar. There is an indication that the pressure difference depends on soak time.

Pressure is likely to be the most critical parameter, as any pressure error will result in temperature and salinity errors via the local T and S gradients. Furthermore, pressure affects the calculation of salinity from conductivity. Similarly, the temperature error will also impact the salinity calculation with the  $\pm 1$ mC tolerance resulting in  $\pm 0.001$  in S- half the aspirational accuracy.

In summary, it is noted that the aspirational targets are ambitious. Temperature is meeting the accuracy goals. Salinity is close to the desired accuracy and SBE is working on improving the sensors. Pressure is close to the desired accuracy and is likely to be the most critical measurement because of its interaction with the other measurements.

### **6.3 Deep Argo float progress**

#### **Deep ARVOR**

VT presented recent results regarding the Deep-Arvor float. This float was designed to achieve more than 150 profiles at 4000m depth. It is equipped with an SBE41CP CTD. This was recommended to us by Seabird because it is adapted to 4000m when equipped with a Kistler pressure sensor. CTD is in a continuously pumping mode during ascent, and can sample every meter (programmable). Oxygen measurements are an option (4330 optode). It is equipped with Iridium & GPS communication. Its weight is 26kg. Two 3500 dbar models were deployed in 2012 and 2013. Two 4000 m (4120 db) industrials prototypes were deployed in 2014. We expect to deploy twelve 4000 m floats in 2015 and 2016.

The four Deep-Arvor worked well. The first two 3500 dbar models achieved 62 and 89 cycles, while the two 4000 m (4120 db) industrials prototypes achieved 30 cycles (10-day cycle) and 140 cycles (2-day cycle).

A fresh bias of 0.01-0.02 psu was observed on the four Deep-Arvor floats. There is no obvious evidence that this bias is pressure dependent.

#### **Deep NINJA**

T. Suga reported on JAMSTEC activities towards Deep Argo, including updates on observations with Deep NINJA floats, evaluations of SBE41CP below 2000 m, and optimal deep float deployment planning based on an adjoint sensitivity analysis experiment. Twelve Deep NINJA floats with the SBE41CP sensor and the capability to measure down to 4000 dbar have been



deployed in the Southern Ocean since 2012. These floats have returned 194 profiles including 154 deep profiles, as of March 2015, which have been transferred to GDAC. It was noted that two floats survived Antarctic winter and resumed data transfer in February 2015; they have observed the Antarctic deep layer under sea ice throughout the winter.

Pressure, temperature, and salinity measurements with SBE41CP sensors on Deep NINJA floats were evaluated by comparison with the shipboard CTD observation at the float deployments. Comparisons were made for 11 float/shipboard CTD pairs (by 4 cruises of 3 ships); the pair observations were carried out almost simultaneously (within about 10 km and about 30 hours) except for 1 case (within 4 days). While the float temperature and pressure were deviated negatively from the shipboard reference on average, especially in the depth below 2000 dbar, the biases were not statistically significant with 95% confidence level. The salinity from all the 11 floats shows fresh-ward pressure dependent negative bias. Since the correction of the “negative pressure bias” made the “calibrated” salinity even fresher, the pressure dependent salinity bias was not caused by the pressure bias.

An adjoint sensitivity analysis experiment with a 4DVAR system was carried out. A 20 year backward calculation was made on the Earth Simulator with targeting global heat content changes below 2000 m. The Indian Ocean sector of the Southern Ocean was identified as a key region affecting global decadal changes along with another key region in the northern North Atlantic. Based on this result, JAMSTEC has deployed 12 Deep NINJA floats so far and are planning to deploy two to four deep Argo floats in FY2015 mainly in the Indian Ocean.

## **Deep SOLO**

Nathalie Zilberman, on behalf of the Scripps Argo Team, reported on the status and progress of the Deep SOLO profiling float. A new generation of free-drifting autonomous profiling floats, Deep SOLO, equipped with strengthened pressure housings and improved Conductivity Temperature Depth (CTD) sensors, and capable of diving to 6000 m depth, is under development at Scripps Institution of Oceanography for sampling the deep ocean. Two Deep SOLO float prototypes deployed in the Southwest Pacific are presently cycling to 5500 dbar every 6.5 days, and have completed over 70 cycles in the 9 months since deployment in June 2014. One of the SBE-61 Deep SOLO CTDs has a small salinity bias, 0.005 relative to shipboard data, and the other has a larger offset of -0.04. Our plan is to recover both Deep SOLO floats in September-November 2015 after 120 cycles (~80% of expected battery capacity) for a better understanding of the mechanical performance and endurance of the float and the calibration of the CTDs. The two Deep SOLOs will be replaced by a pilot array of 10 Deep Argo floats (Deep SOLOs and Deep APEXs) distributed around the Southwest Pacific Basin.

### **6.4 Calibration of pressure sensors**

This topic concerned an action item from last year’s AST meeting and was to be reported on by S. Riser who unfortunately could not come at the last minute. S. Wijffels reported that work has been done on this and it was kept as an action item for the next meeting.

**Action item 14:** Collect independent data on the quality of CTD pressure calibration, analyze it, write it up, and post on various Argo web pages. S. Riser, S. Wijffels

### **6.5 Plans for RBR sensor testing**

A report from Greg Johnson at RBR Ltd about their new RBRargo CTD was given by S. Jayne. It presented work comparing some RBR and SeaBird CTD data collected on a GO-SHIP hydrographic cruise (Brian King). It also broadly covered the integration work and float deployments done with the Webb, MRV, and MetOcean float manufacturers.

Australia, India, the UK and the USA all have plans to test the RBR sensor in the coming years.

**Action item 15:** At AST-17 report on progress in testing new sensors including RBR, SBE61, SBE41 below 2000m. AST members; specifically for RBR: Australia, Canada, India, UK, and USA

## **7 Completing the global mission**

### **7.1 Deep Argo Implementation Workshop**

Nathalie Zilberman and Guillaume Maze, representing the Deep Argo Workshop Steering Committee, reported on planning for the Deep Argo workshop. Deep-ocean (> 2000 m) hydrographic observations are limited to sparse ship-board hydrographic sections repeated every decade and short-lived moored arrays of confined spatial coverage. The upper-ocean (< 2000 m) sampling, largely accounted for by the conventional Argo array, has much higher resolution in space and time. The need for more intensive sampling in the deep ocean has been widely recognized by the scientific community. The development of deep profiling Argo floats, a new set of autonomous instruments capable of diving and recording temperature and salinity down to 4000 to 6000 m depth, is underway, along with a parallel development of deep float CTDs. The Deep Argo Workshop, which is scheduled for May 2015 in Hobart, Tasmania, provides a unique opportunity to develop a science plan to measure anomalies in temperature and salinity in the deep ocean and study the dynamics of the deep Meridional Overturning Circulation by taking advantage of deep profiling floats combined with other observing system technologies.

The main objectives of the proposed workshop are to:

1. Articulate key scientific issues for Deep Argo: (i) closing the heat, freshwater, and sea level budgets, (ii) characterizing decadal variability in deep ocean water masses, (iii) estimating the mean and decadal variability in deep ocean circulation including meridional overturning circulations.
2. Determine sampling requirements to achieve Deep Argo objectives.
3. Review plans for the deployments of Deep Argo pilot arrays.
4. Promote international collaboration within the Deep Argo community.

**Action item 16:** N. Zilberman & G. Maze to submit an abstract to Galway workshop to present Deep Argo Workshop results.

### **7.2 Status of Argo enhancements**

#### **7.2.1 Seasonal ice**

A short update was presented on the activities for the seasonal ice zone with a European perspective on the regional enhancements for the Nordic Seas and Southern Ocean. As the ERIC has been put in place, it will start working on a long term implementation plan based in coordination with the international program and funding for the activities in the seasonal ice zones will be obtained through the national partners and additional funding at EU levels. As far

as the seasonally ice-covered high latitudes are concerned, initial European targets have been defined for the Nordic Seas and the Southern Ocean for which mature technology and successful experience with float deployments exist.

The Nordic Seas at present are sampled by 62 floats which already exceed the initial target of 39 floats for the area. Deployment plans for the area for 2015 include deployments from Finland, Germany, Norway, Poland and the UK and will be sufficient to keep the data coverage complete.

For the Southern Ocean, the European interest is focused on the Atlantic sector. Seeding the Weddell Gyre with floats at nominal Argo design density will require a fleet of 81 active floats. In 2014 only 29 floats sampled the Weddell Gyre and a deployment of 27 floats at the end of 2014 in the area by RV Polarstern had to be cancelled because of technical problems with the new generation of NEMO Floats. All floats in the Weddell Gyre need ice protection and should carry RAFOS antennae to determine profile positions under ice. An extended array of sound sources for this purpose has already been deployed in the Weddell Gyre by the Alfred-Wegener Institute and will be maintained during the following years.

For the Arctic proper with multiyear ice conditions national pilot project such as iAOOS, NAOS and ACOBAR are underway and will be evaluated in the next years. Ice-tethered floats have been used in international cooperation in the Arctic proper and strong links should be developed with these groups. The Alfred Wegener Institute (AWI) has launched a sustained multidisciplinary, year-round surface to seafloor observatory at Fram Strait and has expressed interest to the Argo program to extend the float measurements into the area north of Fram Strait. The AWI is also coordinating the Polar Prediction Project (PPP) and its field phase in the Year of Polar Prediction (YPP) in 2017-2018. The program has also expressed its interest in an extension of Argo float measurements into the polar oceans which would be an important contribution to the overall success of the Year of Polar Prediction.

**Action item 17:** S. Wijffels to discuss with B. Klein how best to interact with SOOS to represent Argo at the upcoming meeting in Hamburg.

### 7.2.2 Marginal Seas

The implementation of Argo in marginal seas was reviewed. In early 2015, about 200 floats were active in the following marginal seas: Sea of Japan, South China Sea, Gulf of Mexico, Caribbean Sea, Red Sea, Persian Gulf, Indonesian Seas, Nordic Sea, Baltic Sea, Mediterranean and Black Sea. Assuming a metric of twice the standard Argo density (i.e., 2 floats in 3° x 3° cells), some seas are still very much under-sampled (Gulf of Mexico, Caribbean, South China Sea, Indonesian Seas) whereas others like the Sea of Japan, the Nordic Sea, the Mediterranean and the Black Sea appear to have reached, or even exceeded, the target density. The numbers of floats operating in the marginal seas in early 2015, as well as the target density based on twice the Argo standard, are listed in Table 1. Excluding the Nordic and Baltic Sea, the implementation of the marginal seas has reached about 85% of the target density. Note that some seas are really over-sampled (Sea of Japan). In addition, adequately sampled seas, like the Mediterranean, are not necessarily well homogeneously sampled in all their sub-basins (most floats are in the northern areas).

<b>Marginal Sea</b>	<b>Floats alive in early 2014</b>	<b>Floats alive in early 2015</b>	<b>Target density</b>
Sea of Japan	40	40	16
South China Sea	8	12	20
Gulf of Mexico	8	15	20
Caribbean	8	10	38
Red Sea/Gulf of Aden	2	2	10
Persian Gulf/Gulf of Oman	8	8	10
Nordic Sea*	30*	45	
Baltic Sea*	1*	2	
Mediterranean	60	60	36
Black Sea	10	10	6
Indonesian Seas	1	2!	21
Sea of Okhotsk	0	2	4
<b>TOTAL</b>	<b>145 (176*)</b>	<b>177 (208*)</b>	<b>209</b>

Table 1. Implementation of Argo in Marginal Seas in early 2015 (\*note that the Nordic and Baltic Seas might be considered as part of the Arctic Ocean).

Regarding the cycling period, the majority of the marginal seas have floats with the standard 10-day cycle. However, in the Mediterranean and Black Seas most floats cycle every 5 days, eventually alternating short and long profiles. This specific mode appears adequate for these seas, although new sensitivity studies of Argo-based products (basin-scale statistics, forecasting skills, etc.) are still in progress as part of the E-AIMS European project.

Some marginal seas are sampled by floats with biogeochemical/optical sensors (Mediterranean, Black Sea, and Nordic Sea); in particular about 20% of the Argo fleet in the Mediterranean, i.e., 10 floats, are equipped with such sensors.

Iridium two-way telemetry has been recommended in order to increase the float operating lives in the marginal seas (decrease of the surfacing time and therefore reduction the possibility of stranding or of being stolen at surface). This has been implemented in some marginal seas. In particular, for the Mediterranean and Black Seas, more than 60% of the floats are using Iridium telemetry and the downlink has been used occasionally to change the cycling and sampling parameters of some floats.

A major issue mostly specific to the marginal seas is the operation of floats in many EEZs and territorial waters of different countries. The notification of deployments through the AIC and the notification by sending a report letter to the Argo national focal points when floats are entering the EEZs of some countries (e.g., Turkey, Egypt, see list in the AIC) should be common routine practice.

### **7.2.3 Western Boundary Currents**

T. Suga reported on the enhancement in the western boundary current (WBC) regions. There are no WB regions which meet the proposed doubling of float number so far. It was noted, however, that the region around the Kuroshio and its extension has been filled with more than 50 floats sampling every 5 days maintained continually by JMA and thus double sampled in terms of the number of profiles to a large extent. It was also noted that the low-latitude western boundary current region in the North Pacific is missed in the Global Argo enhancement proposal map and should be included.

To test how the double sampling will reduce mapping errors in WBC regions which have high eddy kinetic energy, an analysis on mapping error in the Kuroshio/Oyashio extension region was carried out. Argo-like sampling from eddy-resolving OGCM (OFES, JAMSTEC) 1/10-degree and 1 day snapshot during 2010 was made to produce objectively analyzed 1-degree monthly gridded dataset resembling MOAA GPV (Grid Point Value of the Monthly Objective Analysis using the Argo data) updated regularly by JAMSTEC. Three thousand ensembles were used to evaluate means and standard deviations for grid point values. It was shown that double and quadruple sampling would reduce an error bar (95% confidence interval) by 0.67 and 0.5, respectively, and also reproduce better mean fields.

Two examples of enhanced float deployment in WB regions were presented. Nearly 30 floats were deployed in the low-latitude western boundary current region in the North Pacific as part of the process study OKMC, revealing new features of the Luzon Undercurrent and the Mindanao Undercurrent and their connections to the interior. The other example is a multinational effort to fill the gap in the region north of the Gulf Stream to improve mapping ability. Regional process studies and continual efforts contributing to enhanced deployment of Argo floats in the region in each of WBC regions lead by individual PIs should be encouraged. Tools, such as web pages, for raising the profile of the WBC enhancement and sharing information on good practices, opportunities, etc., may help to encourage individual PIs. It was emphasized that the WBC region enhancement of Argo should be part of integrated observing system of WBC regions.

### **7.2.4 Equatorial**

#### **M. Ravichandran**

M. Ravichandran presented the impact of moored buoy, Argo profiling floats, and ship-based components of the Global Ocean Observation System on the quality of tropical Indian and Pacific ocean analyses by conducting Observation System Evaluation experiments (OSEs) using Global Ocean Data Assimilation System (GODAS). Analysis is carried out for the period 2004-2011. Results indicate that the observations of temperature and salinity from Argo profiling floats have positive impact on the quality of ocean analysis in the tropical Pacific and Indian Ocean, especially sea surface height and currents. Although not so significant, ship-based measurements also have positive impact in these regions. Surprisingly, in-situ measurements of T & S profiles from moored buoy have not shown any impact in quality and sometimes even degrade the ocean analysis in these regions. This may be due to the poor vertical and spatial

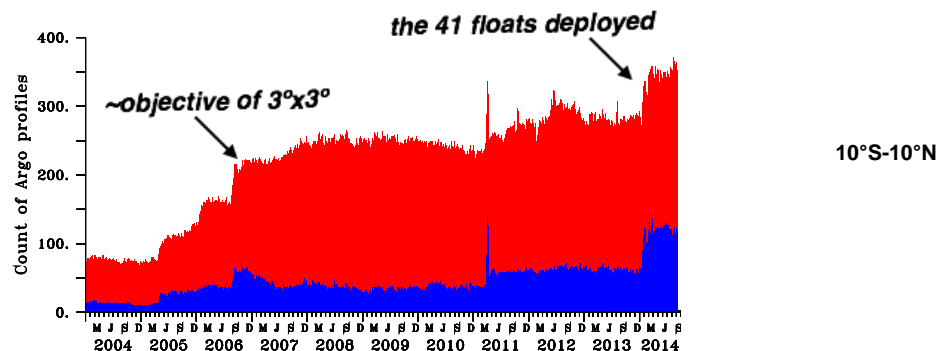
resolution of moored buoys, particularly from sub-surface layers, or to GODAS not being suitable for this type of OSE experiment. We note that the present study provides an overall idea on the impact of each in-situ ocean observation system and it cannot be generalized for all time and space scales. These results need to be tested for all time and space scales using multi-model systems before further conclusions can be drawn regarding redundancies and requirements of the ocean observing systems.

#### D. Roemmich

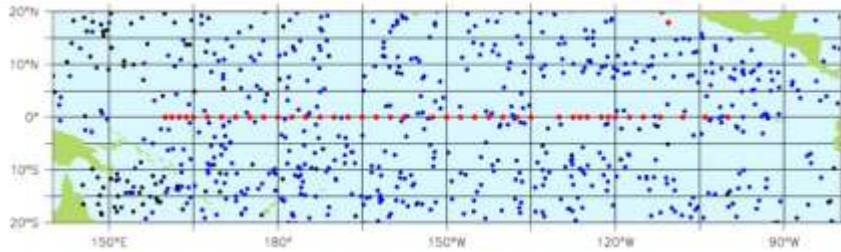
D. Roemmich presented TPOS 2020 which is a re-thinking, refining and re-designing of the Tropical Pacific Observing System. TPOS 2020 started in 2014 and is scheduled to end in 2020 with its primary outcome being an internationally-coordinated and supported sustainable observing system for the Tropical Pacific Ocean. Goals for the observing system include observing and quantifying the state of the ocean on various time scales, providing data to support, validate and improve forecasting systems, supporting calibration and validation of satellite measurements, advancing understanding of the climate system and maintaining and extending, where appropriate, the tropical Pacific climate record. Several specific questions must be addressed regarding how the observing system should change to address the goals. The second TPOS 2020 Steering Committee will meet in Australia this fall. S. Wijffels requested help in identifying people who can do statistical analyses of the region. P.Y. Le Traon mentioned that Mercator is doing studies for TPOS and B. King thought that the UK MetOffice had done studies already. It was noted that this project is an opportunity for Argo to interact with other observational communities and Argo should act on this to help improve both Argo and the general Tropical Pacific Ocean.

#### F. Gasparin

In the tropical Pacific, the Argo Program significantly increased sampling since 2004 (Figure 1a) and by 2006 was close to its objective of  $3^\circ \times 3^\circ$  spacing in the equatorial Pacific (about 300 profiles every 10 days,  $10^\circ\text{S} - 10^\circ\text{N}$ ). In early 2014, the existing Argo array was enhanced by 41 floats deployed along the equator from  $100^\circ\text{W}$  to  $160^\circ\text{E}$  from January to March 2014 (Figure 1b) following recommendations from OceanObs'09 (endorsed by Argo ST) in order to enhance float coverage near the equator for improved estimation of intraseasonal variability. Early models of Argo floats, spending about 12 hours on the sea surface each cycle, were carried out of the equatorial band by surface layer Ekman divergence. Newer models, using iridium communicates, mitigate this problem with 15-minute surface times, enabling much longer residence times on the equator. Argo coverage is now considered as a homogeneous array along the equator with almost one float every  $1^\circ$  of longitude.



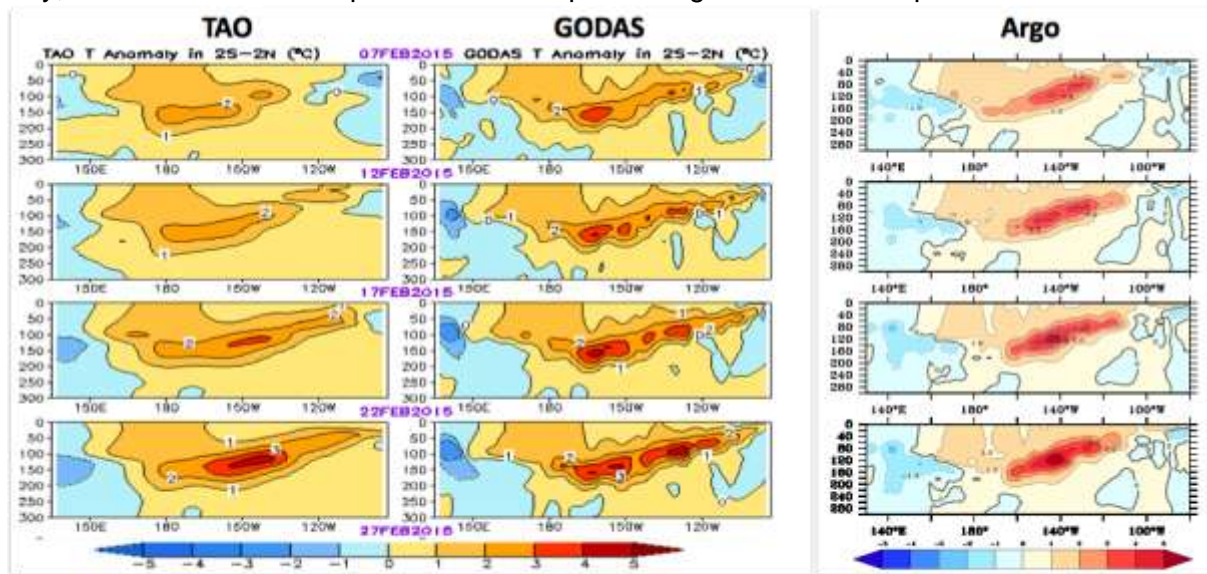
deployments of 41 floats (Jan-Mar 2014) – red dots



These new deployments are expected to improve the description of intraseasonal variability and to be valuable in modeling and data assimilation for the full range of intraseasonal and longer-term variability in the equatorial Pacific Ocean.

Following Roemmich and Gilson (2009) procedures, anomaly fields at 5-day intervals have been constructed utilizing improvements in the optimal interpolation that include more accurate representation of zonal and meridional scales and noise-to-signal ratio, and by including the time domain. The consistency of error estimates from the OI has been validated by comparing Argo and TAO/TRITON temperatures. The RMS error is consistent with RMS differences between gridded Argo temperature and TAO/TRITON, and these error estimates are used to evaluate impacts of the recent deployment of 41 Argo floats for enhanced coverage along the Pacific equator. Impacts of the recent deployment of 41 floats along the equator include reduction of the RMS error along the equatorial thermocline from around 0.8°C to 0.5°C.

Here, we compare temperature anomaly along the equator from TAO-only, GODAS, and Argo-only, which shows clear improvements in representing subsurface temperature anomalies.



Monthly Ocean Briefing  
(NOAA Center for Weather and Climate Prediction)

SCRIPPS Argo-product

## 7.2.5 Caribbean Sea and Gulf of Mexico

The number of active floats in the Intra-American seas has improved but is still below target coverage. Over the past year WHOI has deployed 4 MRV S2A floats in the Caribbean and 4 into the Gulf of Mexico which add to the 7 floats deployed in 2013. Caribbean deployments

included an outreach component as the floats were launched from ships operated by the Sea Education Association and Semester at Sea. So far, the active floats with Iridium telemetry have demonstrated an ability to remain in their deployment basin and not be swept out via the Florida Current nor to cross isobaths into shallow water. For 2015 there are plans to deploy an additional 4 into the Gulf of Mexico and 4 destined for the Caribbean.

**Action item 18:** Refine Western Boundary Current regions, Marginal Seas in ATC's map. M. Belbeoch

### 7.3 GOOS and OOPC update

A. Fischer and T. Suga reported on the status and plan of the Global Observing System (GOOS) and the Ocean Observations panel for Physics and Climate (OOPC) and their connections to Argo. GOOS has been moving toward the truly integrated observing system around Essential Ocean Variables (EOVs) under the Framework for Ocean Observing (FOO) with three observing system panels of physics, biogeochemistry and biology/ecosystems, which interact with technical advisory groups/projects/GOOS Regional Alliances (GRAs) such as Argo that is a core contribution to GOOS. GOOS Strategic Mapping is being developed to visualize the connections among various elements of requirements, observations and data & product as a tool for effective communication, planning and implementation. It is noted that awareness of risks in each of observation network, such as reliance on too few agencies and research agency fatigue, is important to for sustainability of GOOS. In this context, experience points to the need for strong research-operational partnerships.

As a particular activity of OOPC directly relevant to Argo, the development of Observing System Network/Element Specification was introduced. This will provide an essential tool for activities under FOO. The work will be progressed through the OOPC-18 meeting and JCOMM Observation Coordination Group (OCG) meeting both to be held in April and inputs from observing networks including Argo will be sought.

**Action item 19:** Update GOOS network specification sheet. T. Suga, H. Freeland, AST co-chairs

### 7.4 Float lifetime comparison

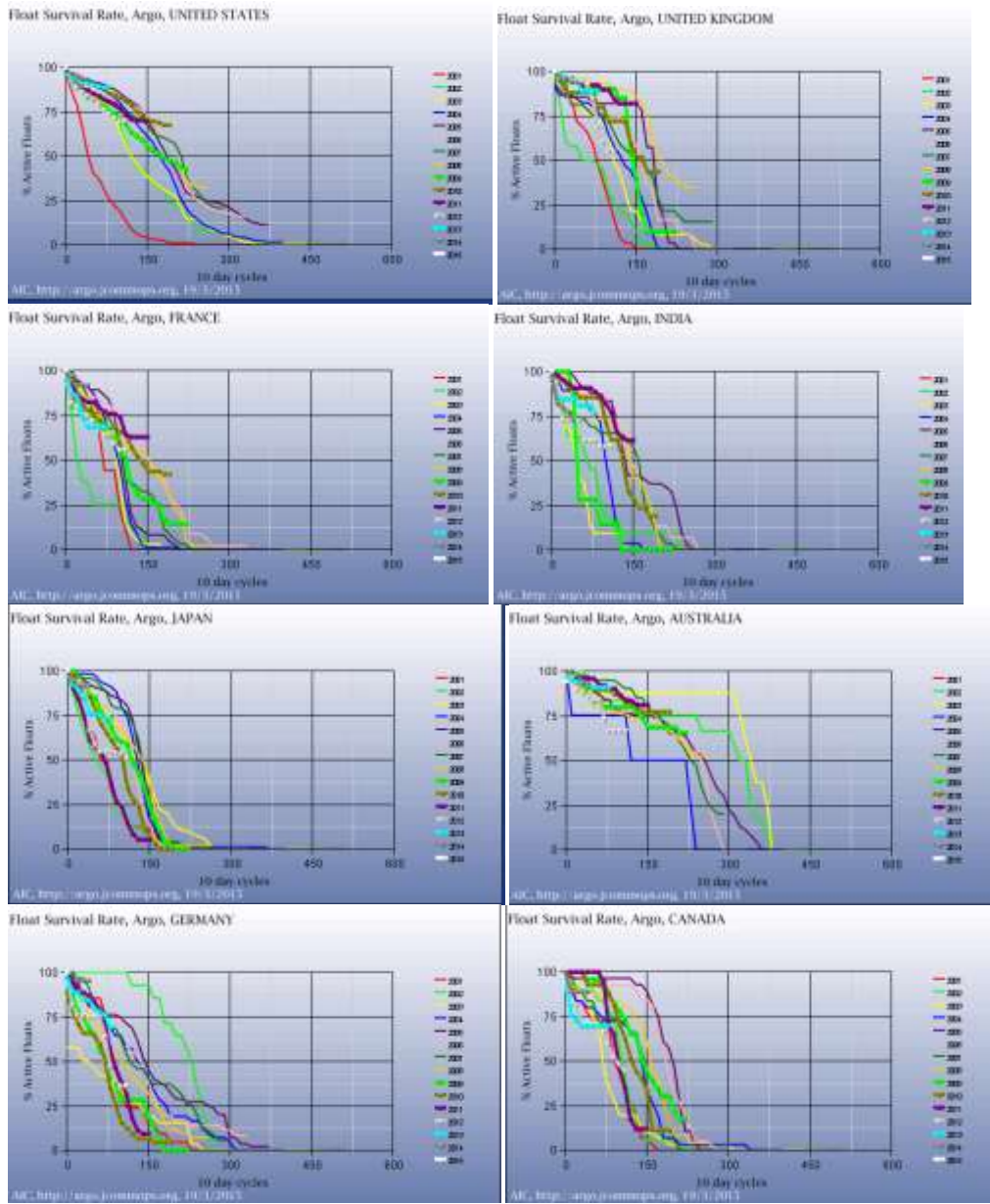
At the start of Argo, a great deal of focus was on increasing the reliability and longevity of floats used in the program. This resulted in a great improvement in float performance, and was achieved via active technical discussion between teams and also with the suppliers, and strong information sharing within the program. Float reliability across the global program peaked in 2005.

Over the past 5 years, reliability/longevity has started to degrade. This is true in nearly all national programs. In addition, there is a great diversity in performance across programs, with some achieving long life (50% reaching 200 profiles) and others short lifetimes (50% only reaching 100 profiles) – see figures. This has a profound impact on the size of the active array that these programs can sustain.

If Argo is to sustain its original coverage goals and to reach the new global design, lifting float reliability across the global program to best practice is essential. The AST discussed how this could be done, and one idea to be pursued is to organize a series of technical workshop with



providers, possibly in Seattle (for North American suppliers) and possibly in Europe organized by Euro-Argo for European suppliers.



**Action item 20:** Improve float lifetime plots. M. Belbeoch, D. Roemmich

**Action item 21:** B. King, B. Klein, M. Belbeoch, S. Wijffels, H. Freeland, J. Turton, S. Hosoda to work on float platform performances and interaction with manufacturers and figure out best way to proceed.

**Action item 22:** ATC to gather a list of questions to ask during float tender experience. M. Belbeoch

## 8. Demonstrating Argo's value

### 8.1 Argo bibliography

M. Scanderbeg reported 1968 papers have published since 1998 including Argo data with 349 papers in 2014. There have been at least 30 more papers per year since 2011 and the number will pass 2,000 in the coming months. Papers from over 30 countries, including some countries not directly involved in supporting the Argo program, are included in the bibliography, but the majority still comes from a handful of countries. The Journal of Geophysics Research, Geophysical Research Letters, and the Journal of Physical Oceanography are the top three journals that have published articles including Argo data. Combined, there are over 550 papers in those three journals. 11 articles with Argo data have been published in Science (IF=31), 11 in Nature (IF=42), 11 in Nature Geoscience (IF=12) and 8 in Nature Climate Change (IF=12). Here, IF stands for Impact Factor. A higher Impact Factor indicates that the journal circulates to a wide ranging audience.

It was noted that many recent papers use Argo and satellite salinity:

- Aquarius used in ~50 papers with 35 in 2014
- SMOS used in ~60 papers with 22 in 2014

Argo data is being used recently to track typhoons, cyclones and hurricanes with 25 of the roughly 100 papers coming in 2014. The gridded fields are also getting extensive use as noted by the CARS climatology being used at least 204 times and the Roemmich & Gilson climatology being used at least 115 times.

Based on feedback from national reports, almost all papers in English are found using the current search techniques. Work still needs to be done to expand to BGC Argo and M. Scanderbeg will reach out to the Bio-Argo/BGC Argo community to make sure that the right journals are being searched. M. Scanderbeg again stressed that if "Argo" is not stated in the paper, authors or AST members must submit the citation in order for it to be included in the bibliography.

M. Scanderbeg recalled that the "Acknowledgements" page on the AST website asks authors to (1) cite a DOI and points them to the ADMT DOI page or (2) cite the acknowledgement statement if a DOI is not possible. Unfortunately, data DOIs are not being tracked by journals or publishing houses making it impossible to use the various data DOIs as a way to find the papers published including them. M. Scanderbeg will continue working with J. Buck as needed to work with journals and publishing houses to fix this. It will involve the journals sending the data DOI along with the other reference DOIs to the publishing houses who must then track these data DOIs in addition.

M. Scanderbeg will work with F. Merceur at IFREMER to establish a list of DOIs citing the general Argo GDAC data DOI.

Not all papers mention Argo in their acknowledgements section and those that do include the requested statement or the US GDAC or Coriolis most of the time with the GADR mentioned occasionally. Of course not all papers require this, but it was suggested that the DOI citation information be clearly included on the GDACs at all places that data is gathered (ftp, http, data selection tools, rsync, etc) to try and improve proper Argo data citation.

Finally, the thesis citation list was shown and now contains almost 150 doctorate theses using Argo data and is based on both database searches and contributions from AST members.

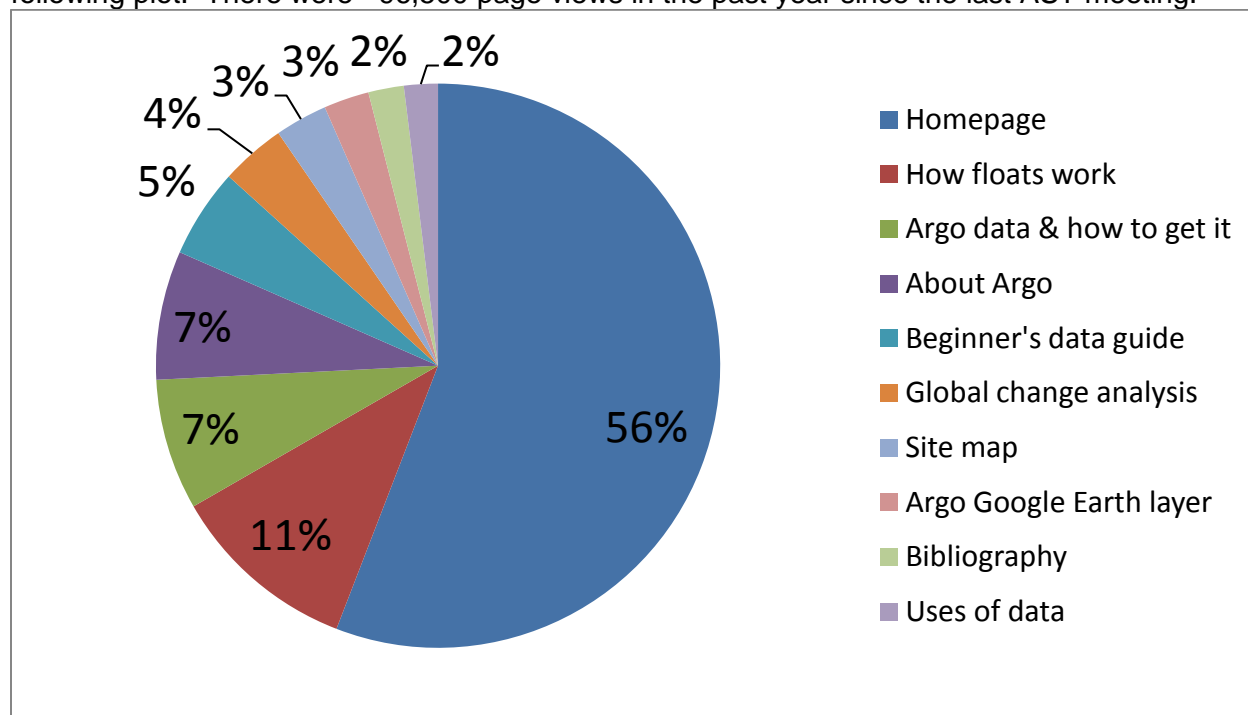
There are decent databases for the US, Canada and parts of Europe, but access to the entire dissertation is not always possible and some are in languages other than English, making it harder to verify Argo data usage. For most other areas of the world, it is important for AST members to contribute thesis citations. This list can be another important way to demonstrate Argo's value, especially in education, so please send thesis citations to [mscanderbeg@ucsd.edu](mailto:mscanderbeg@ucsd.edu) or [argo@ucsd.edu](mailto:argo@ucsd.edu). It was noted that the decrease of papers in recent years may be due to it taking longer for theses to reach these databases and even if they reach the database, sometimes there is a hold placed on the entire document for a year to allow time for publication of data.

The AST acknowledged the usefulness of both the Argo bibliography and the thesis citation list. There was a desire to know how many papers were published outside of the Argo PI community and an action item was created to address this.

**Action item 23:** Keep track of how many papers are published by Argo PIs vs. others. Ask AST members to send M. Scanderbeg a list of PIs in their country. M. Scanderbeg, AST members.

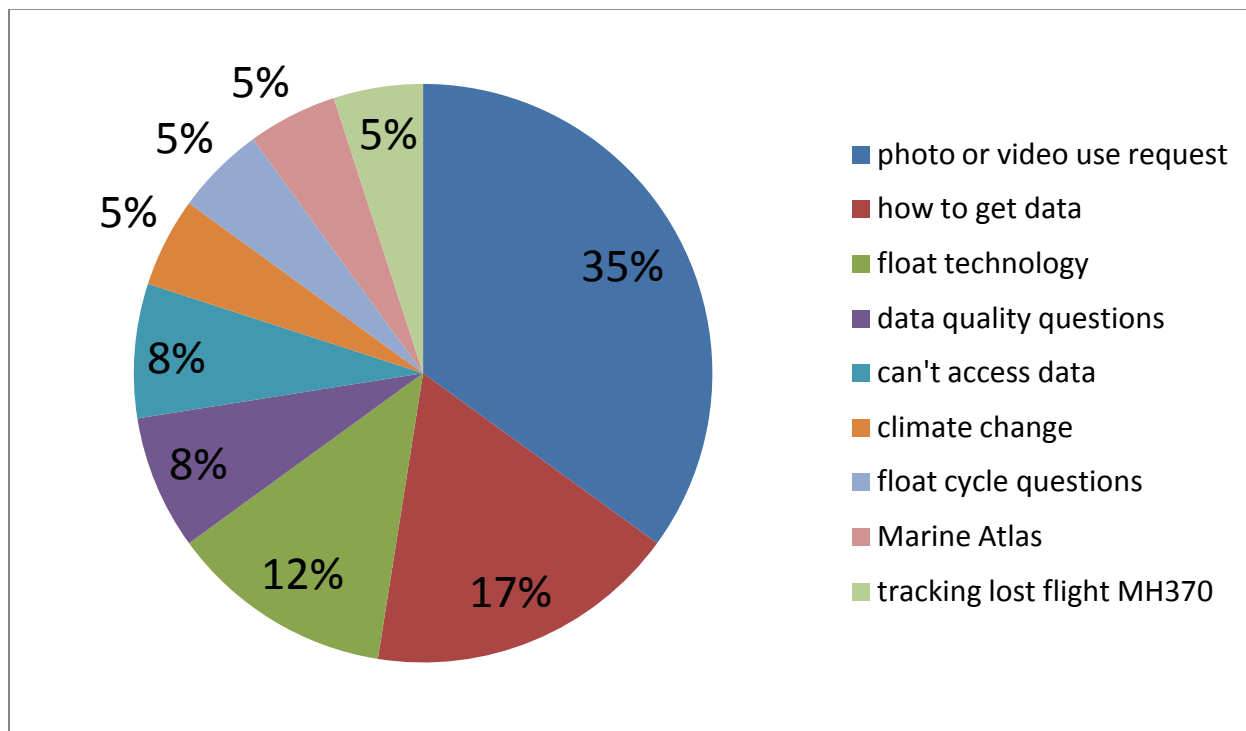
## 9.2 Argo Steering Team Website

M. Scanderbeg presented an update of the work done in the past year on the AST website. A study was done of the top ten pages visited on the AST website and is presented in the following plot. There were ~96,500 page views in the past year since the last AST meeting.



It is possible to see that about half of the traffic is to the homepage, but that about half the people continue on to other pages. It also emphasizes the need to keep these pages as up to date as possible.

M. Scanderbeg also analyzed the questions that came into the [argo@ucsd.edu](mailto:argo@ucsd.edu) and [support@argo.net](mailto:support@argo.net) email addresses in the past year. The breakdown is shown in the following plot:



The majority of questions deal with photo or video use or access to high resolution video. Many of the others deal with the data (how to get it, if certain data is bad, inability to access data) and with float technology or float cycle.

The point of these analyses is to note that working on the data pages is important and the following pages were updated in the past year:

- Argo data and how to get it
- Argo Beginner's Guide to data use
- Gridded fields and products
- Data viewers
- Operation use of Argo data
- Educational use of Argo data
- Video gallery

Links to the GDAC ftps, monthly DOI snapshots, data selection tools at the GDACs, gridded fields and products, data viewers, Google Earth and archived data were added at the top right of the Argo data and how to get it page. It was noted that a link to the rsync service should also be added.

The Argo data beginner's guide was also updated this year as it has not been updated for several years and the data set is becoming larger and more complicated, but there are also additional ways to access it. Links were added throughout to the ADMT documentation page, the greylist, and various ways to access Argo data.

Velocity products were added to the gridded fields page per an ADMT-15 action item. Both ANDRO and its V3.1 NetCDF files are included as well as the YoMaHa product.

An Indian Ocean data viewer was added to the data viewer page which contains a quality controlled set of Argo data profiles and products. It was noted that the Coriolis GDAC tools should be added to this page.

The operational use page was updated after an AST-15 action item. A survey was designed and sent to GODAE OceanView centers and 8 responded. The other centers were updated as well with help from AST members as needed. There are now 20 centers making ocean analyses, re-analyses, ocean and weather forecasts and climatologies.

It was noted that there are many requests for access to high resolution videos and if any are out there, but not on the AST website, it would be good to have them.

Finally, it was agreed that the simple status map would stay on the homepage, but that links should be added to the suite of maps produced by the ATC periodically to reflect the various aspects of Argo. The text should also be updated to reflect the original Argo mission as well as the various enhancements.

**Action item 24:** Update AST homepage with links to maps produced by ATC. M. Scanderbeg

**Action item 25:** Update Data Viewers page to add GDAC tools

### **9.3 Upcoming science conferences and workshops**

Brian King reported on preparation for the GO-SHIP/Argo/IOCCP conference, to be held in Galway, Ireland from 14 to 18 September 2015. All details are on the conference web site <http://gaic2015.org>. AST members are asked to promote the conference in their national communities.

### **9.4 Argo (review of major findings) in Nature Climate Change**

H. Freeland reported that it is taking rather longer than originally expected to write a paper for Nature Climate Change, but the first draft was written by Howard Freeland and Steve Riser. It was then edited extensively by the Argo co-chairs and revised, then circulated to all members of the Argo Steering Team for comment. Thank you to all who contributed comments.

A new draft should be available imminently. The authorship will change to reflect the fact that though Howard Freeland took the lead originally, by now the paper has much more to do with Steve Riser than anyone else. We will find a way of listing the names of all contributors. When the latest draft is received, which could be this weekend, H. Freeland will re-read it, but it is likely to be in a state to submit to Nature CC.

### **9.5 YouthMobile MyOcean Mobile App Competition**

**Action item 26:** Test Android mobile app created by ATC. H. Freeland, S. Wijffels, G. Maze

**Action item 27:** Test new AIC website. S. Diggs, F. Carse, S. Wijffels, M. Scanderbeg

## **9.6 Argo Education Workshop**

H. Claustre noted that 20% of their budget is directed towards outreach efforts, so Argo needs to think carefully about how it might undertake outreach efforts as a whole.

**Action item 28:** Continue investigating an Education Workshop. Ensure that educators are involved in the process. T. Morris, Ravi, Workshop organizing committee

## **10. Future meetings**

### **10.1 ADMT-16**

The ADMT-16 meeting will be hosted by BIOS in Bermuda the week of November 2-6, 2015.

### **10.2 AST-17**

Japan offered to host the AST-17 meeting in 2016 in Tokyo or Yokohama, Japan.

## **11. AST memberships**

Denis Gilbert is passing over the Canadian AST membership to Blair Greenen of the Bedford Institute of Oceanography in Halifax. S. Wijffels thanked Denis for his five years as the Canadian AST representative.

Jon Turton will be passing his UK AST membership to Fiona Carse at the UK Met Office in Exeter over the next several months. S. Wijffels thanked Jon for his many years of service on the AST.

**Action item 29:** Ask M. Belbeoch to send out email to invite countries (Poland, Brazil, etc) without an AST member but who are deploying floats to be part of the AST.

## **12. Other business**

Argo Steering Team Meeting (AST-16)  
Brest, France, March 18-20, 2015  
Host: Ifremer and JCOMMOPS

AST Exec meeting: 17 March 5 pm  
AST-16: 18 March 9 am – 20 March 5 pm.  
Location: Salon de l'Océan

1. 9:00 Welcome (9 am March 18)
2. 9:10 Local arrangements
3. 9:20 Objectives of the meeting/adoption of the agenda
4. 9:50 Status of action items from AST-15 (Scanderbeg)

**10:20 Break**

5. Implementation issues
  - 5.1 10:50 Update commitments table (Scanderbeg)
  - 5.2 11:05 Tracking progress on original mission (Belbéoch)
  - 5.3 11:20 AIC Funding (Freeland)
  - 5.4 11:40 Bio-Argo/Biogeochemical Argo (K. Johnson, H. Claustre)
  - 5.5 12:20 Euro-Argo update (P.Y. Le Traon)
  - 5.6 12:40 UK Argo (B. King, J. Turton)

**Lunch**

- 5.7 14:00 Discussion items from National Reports
- 5.8 14:20 Argo's DOIs (J. Buck)
  
- 5.9 14:30 AIC Report on Status of Argo (Belbéoch)
- 5.10 15:15 Float deployment opportunities (Kramp)
- 5.11 15:35 JCOMM Observing Program Support Centre (Belbéoch)

**16h00 Break**

- 16h15 Group photo  
16h30 depart by bus to Océanopolis  
17h30 Oceanopolis Aquarium visit and cocktails  
20h30 bus return to downtown Brest



6. Data Management and related issues
  - 6.1 Feedback from ADMT-15 (Pouliquen)
  - 6.2 Status of Trajectory V3.1 files (M. Scanderbeg)
  - 6.3 Argo BUFR enhancements (J. Turton)
  - 6.4 Quality of the Argo reference database from CCHDO data (C. Coatanoan)
  - 6.5 CTD Reference data & API (Diggs, Barna)
  
7. Regional science, education and outreach
  
8. Technical issues
  - 8.1 Float technology progress (HM2000 float – Z. Liu)
  - 8.2 Report on Tangaroa/Deep Argo deployment and CTD validation cruise (Phil Sutton)
  - 8.3 Deep Argo floats progress:
    - Deep NINJA – Toshio Suga
    - Deep ARVOR – Virginie Thierry
    - Deep SOLO – Nathalie Zilberman
  - 8.4 Calibration of pressure sensors (S. Wiffels)
  - 8.5 Plans for RBR sensor testing
  
9. Completing the global mission
  - 9.1 Deep Argo Implementation Workshop – Nathalie Zilberman/Guillaume Maze
  - 9.2 Given the present status of Argo enhancements, the focus of this discussion should be on describing the standalone value of each new mission. What is the valuable science than has been done or could be done with these missions? Examples?
    - Seasonal ice (Klein)
    - Marginal Seas (Poulain)
    - Western Boundary (Suga)
    - Equatorial (Gasparin/Roemmich, Ravi)
    - Caribbean Sea and Gulf of Mexico (Robbins)
  - 9.3 GOOS and OOPC update (T. Suga, A. Fischer)
  
10. Demonstrating Argo's value
  - 10.1 Argo bibliography (Scanderbeg)
  - 10.2 Argo Steering Team Website (Scanderbeg)
  - 10.3 Upcoming science conferences and workshops –
    - a. ASW-5/GAIC in Galway, Ireland, 14 – 18, September 2015

- 10.4 Argo (review of major findings) in Nature Climate Change (Freeland)
- 10.5 YouthMobile MyOcean Mobile App Competition (Belbéoch)
- 10.6 Argo Education Workshop (M. Belbéoch)
- 10.7 Other Argo outreach activities –

- 11. Future meetings
  - 11.1 ADMT-16
  - 11.2 AST-17
  - 11.3

12. AST Membership

13. Other business

Meeting adjourns Friday 20 March, 5 p.m.

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	Action	Responsibility	Status
1	Write letter of thanks to local host Antoine Dosdat, director of IFREMER Brittany	AST co-chairs	
2	H. Freeland to email float manufacturers and suggest that they make energy budget simulator software available	H. Freeland	
3	Howard Freeland to ask each national program when they would like to be invoiced for payments to AIC	H. Freeland	
4	Ask National Programs to investigate how they are archiving their raw data and report on this at the ADMT-16 meeting.	National programs	
5	Ask AST members to ensure their country has an active Argo focal point	AST members	
6	Write Argo data paper for submission to a data journal	J. Buck, S. Poulouen, H. Freeland, M. Scanderbeg S. Wijffels S. Jayne	
7	Include citation information when data is downloaded from GDACs including FTP, HTTP, Data Selection Tools and rsync service	GDACs	
8	Working group to collect Argo indices/metrics/quality plots, decide how frequently to make them and where they will be stored. Could be two groups of metrics – one for internal use and one for general public	B. King S. Wijffels S. Poulouen M. Belbeoch	
9	Send out an email to general Argo list about the rsync service at the GDACs	M. Scanderbeg	
10	Add short document to website about what cycle timing information Argo would like all float types to send back. Circulate to manufacturers and PIs	M. Scanderbeg	
11	Document how CTD reference database is made and report to ADMT-16. Work with dmode community to find a way of adding metadata on quality of CTD data in ref db	S. Diggs C. Coatanoan T. Carval	
12	Ask M. Kramp & S. Diggs to monitor through time of GOSHIP data on CCHDO site	M. Kramp S. Diggs	
13	Add more details into the CTD request in national reports. Would like to know names of PIs who submitted data, when CTD cruises will occur and names of those PIs.	M. Scanderbeg S. Diggs	
14	Collect independent data on the quality of CTD pressure calibration, analyze it, write it up, and post on various Argo web pages	S. Riser S. Wijffels	
15	At AST-17 report on progress in testing new sensors including RBR, SBE61, SBE41 below 2000m	AST members RBR: Australia, Canada, India,	

		UK, USA	
16	N. Zilberman & G. Maze to submit an abstract to Galway workshop to present Deep Argo Workshop results.	N. Zilberman G. Maze	
17	S. Wijffels to discuss with B. Klein how best to interact with SOOS to represent Argo at the upcoming meeting in Hamburg	S. Wijffels B. Klein	
18	Refine Western Boundary Current regions, Marginal Seas in ATC's map.	M. Belbeoch	
19	Update GOOS network specification sheet	T. Suga H. Freeland Co-chairs	
20	Improve float lifetime plots	M. Belbeoch D. Roemmich	
21	B. King, B. Klein, M. Belbeoch, S. Wijffels , H. Freeland, J. Turton, S. Hosoda to work on float platform performances and interaction with manufacturers and figure out best way to proceed.	B. King B. Klein M. Belbeoch S. Wijffels H. Freeland J. Turton S. Hosoda S. Pouliquen	
22	ATC to gather a list of questions to ask during float tender experience	M. Belbeoch	
23	Keep track of how many papers are published by Argo PIs vs others. Ask AST members to send M. Scanderbeg a list of PIs in their country.	AST members M. Scanderbeg	
24	Update AST homepage with links to maps produced by ATC	M. Scanderbeg	
25	Update Data Viewers page to add GDAC tools	M. Scanderbeg	
26	Test Android mobile app created by ATC	H. Freeland S. Wijffels G. Maze	
27	Test new AIC website	S. Diggs F. Carse S. Wijffels M. Scanderbeg	
28	Continue investigating an Education Workshop. Ensure that educators are involved in the process.	T. Morris Ravi Workshop organizing committee	
29	Ask M. Belbeoch to send out email to invite countries (Poland, Brazil, etc) without an AST member but who are deploying floats to be part of the AST.	M. Belbeoch	



	2010 estimated	2010 Argo deployed	2010 Argo equiv deployed	% deployed vs. estimated	2011 estimated	2011 Argo deployed	2011 Argo equiv deployed	% deployed vs. estimated	2012 estimated	2012 Argo deployed	2012 Argo equiv deployed	% deployed vs. estimate
Argentina					4				4	4		100
Australia	95	72		76	90	112		124	50	47		94
Brazil	2			0	3	3		100	1			0
Canada	25	28		112	16	17		106	27	27		100
Chile												
China	50	23		46	50	44		88	30	20		67
Costa Rica												
Denmark												
Ecuador												
European Union												
Finland		2				2			2	3		150
France	95	55		58	80	53		66	65	82		126
Gabon												
Germany	110	41		37	48	48		100	66	72		109
Greece	1	1		100	3	3		0	4			
India	40	26		65	45	48		107	40	32		80
Ireland	3	3		100	3	3		100	3	2		67
Italy	2	1		50	30	4		13	24	2		79
Japan	116	51	44	82	127	73	40	89	123	54	29	67
Kenya												
Korea (Republic of)	12	12		100	14	14		100	15	15		100
Lebanon												
Mauritius	2			0	4	4		100	4			0
Mexico												
Netherlands	8	9		113	7	7		100	7	7		100
New Zealand	2	2		100	2	2		100	2	2		100
Norway	4	4		100	8			0	3			0
Poland	3			0	2			0	2	1		50
Russia												
Saudi Arabia		1										
South Africa					2			0				
Spain	12	10		83	5	17		340	13	6		46
Sri Lanka										1		
UK	40	25		63	40	39		98	36	38		106
UN (ice tethered profilers)												
USA	500	333	28	72	450	311	42	78	360	328	104	120
Subtotals	1122	699	72		1049	801	82		881	743	150	
Total		771		62	883	883	84			893		101
	2010 estimated	2010 Argo deployed	2010 Argo equiv deployed	% deployed vs. estimated	2011 estimated	2011 Argo deployed	2011 Argo equiv deployed	% deployed vs. estimated	2012 estimated	2012 Argo deployed	2012 Argo equiv deployed	% deployed vs. estimate

- Donated by UK

\*Numbers compiled from AIC website

2013 estimated	2013 Argo equiv estimated	2013 Argo deployed	2013 Argo equiv deployed	% deployed vs. estimate	2014 estimated	2014 Argo equiv estimated	2014 Argo deployed	2014 Argo equiv deployed	% deployed vs. estimate	2015 estimated	2015 Argo equiv estimated	Notes
60	2	56		3	18		27	3				Argentina
					10							Australia
	1	1		100		3						Brazil
34		32		94	14		9			29		Bulgaria 3/yr 2015-2020
												Canada
												Chile
40		8		20	30		36	49		10	20	China
												Costa Rica
												Denmark
												Ecuador
4	21	2	2	16		10	7					14 argo equivalent in 2016 ATLANTOS project
	4	4		100	70	3	5					Discussion with EC to buy 40 in 2015 80 in 2016 additional T&S floats
65	15	65	16	101		10	87	10		70	10	3/yr 2015-2020
												France
												Gabon
38	7	31	7	84	51	27	58	15		65	12	11 in 2015 are warranty floats; 12 equivalent in 2015 are AWI floats ; 40/yr 2015-2020
	3		2	67		6						5/yr 2015-2020
40		24		60	40		44			40		40 floats/yr 2012-2017
4		1		25	3		2					3/yr 2015-2020
16	0	12		75		25	21			30		20/yr in marginal seas; 10/yr in open ocean
70	33	43	35	76	50	38	51	41		23	33	Italy
	0	16		100	16		14					Japan
												Kenya
2		2		100	2		2					Korea (Republic of)
												Lebanon
												floats provided by UK, aim for up to 4 per year
7		4		57	10		3					Mauritius
												Mexico
2		2		100			4					Netherlands
												New Zealand
3	3	2	1	100	3	3	6			3		Norway
	1			0								Poland
												Russia
10	3	0	2	0	6	0						Saudi Arabia
3	3	1		17	2	3	1					South Africa
												Spain
												Sri Lanka
38		36		95	38	17	39					Turkey
												UN (ice tethered profilers)
320	96	316	83	125	330	145	309	73				USA
769	663	663	148	94	693	838	727	191	110%	270	75	
865		811			838		918			345		
2013 estimated	2013 Argo equiv estimated	2013 Argo deployed	2013 Argo equiv deployed	% deployed vs. estimate	2014 estimated	2014 Argo equiv estimated	2014 Argo deployed	2014 Argo equiv deployed	% deployed vs. estimate	2015 estimated	2015 Argo equiv estimated	

# Argo Australia – 2014 Activities

Report to the Argo Steering Team

Susan Wijffels, Ann Thresher, Esmee Van Wijk,  
Catriona Johnson, Alan Poole, Craig Hanstein

The Australian Centre for Atmosphere, Weather and Climate Research: a joint partnership between the Australian Bureau of Meteorology and CSIRO  
CSIRO Oceans and Atmosphere Flagship

Lisa Cowan  
Australian Bureau of Meteorology

## 1. Status of implementation

### Floats deployed and their performance

Australia currently has 403 floats actively reporting good data across the Indian, Pacific and Southern Oceans (Figure 1).

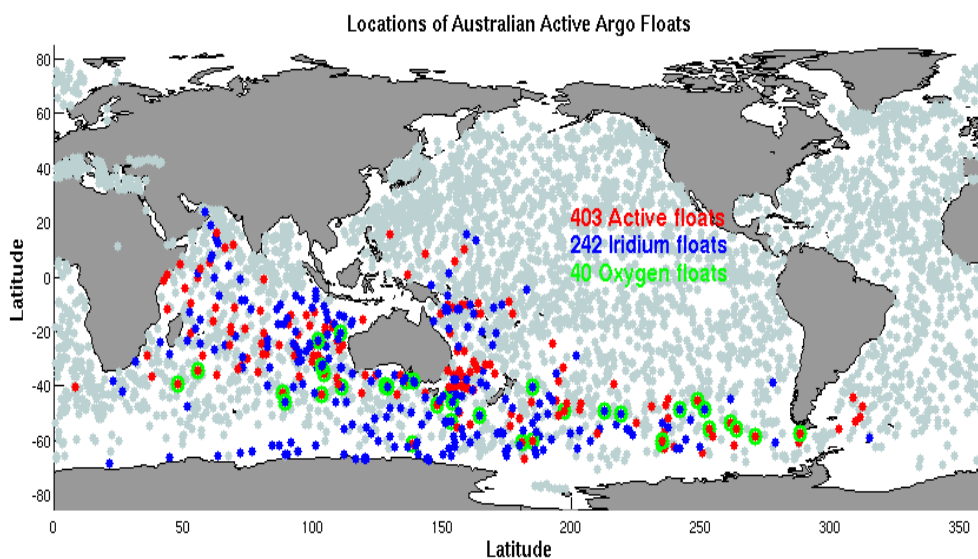


Figure 1. Locations of active Argo Australia floats (colours – defined as float reporting in the last 30 days north of 55°S, in the last year south of 55°S) as of March 2014 with active international floats in gray. Australian floats using Iridium Communications are in blue and those equipped with oxygen sensors are circled in green.

In the calendar year 2014, the program deployed 45 floats mainly spread throughout the Eastern Pacific, Indian and in the Southern Oceans – though 2 failed on deployment. We have deployed a further 18 already in 2015. Once again, on a joint US/Australia/New Zealand cruise, RV *Kaharoa* deployed floats for Argo Australia in the Indian Ocean continuing her successful contribution to the program.

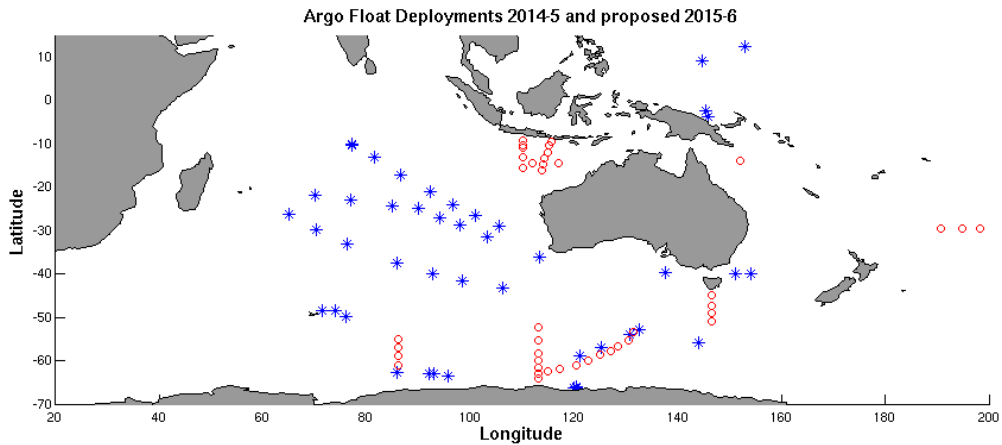


Figure 2. Locations of float deployments in 2014 (\*), with proposed deployments for 2015-6 (o)

Production of format version 3.1 files: Conversion to V3.1 formats were finished for all file types except one, in late 2014. We now deliver Technical, Profile and Metadata files (including mission information) in version 3.1 to the GDACS and are ready to deliver BR files (realtime Bio-Argo files) as soon as the GDACS are ready to accept them. All files are currently passing the format checks, including the BR files. We have coded Trajectory files into version 3.1 but only for floats equipped with an Argos transmitter. We are currently working on delivery of Iridium equipped floats but this will take additional time. That will complete our conversion to version 3.1 and we anticipate it will be done by the middle of this year.

### Technical problems encountered and solved

All but 11 floats in our Iridium fleet have been switched to RUDICS communications. The change over has decreased our costs with our provider by approximately 25%. Technical problems in the core fleet have been very few this year. Our fleet is also aging and we are now losing many of our floats as they reach operating ages of 7 or 8 years. Deployments have been able to fill the gaps caused by these losses.

### Float Failure Mode Analysis

As of the March 2015, the Australian Argo program had deployed 672 floats. From the total number of floats deployed; 252 are now dead. Of the remaining 420 floats, more than 95% are returning good data with 17 floats producing suspect or bad data (on the grey list). Of the dead floats, 41% ceased to operate due to normal end of life when they ran down their battery packs. A further 13% died of unknown causes and ~6% died on deployment. The remainder of floats ceased working mainly due to environmental reasons – see the table below.

Float failure mode for dead floats	Number of floats (252)	% of dead floats
End of life	104	41.3
Grounded	34	13.5
Unknown	33	13.1
Leak	23	9.1

Died on Deployment (5 from mechanical failure, 8 unknown and 3 turned on early)	16	-
Lost under ice	16	6.3
Mechanical or software malfunctions	34	13.5
Float preparation errors	3	1.2
Retrieved	5	2.0

### **Summary of Technical Issues**

We have had a very good year with respect to technical performance. Not included in the total above, however, are two floats that disappeared on deployment – they won't be declared dead until we are satisfied they won't return. One was a new APF11 float deployed in a group of 3. The other two APF11s, which were deployed at the same time, are producing good data and we will be deploying another APF11 shortly containing new firmware with modification to match our specifications.

### **Status of contributions to Argo data management**

Ann Thresher is co-chair of the Argo Data Management Team.

Collaboration with Argo India: The program has continued to work intensively with the Indian Argo program, on coding for new data formats, Bio-Argo data and version 3.1 formats.

Metadata Standardisation: Esmee van Wijk and Matthieu Belbeoch (with the help of the broader Argo community and manufacturers) have continued working on making the content of the global metadata files consistent. A table of fixed configuration parameter names exists on the ADMT website so that file content is standardised. Any new names required for new floats etc. must be added to this table and vetted for consistency before being used in the files. Work on unifying the labelling of data formats is continuing. The manufacturers have been asked to provide a unique data format label with all new floats and manuals. The task to identify old float formats is ongoing but will take some time.

With the increase of sensor types and acceptance of more data parameters, it has been necessary to revise and expand the technical variable names permitted, as well as the range of units that are allowed. Ann Thresher has led this effort, with help from the Bio-Argo community.

### **Status of delayed mode quality control process**

<u>Australian DM Statistics</u>	<u>05/03/2014</u>	<u>11/03/2015</u>
D files submitted to GDAC	38094	58413
Total R files	47971	43447
R files eligible for DMQC	32934	28361
Total eligible files for DMQC	71028	86774
Total files at GDAC	85905	101860

Table 1. Delayed Mode processing statistics for the Australian array.

The Australian Argo array continues to grow with 672 floats deployed to date since the beginning of the program and more than 100,000 Australian profiles available at the GDACs. A total of 403 floats are operational and returning good data. A further 249 floats have reached end of life and 16 are returning suspect or bad data. As of 11/03/2015, 67% of eligible profiles (those that are greater than 12 months old) have been processed through delayed mode quality control.

We have made good progress in the last 12 months in bringing up our fraction of delayed mode profiles at the GDAC with an extra half time DM person. We hope to be back up to full speed by the next AST meeting. In addition, a second new hire spent 6 months developing a prototype oxygen QC software suite. Unfortunately this person has now left to pursue a post-doc but we are hiring a casual (from May) for 3 months to start pushing oxygen data through the new software suite. As our array size is now stabilizing (deaths = deployments), with the new manpower we hope to reach Argo delivery requirements as soon as possible.

In total 520 floats have been assessed through the DMQC process for drift of the salinity sensor, many of these are now assessed in routine maintenance mode (i.e. at least once per year). Of these, 14 floats (3%) returned no data from deployment and 9 floats (2%) returned bad data for most of the record due to pressure sensor issues, cracked conductivity cells or other hardware problems. Of the remaining 497 assessable floats; 429 (86%) showed no salinity drift for the life of the float, 57 floats (11%) showed a positive salinity drift and 11 floats (2%) are affected by a fresh offset, most likely to be bio-fouling. Most floats with either a salty or fresh drift were able to be corrected using the OW software. A further 16 old floats (3%) suffered from TBTO fouling at the start of the record, generally only the first or second profiles but in some cases up to 7 profiles.

This year we have spent a lot of time transitioning to the new version 3.1 format netcdf files that ensure that a larger suite of metadata variables are adequately captured in the files and can accommodate multi-profile data from floats. We have appointed a new DM person to help with Delayed Mode QC and also to build a database that will host technical, engineering, metadata, real time and delayed mode QC information from floats.

We have also rewritten our Delayed Mode QC software to cope with multi-profile floats, i.e. those that contain secondary profiles with near surface data or oxygen data. Our delayed mode software has been completely revised from scratch to incorporate data from Bio Argo floats and also to include significant improvements in the way we visualise our data compared to nearby Argo floats. We are currently in the final phases of bug testing our new software to ensure consistency of outputs compared to the old software suite. The new software enables a first cut at the Delayed Mode QC of oxygen data from Argo floats.

Over the next 12 months we will focus on getting the new DM and oxygen software suite thoroughly bug tested and robust. We will also revisit the difficult floats that experience some type of salinity drift on a regional basis to ensure consistency of DM decisions. We will also closely assess the float performance of the new float types we have deployed (Seabird Navis, Solo II, S2A and APEX APF11 floats). Our new software has been developed to be flexible enough to handle new data types from extra biogeochemical sensors (i.e. fluorescence, backscatter, nitrate etc) although DM procedures for these variables will be a long way down the track. We also hope to have time to work on the delayed mode QC of trajectory files over

the next 12 months. With the increasing number of available Argo profiles globally we would like to invest more time into the development of global Argo products.

For those working with trajectory data or whom are interested in float data formats, electronic copies of the CSIRO APEX float manuals are now available online:

[http://www.cmar.csiro.au/argo/dmqc/html/Australian\\_float\\_manuals.html](http://www.cmar.csiro.au/argo/dmqc/html/Australian_float_manuals.html)

## **2. Present level of and future prospects for national funding for Argo**

Argo Australia has been part of Australian Government initiative: an Australian Integrated Marine Observing System (IMOS; [www.imos.org.au](http://www.imos.org.au)) for research infrastructure funded under the Education Infrastructure Fund (EIF) and the National Collaborative Research Infrastructure Strategy (NCRIS). Argo Australia also gets direct funding from CSIRO's Ocean and Atmosphere Flagship, the Australian Climate Change Science Program (ACCSP), in kind assistance from the Bureau of Meteorology and also logistical assistance from the Royal Australian Navy. The renewed Antarctic Climate and Ecosystem Cooperative Research Centre (ACE) has partly restored a key Southern Ocean contribution to Argo Australia through around 10 deployments per year, some of which will be deployed very close to the ice-shelves and may include deep Argo floats in the future.

After a year of reduced budgets under a stop-gap funding program, in late 2013 a new NCRIS program restored funding out to June, 2015. However, at this time (March 2015) the extension of the NCRIS funding remains uncertain and is not guaranteed beyond June 2015. There is thus the real possibility of the program losing over 50% of its funding. If this were to occur, and given the recent cuts to the CSIRO as a whole, Argo Australia may face a complete shut down. If NCRIS funding were to be extended, reductions in other national partner programs (ACE, ACCSP) would still result in a reduced level of float deployments in the future. Funding support in Australia for Argo has never been this tenuous since the first deployments in 1999.

Argo Australia has about 2.5 full time equivalents (FTE) in data management, 1 FTE in technical support and preparation and 0.3 FTE in leadership and management.

## **3. Summary of deployment plans (level of commitment, areas of float deployment)**

Once again, we have had a successful deployment year, with very few floats remaining in the lab. We have just ordered another 45 floats, all with identified deployment opportunities, for next year. Deployments of these begin in July. One of our focuses this year will be seeding the area between Indonesia and northwest Australia from a GOSHIP line carried out by Japan (we particularly thank Katsuro Katsumata from JAMSTEC for his excellent assistance). In addition, we will continue to assist in funding R/V *Kaharoa* voyages for as long as we are able and will provide 5 floats for her next trip. We will also be deploying 3 Argo Canada floats into the Southern Ocean before the end of this year. Thanks to our Canadian colleagues.

Some pilot floats with a new CTD may be deployed from the RV L'Atlante by Dr. Sophie Cravatte (IRD, France) in the Coral Sea.

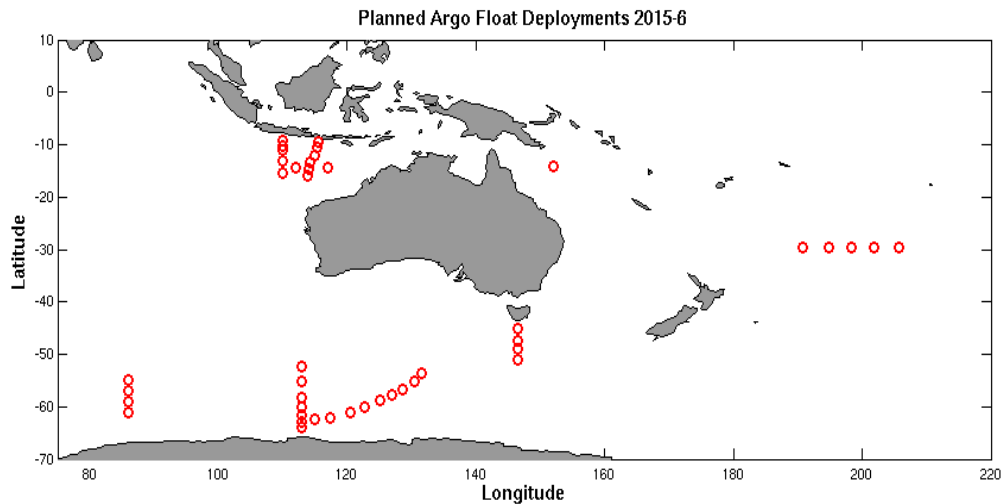


Figure 3. Proposed Locations of planned float deployments over the next year

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

- Argo data are routinely used in the operational upper ocean analyses Australian Bureau of Meteorology (<http://www.bom.gov.au/bmrc/ocean/results/climocan.htm>).
- The dynamical seasonal forecasting system POAMA heavily uses Argo data for forecast initialization, including assimilating salinity which greatly improves the analysis – Oscar Alves, Australian Bureau of Meteorology
- CSIRO Oceans and Atmosphere Flagship, in collaboration with the Bureau of Meteorology Research Center, has developed an ocean model/data assimilation system for ocean forecasting and hindcasting. Argo data is the largest *in situ* data source for this system. The ocean reanalysis products can be found here: <http://wp.csiro.au/bluelink/global/bran/>.
- The OceanMap forecasts are now routinely published and are available via the Bureau of Meteorology website.
- Many students in the CSIRO/University of Tasmania graduate program and University of New South Wales are utilizing Argo data in their thesis studies.

Argo Australia's web site is: <http://imos.org.au/argo.html>

Real Time data documentation:

<http://www.marine.csiro.au/~gronell/ArgoRT/http://www.marine.csiro.au/~gronell/ArgoRT/>

Delayed Mode data documentation: <http://www.cmar.csiro.au/argo/dmqc/index.html>

#### **5. Issues to be raised with the Argo Steering Team**



The transition to V3.1 has had a large impact on our software and DM processing, and has greatly delayed our ability to start QC on the trajectory data. The fewer time Argo has to reformat the global archive the better!

## **6. CTD cruise for Argo calibration purposes**

Our new BlueWater research ship, RV *Investigator*, is just finishing its shakedown period at present. Once it enters a more routine science schedule we will liaise with the data centre to ensure any deep CTD casts are available for the Argo data base.

## **7. Argo Publications**

We routinely update and synchronize our publications list (<http://imos.org.au/imospublications.html>) with that on the IAST website.

## 2014 Argo Canada report of activities

(submitted by Denis Gilbert)

16<sup>th</sup> meeting of the Argo Steering Team (AST-16)

Brest, France

18-20 March 2015



### 1. Status of implementation (major achievements and problems in 2014)

#### - floats deployed and their performance

In 2014, Argo Canada deployed 9 NOVA floats (4 in the northeast Pacific, 5 in the northwest Atlantic). Of these 9 floats, one died prematurely. The 8 remaining floats are still active and functioning properly.

#### - problems in 2014

We spent nearly all of 2014 without a valid standing offer in place for the procurement of Argo floats, which partly explains our lower than normal number of float deployments. Our request for a more robust and more reliable replacement warranty for defective floats, especially early deaths within 180 days, has led to 3 iterations of the bidding process. A new standing offer was finally awarded by PWGSC (Public Works and Government Services Canada) in early November 2014. It contains options for renewal until March 2018, and gives us the opportunity to have floats shipped directly from the manufacturer to Australia so that Canada now has a mechanism in place for contributing to the southern Argo float array.

- Status of contributions to Argo data management (including status of pressure corrections, technical files, etc)

MEDS continues to acquire data from 67 Argo floats. Of which 19 floats seemed to be in trouble and have not reported data for at least 6 months, so that our number of active floats is actually 48. Data are issued to the GTS and GDACs hourly in TESAC, BUFR and NetCDF format. The data of all Canadian floats together with some graphics are posted on a website and updated daily:

<http://www.isdm.gc.ca/isdm-gdsi/argo/index-eng.html>

On average 87% of data from January 2014 to January 2015 data were issued to the GTS within 24 hours of the float reporting in TESAC and BUFR format. We sent no BUFR data on the GTS in January 2014 due to system failure.

Since AST-15, we completed the following tasks:

- All of the existing NetCDF profiles collected up to the end of January 2015 from various versions were converted to version 3.1. The NetCDF profiles from floats

equipped with dissolved oxygen are still in version 2.2 since the GDACs are not ready to accept them yet.

- All of the meta data NetCDF files were converted to version 3.1
- The remaining profiles in version 3.0, trajectory (version 2.2), and technical NetCDF version 3.0 will be converted to version 3.1 by April 2015.
- We worked with BODC to validate the new Argo BUFR template to send dissolved oxygen and surface observations on the GTS
- We rewrote the BUFR encoder to read NetCDF profile version 3.0 and 3.1 in order to send dissolved oxygen and surface observations on the GTS.
- ISDM provides ADMT with quarterly reports on the performance of Argo data on the GTS in TESAC and BUFR formats.

#### - Status of delayed mode quality control process

As of March 2015, 18% of all eligible floats, active and inactive, had their profiles visually QCed and adjusted for pressure and salinity according to the latest delayed-mode procedures. The salinity component of DMQC has been performed on 57% of all eligible cycles at least once. Five North Atlantic floats had their calibration modified following the results of Cabanes et. al. (2014).

## **2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.**

### Financial resources

Canada does not have multi-year commitments of money devoted to Argo. New paperwork and lobbying is necessary on an annual basis to renew the funding required to purchase new floats and for satellite data transmission, in a context of ever tighter public spending by Canada's government. Nevertheless, we were able to secure 411k for the purchase of 29 Argo floats in late 2014. Some of that money was end-of-fiscal-year money left over from other programs.

### Human resources

Year 2015 will see major changes in our human resources. Blair Greenan of the Bedford Institute of Oceanography (BIO) agreed to replace Denis Gilbert as national leader of the Argo Canada program. Blair's leadership will officially begin on April 1, 2015. He will benefit from the expert assistance of Ingrid Peterson who will take over many of Denis' responsibilities with respect to float deployment logistics and satellite data transmission.

Moreover, a staffing process is well underway for the replacement of Howard Freeland at the Institute of Ocean Sciences, nearly two years after he retired from DFO. We are hoping that Howard's successor at IOS will be able to maintain some of the data products developed by him, such as surface circulation maps of the Gulf of Alaska, Argo data interpolated to station Papa and projected onto Line P.

**3. Summary of deployment plans (level of commitment, areas of float deployment, low or high resolution profiles, additional sensors) and other commitments to Argo (data management) for the upcoming year and beyond where possible.**

In 2015, we plan to deploy 29 floats (firm commitment), all of which have already been purchased: 14 will be deployed in the Gulf of Alaska, 5 in the Labrador Sea, 4 in the Gulf Stream's northern recirculation gyre, 3 in the North Atlantic subtropical gyre by the Canadian Navy, and 3 south of Tasmania with help from CSIRO. Canada's last float deployments in the southern ocean occurred more than 10 years ago. We are glad to be back in this under sampled region.

**4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers. Please also include any links to national program Argo web pages to update links on the AST and AIC websites.**

Scientists from the Canadian Meteorological Centre (Dorval, Québec) began assimilating real-time Argo temperature and salinity data in experimental mode in 2013. Early results indicate better prediction skill than in the operational model that is currently being run by Environment Canada for issuing weather forecasts. Increased skill is mainly seen at forecast times of 48 hours and longer. Migration from experimental mode to fully operational mode was expected to occur in October or November 2014. However, this had to be postponed due to various human resources staffing issues that are required for running a 24/7 fully operational service. National Defence Navy scientists routinely use real time Argo vertical profiles of temperature into their Ocean Work Station to aid in the computation of sound velocity profiles.

**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.**

Blair Greenan and Ingrid Peterson are proposing some changes to the AIC float density maps. In the Gulf Stream Extension where ASW-4 and AST-14 recommended double density sampling, the AIC density maps do not reflect this doubled density goal (a score of 100% means 4 floats per  $6^\circ \times 6^\circ$  square, rather than 8 floats per  $6^\circ \times 6^\circ$  square). Blair and Ingrid also propose that the fractional area of a  $6 \times 6$  degree square that is shallower than 2000 m should be taken into consideration in estimating float density. For instance, if a single density square has three quarters of its area deeper than 2000m, then a score of 100% for that square could be achieved with 3 floats instead of 4.

**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.**

Most of the recently collected Canadian CTD data are transferred from ISDM to NODC and then to CCHDO. Steve Diggs sometimes obtains data directly from Canadian PI's at DFO labs.

**7. Argo bibliography (<http://www.argo.ucsd.edu/Bibliography.html> ).**

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## Argo Chinese National Report 2014

(Jianping Xu & Zenghong Liu, The Second Institute of Oceanography, SOA)

### 1. The status of implementation

#### - floats deployed and their performance

From March 2014 to February 2015, China Argo deployed 29 Argo profiling floats in Northwestern Pacific ocean. Among these floats, 17 Iridium PROVOR floats with Aanderra 4330 Optode were purchased by Ocean University of China, and deployed by "DongFangHong-2" research vessel in March 2014. During this cruise, CSIO also deployed 8 APEX floats. The remaining 4 floats were deployed by CSIO through "KeXue-1" research vessel (Institute of Oceanology, Chinese Academy of Sciences) in November 2014.

In the efforts of Prof. Xu Jianping, 137 floats (108 PROVOR and 29 APEX floats) deployed by other institutions in China have been added into China Argo equivalent. All the data from these Argo equivalent floats have been submitted to GDAC since October 2014.

As of January 2015, China Argo (including China Argo equivalent) has deployed 336 floats, and 203 floats are still active now. From the last AST meeting, China deployed 73 floats including 44 Argo equivalent floats.

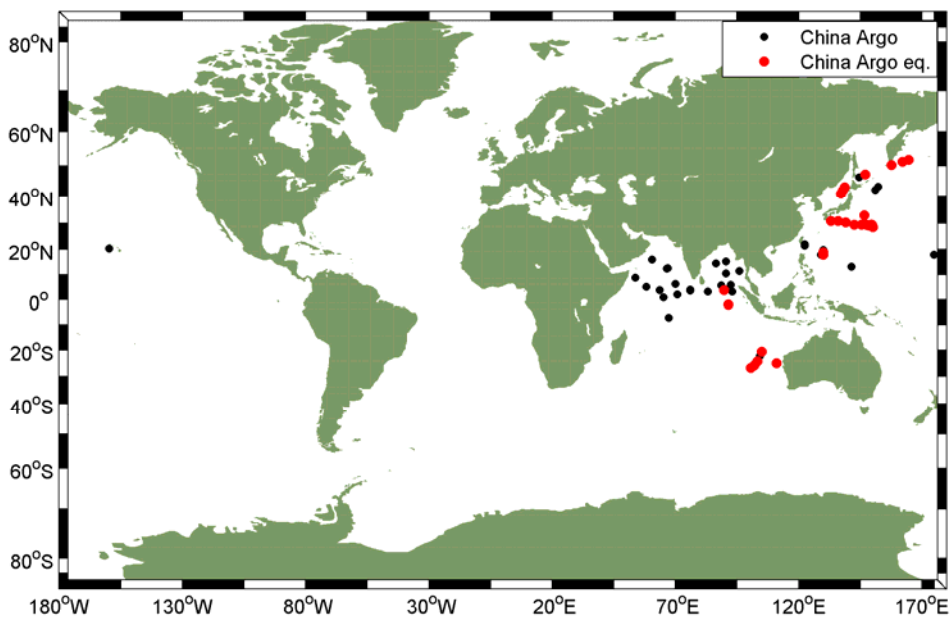


Fig.1 The launch positions of all floats from the last AST meeting

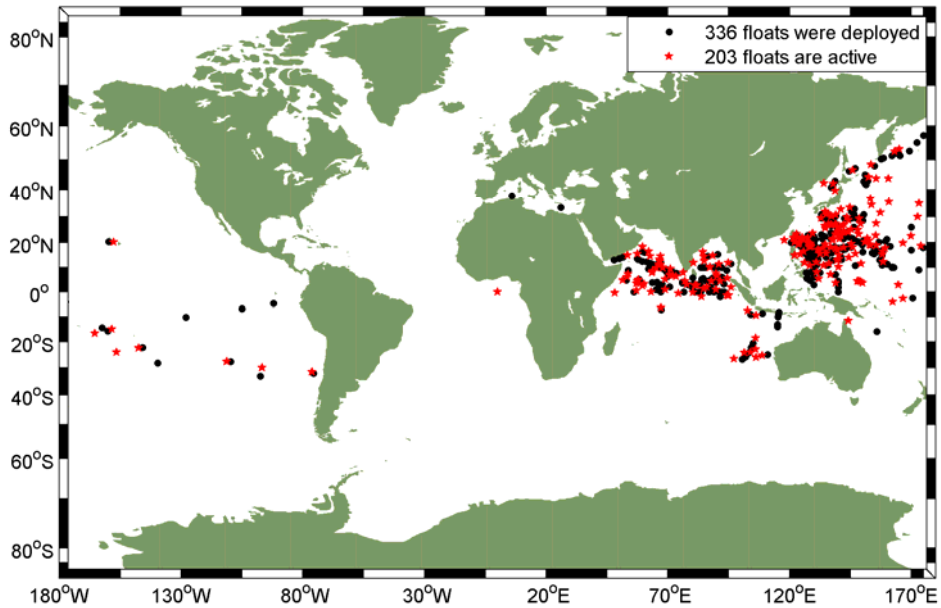


Fig.2 The launch positions of all floats (black dots) and latest positions of the active floats (red pentagons) as of January 2015.

During the cruise in November 2014, a HM2000 profiling float developed by Qingdao Hisun Ocean Equipment Corporation Limited was deployed. A comparison between HM2000, APEX float (Iridium), CTD cast and salinometer has been carried out. The cycle time of HM2000 float was set to 1 day. For better comparison, the cycle time of the Iridium APEX float was shortened to 2 days. The result shows that observations from the HM2000 are reliable. This type of float makes use of both Beidou and GPS system for data transmission and positioning, and also uses SBE41 or SBE41CP CTD sensor. It has a maximal profiling depth of 2000 meters, and the advantages of two-way communication, grounding protection, automatic data retransmission and maximal depth protection. The float is still active now, and has observed 39 profiles.

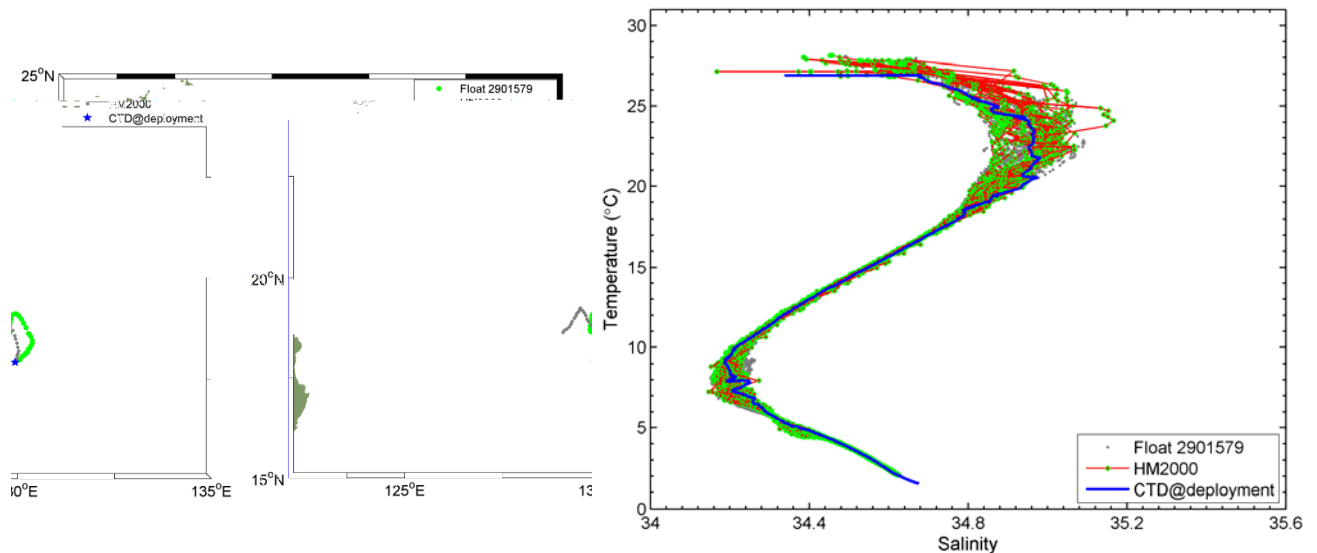


Fig.3 The profile positions and T-S of HM2000 float, CTD cast and float 2901579 (APEX)

### **- technical problems encountered and solved**

The abnormal sea surface pressures such as 25 or -25 dbar were reported by the 8 APEX floats which were deployed in March 2014. We reported the problem to Teledyne Webb. They finally found that there was an error in regard to the data format of surface pressure in the user manual. After revising the decoder, we have solved the problem.

### **-status of contributions to Argo data management (including status of pressure corrections, technical files, etc)**

From March 2014 to January 2015, China Argo received data from 229 active floats and submitted 10341 TS and 4319 O2 profiles to GDAC. Coriolis still helps us process data from 8 ARVOR floats. In order to capture variations of mid-scale eddies, the cycle time of the 17 Iridium PROVOR-DO floats deployed by Ocean University of China have been set to one day from their first cycle, therefore those floats have observed quite a lot of O2 profiles. CLS still helps us to insert all Argo profiles into GTS. However, China Argo has reached an agreement with Chinese meteorological department on submitting Argo data into GTS via the Beijing interface before June 2015.

After the ADMT-15 meeting (November 2014), CSIO started to update data to version 3.1, including meta files, profile files and technical files. The update of the trajectory files has not yet been started.

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

In the past year, CSIO didn't submit any D-files to GDAC because it took us a lot of time to



reprocess all the data from over 100 Argo equivalent floats, develop decoder for Iridium PROVOR-DO float and update data to version 3.1. We plan to restore DMQC from the early of 2015.

## **2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.**

China Argo is funded by Ministry of Science and Technology (MOST), State Oceanic Administration (SOA) and National Natural Science Foundation of China (NSFC). Because the funding is not operational, the number of float deployment is determined by the actual allocated funding.

Currently, there are 5 staffs working for float deployment and data processing at CSIO. The China Argo data centre at NMDIS is in charge of processing data from the floats deployed by East China Sea Branch, SOA, and data archives from Chinese floats.

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

At present, CSIO has 5 floats in storage, and ordered 5 Iridium APEX floats in 2014. The number of floats to be purchased depends on the actual allocated funding this year. The number of Argo equivalent floats to be deployed is still unpredictable. However, we estimate that about 30 floats including 20 Argo equivalent floats will be deployed.

## **4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers. Please also include any links to national program Argo web pages to update links on the AST and AIC websites.**

Argo data and its gridded products have been widely used in oceanic and atmospheric sciences, as well as in operational departments. Many articles that published on important journals utilized Argo data. For example, in the paper titled " Oceanic mass transport by mesoscale eddies" (Science, vol.345, 2014) , the author (Dr. Zhang Zhengguang from Ocean University of China) utilized altimetric height and Argo data to reveal quantitative relationships between three-dimensional structures of mesoscale eddies and their sea surface signals. Argo data has been used to a global ocean four-dimensional variational data assimilation system (NCC-GODAS) developed by National Climate Centre, as well as the Ocean Variational Analysis System (OVALS) developed by Institute of Atmospheric Physics, CAS, which provided more realistic ocean initial fields to the global air-sea coupling modeling for seasonal climate predicting, and played an

important role in improving the level of predicting.

There are two websites routinely maintained by China, one is maintained by NMDIS ([www.argo.gov.cn](http://www.argo.gov.cn)) at Tianjin (China Argo data center), and another is maintained by CSIO ([www.argo.org.cn](http://www.argo.org.cn)) at Hangzhou (China Argo Real-time data center). The implement status of China Argo, real-time data display including T/S/O2 profiles, float trajectory, profile data, the derived products and status of global Argo are presented. Meanwhile, GDACs, related international organizations and member's Argo websites can be accessed through these two websites.

## **5. Problems encountered during the operation of international Argo and suggestions**

**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.**

In February 2015, CSIO submitted 12 CTD casts in the northwestern Pacific ocean to Coroilis.

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## ARGO National Report 2015 – The Netherlands

### 1) Status of implementation

The Dutch Argo program started in 2004 and is run by the Royal Netherlands Meteorological Institute (KNMI).

The Netherlands are a founding member of the Euro Argo ERIC.

Contribution to the Argo array:

- 69 floats have been purchased
- 67 have been deployed
- 2 are awaiting deployment
- 17 are working

Floats purchased between 2009 and 2012 suffered from the APEX battery leakage problem and died prematurely.

### 2) Present level of (and future prospects for) national funding for Argo including summary of human resources devoted to Argo.

In their observation strategy adopted in 2006 KNMI has expressed the intention to deploy about 7 floats per year, a level that has approximately been reached during the past years. A semi-permanent fixed budget is available.

One person (Andreas Sterl) is working on ARGO. He does so besides his other duties.

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

About 7 floats will be purchased, most probably through the Euro Argo ERIC.

Deployment is not yet planned, but preferably in the Atlantic Ocean.

### 4) Summary of national research and operational uses of Argo data

Argo data and/or products derived from Argo data are used to initialize climate models by groups at KNMI and Utrecht University.

Process studies using Argo data are performed at the Netherlands Institute for Sea Research (NIOZ).

### 5) Issues that your country wishes to be considered (and resolved) by AST regarding the international operation of Argo

Nothing.

### 6) CTD data uploaded to CCHDO

Yes.

### 7) Bibliography

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# French National Report on Argo - 2014

## Present status and future plans

Mar. 3rd, 2015

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# 1 BACKGROUND, ORGANIZATION AND FUNDING OF THE FRENCH ARGO ACTIVITIES

## 1.1 Organization

Argo France<sup>1</sup> 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<sup>2</sup> 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<sup>3</sup> 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"<sup>4</sup> (LPO, Brest, France) and the "Laboratoire d'Océanographie de Villefranche"<sup>5</sup> (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<sup>6</sup> (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<sup>7</sup> 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<sup>8</sup> 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<sup>9</sup> 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).

<b>Year</b>	<b>Funding</b>	<b>Man/Year</b>	<b>French floats</b>	<b>Co-funded EU floats</b>	<b>Total</b>
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
<b>Total (2000-2014)</b>			<b>817</b>		<b>892</b>
<b>2015</b>	<b>1400k€</b>	<b>12</b>	<b>95</b>		<b>95</b>

**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<sup>10</sup> 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 2<sup>nd</sup> 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.

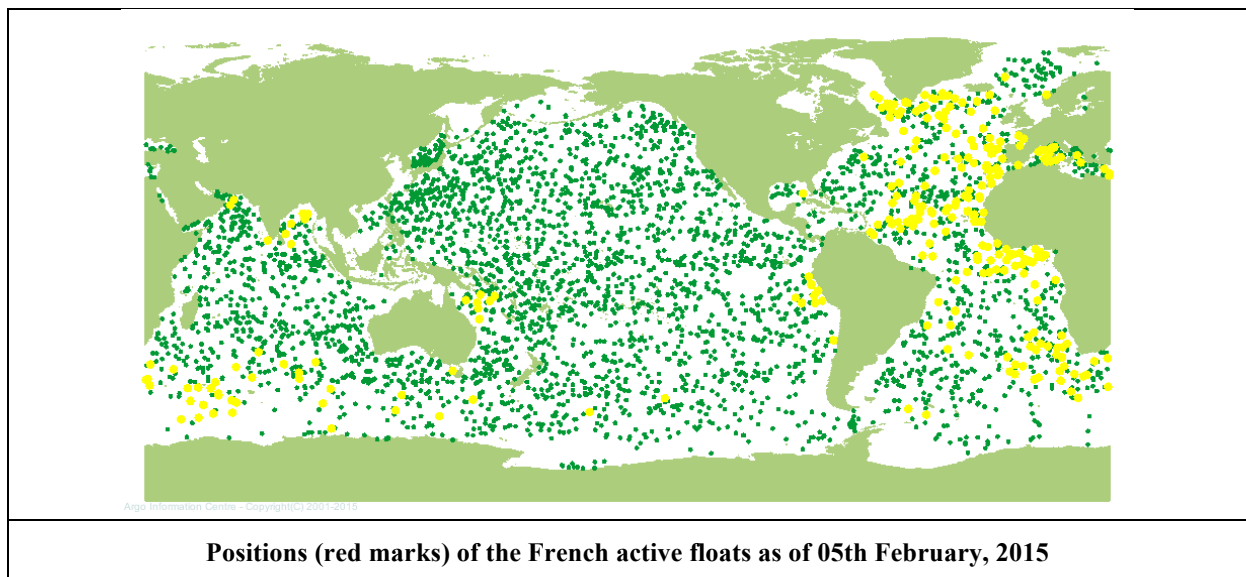
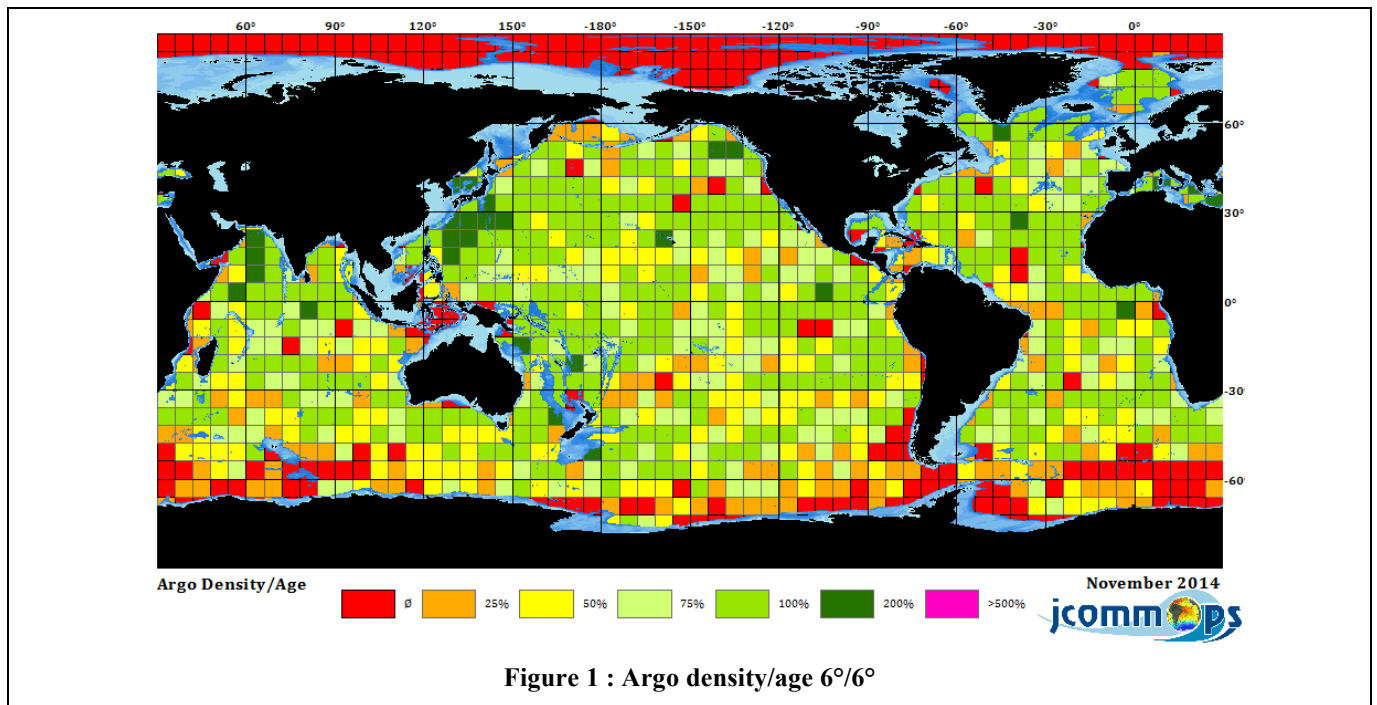
The Deep-Arvor industrial phase has started. Two industrial prototypes (CTD + Oxygen) were realized, delivered, and then deployed in the North Atlantic Ocean during Geovide cruise in May 2014. The two floats start their profile at 4120 dbars (~4000m depth) and should demonstrate their stability during long immersion periods, their ability to cycle during a long time, and the quality of their measurements. By the end of December 2014, the 2<sup>nd</sup> 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.

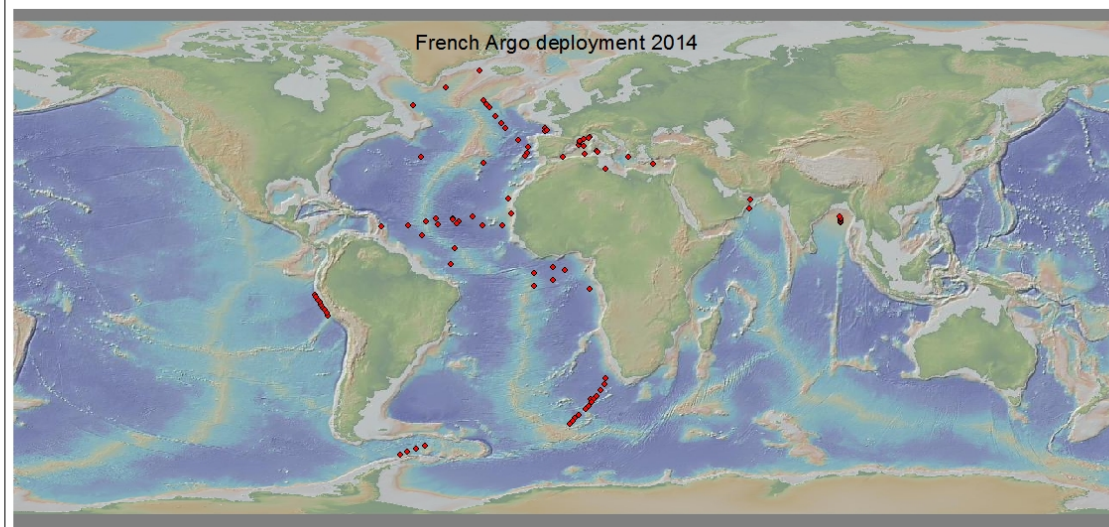
Another main aspect of the development concerns the bio-geochemical applications. The Provov-CTS5 developed in 2013 is dedicated, i) to embed additional optical sensors, ii) to do other cycle schemes than Argo standard ones, iii) to modify its programmed mission itself depending on measurements or on 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).





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

**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<sup>11</sup>** (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<sup>12</sup>

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 were 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.



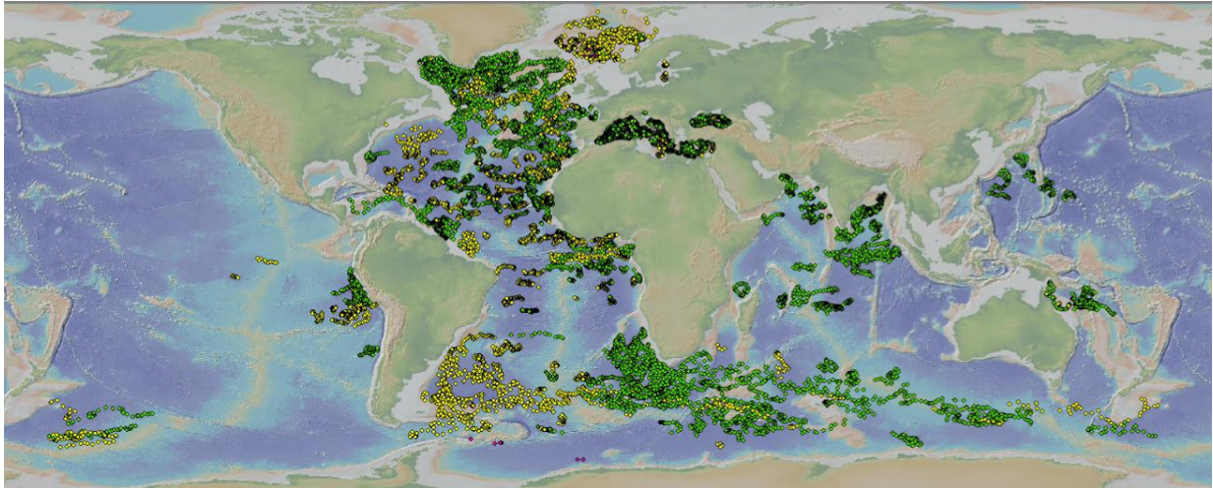


Figure: Maps of the 30 753 profiles from the 687 floats managed by Coriolis DAC in 2014.

### 3.3.2 Global Argo Data Centre<sup>13</sup>

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.

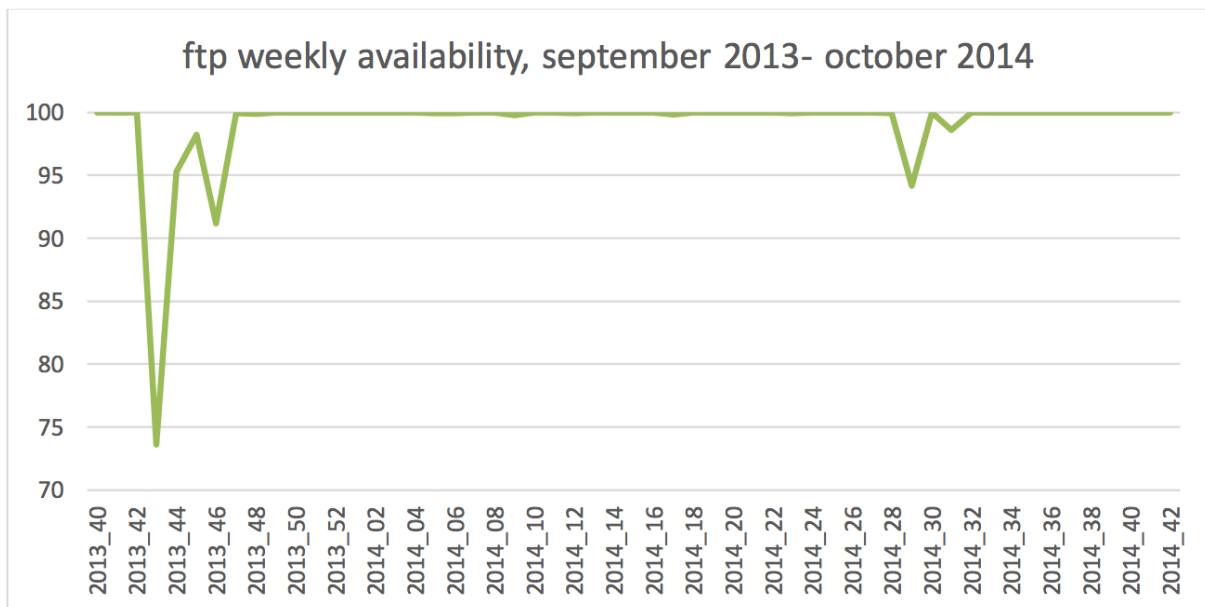


Figure 2 : Nagios monitoring: between October 2013 and September 2014.



### 3.3.3 North Atlantic Argo Regional Centre<sup>14</sup>

See section 5.4

### 3.4 Status of delayed mode quality control process

In 2014, a total of 6835 new delayed mode profiles were 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).

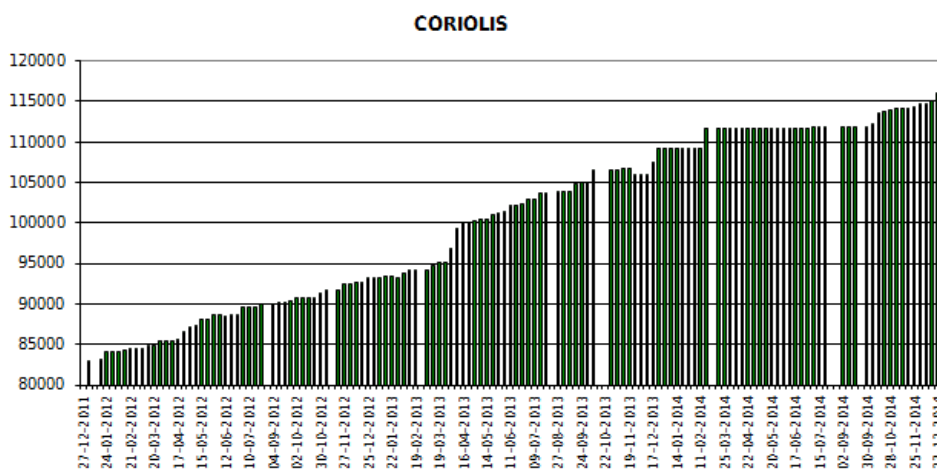


Figure 5: Evolution of the DM profiles' submission versus dates

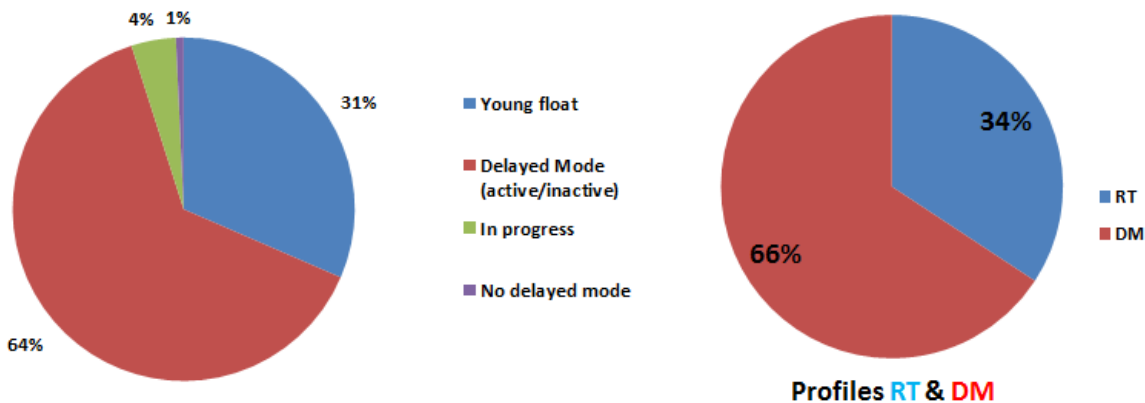


Figure 6. Status of the floats processed by Coriolis DAC. Left: in terms of float percent and right: in terms of profile percent (DM : delayed mode – RT : real time).

#### **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:

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

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.

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\* 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<sup>6</sup> 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.**

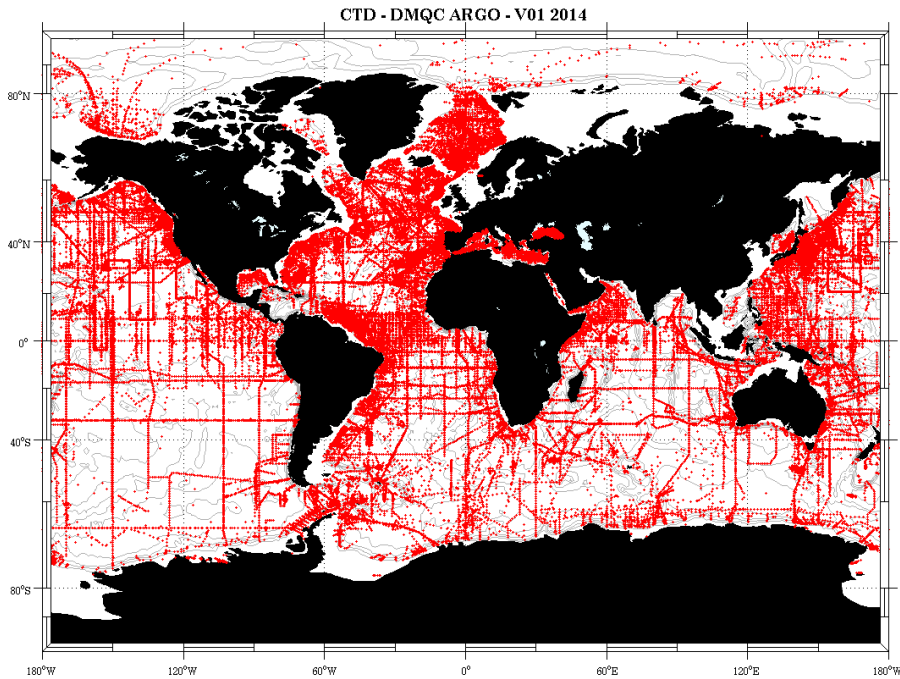
*These might include tasks performed by the AIC, the coordination of activities at an international level and the performance of the Argo data system. If you have specific comments, please include them in your national report.*

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<sup>15</sup> and on the Argo Bibliography<sup>16</sup> 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>.

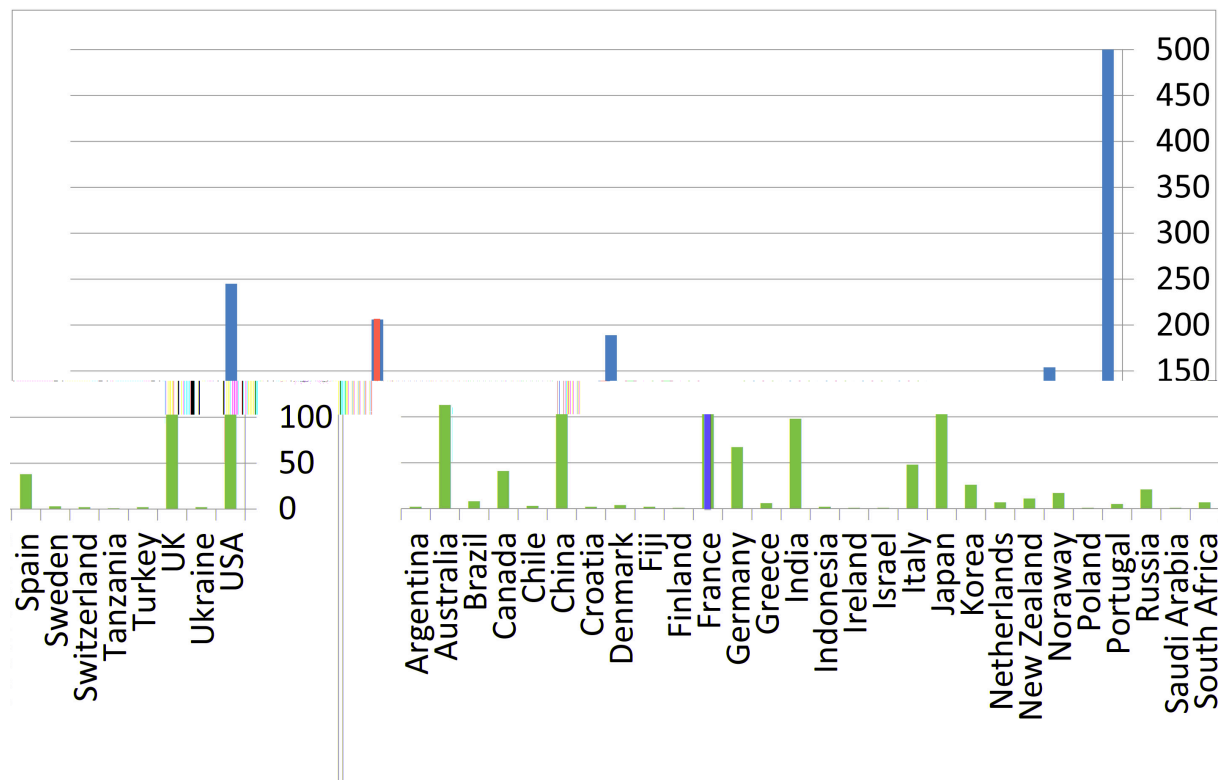


Figure 3: Number of paper using Argo data as function of the country of the lead author. France contribution is highlighted in red (Feb/2015).

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## Footnotes

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- <sup>1</sup> Argo France: <http://wwz.ifremer.fr/lpo/SO-Argo>
- <sup>2</sup> Euro-Argo: <http://www.euro-argo.eu>
- <sup>3</sup> Coriolis: <http://www.coriolis.eu.org>
- <sup>4</sup> Laboratoire de Physique des Océans: <http://wwz.ifremer.fr/lpo>
- <sup>5</sup> Laboratoire d'Océanographie de Villefranche: <http://www.obs-vlfr.fr/LOV>
- <sup>6</sup> Mercator: <http://www.mercator-ocean.fr>
- <sup>7</sup> IUEM OSU: <http://www-iuem.univ-brest.fr/observatoire>
- <sup>8</sup> NAOS project: <http://www.naos-equipex.fr>
- <sup>9</sup> REMOCEAN project: <http://www.oao.obs-vlfr.fr>
- <sup>10</sup> SIDERI project: <http://www.euro-argo.eu/EU-Projects-Contribution/SIDERI2>
- <sup>11</sup> 2014 Coriolis report as DAC/GDAC: <http://archimer.ifremer.fr/doc/00221/33248/>
- <sup>12</sup> Coriolis DAC: <http://www.coriolis.eu.org/Observing-the-ocean/Observing-system-networks/Argo>
- <sup>13</sup> Coriolis FTP: <http://www.coriolis.eu.org/Data-Services-Products/View-Download/Download-via-FTP>
- <sup>14</sup> NA-ARC data mining website: <http://www.ifremer.fr/lpo/naarc>
- <sup>15</sup> French bibliography: <http://wwz.ifremer.fr/lpo/SO-Argo-France/Publications>
- <sup>16</sup> Argo PhD list: [http://www.argo.ucsd.edu/argo\\_thesis.html](http://www.argo.ucsd.edu/argo_thesis.html)

# Argo Germany National Report 2014

February 2015

Birgit Klein, BSH

## 1. The status of implementation (major achievements and problems in 2014)

### Data acquired from floats:

Most of the floats deployed by Germany are operated by BSH but additional funding has been acquired by various research institutes. BSH deployed 58 floats in 2014, 18 floats purchased in 2014 were kept in store to serve deployment cruises early 2015 and 3 additional floats needed repair and will be re-delivered in 2015. Additionally planned deployments for 3 floats in the Mediterranean had to be cancelled because the working permits for the Turkish Waters were denied. The Alfred-Wegener-Institute (AWI) had planned to deploy additional 27 floats in the Atlantic Sector of the Southern Ocean and in the Weddell Sea between December 2014 and January 2015. 15 floats have been deployed but so far haven't sent data. When the ongoing technical analysis is finished the remaining floats could be deployed at the end of 2015. 8 floats have been deployed by GEOMAR in the Pacific. This gives a total of 71 German float deployments until the end of 2014.

Currently (February 2<sup>th</sup>, 2015) 144 German floats are active (Fig.1) and the total number of German floats deployed within the Argo program increased to 694.

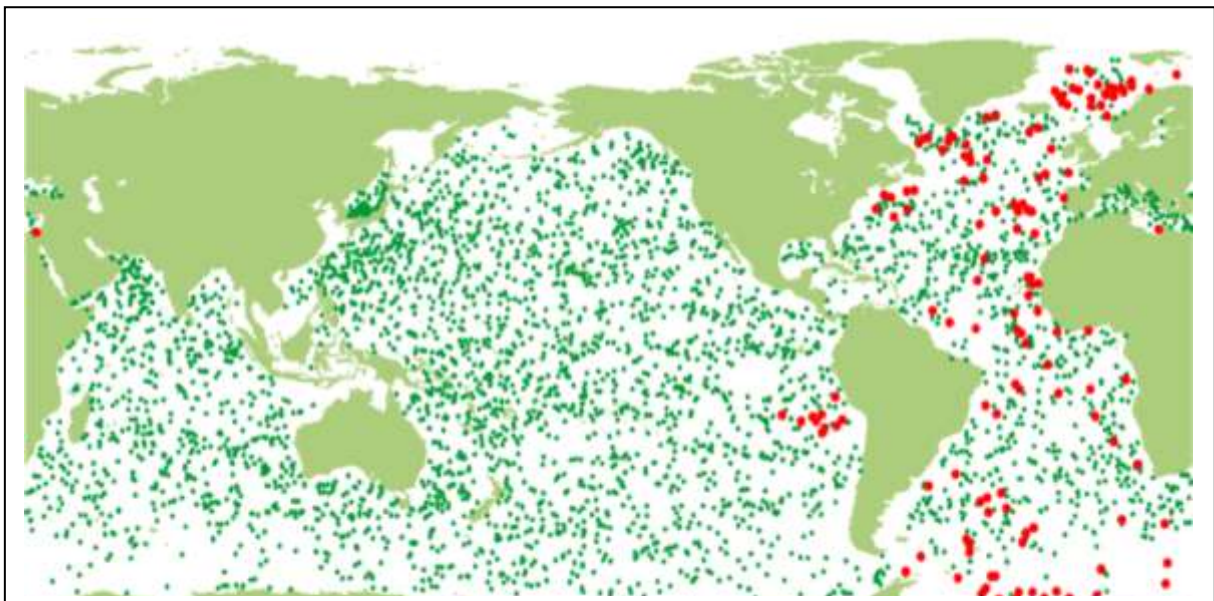


Fig. 1: Locations of active German floats (red) with active international floats (green) (Argo Information Centre, February 2015).

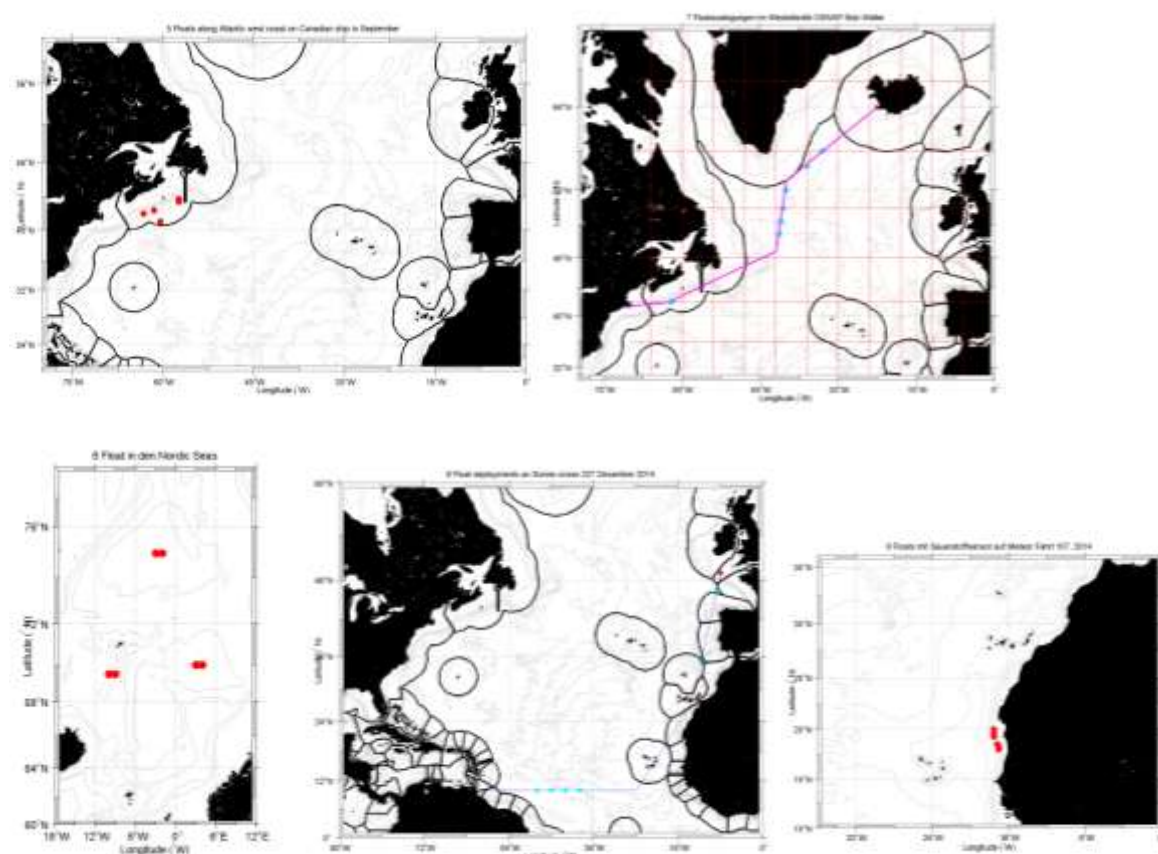
In the past most of the German floats were APEX floats purchased from Webb Research, but a smaller amount of floats were manufactured by the German company OPTIMARE. The company has been working in close collaboration with the AWI and has developed a float type suitable for partially ice covered seas. These floats are equipped with an ice sensing algorithm which prevents the float from ascending to the surface under ice conditions and prevents it from being crushed. Float profiles are stored internally until they can be transmitted during ice free conditions. In the last year three manufacturers supplied the floats

purchased by BSH: ARVOR floats from NKE and NOVA floats from METOCEAN. Additionally 14 APEX floats were supplied by WEBB/TELEDYNE as replacement for floats which had problems with their alkaline batteries.

We had discovered major technical problems with the alkaline batteries in our APEX floats deployed since 2010. Until early 2014 more than 30 floats expired early with life cycles of about 700-800 days. The technical data sent back from the floats indicate a sudden loss of battery voltage to values of around 7 volts during the last profile and increased battery consumption during the previous cycles. We contacted TELEDYNE/WEBB about the problem and it was discovered that the floats were experiencing 'energy flue' because of a design change in the floats. As a possible fix against the premature fail of the entire battery pack due to failure of an individual alkaline battery a diode was installed in the design in 2004, but was removed again in 2009/2010. WEBB/TELEDYNE has offered 14 floats in compensation for the malfunctioning floats in 2014 and we are expecting more replacements in 2015.

Most of the German floats deployed in 2014 are standard TS floats, but 6 floats deployed by BSH and 8 floats deployed by GEOMAR carried additional oxygen sensors. Deployment was carried out mostly on research vessels but also with the help of the German Navy. The research vessels comprised Canadian, German, UK, and US ships.

The deployment locations for 2014 are shown in Fig. 2a-j.



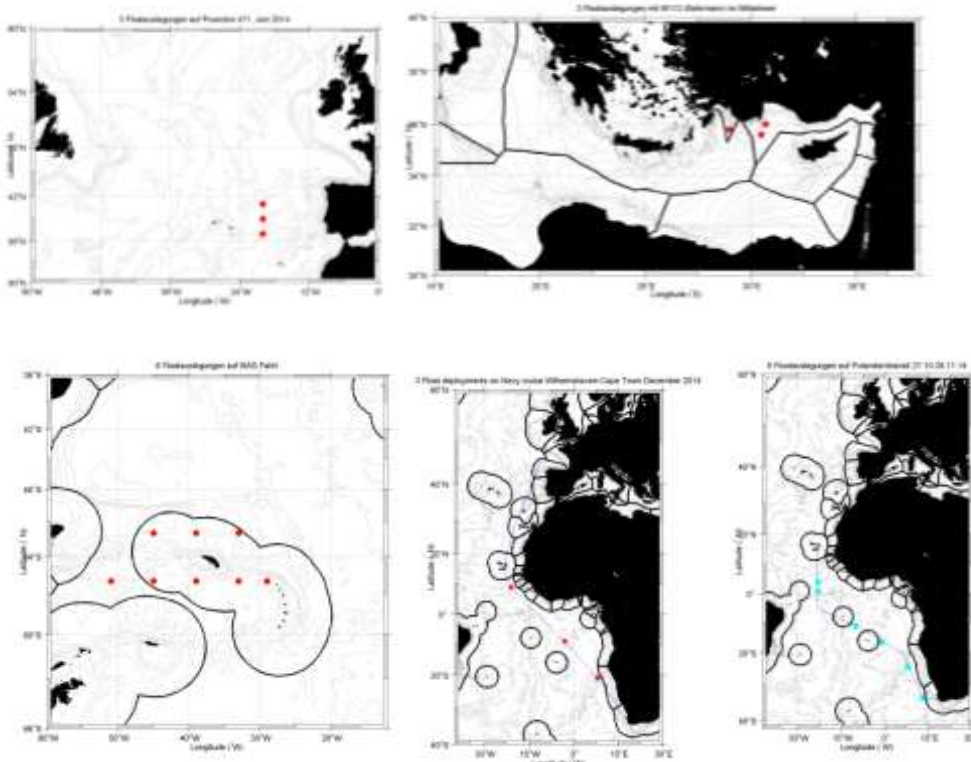


Fig. 2a-j: Deployment cruises and positions for 2014. Please note that the cruise in the Mediterranean has been cancelled.

Germany has joined the new European Research Infrastructure Consortium EURO-ARGO-ERIC which was established in July 2014 in Brussel by 9 founding countries (France, Germany, United Kingdom, Italy, Netherlands, Norway, Greece, Poland and Finland).

## 2. Deployment plan for 2015

The deployment plans for 2015 will comprise at present about 54 floats from BSH in the Atlantic, the Nordic Seas, Indian Ocean and the Southern Ocean and consists of floats purchased already in 2014, funds from 2015 and returned floats/repairs. The priority of our deployments is grid completion and extension of the core Argo array into the seasonally ice covered oceans in the Nordic Seas and the Southern Ocean. We are expecting additional replacements by WEBB/TELEDYNE for floats with energy flu in 2015, the numbers will be evaluated in March 2015. Contacts with researchers on potential deployment cruises have been established and agreement has been reached on the possibility to deploy floats. We will decide on additional deployment positions during the first half of 2015, depending on the exact numbers of available floats. The German Navy has been contacted about potential deployments in the Indian Ocean during the regular survey operations. 6 Floats for the Indian Ocean have been uploaded on a German Navy ship and will be deployed during their patrol duty. Deployment positions for already the planned cruises are given in Fig. 3, 4 and 5. The AWI has 12 remaining floats from the Polarstern cruise in 2014/2015 which could be ready for deployment at the end of 2015.



Fig. 3: South Atlantic deployments

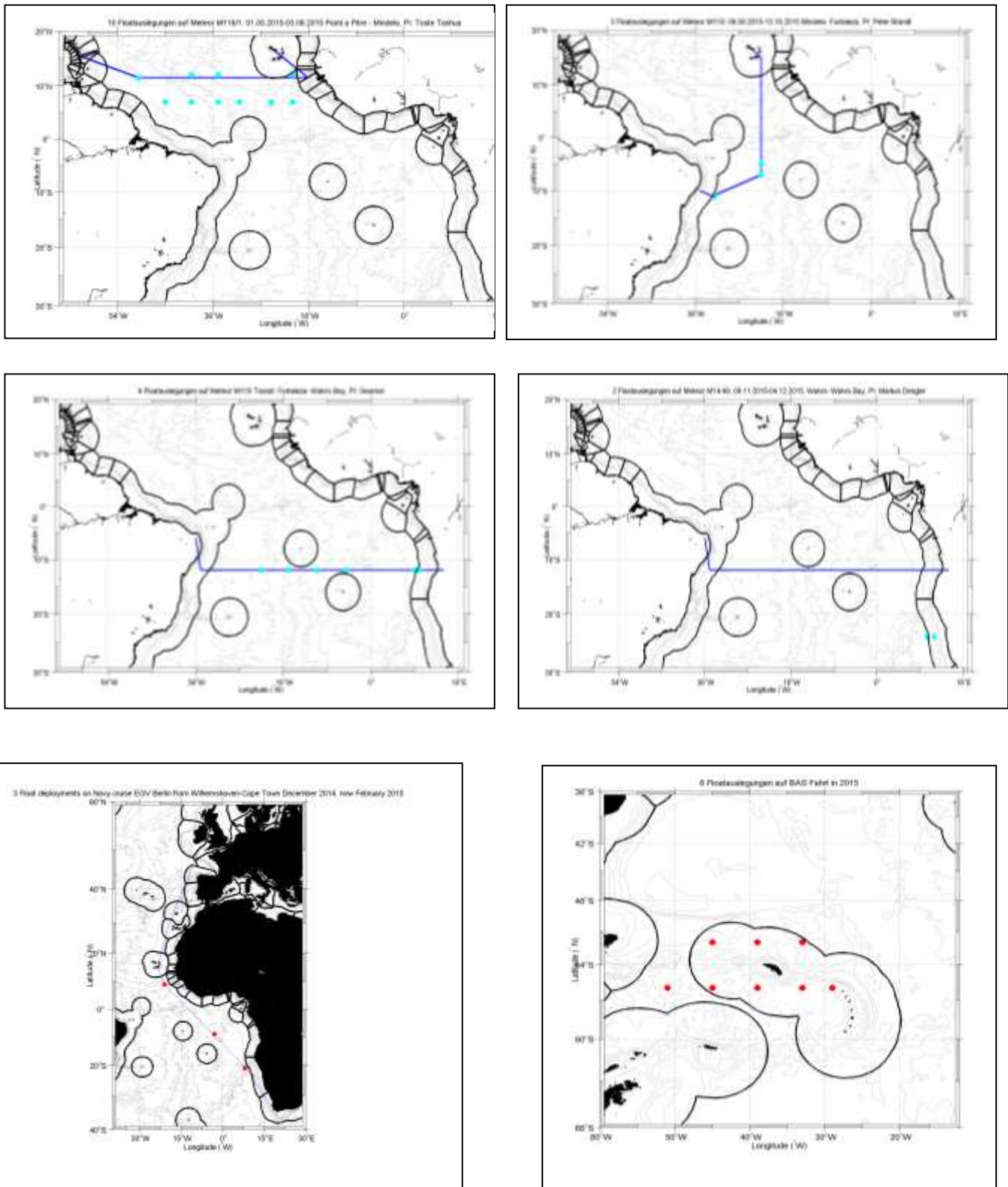


Fig. 4: North Atlantic deployments

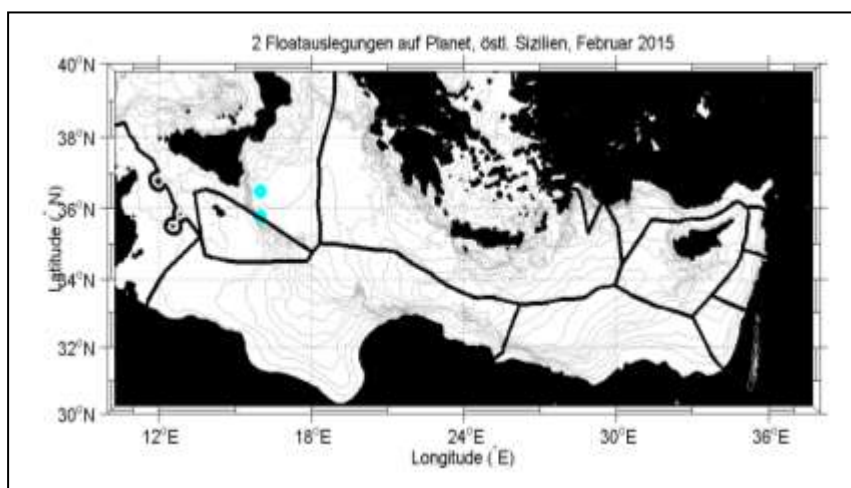
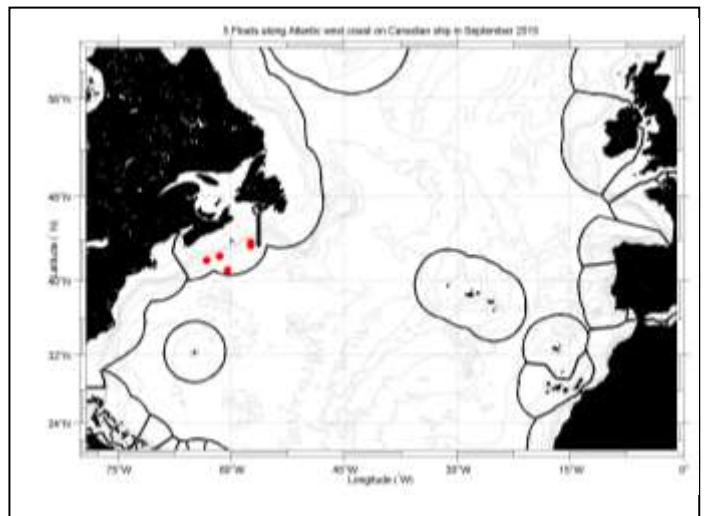
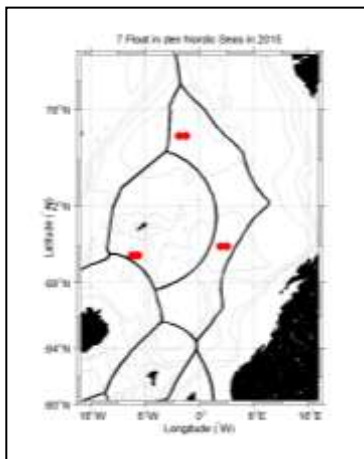
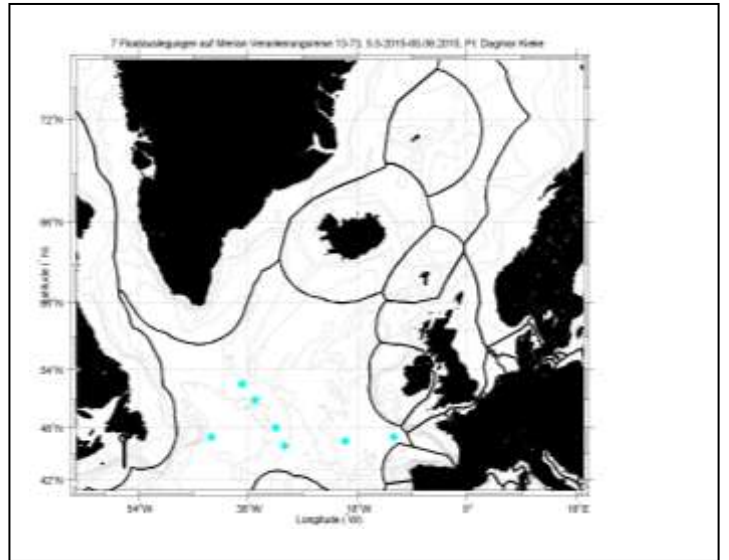
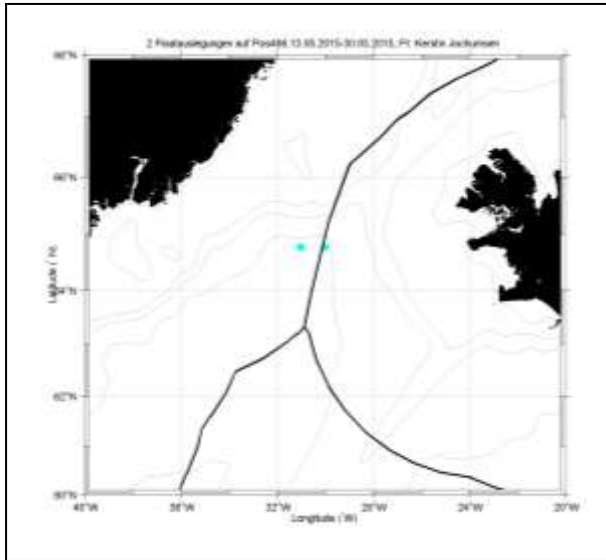
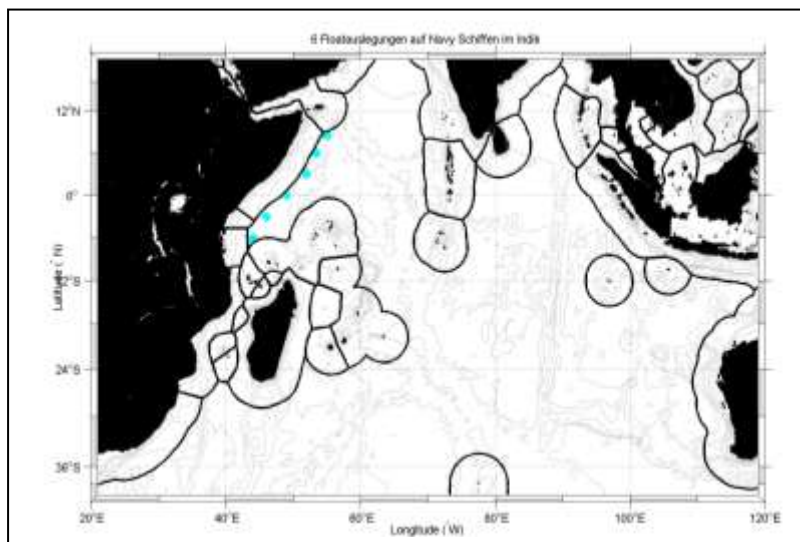


Fig. 5: Indian Ocean deployments



### 3. Commitments to Argo data management

#### Data issued to GTS

The profiles for all German floats are processed by Coriolis and are distributed on the GTS by way of Meteo-France.

#### Data issued to GDACs after real-time QC

The real-time data processing for all German floats is performed at the Coriolis Center in France. Data processing follows the procedures set up by the Argo Data Management Team.

#### Data issued for delayed QC

The delayed mode processing is distributed between the various German institutions contributing to Argo, depending on their area of expertise. The Alfred-Wegener Institute is responsible for the Southern Ocean and GEOMAR is processing the Pacific floats. IfM-Hamburg together with BSH are processing the German floats in the Nordic Sea, while BSH is covering the tropical, subtropical and subpolar Atlantic. German floats in the Mediterranean on the other hand are processed by MEDARGO. The sharing of delayed-mode data processing will be continued in the coming years, but BSH will cover all German floats which have not been assigned to a PI. BSH has also adopted some European floats which did not have a DMQC operator assigned to them, such as national Argo programs from the Netherlands, Denmark, Norway, Finland and Poland. All German institutions have been working in close collaboration with Coriolis and delayed mode data have been provided on a 6 month basis. Delays in delayed-mode data processing have occurred occasionally due to changes in personal and delay in data transmission in the Southern Ocean due to ice



coverage. Delayed-mode data processing follows the rules set up by the Data Management Team. The DMQC process is well underway and no major delays have been encountered.

### **Delayed mode data send to GDACs**

All delayed mode profiles from BSH have been sent to the Coriolis GDAC node. The total number of available profiles from German floats is 48894 (February 2<sup>th</sup>, 2015), the number of DM profiles is 43608. The percentage of DM profiles with respect to the total number of profiles is about 85%.

## **4. Summary of national research and operational uses of Argo data**

### **Web pages**

BSH is maintaining the Argo Germany Web site. The URL for the Argo Germany is:

<http://www.german-argo.de/>

It provides information about the international Argo Program, German contribution to Argo, Argo array status, data access and deployment plans. It also provides links to the original sources of information.

### **Statistics of Argo data usage**

Currently no statistics of Argo data usage are available. The German Navy uses Argo data on a regular basis for the operational support of the fleet and uses their liaison officer at BSH to communicate their needs. The SeaDataNet portal uses German Argo data operationally data for the Northwest European Shelf.

Publications based on Argo:

Bittig, Henry C. (2014). Towards a Quantum Leap in Oceanic Oxygen Observation - From Oxygen Optode Characterization to Autonomous Observation of Gas Exchange and Net Community Production, Dissertation, Christian Albrecht University Kiel.

Bittig, H.C., B. Fiedler, R. Scholz, G. Krahnemann, and A. Körtzinger (2014). Time response of oxygen optodes on profiling platforms: Dependence on flow speed and temperature and recommendations for field applications. *Limnol. Oceanogr.: Methods* 12, 617-636, doi: 10.4319/lom.2014.12.617.

Ronja Eisner, Die Entwicklung der Deckschicht im Islandbecken und ihr Beitrag zum Nordatlantischen Tiefenwasser, Bachelor Thesis, 52 pp., University of Hamburg, 2012.

Kieke, D., und I. Yashayaev (2015), Studies of Labrador Sea Water formation and variability in the subpolar North Atlantic in the light of international partnership and collaboration, *Prog. Oceanogr.*, 132, [doi:10.1016/j.pocean.2014.12.010](https://doi.org/10.1016/j.pocean.2014.12.010).

### **Products generated from Argo data**

A key aspect of the German Argo program is to develop a data base for climate analysis from Argo data, to provide operational products for interpretation of local changes and to provide data for research applications.

Argo data are being used by many researchers in Germany to improve the understanding of ocean variability (e.g. circulation, heat storage and budget, and convection), climate monitoring and application in ocean models.

Germany contributes to the NARC and contributes recent CTD data to the Argo climatology.

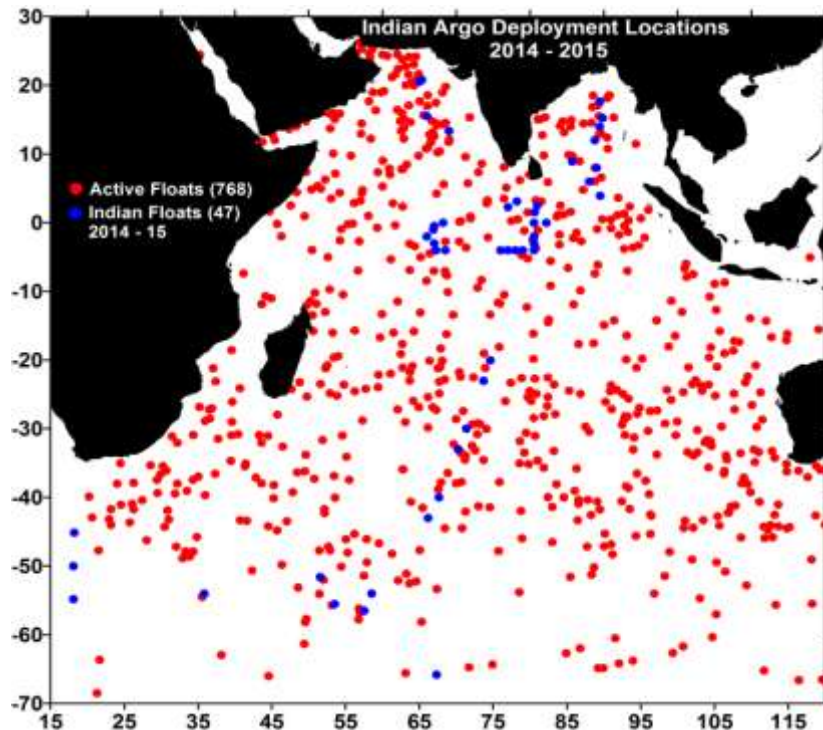
## Argo Steering Team Meeting (AST-16)

National Report – India  
(Submitted by M Ravichandran)

### 1. The status of implementation

#### 1.1a Floats deployment

During the year 2014–15, 47 floats (Blue color in the below figure) were deployed in the Indian Ocean taking the total to 365. The new deployment includes 13 Bio-Argo floats with additional sensors like Doxy, FLBB, Chla and 2 floats with ice detection software.



#### 1.1b performance Analysis of Floats deployed

Out of 365 floats deployed so far 117 floats are actively giving data. Out of these 117 active floats, 94 floats are less than 3 years old.

#### 1.2 Technical problems encountered and solved

None

#### 1.3 Status of contributions to Argo data management

- **Data acquired from floats**  
India had deployed 365 floats so far. Out of these 117 floats are active. All the active floats data are processed and sent to GDAC.
- **Data issued to GTS**  
TESAC format messages from these floats are being sent to GTS via New Delhi RTH. The issue wrt to the GTS messages not appearing in meteo France is still continuing.

- **Data issued to GDACs after real-time QC**  
All the active floats (117) data are subject to real time quality control and are being sent to GDAC.
- **Web pages**  
INCOIS is maintaining Web-GIS based site for Indian Argo Program. It contains entire Indian Ocean floats data along with trajectories. Further details can be obtained by following the link:  
[http://www.incois.gov.in/incois/argo/argo\\_home.jsp](http://www.incois.gov.in/incois/argo/argo_home.jsp).
- **Statistics of Argo data usage**  
Argo data is widely put to use by various Organisations/ Universities/Departments. INCOIS Argo web page statistics (for the past one year) are as shown below

Page	Views	Visitor
Argo Web-Gis	922	1052
Data downloads	1237	1476
Live Access Server	2,40,189	1,03,227
Argo products	1522	901

- Argo data viewer developed at INCOIS and supplied to the users through DVDs is now also available from Argo UCSD web site. The link for viewing the same is: [http://www.argo.ucsd.edu/incois\\_ADV.html](http://www.argo.ucsd.edu/incois_ADV.html)
- User interactions were conducted to bring about awareness about the Argo data among the researchers and students from various organizations and universities respectively.
- INCOIS is also conducting University outreach program where in scientist visit various universities to bring about the awareness about the data with INCOIS. Students are encouraged to use Argo data for their MS thesis dissertations, thereby giving wide publicity to the Argo program. The publications and dissertations arising out of the Argo program are well documents with INCOIS.
- INCOIS also started issuing projects to universities to utilize the Argo data. A visualization project using Argo data is sanctioned to IIT, Bangalore.

#### 1.4 Status of Delayed Mode Quality Control process

DMQC is done on all eligible floats on a routine basis.

- Around 190 floats were passed through the DMQC s/w and the following problems are tackled
  - Pressure Sensor offsets.
  - Salinity drift.
  - Salinity Hooks.
  - TBTO problems.
  - TNPD problems. etc
- Around 60 % of FLOATS are DMQCed for INCOIS DAC.

### **1.5 Trajectory files status:**

A total of 362 trajectory netcdf files were processed and uploaded to the GDAC. The process of generation of trajectory netcdf files undergoes quality checks like position, time, cycle number, etc., and corresponding quality status is assigned to each parameter.

## **2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.**

Indian Argo Project is a 5 year Program (April 2012 to March 2017) fully funded by Ministry of Earth Sciences, (MoES), Govt. of India. Funding is secured for deployment of 200 Argo floats (40 floats per year including 10 Bio-argo floats), Data management activities, Data analysis, etc. until 2017.

Three Permanent and three temporary scientific/technical personnel are working under Indian Argo project, which include personal for deployment of Argo floats, Data system, Analysis of Data, etc.

## **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.**

India is committed to deploy floats in the Indian Ocean wherever gap exists. India has committed 40 floats per year until 2017 (10 floats in the Southern Ocean, 10 floats in the Bay of Bengal, 10 floats in the equatorial Indian Ocean and remaining 10 in the Arabian Sea). Out of 40 floats, 10 floats will be bio-argo floats. After ascertaining the gap region and cruise plan of MoES research vessels, these floats will be deployed. The existing data management resources will continue until 2017.

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

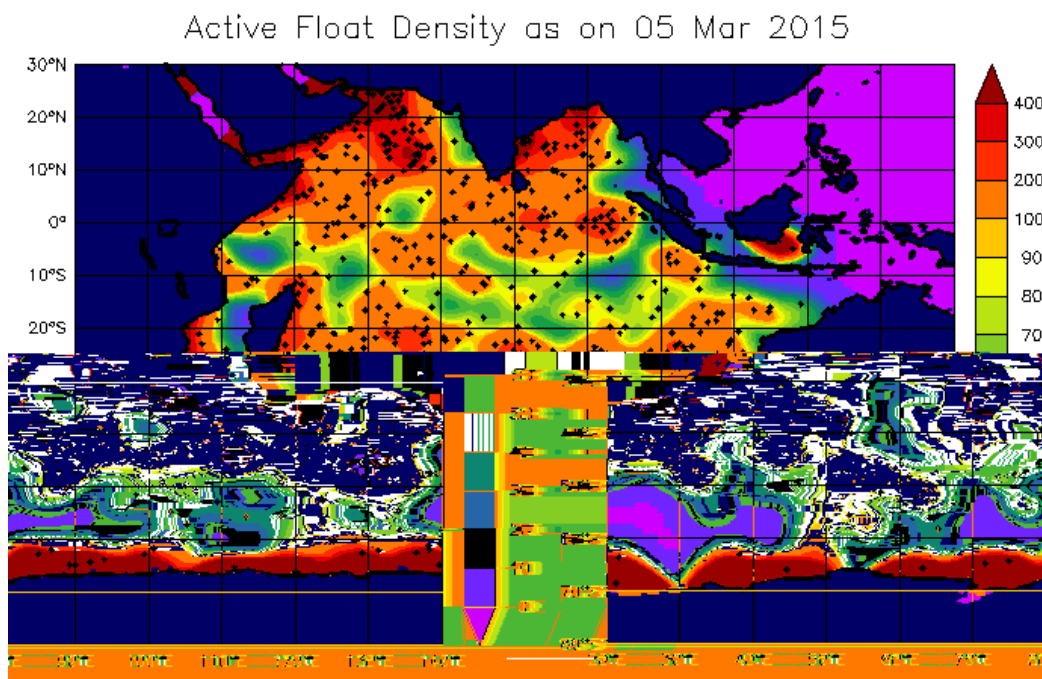
**Operational:** All Argo data are being routinely assimilated in Ocean Model for providing Global ocean analysis. This analysis is being used by MET department for initialization of coupled ocean-atmosphere forecast of the Monsoon. From the year 2011, India could provide seasonal forecast of monsoon using dynamical model wherein Ocean analysis (with assimilation of Argo) is an important contribution. The analysis products are being made available at INCOIS live access server ([las.incois.gov.in](http://las.incois.gov.in))

**Research:** Argo data are being widely used for many applications to understand the Indian Ocean dynamics, cyclone and monsoon system in relation to heat content, thermohaline component of sea level and validation of OGCM by various Indian institutions and university students.

**Argo Regional Centre (ARC) - Indian Ocean**  
(<http://www.incois.gov.in/argo/ARDCenter.jsp>)

- Acquisition of Argo data from GDAC corresponding to floats other than deployed by India and made them available on INCOIS web site.
- Delayed Mode Quality Control  
(Refer 2.0 above)
- Data from the Indian Ocean regions are gridded into 1x1 box for monthly and 10 days and monthly intervals. These gridded data sets are made available through INCOIS Live Access Server (ILAS). Users can view and download data/images in their desired format.
- Data Sets (CTD, XBT, Subsurface Moorings) are being acquired from many principle investigators. These data are being utilized for quality control of Argo profiles.
- Value added products:
 

Two types of products are currently being made available to various user from INCOIS web site. They are: (i) Time series plots corresponding to each float (only for Indian floats). This include Water fall plots, Surface pressure, Bottom most pressure, Surface temperature, Bottom most temperature, Surface salinity, Bottom most salinity, Trajectory of float, T/S plots. Also, Spatial plots using the objectively analysed from all the Argo floats data deployed in the Indian Ocean. This includes Temperature (at 0, 75, 100, 200, 500, 1000 meters), Salinity (at 0, 75, 100, 200, 500, 1000 meters), Geostrophic Currents (at 0, 75, 100, 200, 500, 1000 meters), Mixed Layer Depth, Isothermal Layer Depth, Heat Content up to 300 mts, Depth of 20 deg and 26 deg isotherms. These valued added products can be obtained from the above web site.
- Other statistics
- Regional Co-ordination for Argo floats deployment plan for Indian Ocean. The float density in the Indian Ocean as on 05 March 2015 is shown below.



**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. As part of an action item from AST-15 aimed to improve 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.**

None

## **7. Argo bibliography**

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## Report on the Italian Argo Program for 2014

### 1. The status of implementation (major achievements and problems in 2014).

#### - floats deployed and their performance:

In total, **25 Italian floats** were deployed in 2014 (see Tables 1 and 2 for details). These floats were Arvor and Provor designs manufactured by NKE (France) and Apex floats produced by Teledyne Webb Research (USA). The majority of the floats transmit data via Iridium telemetry (Arvor-I, Provor Bio, Provor Nut) and some have Argos telemetry (Arvor-L and Apex).

Two floats were deployed in the Black Sea and 16 units were released in the Mediterranean (Table 1). Except for float WMO 6901860, all the instruments were still operating at the end of February 2015. In the Mediterranean, most floats (Arvor-I) have a parking depth at 350 dbar and maximal profiling depths alternating at 700 and 2000 dbar. In the Black Sea, the parking depth was set to 200 dbar. They all have cycles of 5 days.

Most floats were deployed from research vessels of opportunity (e.g., R/V Urania, R/V SOCIB, R/V Poseidon, NRV Alliance and R/V OGS Explora for the Mediterranean and R/V Akademik for the Black Sea) with the help of colleagues from NATO, Italy, Spain, Germany, Cyprus and Bulgaria.

Three floats equipped with biogeochemical and optical sensors (Provor Bio and Provor Nut) were deployed in the southern Adriatic - northern Ionian and in the eastern Alboran Sea, during the ADREX and ALBOREX cruises, respectively, of the EC FP7 Perseus project. The Provor Bio is a Provor CTS 4 with Iridium global telephone network (RUDICS) for data telemetry and a GPS receiver for position. It measures at 1 dbar vertical resolution not only temperature and salinity (Sea-Bird CTD) but also irradiance at three wavelengths (412 nm, 490 nm, 555 nm), fluorescence of colored dissolved organic matter, fluorescence of chlorophyll-a, backscattering coefficient (530nm) and attenuation coefficient (660 nm). The Provor Nut float is a Provor Bio float with additional sensors: an Aanderaa optode oxygen sensor and a SUNA nitrate sensor. The floats were initially programmed to sample profiles from, and drift at, 1000 dbar near local noon time every day. After about a month, the period was changed to 5 days and the parking depth was set to 350 dbar, using the Iridium downlink.

Seven Italian floats were deployed in the Pacific Ocean sector of the Southern Ocean and ice-free Ross Sea (Table 2) with the help of Italian colleagues onboard R/V Italice. These floats included two refurbished units from NKE (a Provor CTS 2 and an Arvor-L) and 5 new Apex floats from Teledyne Webb Research. In the Southern Ocean, they cycle between the surface and 2000 dbar every 10 days and drift at the parking depth of 1000 dbar. Out of six floats deployed in the Southern Ocean, three units were still operational at the end of February 2015.

<u>Model</u>	<u>WMO</u>	<u>Deployment date</u>	<u>Lat</u>	<u>Lon</u>	<u>Cycles</u>	<u>Last TX date</u>	<u>Lat</u>	<u>Lon</u>	<u>Status</u>	<u>Cycle</u>
Provov Bio	<a href="#">6901860</a>	<a href="#">12-Feb-2014 13:47</a>	38.5	19.93	107	06-Feb-2015 10:35	38.24	19.16	D	5
Arvor I	<a href="#">6901829</a>	<a href="#">13-Feb-2014 19:11</a>	38.53	18.47	80	24-Feb-2015 23:55	38.49	18.69	A	5
Arvor I	<a href="#">6901830</a>	<a href="#">14-Feb-2014 08:19</a>	39.25	18	78	25-Feb-2015 23:58	38.96	18.4	A	5
Provov Nut	<a href="#">6901865</a>	<a href="#">18-Feb-2014 17:28</a>	41.83	17.76	108	28-Feb-2015 10:35	38.65	17.45	A	5
Arvor I	<a href="#">6901879</a>	<a href="#">05-Apr-2014 05:31</a>	42.12	10.76	72	26-Feb-2015 05:15	41.28	10.02	A	5
Arvor I	<a href="#">6901846</a>	<a href="#">13-Apr-2014 05:32</a>	35.6	17.25	69	01-Mar-2015 00:06	36.4	17.19	A	5
Arvor I	<a href="#">6901847</a>	<a href="#">15-Apr-2014 17:36</a>	34.75	22.42	67	26-Feb-2015 00:00	37.68	18.82	A	5
Arvor I	<a href="#">6901848</a>	<a href="#">17-Apr-2014 06:10</a>	34.4	26.02	65	27-Feb-2015 23:54	34.37	24.37	A	5
Arvor I	<a href="#">6901839</a>	<a href="#">17-May-2014 12:56</a>	42.96	10.15	61	28-Feb-2015 00:19	43.38	9.83	A	5
Provov Bio	<a href="#">6901861</a>	<a href="#">25-May-2014 19:54</a>	36.9	-0.9	66	27-Feb-2015 11:15	36.6	1.83	A	5
Arvor I	<a href="#">6901835</a>	<a href="#">06-Jun-2014 22:51</a>	41.5	9.67	56	28-Feb-2015 00:21	41.87	9.96	A	5
Arvor I	<a href="#">6901836</a>	<a href="#">08-Jun-2014 19:31</a>	39.9	7.95	56	25-Feb-2015 00:09	43.39	8.9	A	5
Arvor I	<a href="#">6901831</a>	<a href="#">18-Jul-2014 06:51</a>	49.17	29	48	25-Feb-2015 00:11	43.01	36.36	A	5
Arvor I	<a href="#">6901845</a>	<a href="#">18-Aug-2014 12:25</a>	33.5	33	41	26-Feb-2015 00:13	35.38	32.03	A	5
Arvor I	<a href="#">6901832</a>	<a href="#">12-Sep-2014 06:20</a>	43.17	29	36	26-Feb-2015 00:15	42.57	33.47	A	5
Arvor I	<a href="#">6901823</a>	<a href="#">14-Sep-2014 08:45</a>	41.37	9.88	36	28-Feb-2015 00:16	40.32	11.46	A	5
Arvor I	<a href="#">6901837</a>	<a href="#">14-Nov-2014 12:50</a>	42.22	10.85	30	26-Feb-2015 00:12	40.41	9.98	A	5
Apex	<a href="#">6901868</a>	<a href="#">01-Dec-2014 12:43</a>	32.73	33.63	18	26-Feb-2015 00:07	35.37	35.45	A	5

*Table 1. Status information for the 18 Italian floats deployed in the Mediterranean and Black Sea (grey rows) during 2014.*

<b>Model</b>	<b>WMO</b>	<b>Deploy Date</b>	<b>Lat</b>	<b>Lon</b>	<b>Cycles</b>	<b>Last Date</b>	<b>Lat</b>	<b>Lon</b>	<b>Status</b>	<b>Cycle</b>
Apex	<a href="#">6901856</a>	<a href="#">30-Dec-2013 18:48</a>	-51	175.74	38	25-Feb-2015 04:21	-51.08	-171.77	A	10
Apex	<a href="#">6901850</a>	<a href="#">01-Jan-2014 19:24</a>	-60.98	-177.6	43	27-Feb-2015 04:11	-60.7	-160.58	A	10
Apex	<a href="#">6901849</a>	<a href="#">02-Jan-2014 07:59</a>	-62.98	-176.01	33	07-Feb-2015 06:44	-57.37	-146.08	D	10
Apex	<a href="#">6901855</a>	<a href="#">02-Jan-2014 21:33</a>	-65	-176.08	4	07-Feb-2015 23:21	0	0	D	10
Apex	<a href="#">6901857</a>	<a href="#">02-Jan-2014 22:55</a>	-58.95	-178.9	42	26-Feb-2015 19:09	-57.37	-157.37	A	10
Arvor L	<a href="#">6901853</a>	<a href="#">11-Jan-2014 00:50</a>	-75.16	-164.46	0	26-Jul-2012 10:29	14.87	342.47	D	10
Provov	<a href="#">6901854</a>	<a href="#">15-Feb-2014 06:30</a>	-67.52	178.99	0	11-May-2014 05:57	-66.75	-172.54	D	-

*Table 2. Status information for the 7 Italian floats in the Southern Ocean and Ross Sea (grey row) during 2014.*

- technical problems encountered and solved

In the Mediterranean, the Provov Bio float WMO 6901860 reported erroneous irradiance and PAR values from the beginning of its mission. A systematic negative offset of salinity as large as 0.2 appeared systematically after 26 March 2014 (cycle number 41). This offset could eventually be easily corrected during delayed mode quality control. On 21 July 2014, all the biogeochemical and optical sensors stopped functioning.

In the Southern Ocean, the Apex floats WMO 6901849 and WMO 6901855 were incorrectly programmed and did not stay at the surface enough time to transmit their data via the Argos satellite system. As a result, float WMO 6901849 provided only 19 incomplete profiles (out of 37 cycles) and no data were obtained from float WMO 6901855. The problem was discussed with Teledyne Webb Research but there was nothing that we could do to solve the problem since the floats were at sea and Argos telemetry does not allow downlink commands.

The provor CTS 2 WMO 6901854 which was actually refurbished by NKE apparently went into “end of mission” mode just after deployment and stayed at surface without profiling until 11 May 2014.

Unfortunately, float WMO 6901853, which was tethered to act as a virtual mooring in Ross Sea had transmission/floatation problems and never transmitted data.

- status of contributions to Argo data management (including status of pressure corrections, technical files, etc)

The data management for the Italian float was done by the Coriolis GDAC. Metadata and data are available through the Coriolis web site in near real-time.

- status of delayed mode quality control process

Delayed mode quality control (DMQC) of the data provided by the Italian floats was done for 18 floats. OGS will continue this activity in 2015 as part of the EC FP7 E-AIMS and MyOcean-FO and PERSEUS projects. Note that OGS is responsible for the DMQC of all the floats operated in the Mediterranean and Black seas. The temperature and salinity data of 142 floats (over a total of 269 floats; 197 dead and 72 alive floats) have been quality controlled following the standard Argo procedure, covering the period 2000-2015.

## **2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.**

The Italian Ministry of Research has provided funding to buy 20 floats in 2014, including 5 instruments with dissolved oxygen sensors. In addition, the Italian human resources per year devoted to Argo-Italy amounts to about 50 man-months for technical, administrative and scientific personnel involved in the project in 2014. It is expected that the same level will be maintained in 2015, including the procurement of 22 additional standard floats and 2 special floats that can profile as deep as 4000 dbar. The Italian Ministry of Research is committed to provide funding in order to sustain the Italian contribution to Argo beyond 2015 as founding member of the Euro-Argo Research Infrastructure Consortium. In addition to the Italian national funding, OGS has funding from the EC FP7 PERSEUS, MyOcean-FO and E-AIMS projects, for several activities (technical development, data management, capacity building and training, EuroArgo strategy, etc.) related to Argo.

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

The Italian deployment plans are detailed in Table 3. The main areas of interest are the Mediterranean and Black seas and the Southern Ocean.

Year	Floats with T/S		Floats with biogeochemical sensors		Total
	Quantity	Area	Quantity	Area	
2015	15	Mediterranean	2	Mediterranean	<b>30</b>
	2	Black Sea	1	Black Sea	
	10	Southern Ocean			
2016	14	Mediterranean	3	Mediterranean	<b>30</b>
	1	Black Sea	2	Black Sea	
	10	Southern Ocean			
2017	14	Mediterranean	3	Mediterranean	<b>30</b>
	1	Black Sea	2	Black Sea	
	10	Southern Ocean			

*Table 3. Italian deployment plans for 2015-2017.*

OGS is committed to carry out DMQC on all the Argo floats of the Mediterranean Sea as part of the E-AIMS and MyOcean-FO and PERSEUS projects over the next years.

The website for the Italian contribution to Argo (Argo-Italy) was improved and upgraded (<http://argoitaly.ogs.trieste.it/>). The link to the Mediterranean & Black Sea Argo Centre (MedArgo) is <http://nettuno.ogs.trieste.it/sire/medargo/>.

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

##### Operational ocean forecasting.

All Argo temperature and salinity data in the Mediterranean (alongside with other in-situ and remotely sensed data) are routinely assimilated into the Mediterranean Forecasting System (MFS) operational forecasting system run by the Italian Istituto Nazionale di Geofisica e Vulcanologia (INGV). Assessments have clearly demonstrated the positive impact of Argo data on ocean analyses and predictions. In particular, studies on the optimization of float sampling and cycling characteristics for the Mediterranean have been performed, as well as the development of methodology for the assimilation of Argo float sub-surface velocities into numerical models.

##### Ocean science.

Argo data are being used by several researchers in Italy to improve the understanding of marine properties (e.g. circulation, heat storage and budget, and mixing), climate monitoring and on how they are applied in ocean models, with particular focus to the Mediterranean Sea.

**5. Issues that your country wishes to be considered and resolved by the AST.**

N/A

**6. Number of CTD cruise data added to the Argo reference database by Italian PIs in 2014.**

N/A

**7. Italian contribution to Argo bibliography in 2014.**

Gacic M., Civitarese G., Kovacevic V., Ursella L., Bensi M., Menna M., Cardin V., Poulain P.-M., S. Cosoli, G. Notarstefano, and Pizzi C., 2014: Extreme winter 2012 in the Adriatic: an example of climatic effect on the BiOS rhythm. *Ocean Sci.*, **10**(3), 513-522, doi:10.5194/osd-11-425-2014.

Lacorata, G., L. Palatella, and R. Santoleri, 2014: Lagrangian predictability characteristics of an Ocean Model, *Journal of Geophysical Research: Oceans*, **119**(11), 8029-8038, <http://dx.doi.org/10.1002/2014JC010313>.

Marullo, S., R. Santoleri, D. Ciani, P. Le Borgne, S. Péré, N. Pinardi, M. Tonani, and G. Nardone, 2014: Combining model and geostationary satellite data to reconstruct hourly SST field over the Mediterranean Sea, *Remote Sens. Environ.*, **146**(0), 11-23, <http://www.sciencedirect.com/science/article/pii/S0034425713004069>.

Rio, M. H., A. Pascual, P. M. Poulain, M. Menna, B. Barceló, and J. Tintoré, 2014: Computation of a new mean dynamic topography for the Mediterranean Sea from model outputs, altimeter measurements and oceanographic in situ data, *Ocean Sci.*, **10**(4), 731-744, <http://www.ocean-sci.net/10/731/2014/>.

## Japan National Report

(Submitted by Toshio Suga)

### 1. The Status of implementation (major achievements and problems in 2014)

#### 1.1 Floats deployed and their performance

The current positions of all the active Japanese Argo floats are shown in Fig.1.

Japan Agency for Marine-Earth Science and Technology (JAMSTEC) deployed 61 Argo and Argo equivalent floats from January to December 2014: 23 ARVOR, 30 Navis and 8 Deep NINJA floats. All the floats were deployed with the aid of R/Vs of 7 domestic organizations.

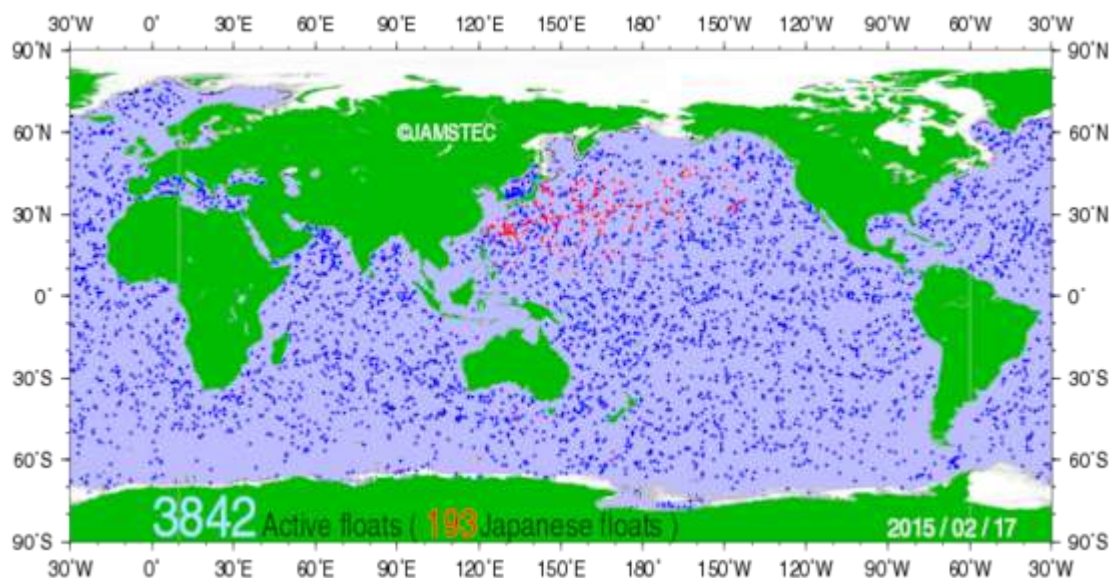


Figure 1: The distribution of active Argo floats. The red dots represent active Japanese floats.

While JAMSTEC planned to deploy one float by a voluntary cargo ship owned by a Japanese merchant ship company, NYK Line, during 2014, the deployment has not been done yet due to ship scheduling matter. The deployment will be done by the end of March 2015. The arrangement of the semi-regular float deployment by cargo ships was made under the cooperative relationship between JAMSTEC and NYK line, which was established in 2011 to increase float deployment opportunities. NYK Line has a lot of cargo shipping routes covering the global ocean, which is very useful to deploy Argo floats in the area of sparse float density. This is also part of environment conservation efforts of NYK Line through optimal routing owing to improvement of ocean current prediction that is benefitted from Argo.

From 1999 to the end of December 2014, JAMSTEC deployed 1076 (1109) Argo and Argo equivalent floats (the number in parenthesis includes floats deployed as non Argo floats; most of their data are to be released as Argo data later) in the Pacific, Indian and Southern Oceans: 739

(764) APEX, 141 (143) PROVOR, 104 (104) ARVOR, 33 (39) NEMO, 30 (30) Navis, 11 (11) NINJA, 12 (12) Deep NINJA and 6 (6) POPS floats. As of the end of December 2014, 152 (173) floats [7 (25) APEXs, 16(18) PROVORs, 90 (90) ARVORs, 29 (29) Naviss, 0 (1) NEMO, and 10 (10) Deep NINJAs] are in normal operation. The other 828 (862) floats terminated their missions, including 9 floats transmitting on the beaches after stranding or being captured by ships, 12 floats drifting at the sea surface and 10 floats recovered. JAMSTEC deployed 4 floats (Navis) in February 2015.

The Japan Meteorological Agency (JMA) deployed 26 Argo equivalent floats (26 APEX floats) in the seas around Japan from January to December 2014. All the floats get 2,000 dbar T/S profiles every 5 days for operational ocean analysis and forecast.

Among 192 floats (16 PROVORs, 149 APEXs and 27 ARVORs) which JMA has deployed from 2005 to 2014, 46 floats (46 APEXs) are active as of the end of December 2014, while 16 floats (7 APEX and 9 ARVOR floats) terminated the transmission in 2014. JMA deployed 6 APEX floats in January 2015.

A profiling float for deep ocean observation, Deep NINJA, was developed by JAMSTEC and Tsurumi Seiki Co. Ltd. and has been available for public since April 2013. In 2013/14 austral summer, seven Deep NINJA floats were deployed in two regions off the Antarctica (five off the Budd Coast by R/V Umitaka-maru in January 2014 and two off the Adelie Coast by Shirase in March 2014). In 2014/15 austral summer, one Deep NINJA was deployed off the Budd Coast. Four floats off the Antarctic coasts lost contact from the end of March 2014, probably due to sea ice extension there. Two floats survived Antarctic winter and resumed data transfer in February 2015. We confirmed that they have observed the Antarctic deep layer under sea ice throughout the winter. Recently, the data measured by these Deep NINJA floats have begun to be transferred to GDAC.

Okinawa Institute of Science and Technology Graduate University (OIST) has deployed 4 NEMO floats near Ishigaki Island and 1 NEMO float near Ogasawara Islands as Argo equivalent floats during 2014. The floats deployed near Ishigaki Island measure P, T, and S from 1000 dbar to surface every 30 days, and the float deployed near Ogasawara Islands measure P, T, and S from 1000 dbar to surface every 3days.

### ***1.1.1 Floats deployment for synchronous array observation***

JAMSTEC also deployed 7 NAVIS floats along 170W line in the central North Pacific to observe formation and dissipation process of central mode water (CMW). Since the formation region of CMW is to be under strong influence of PDO activity and corresponds to one of important regions for monitoring decadal heat content change by Argo floats (Masuda and Hosoda, 2014), the goal of the observation is to understand effects of variation in Aleutian low, quantifying contribution of CMW on decadal heat content change. Also, it will contribute to understanding of the role of CMW on dynamics of ocean circulation and its variability. The arrayed 7 NAVISs synchronize sampling interval and use deeper parking depth to minimize drift, which were deployed every 2.5 degrees in meridional direction observing from a depth of 2000m to the surface every 10 days. After the deployment in August, the array observation is ongoing through this winter season when mixed layer is deepened, although some NAVIS floats suffered technical trouble and then became uncontrollable.

## **1.2 Technical problems encountered and solved**

### ***1.2.1 Float hardware troubles***

Fifty five APEX floats equipped with alkaline batteries, purchased by JAMSTEC in 2010 and 2011 (52 APEX floats) and by JMA in 2008 (15 APEX floats), had terminated their missions before 100 cycles, which were clearly shorter than the specification (150 cycles). The manufacturer,

Teledyne Webb research inc., reported that the trouble was probably caused by energy flu because of troubles in some battery cells. While the manufacturer recommended us to use lithium batteries for future purchasing float to avoid energy flu, JAMSTEC asked further investigation and information for this problem. However, they have not provided any comments yet.

JAMSTEC also purchased 65 PROVOR manufactured by nke instrumentation in FY2009 but suffered some hardware/software troubles on the almost all of the PROVORs. Since the troubles were due to multiple causes such as pump, sensor and software, then we stopped to deploy for a while and influenced to our deployment plan, which had been reported previously. Although the floats were repaired and took back until 2011, 14 of them terminated data transmission within 20 cycles, which is far shorter than expected lifetime (150 cycles). Also, 51 Arvors were purchased in FY2012 and FY2013 but 14 of 65 Arvors terminated data transmission within 20 cycles. Since the two situations are very similar, JAMSTEC asked further information and report on cause of trouble to nke. However, the cause is still unknown.

### ***1.2.2 Deep Ninja and Rinko sensor on S3A***

It is worth to report a salinity bias found in Deep NINJA measurements. Comparisons with shipboard CTD measurements showed that float salinity is less saline at deeper depth besides having a constant bias, which means the bias possibly depends on pressure linearly. The pressure dependency of the bias was verified in all of the 11 floats in which the CTD measurements at float deployment were available for the comparison. And in some cases, the pressure dependency was changed in time.

Dissolved oxygen derived from the first profile of S3A floats were compared with high-quality shipboard CTD and discrete water sampled data obtained at deployment of the S3A floats. The first oxygen profiles from the S3A were quite similar between the two floats (Fig. 2). Also, the oxygen profiles from the S3A represent relatively small scale vertical oxygen structure such as subsurface minimum and maximum near the surface (Fig. 2a). Time difference between the first profile of S3A and the shipboard CTD profile was about 12 hours. Since a depth of the pycnocline (and also oxycline) may change largely in time due to mesoscale variability, the oxygen profiles were compared on the same density surface (Fig. 2b). However, dissolved oxygen from the S3A was slightly smaller than the discrete water sampled data (Fig. 3). The comparison shows that a span correction is appropriate for the S3A RINKO sensors. The correction factor was estimated to be 1.035 for the two S3A RINKO sensors. Standard deviation of the difference between the S3A and the discrete water sampled Winkler data was about 4  $\mu\text{mol/kg}$ .



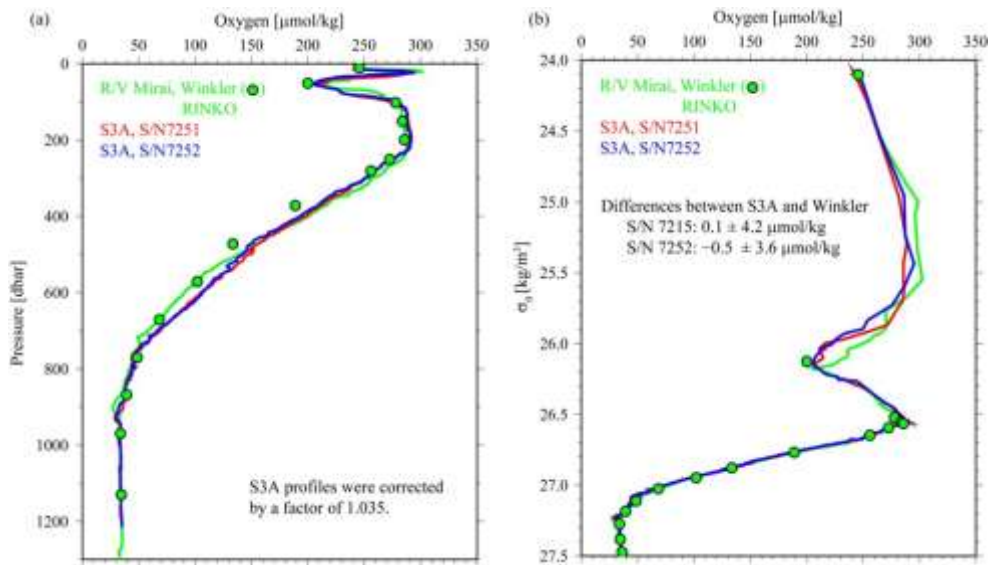


Figure 2. Comparison of dissolved oxygen profile derived from S3A and high-quality shipboard CTD measurements plotted against (a) pressure and (b) potential density ( $\sigma_\theta$ ). The S3A data were corrected by a factor of 1.035 to correspond with the discrete sampled Winkler data.

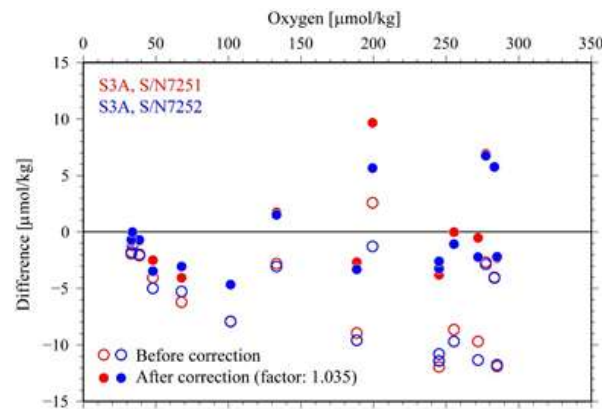


Figure 3. Difference between the S3A oxygen and the discrete sampled Winkler data. The S3A oxygen data were interpolated onto the same potential density as the Winkler data for comparison. Mean with standard deviation of the difference after correction of the S3A was  $0.1 \pm 4.2 \mu\text{mol/kg}$  and  $-0.5 \pm 3.6 \mu\text{mol/kg}$  for S/N 7251 and 7252, respectively.

### 1.3 Status of contributions to Argo data management

The Japan DAC, JMA has operationally processed data from all the Japanese Argo and Argo-equivalent floats including 193 active floats as of February 15, 2015. Ten Japanese PIs agree to provide data to the international Argo. All the profiles from those floats are transmitted to GDACs in the netCDF format and are also issued to GTS using the TESAC and BUFR codes after real-time QC on an operational basis. Argo BUFR messages have been put on GTS since May 2007.

Note that the addresses of following web pages have been changed due to the address change of the JMA website last fall.

JAPAN ARGO Real Time Data Base : <http://ds.data.jma.go.jp/gmd/argo/data/index.html>  
Float Status : <http://ds.data.jma.go.jp/gmd/argo/data/status/statusE.html>

#### **1.4 Status of delayed mode quality control process**

JAMSTEC has submitted the delayed-mode QCed data of 95,423 profiles to GDACs as of December 2014.

JAMSTEC will have converted D-profile files of Japanese ARGOS floats and meta-files of our ARGOS floats from v2 to v3.1 by the end of March 2015.

#### **2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.**

Japan Argo had been conducted in a 5-year program from FY1999 to FY2004, as a part of Millennium Project implemented under cooperation among the Ministry of Education, Culture, Sports, Science and Technology (operation: by JAMSTEC), the Ministry of Land, Infrastructure and Transport, JMA and Japan Coast Guard. After the Millennium Project terminated in March 2005, JAMSTEC has continued the operation until FY2013 nearly in the same scale (about 80 floats to be deployed every year and associated delayed-mode data management) under its two consecutive mid-term programs for FY2004-2008 and FY2009-2013. JAMSTEC continues the operation but in the scale somewhat lower than ever before (less than 50 floats to be deployed every year with delayed-mode data management) under its new mid-term program FY2014-2018. In FY2015, since their fund for research activity including Argo is cut >20% based on the fund in FY2014, the number of deployment/purchase of Argo floats should decrease. Due to this budgetary situation, the number of technical staff devoting for delayed mode QC and PARC will decrease from 5 to 4 after FY 2015. Additional research fund for enhancement of Argo, including competitive research funding, should be sought. JMA allocates operational budget for 27 floats every fiscal year.

#### **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.**

In FY 2015, JAMSTEC will deploy about 23 floats in total in the North Pacific and Indian Oceans for the Argo core mission. The main purposes of deployment is to fill the blank of 3x3 degree bins in the global Argo array. Two to four Deep Argo floats will be deployed as Argo equivalent floats in FY2015 mainly in the Indian Ocean. To investigate response of physical/biogeochemical oceanic processes to explosive cyclones, four NAVIS floats with CTD sensor (SBE Inc.) will be deployed as Argo equivalent floats along winter-time storm track in the western North Pacific, based on competitive research funding. Since several Japanese scientists are applying for competitive research funding to purchase Argo floats, deep floats and bio Argo floats, the number of floats to be deployed in FY2015 may be increased.

JMA plans to deploy 27 Argo equivalent floats around Japan in FY2015 and in the coming years. All the JMA floats are identical with the core Argo floats except that they are operated in a 5-day cycle, synchronized with JMA's real-time ocean data assimilation and forecast system.

JMA continues serving as the Japan DAC. JAMSTEC continues running the Pacific Argo Regional Center for the upcoming year.

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

Many groups in JAMSTEC, JMA, FRA and Japanese universities are using Argo data for oceanographic researches on water mass formation and transport in the Pacific Ocean, the mid-depth circulation, the mixed layer variation, the barrier layer variation, and tropical atmosphere-ocean interaction in the Pacific and Indian Ocean and so on. Japanese fisheries research community is conducting their biogeochemical studies using Argo floats equipped with chlorophyll and/or oxygen sensors.

The global Argo TESAC messages are used for operational ocean analysis and forecast by JMA. Daily and monthly products of subsurface temperatures and currents for the seas around Japan and western North Pacific, based on the output of the real-time ocean data assimilation system (MOVE/MRI.COM-WNP), are distributed through the JMA web site (in Japanese). Numerical outputs of the system are available from the NEAR-GOOS Regional Real Time Data Base (<http://ds.data.jma.go.jp/gmd/goos/data/database.html>) operated by JMA. Monthly diagnosis and outlook of El Nino-Southern Oscillation based on the outputs of the Ocean Data Assimilation System and the El Nino Prediction System (an ocean-atmosphere coupled model) are also operationally distributed through the JMA web site (in Japanese) and the Tokyo Climate Center (TCC) web site (<http://ds.data.jma.go.jp/tcc/tcc/products/elnino/>). JMA has introduced the ocean-atmosphere coupled model, which is the same as that for El Nino prediction, into seasonal forecast of climate in Japan since February 2010. The model products for seasonal forecast are available from the TCC web site (<http://ds.data.jma.go.jp/tcc/tcc/products/model/>).

JAMSTEC is providing a variety of products including objectively mapped temperature and salinity field data (Grid Point Value of the Monthly Objective Analysis using Argo float data: MOAA-GPV: [http://www.jamstec.go.jp/ARGO/argo\\_web/MapQ/Mapdataset\\_e.html](http://www.jamstec.go.jp/ARGO/argo_web/MapQ/Mapdataset_e.html)), objectively mapped velocity field data based on YoMaHa'07 (version September 2010) ([http://www.jamstec.go.jp/ARGO/argo\\_web/G-YoMaHa/index\\_e.html](http://www.jamstec.go.jp/ARGO/argo_web/G-YoMaHa/index_e.html)), and gridded mixed layer depth with its related parameters (Mixed Layer data set of Argo, Grid Point Value: MILA-GPV [http://www.jamstec.go.jp/ARGO/argo\\_web/MILAGPV/index\\_e.html](http://www.jamstec.go.jp/ARGO/argo_web/MILAGPV/index_e.html)). JAMSTEC have released Argo temperature and salinity profile data put through more advanced automatic checks than real-time quality controls (Advanced automatic QC Argo Data version 1) since October 2014. We add our own new flag to real time profile data which tells whether it passed each check or not. Users can select profiles even if they have bad flags of our checks. The dataset is provided not only netcdf but also ascii formats for users who are unfamiliar with netcdf format. JAMSTEC has also provided scientifically quality controlled data of Deep NINJA for convenient use on scientific or educational purposes (<http://www.jamstec.go.jp/ARGO/deepninja/>). The QC is based on comparisons with high accurate shipboard CTD observations conducted nearby float observations.

JAMSTEC is also providing information about consistency check of float data related to delayed-mode QC for the Pacific Argo Regional Center (PARC) web site as a main contributor. JAMSTEC will support the activities of the Southern Ocean ARC (SOARC) in the Pacific sector.

ESTOC (Estimated state of ocean for climate research) is a JAMSTEC product; an integrated dataset of ocean observations including Argo data by using a four dimensional variational (4D-VAR) data assimilation approach. ESTOC is the open data that consists of not only physical but also biogeochemical parameters for 55 years during 1957-2011 (See the web site in JAMSTEC, <http://www.godac.jamstec.go.jp/estoc/e/top/>).

JCOPE2 (Japan Coastal Ocean Predictability Experiment 2) is the model for prediction of the oceanic variation around Japan which is operated by Application Laboratory of JAMSTEC. JCOPE2 is the second version of JCOPE1, developed with enhanced model and data assimilation

schemes. The Argo data are used by way of GTSP. The reanalysis data 20 years back and the forecast data 2 months ahead are disclosed on the following web site: <http://www.jamstec.go.jp/frcgc/jcope/>. More information are shown in

[http://www.jamstec.go.jp/frcgc/jcope/htdocs/jcope\\_system\\_description.html](http://www.jamstec.go.jp/frcgc/jcope/htdocs/jcope_system_description.html).

FRA-ROMS is the nowcast and forecast system for the Western North Pacific Ocean developed by Fisheries Research Agency (FRA) based on the Regional Ocean Modeling System (ROMS). Instead of FRA-JCOPE, which was the previous system of providing the hydrographic forecast information around Japan, FRA started the FRA-ROMS operation in May 2012. Argo has been one of important sources of in-situ data for the FRA-ROMS data assimilation system. The forecast oceanographic fields are provided every week on the website <http://fm.dc.affrc.go.jp/fra-roms/index.html/>.

## **5. Issues that our country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo.**

As reported in 2011, EEZ clearance procedure for Argo float deployed by Japanese PIs has been simplified following IOC Resolution XLI-4. This change reduced our time and effort for the process of EEZ clearance significantly. However, the traditional EEZ clearance is still needed for some key countries because Argo national focal points (NFPs) of those countries are not registered on the listed at AIC. Since the procedure following IOC Resolution XLI-4 is applied only to the coastal nations whose Argo NFP is registered. Japan Argo has a strong desire for NFPs especially of nations in and around the Pacific Ocean to be registered to facilitate more timely and optimal deployment of Argo floats. This could be also helpful for smooth implementation of any future extension of Argo.

## **6. Summary of the number and location of CTD cruise data to the CCHDO website.**

Data of 710 CTD casts conducted by JMA in the western North Pacific from January 2013 to January 2014 were uploaded to the CCHDO website.

## **7. Argo bibliography**

### **(1) Articles**

- Abe, H. and N. Ebuchi: Evaluation of sea-surface salinity observed by Aquarius, *Journal of Geophysical Research - Oceans*, 119, doi:10.1002/2014JC010094.
- Ito, K., T. Kuroda, K. Saito and A. Wada: Forecasting a large number of tropical cyclone intensities around Japan using a high-resolution atmosphere-ocean coupled model, *TBD*, doi:10.1175/WAF-D-14-00034.1.
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- Shiozaki, T., S. Ito, K. Takahashi, H. Saito, T. Nagata and K. Furuya: Regional variability of factors controlling the onset timing and magnitude of spring algal blooms in the northwestern North Pacific, *Journal of Geophysical Research: Oceans*, 199. 1-13, doi:10.1002/2013JC009187.
- Shiozaki, T., T. Kodama and K. Furuya: Large-scale impact of the island mass effect through nitrogen fixation in the western South Pacific Ocean, *Geophysical Research Letters*, 41 2907-2913, doi:10.1002/2014GL059835.
- Sugimoto, S. and K. Hanawa: Influence of Kuroshio path variation south of Japan on formation of subtropical mode water., *Journal of Physical Oceanography*, 44 (4), 1065-1077, doi:10.1175/JPO-D-13-0114.1.
- Sugimoto, S., N. Kobayashi and K. Hanawa: Quasi-decadal variation in intensity of the western part of the winter subarctic SST front in the western North Pacific: The influence of Kuroshio Extension path state, *J. Phys. Oceanogr.*, 44(10) 2751-2760, doi:10.1175/JPO-D-13-0265.1.
- Tozuka, T. and M. F. Cronin: Role of mixed layer depth in surface frontogenesis: the Agulhas Return Current front, *Geophysical Research Letters*, 41, 2447-2453, doi:10.1002/2014GL059624.
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- Toyama, K., 2010: Three-dimensional structure of the North Pacific mode waters and central water viewed by Argo, Tohoku University.
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## **National Report on Argo-2014**

**by Republic of Korea**

### **► Deployment in 2014 and Future Plan**

Korea Meteorological Administration/National Institute of Meteorological Research (KMA/NIMR) and Korea Institute of Ocean Science & Technology (KIOST) are involved in the International Argo Program since 2001. In July 2014, KMA deployed additional 15 floats in the East Sea/Sea of Japan (11 floats) and southwestern region of Kamchatka Peninsula (4 floats) respectively with the help of 'Araon', the ice breaker from Korea Polar Research Institute (KOPRI). The 57 Argo floats are active in the East Sea/Sea of Japan and the North Pacific Ocean.

KMA has a plan to deploy 17 floats in the East Sea/Sea of Japan in mid-July 2015. One of the floats equipped with DO sensor will be deployed in the East Sea/Sea of Japan. It is expected that KMA is able to continue the float deployment.

### **► Status of Argo data management**

During the period of January to December 2014, 2,332 R-files of KMA were sent to GDAC.

National Fisheries Research and Development Institute (NFRDI)/Korea Oceanographic Data Center (KODC) is responsible for Delayed Mode QC (DMQC). NFRDI/KODC has fixed the format errors reported at the ADMT-15, and the corrected D-files will be uploaded before the AST-16 meeting. NIMR built new data transfer system using 'web service' and 'sftp' for security enhancement at the end of December 2014. Also we additionally have started to broadcast the BUFR format data through GTS since November 2014.

### **► Research and operational uses of Argo data**

KMA has investigated the characteristics of dissolved oxygen as an ocean environmental monitoring in the East Sea/Sea of Japan. In a case of summer season,

dissolved oxygen is minimum in the surface layer and maximum at an oceanic depth of 150m, which corresponds to maximum salinity. The findings are maximum salinity and minimum dissolved oxygen occurred by Tsushima current. The concentration of dissolved oxygen in surface layer was much higher than intermediate water in winter. This result is consisted with the previous findings as marine characteristics in the East Sea/Sea of Japan, which is all the more meaningful in that Argo profile is used for this research.

### Web pages

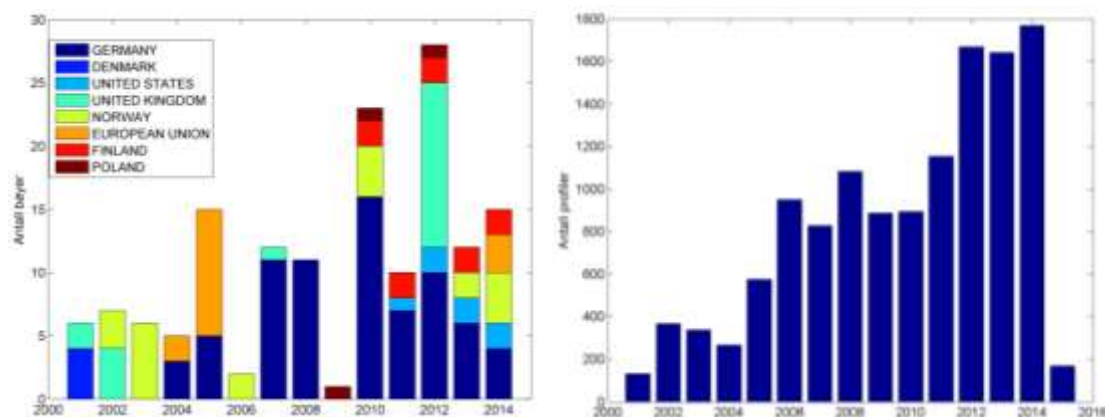
KMA/NIMR is operating the Argo Web site. The URL is:  
<http://argo.nimr.go.kr/>

# Status of Argo Norway, 13<sup>th</sup> March 2015

The Institute of Marine Research (IMR) is involved in the international Argo programme with contribution of Argo floats, ship time for deployment and user of the data. At present, IMR is the only institution in the Argo Norway.

## 1. The status of implementation

At present we have in total purchased and deployed 15 floats, all in the Norwegian Sea. Three floats were deployed in 2002, six floats in 2003, two floats in 2006 that included oxygen and fluorescence sensors, and four floats in 2010 that also included oxygen and fluorescence sensors. In 2013 two floats were deployed in the Norwegian Sea that included oxygen and fluorescence sensors, in 2014 six floats were deployed, 2 in the Irminger Sea that include oxygen and 4 in the Norwegian Sea that included oxygen and fluorescence sensors. In 2015 we plan to deploy 3 floats in the Norwegian Sea. All floats are APEX floats and the last years we have only deployed floats with Iridium telemetry. At present only two of our floats are active.



**Figure 1.** Left: Number of Argo floats deployed in the Nordic Seas. Right: Number of profiles in the Nordic Seas (updated 29. January 2015).

### Delayed mode quality control

Regarding the “Delayed mode” Argo Germany do delayed mode quality control for all floats in the Nordic Seas including our floats.

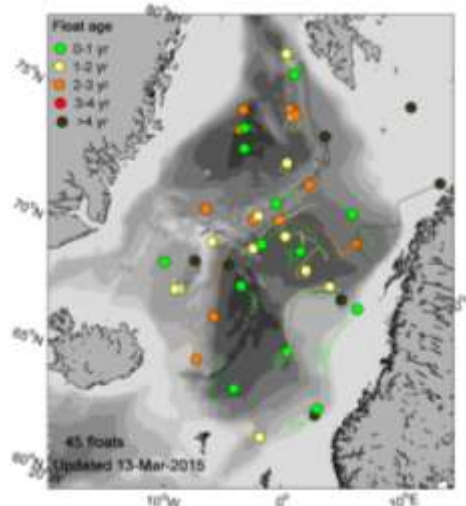
## 2. Present level of and future prospects for national funding for Argo

The funding was self-financed (i.e. funded by our institute) until 2012. In 2012 IMR received funding from the Norwegian Research Council (NRC, Ministry of Education and Research) for funding of three Argo floats per year the next three years (2013-2015). The future funding of Argo is uncertain, but this will be discussed the next months between several Norwegian research institutes.



### 3. Summary of deployment plans

With the funding from NRC we plan to deploy three APEX floats in the Norwegian Sea in 2015. Some of these floats will include oxygen and fluorescence sensors. These floats will be deployed within the Nordic Seas where the needs are largest.



**Figure 2.** Active Argo floats within the Nordic Seas, updated 13<sup>th</sup> March 2015. The colours indicate age in years while the thin lines (for some floats) are the drift over the last 2 months.

### 4. Summary of national research and operational uses of Argo data

ARGO Norway focuses on both research topics and marine climate monitoring of the Nordic Seas. Approximately 3 scientists in 3 projects are directly involved in Argo Norway but also other people contribute with technical expertise, data management, ship time for deployments, and processing and analysing the data. There is an increasing interest in using Argo data in Norway, and two climate centres are now using the data operationally in climate models.

The present scientific topics are mainly within the Nordic Seas (Norwegian, Iceland and Greenland Seas) and include:

- Studies of the deep ocean circulation in the Nordic Seas. These studies have so far brought new insights in the circulation of the Nordic Seas.
- Water mass changes and also in relation with biological activities. This topic is also one of the reasons that we have included both oxygen and fluorescence sensors on our Argo floats.
- Studies that involve changes in the mixed layer.

### 5. Issues we wish to be considered and resolved

At the moment we have no suggestion.

# Argo National Report – South Africa

Report to Argo Steering Team Meeting: March 2015

The South African Argo Program presently is one of deployment opportunities and educational outreach as opposed to procuring of floats and seeding the global Argo array. However, we are striving to develop projects and funding opportunities in that direction. Given South Africa's unique position geographically of bordering three oceans – The Atlantic, Indian and Southern Oceans – we are able to provide numerous deployment opportunities for Argo floats to the global array. We are also working on dynamic research programs and experiments using Argo floats to a) study physical forcing dynamics and b) contribute to the development of biogeochemical floats particularly in the Southern Ocean. The research groups currently involved in the South African Argo program are: The South African Weather Services (SAWS) – who are the National Focal Point, Bayworld Centre for Research and Education (BCRE), University of Cape Town (UCT), the Department of Environmental Affairs (DEA), The Council for Scientific and Industrial Research (CSIR), The South African Environmental Observation Network (SAEON), the Research Schooner *Lady Amber* and the Nansen-Tutu Centre for Marine Environmental Research.

## 1. Status of implementation (major achievements and problems in 2014):

### Floats deployed and their performance

#### Southern Ocean and South Atlantic Ocean:

Gough Island Cruise (RV SA *Agulhas II*) – September 2014

6 APEX floats: UK Met Office with UCT / DEA

(serial #'s: 6994, 6995, 6993, 6992, 6991, 6990)

SANAE Cruise (RV SA *Agulhas II*) – November 2014-February 2015

14 ARVOR floats: University of Brest with UCT

4 Bio-Argo floats: Laboratoire d'Océanographie de Villefranche (LOV) with UCT

(serial #'s: lovbio 019b, lovbio 041c, lovbio 049b, lovbio 081b)

#### Indian Ocean:

Walter Shoal Expedition (RV *Algoa*) – May 2014

6 APEX floats: UK MetOffice with BCRE

(WMO#'s: 1901846, 1901847, 1901848, 1901849, 1901850, 1901851)

### Technical issues encountered and solved:

- a) The Department of Environmental Affairs' Nova floats (10) were sent to Lwandle Technologies for float self testing checks as they had been in storage for an extended period of time. Two float were not responding to tests and once sent back to the manufacturers were found to have faulty vacumm switches. These were since replaced and floats retested. No plans exist yet to deploy the remaining eight floats.

- b) An application to the South African Cabinet was made to allow Argo floats (and other instruments such as drifters, etc) to be freely deployed in South Africa's EEZ. This has not yet been approved.

**Status of contributions to Argo data management ( including status of pressure corrections, technical files, etc)**

None

**Status of delayed mode quality control processes:**

Not applicable

**2. Present level of (and future prospects for) national funding for Argo including summary of human resources devoted to Argo:**

Dedicated Argo funding to procure new floats to seed the global array is currently being investigated through the South African Environmental Observation Network (SAEON). Individuals from organisations (listed above) work on different projects involving Argo floats and have come together under the auspices of the South African Argo program to share knowledge, resources, cruise time where applicable and information regarding Argo. We are working towards taking this forward now.

We have one Argo representative for the South African Marine Science community who is also looking to drive the Argo float procurements and data management plans in future endeavours.

**3. Summary of deployment plans (level of commitment, areas of float deployment, low or high resolution profiles, extra sensors, Deep Argo) and other commitments to Argo (data management) for the upcoming year and beyond where possible:**

Southern Ocean:

Marion Island Cruise (RV SA *Agulhas II*) – April/May 2015

4 Bio-Argo floats: LOV with UCT

Gough Island Cruise (RV SA *Agulhas II*) – September 2015

available for deployment assistance

SANAE Cruise (RV SA *Agulhas II*) – December 2014 / January 2015

available for deployment assistance

Indian Ocean:

Agulhas System Climate Array (ASCA) deployment cruise – April 2015

available for deployment assistance

East coast mooring cruise (RV *Algoa*) – June-July 2015

available for deployment assistance

East coast mooring cruise (RV *Algoa*) – November-December 2015

available for deployment assistance

International Indian Ocean Expedition (IIOE-2) Expeditions

Cruises are being developed for both the eastern and western Indian Ocean and these can be communicated for interested countries wanting to deploy Argo floats into the Indian Ocean. The Research Schooner *Lady Amber* will also be taking part in these expeditions and her contact details are found below.

Atlantic Ocean:

SAMBA Mooring Array (RV *Algoa*) – October 2015

available for deployment assistance

Pacific Ocean: 2016-2017 (future plans):

The Research Schooner *Lady Amber* will be working with NASA from April 2016 to August 2017 on the Salinity Processes Upper-ocean Regional Study (SPURS-2) Experiment around 10° N and 125° W. There could be opportunities here to deploy Argo floats within the Pacific Ocean but also en route to and from the study region.

Contact: Capt. Peter Flanagan on [explorerstrust\\_uk@yahoo.co.uk](mailto:explorerstrust_uk@yahoo.co.uk)

**4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers. Please also include any links to national program Argo web pages to update links on the AST and AIC websites:**

Three research and two outreach project are noted below:

a) SOBOM:

*Isabelle Ansorge*

The Centre for Southern Ocean Biogeochemical Observations and Modeling (SOBOM) are a focused group developing a new ocean observing system for carbon, nutrients and oxygen that will complement the already established observing system for heat and freshwater. To this end, 150-200 profiling floats equipped with biogeochemical sensors will be deployed throughout the Southern Ocean and the cruises run by UCT (Dr. Ansorge) in this region (i.e. SANAE and Gough Island) will be used as a platform for deployments. Four bio-Argo floats from LOV were deployed on the 2014/2015 SANAE cruise, with a further four more planned for the Marion 2015 cruise in April.

<http://sobom.princeton.edu/content/deployment-opportunities>

b) SOSCEX III:

*Pedro M.S. Monteiro, Sebastiaan Swart, Sandy Thomalla and Thato Mtshali*

SOSCEX III is the focus of a suite of five NRF-SANAP projects funded for the 2015 – 2017 cycle. This forms a central part of the new Climate focused research theme in the Southern Ocean as articulated in both ARESSA as well as the emerging Antarctic and Southern Ocean strategy of the NRF-DST. It is our aim to attract wider collaboration from national, regional and international partners into this unique Climate – Carbon – Ecosystems research platform. To this end we will be publishing the more detailed SOSCEX III White Paper and focusing on linking up with the US based SOCOM initiative (using floats as central platforms) as well as inviting graduate student participation from Mozambique, Namibia and Zimbabwe.

Please refer to Appendix 1 for further information.

[www.csir.co.za/nre/coasts\\_and\\_oceans/osc.html](http://www.csir.co.za/nre/coasts_and_oceans/osc.html)

c) Validating Hycom-EnOI in the Agulhas using Argo profiling floats - The Nansen-Tutu Centre for Marine Environmental Research (UCT)

*Charine Collins, Björn Backeberg, François Counillon and Johnny Johannessen*

The greater Agulhas Current system, one of the most energetic systems in the world, plays a key role in the global ocean circulation, regional weather, and the marine environment. A prediction system of the marine environment around southern Africa would not only be beneficial to regional commercial, industrial, and leisure activities, but it would also aid search and rescue activities, and the monitoring of accidental pollutants and harmful algal blooms.

Despite the emergence of various global prediction (operational data assimilation) systems (e.g. MyOcean, Blue-Link), there is hitherto no system for the southern African regional ocean. As a first attempt towards an ocean prediction system for southern Africa, A regional data assimilation system of the greater Agulhas system was developed recently (Backeberg et al., 2014). This system, while not operational yet, assimilates satellite altimeter along-track sea level anomaly (SLA) data into a HYbrid Coordinate Ocean Model (HYCOM) simulation of the Agulhas Current System using the Ensemble Optimal Interpolation (EnOI) data assimilation scheme (hereafter referred to as HYCOM-EnOI). While HYCOM-EnOI improved the meso-scale dynamics in the Agulhas Current system, as well as the water mass characteristics and velocities at ~1000m, there was a slight degradation of the SST distribution.

In this study, we assess the limitations of HYCOM-EnOI in reproducing the water mass properties of the Agulhas Current region through a detailed comparison with Argo profiling floats. A comparison between HYCOM-EnOI and the Argo profiling floats is made in terms of temperature and salinity differences at various depths, differences in water mass characteristics, and mixed layer depth.

The temperature values in the upper 100m simulated in HYCOM-EnOI are, for most of the region, in close agreement ( $\pm 1^\circ\text{C}$ ) with the observations (Figure 3a). On the contrary there is an overestimation of the salinity values in the upper 100m simulated in HYCOM-EnOI by about 0.1psu (Figure 3b). In the 500-1000m depth range, HYCOM-EnOI tends to underestimate temperature (Figure 3c) and salinity (Figure 3d) values south of the Agulhas bank, in the vicinity of the Agulhas Retroflexion region and the Agulhas Return Current. West of the Agulhas bank, the temperature of HYCOM-EnOI is in good agreement with the observations ( $\pm 1^\circ\text{C}$ ), however, there is again an overestimation of the salinity values by more than 0.1psu. In the deeper layers (1000-2000m, HYCOM-EnOI tends to underestimate the temperature and salinity throughout the region, except east of the Agulhas Bank where there is a good agreement with the observations.

d) Educational Outreach – The Argo Floats Program by SAEON Egagasini:

*Thomas Mtontsi and Tamaryn Morris*

Five secondary schools have been identified in the Western Cape region to track changes at sea from data collected on floats 1901469 and 1901470 purchased by SAEON/SANAP with support from SAWS and deployed in 2009.

In 2014 school monitoring teams were encouraged to do schools science projects on:

1. The Identification of deep water masses and their direction using temperature
2. Relationships between salinity and depth
3. Relations of temperature, pressure and salinity

The overall focus of the SAEON Egagasini education programme is to:

- primarily encourage awareness of science skills to learners
- to create a platform where Marine Science Research can be integrated into School Sciences curriculum by encouraging interactions between learners, educators and scientists
- to promote an understanding of, create awareness and generate an interest about our oceans

e) Educational Outreach – The Research Schooner *Lady Amber*:

*Capt Peter Flanagan*

Capt. Flanagan, along with Mrs Carol Young, the Education Consultant for UNESCO, attended and hosted the third Argo Outreach Program held in Mauritius by invitation of the Honorable Dr. Bunwaree – Minister for Education. A week long workshop from 07-11 July 2014 was held developing skills on Argo data downloading and interpretation. A total of 98 schools were represented from around Mauritius and each “adopted” an Argo float to continue monitoring in their own capacities.

Continued effort is being made by Capt. Flanagan and his crew from the Research Schooner *Lady Amber* to bring awareness of the Argo program to secondary schools. Most notably in collaboration with the GLOBE project out of Mossel Bay.

- 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 at this stage.

- 6. To continue improving the quality and quantity of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include any CTD station data that was taken at the time of float deployments this year. Additionally, please list CTD data (calibrated with bottle data) taken by your country in the past year that may be added to the reference database. These cruises could be ones designated for Argo calibration purposes only or could be cruises that are open to the public:**

The following cruises in the Mozambique Channel were loaded onto the CLIVAR + Carbon Hydrographic Data Office (CCHDO) website for Argo data validation:

- Alg 134 – April 2005 data
- Alg 160 – August 2007 data
- Nansen 2008 – November/December 2008 data
- Nansen 2009 – August 2009 data
- Antea\_2009 – October / November 2009 data
- Antea\_2010 – April 2010 data

- 7. Keeping the Argo Bibliography up to date:**

Ansorge, I.J, Jackson, J.M., Reid, K., Durgadoo, J.V., Swart, S. and Eberenz, S. – 2014. Evidence of a southward eddy corridor in the South-West Indian Ocean. Article in press. Special issue editor Igor Belkin.

Tagliabue, A., J-B Sallée, A. R. Bowie, M. Lévy, S. Swart and P. W. Boyd, Surface water iron supplies in the Southern Ocean sustained by deep winter mixing, *Nature Geoscience*, doi:10.1038/ngeo2101, 2014.

Domingues, R., G. Goni, S. Swart, and S. Dong. Wind forced variability of the Antarctic Circumpolar Current south of Africa between 1993 and 2010, *J. Geophys. Res. Oceans*, 119, 1123–1145, doi:10.1002/2013JC008908, 2014.

Thomalla, S. J., N. Fauchereau, S. Swart, and P. M. S. Monteiro. Regional scale characteristics of the seasonal cycle of chlorophyll in the Southern Ocean, *Biogeosciences*, 8, 2849-2866, doi:10.5194/bg-8-2849-2011. 2011.

Swart, S., S. Speich, I. J. Ansorge, and J. R. E. Lutjeharms. An altimetry-based gravest empirical mode south of Africa: 1. Development and validation, *J. Geophys. Res.*, 115, C03002, doi:10.1029/2009JC005299. 2010.

Swart, S., and S. Speich. An altimetry-based gravest empirical mode south of Africa: 2. Dynamic nature of the Antarctic Circumpolar Current fronts, *J. Geophys. Res.*, 115, C03003, doi:10.1029/2009JC005300. 2010.

Note: Submitted here are all papers that we were made aware of last year, though you may already have them.

#### **8. Thesis citation list:**

Swart, S. 2009. Transport and variability of the Antarctic Circumpolar Current south of Africa. PhD, University of Cape Town, South Africa, December 2009.

Note: This thesis may be in your list already, but noted here just in case.

# The 3rd Southern Ocean Seasonal Cycle Experiment (SOSCEX III)

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## Introduction

### Strategic Context

SOSCEX III is the focus of a suite of five NRF-SANAP projects funded for the 2015 – 2017 cycle. This forms a central part of the new Climate focused research theme in the Southern Ocean as articulated in both ARESSA as well as the emerging Antarctic and Southern Ocean strategy of the NRF-DST. It is our aim to attract wider collaboration from national, regional and international partners into this unique Climate – Carbon – Ecosystems research platform. To this end we will be publishing the more detailed SOSCEX III White Paper and focusing on linking up with the US based SOCOM initiative (using floats as central platforms) as well as inviting graduate student participation from Mozambique, Namibia and Zimbabwe.

### Science Context

The Southern Ocean is a key component of the earth system, being responsible for 50% of ocean uptake of atmospheric CO<sub>2</sub> and 30% of carbon export flux to the deep ocean (Schlitzer et al., 2002, Majkut et al., 2014). Climate models and decadal data sets predict changes in the Earth's climate that will influence the effectiveness of the Southern Ocean CO<sub>2</sub> sink through adjustments to sea surface temperature, stratification and mixing (Boyd 2002), all of which affect the nutrient and light supply necessary for phytoplankton production (and associated carbon export). The challenge in predicting long term trends in the Southern Ocean carbon cycle lies in our ability to resolve interannual variability and the link between seasonal and intraseasonal dynamics in physical drivers and biogeochemical responses. Despite their importance, surface ocean processes at these scales are poorly understood and quantified due to operational limitations of ships and moorings. This has necessitated the use of autonomous, remotely sensed and modeling platforms that are able to address the temporal and spatial scale gaps in our knowledge of a hitherto under sampled ocean.

## Aims

- **Understanding through seasonal scale observations, the role of fine scale upper ocean physical dynamics on CO<sub>2</sub> fluxes and primary production in the Southern Ocean and its impact on large-scale carbon-climate sensitivities.**
- **To make a significant contribution to improving the way global climate models reflect CO<sub>2</sub> and primary productivity climate sensitivities in the Southern Ocean.**



## Approach

A novel aspect of SOSCEX III is the integrated multi-platform approach, which aims to explore new questions about the climate sensitivity of carbon and ecosystem dynamics and how these processes are parameterized in models.

### 1. Observational

The observational approach employs the research ship together with robotics-based continuous year-round, high-resolution observations of the upper ocean. The primary objective is to understand how meso- to sub-mesoscale features (eddies and fronts) interact with seasonal to subseasonal scales (heating & transient storms) to characterize the seasonal cycle of upper ocean mixed layer depth, CO<sub>2</sub> fluxes Fe and light availability, primary production and associated carbon export.

### 2. Modelling

A hierarchy of medium to ultra-high resolution forced ocean model domains (NEMO-PISCES) will be used to test our understanding of the links between surface boundary layer physical drivers and the biogeochemical response scales, especially in terms of air-sea CO<sub>2</sub> fluxes, ocean productivity and associated carbon export.

## Cruise Plan

The observation plans are centered on three seasonal ship-based cruises of the Atlantic Sub-Antarctic Southern Ocean in winter 2015, summer 2015 and autumn 2016 spanned by continuous high resolution robotics-based observations. The primary aims of each cruise and required ship time are summarized below:

### 1. Winter

- Description: Date: July – August 2015; Cape Town to 55°S along GoodHope Line; Ship time: 21 Days; Berth requirements: 20
- Aim 1. Two process stations in the SAZ with twinned glider deployments - surface wave glider and sub-surface buoyancy glider.
- Aim 2. CTD deployments at each process station to provide a) winter Fe profile, b) biogeochemical measurements to characterize the plankton community and rates of production and c) necessary calibrations for the gliders.

### 2. Summer

#### Leg 1

- Description: Date: November - December 2015; Cape Town to Antarctica along GoodHope Line on SANAE 55; Ship stopping time: 4 Days; Berth requirements: 10
- Aim 1. Swap out buoyancy gliders and retrieve wave gliders (for overhaul and refurbishment) at both process stations in the SAZ
- Aim 2. CTD deployments at each process station to provide a) early summer Fe profile, b) necessary calibrations for the gliders.

#### Leg 2

- Description: Date: December 2015 - January 2016; Cape Town to 55°S along GoodHope Line; Ship time: 35 Days; Berth requirements: 25
- Aim 1. Redeployment of wave gliders at two process stations in SAZ to continue twinned sampling above of the buoyancy gliders.
- Aim 2: Ship alternates sampling between two process stations for 21 days (sampling each every alternate day) to measure meso and sub mesoscale evolution of physical, chemical and biological response to sub seasonal storm event.
- Aim 3. Deployment of Lagrangian bio-optics floats at each process station that continue sampling the SAZ till autumn 2016 completing a full seasonal cycle.

- Aim 3. CTD deployments at each process station to provide a) summer Fe profiles, b) time evolution of biogeochemical parameters, c) necessary calibrations for the gliders and floats.

### **Leg 3**

- Description: Date: January - February 2015; Antarctica to Cape Town along GoodHope Line on SANAE 55 return voyage; Ship stopping time: 4 Days; Berth requirements: 10
- Aim 1. CTD deployments at each process station to provide a) late summer Fe profile, b) necessary calibrations for the gliders and floats.
- Aim 2. Retrieval of all buoyancy and wave-gliders at both process stations (floats continue sampling)

### **3. Autumn**

- Description: Date: April – May 2016; Cape Town to Marion Island to 55°S to bio-optics float locations; Ship time: 10 Days; Berth requirements: 10
- Aim 1. CTD deployments at both Lagrangian bio-optics float locations to calibrate float sensors.
- Aim 2. Retrieval of both bio-optics floats.

## **List of critical requirements**

- The redesign of the intake system of the scientific sea water supply to prevent blockage and subsequent pump damage when the pump enters the ice (or kelp beds surrounding subantarctic islands), such that oceanographic research can take place in the marginal ice zone (which dominates the time and spatial coverage of the SA Agulhas II on all SANAE voyages).
- Sufficient band width for efficient internet access particularly during glider and float deployment and retrievals.
- The use of the rubber duck (Zodiac) may be needed for float/glider retrievals, weather permitting.

# UK ARGO PROGRAMME

## REPORT FOR ARGO STEERING TEAM 16<sup>TH</sup> MEETING, MARCH 2015

The UK Argo programme is undertaken by a partnership between the Met Office, the National Oceanography Centre Southampton (NOCS) and the British Oceanographic Data Centre (BODC). The Met Office are responsible for programme management and coordination, organizing float deployments, preparation of floats for deployment, telecommunications (costs) and international contributions. NOCS and BODC have responsibility for Argo science and data management. With the recent expansion of the UK programme into bio-Argo, Plymouth Marine Laboratory (PML) is now also involved.

The most pressing issue for the UK programme remains on securing ongoing funding for UK Argo and, internationally, on continued delivery of data from the core Argo array. It is important that the core Argo array is complemented by the Argo extensions into deeper profiling, bio-geochemistry and high latitudes such that these do not lead to a reduction in core Argo below its target density.

A second issue is ensuring that the GTS data stream, that delivers data to operational users, is successfully migrated to the BUFR format in 2015 (when the use of TESAC on GTS should cease) without degrading the timeliness of delivery. Also it will be important to ensure that the BUFR format(s) continue to evolve in parallel to the Argo NetCDF to allow for the exchange of additional profiles (e.g. near-surface and bio-geochemistry).

### Floats deployed and their performance

Floats deployed. Since 2001, over 480 UK floats have been deployed (including 7 floats donated to Mauritius) in support of the Argo array. As can be seen from Figure 1, the number of floats purchased each year has been variable as it has often been reliant on the release of end-year under-spend funding. As a result, the number of deployments each year has also been variable, but with an increase over the last 4 years with 169 floats having been deployed, with 50 floats deployed in 2014.

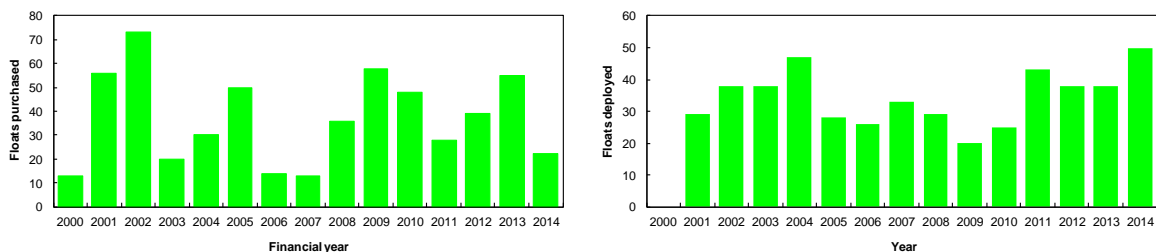


Figure 1. Showing (left) the number of floats procured each financial year (Apr-Mar) and (right) the number deployed in each calendar year.

With the increase in the number of floats deployed in the last 3 years the number of UK floats contributing to Argo (including 6 Apex that were provided to and deployed by Mauritius) has increased from around 100 to around 130, as shown in Figure 2. There are a few active floats for which data processing has not yet been set up, these are not included in Figures 2 and 3.



Figure 2. Number of UK (including Mauritius) floats reporting data to Argo by month.

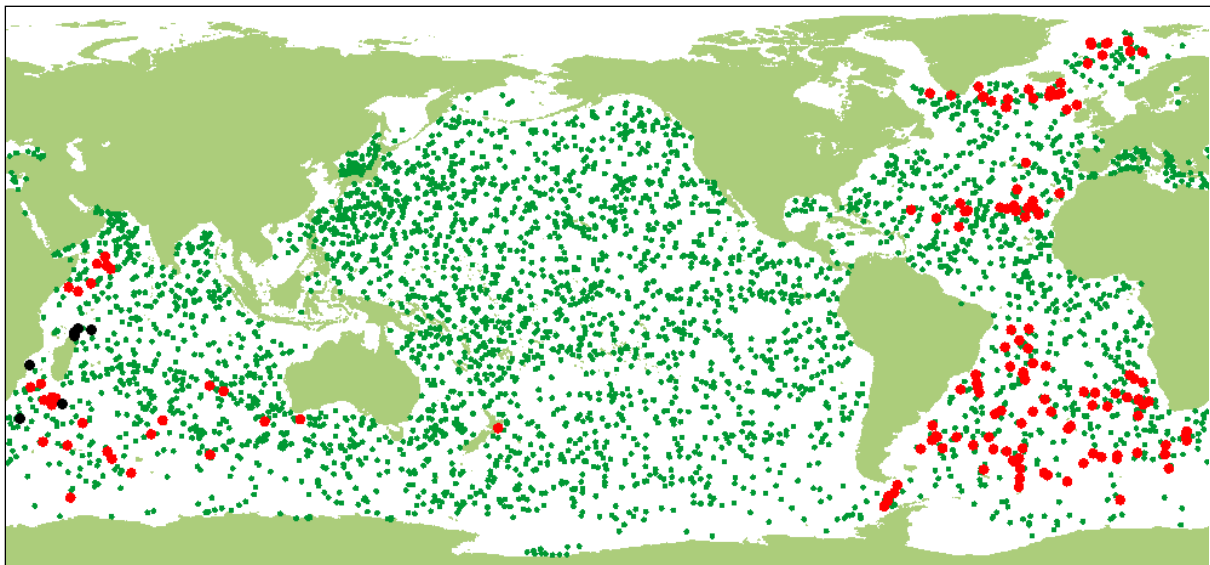


Figure 3. Showing the locations of operating UK floats (in red) and the six Mauritius floats (black) at mid-February 2015.

Float lifetime. The majority of UK floats deployed have been Webb Apex floats, which have seen a steady improvement in reliability (survival) since 2004 in terms of cycles completed, as shown in Figure 4. (Here the number of cycles has been normalised to 2,000m for floats that make shallower profiles, or only make intermittent deep profiles to 2,000m, where invalid profiles due to pressure transducer failure on pre-2004 floats have been discounted and deployment failures omitted.)

For floats deployed 2004-2006 only 66% of floats reached the target 4 year lifetime (140 profiles), whereas for 2007-2009 floats 69% reached this mark, with 14 floats (27%) having passed the 200 profiles mark with 3 still operating having made over 290 profiles. For floats deployed in 2010-2012, 88% have reached the 2 year (70 profile) mark.

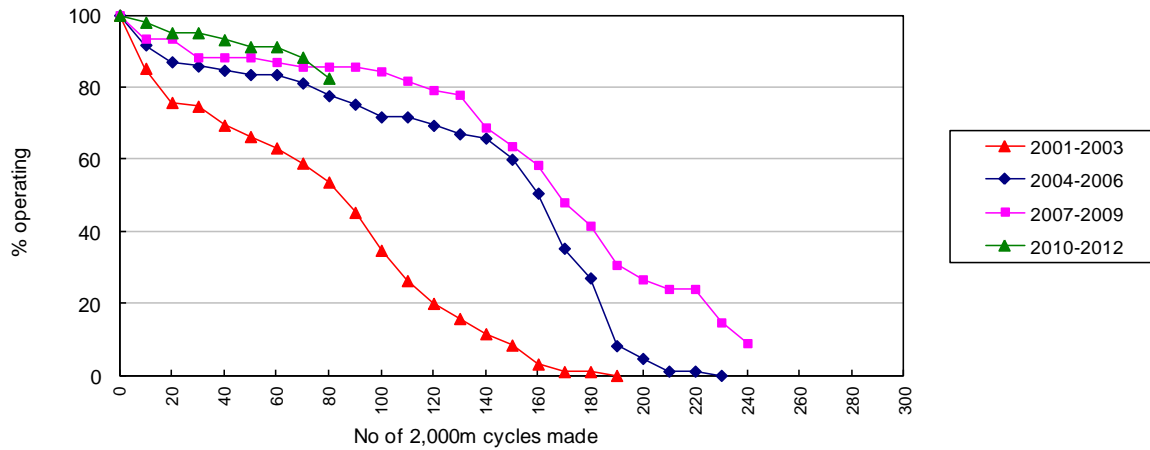


Figure 4. Number of (normalised) cycles made by UK Apex floats deployed in 2001-2003, 2004-2006, 2007-2009 and 2010-2012.

The extended (beyond the nominal 4 years) lifetime of our floats is also a result of fitting lithium batteries. From 2007 we have fitted lithium batteries in over 50% of Apex floats deployed. Figure 5 shows lifetime figures from AIC for our floats deployed since 2007. This clearly shows with alkaline batteries the longest living floats expire after 110 – 200 cycles (apart from one that has made 235 cycles), while with lithium batteries a significant number of floats are operating beyond 180 cycles.

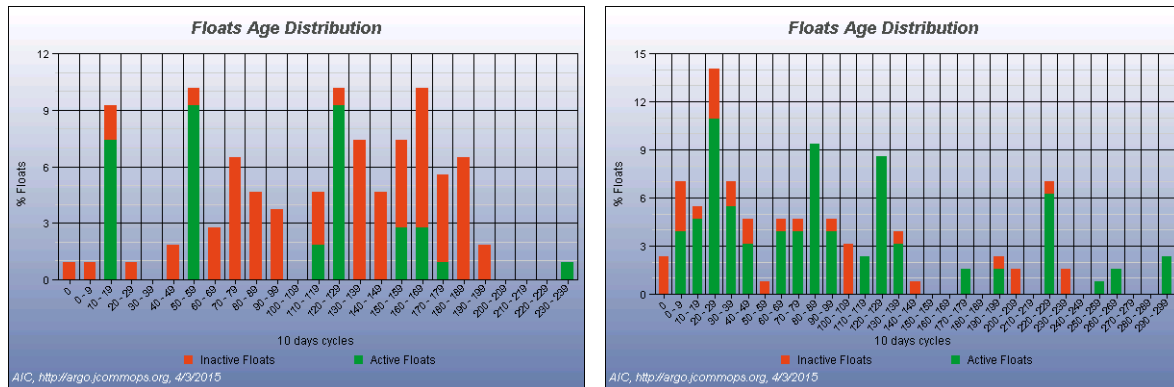


Figure 5. Number of cycles made by UK Apex floats deployed since 2007 with (left) alkaline and (right) lithium batteries. Note the horizontal scales are different.

**Float enhancements.** Following some early float losses in 2007 to ice damage, since 2008 all Southern Ocean floats have been specified with ice-avoidance capability. In 2008 our first Apex Argos floats with near surface temperature measurement capability (un-pumped measurements) were deployed and all our Apex Argos floats (other than those with ice-avoidance) now have near surface temperature capability.

Although the majority of our deployed floats use Argos for communications, we have deployed a number of Iridium floats: 17 Webb Apex, 4 Webb Apex BGC, 10 SeaBird Navis, 3 SeaBird Navis BGCi, 1 MetOcean Nova (provided free-of-charge by MetOcean) and 7 NKE E-AIMS BGC floats (including 5 funded by PML) and floats.

## Outline deployment plans for 2015

So far in 2015 we have deployed 6 floats (shown in Figure 3) in the Drake Passage and (at end Feb 2015) have around 45 Apex floats available for deployment, with a further 11 floats expected to be delivered before March. The available floats include 2 deep Apex (6,000m depth capability) equipped with SBE61 and oxygen sensors and 2 deep ARVOR (expected depth capability 3,500 – 4,000m) equipped with ruggedized SBE41 and oxygen sensors expected to be deployed later in 2015. In addition there are a further (PML-funded) 6 NKE bio-geochemical floats available to be deployed in 2015.

At present, outline deployments in 2015 are likely to include:

- 6 floats South Atlantic/Argentine Basin (Apr/May)
- 4-8 floats Rockall Trough/Iceland basin (May/Jun)
- 4-6 floats SE Atlantic (SA Agulhas, Sep)
- 4-10 floats S Atlantic (AMT cruise, Oct/Nov)
- 4-10 floats 26N (RAPID cruise) Nov/Dec
- 2-4 floats for Mauritius

Other deployments will be arranged as opportunities arise. The aim is to deploy around 40 floats during the year, including floats provided to Mauritius.

## Data management

The UK Argo Data Centre, established at BODC, processes all our float data (including the floats donated to Mauritius) and also Irish and Portuguese floats, 168 active floats in total including various Apex, Navis and Provor float models. Data from all UK floats are received at BODC by automatic download from the CLS database every 12 hours and BODC endeavours to set up floats for distribution of data to the WMO GTS (Global Telecommunications System) and the Argo GDACS (Global Data Assembly Centres) within a week of notification of deployment.

During the year to date, the challenge has been to sustain the core Argo mission processing while setting up the data system to handle the newer bio-geochemical floats, where the setup of data distribution from the Navis and Provor bio-geochemical floats is ongoing and expected to be complete by spring 2015. There has also been a complete rewrite of the processing software in readiness to the transition to the new V3 Argo NetCDF (Network Common Data Form) file format, which in turn should resolve some issues with the WMO BUFR (Binary Universal Form for the Representation of [meteorological] data) formatted data exchanged on the GTS.

All delayed-mode QC on BODC hosted floats is done within BODC, who use the OW (Owens-Wong) software with latest reference data available from Coriolis (CTD climatology and Argo profile climatology) for guidance. 70.0% of UK floats profiles eligible for delayed mode QC have been processed and submitted to the GDACs in D-mode. Addressing the backlog of delayed-mode QC is the priority after the transition to Argo V3.0 formats.

BODC works with three other organizations to operate the Southern Ocean Argo Regional Centre (SOARC) covering the entire Southern Ocean. Responsibilities are: BODC - Atlantic Ocean Sector, CSIRO - 'Australian' sector, JAMSTEC - Pacific Ocean Sector and the University of Washington - Indian Ocean Sector. BODC hosts the main SOARC data and information web pages ([http://www.bodc.ac.uk/projects/international/argo/southern\\_ocean/](http://www.bodc.ac.uk/projects/international/argo/southern_ocean/)).

## Scientific and operational use of Argo data

At the Met Office Argo data are assimilated into FOAM-NEMO (Forecasting Ocean Assimilation Model - Nucleus for European Modelling of the Ocean), see <http://www.metoffice.gov.uk/research/weather/ocean-forecasting>, which is the Met Office deep ocean forecasting system Blockley et. al. (2014)<sup>1</sup>, Lea et.al. (2014)<sup>2</sup>.

Argo data are also used in the GloSea (Global Seasonal) coupled model run by the Met Office to make seasonal forecasts for several months ahead. Seasonal forecasting is still an area in which the science is being developed. On longer timescales the Hadley Centre DePreSys (Decadal Prediction System) is being developed for climate predictions on decadal timescales, where the impact of Argo data on decadal climate forecasts has been demonstrated through idealised experiments. See <http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal>.

The Hadley Centre also maintains the HadGOA (sub-surface global analysis) dataset of historical temperature and salinity. The dataset includes available Argo data and will include near real-time updates using Argo data. The dataset is used for global ocean heat content analyses. For further information see <http://www.metoffice.gov.uk/research/climate/climate-monitoring/oceans-and-sea-ice>.

As part of the FP7 E-AIMS project work has been carried out to assess the impact of Argo data on coupled analyses and short-range forecasts and for validation of SST analyses.

## Funding

It was initially agreed in 1999 that MoD and DETR (then Defra and now DECC) would provide matching funding (through the Met Office) for UK Argo, and that NERC would also provide regular funding for support activities (e.g. data processing, science leadership) with additional capital funding for floats being provided on an opportunistic basis (e.g. via open calls for proposals). The matched funding agreement collapsed after MoD withdrew its funding in April 2010. Regular annual funding from DECC (ex Defra) to the Met Office has also reduced, although it has been supplemented in most years with year-end funding for floats. NERC has maintained regular, stable funding for support activities at NOCS and BODC, whilst funding for floats has remained variable relying largely on bids for NERC capital funds and year-end funds. Hence, the funding profile for UK Argo has exhibited large year-to-year variations.

For the period April 2012 to March 2015 the Met Office (Public Weather Service Programme) agreed to co-fund UK Argo with DECC and it is expected that a MoU for the coming year's funding will soon be agreed with DECC. This will only be for one year due to the impending government Comprehensive Spending Review in 2016. However the level of funding is not yet confirmed, so it is not known how much will be available for floats.

It is expected that NERC will continue to fund its Argo support activities at NOCS and BODC. The funding outlook for data management is good: on-going national capability support from NERC has been sustained and the European E-AIMS project is supporting the

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<sup>1</sup> Blockley, E. W., Martin, M. J., McLaren, A. J., Ryan, A. G., Waters, J., Lea, D. J., Mirouze, I., Peterson, K. A., Sellar, A., and Storkey, D.: Recent development of the Met Office operational ocean forecasting system: an overview and assessment of the new Global FOAM forecasts, *Geosci. Model Dev.*, 7, 2613-2638, doi:10.5194/gmd-7-2613-2014.

<sup>2</sup> Lea, D.J., M.J. Martin, and P.R. Oke. Demonstrating complementarity of observations in an operational ocean forecasting system. *Q. J. R. Meteorol. Soc.* 140: 2037–2049, July 2014 B DOI:10.1002/qj.2281.

development needed for Bio-Argo. In addition further resources are anticipated through funding provided under the EU AtlantOS proposal and DG-MARE funding (through Euro-Argo).

### **Euro-Argo**

Euro-Argo was formally established as an ERIC (European Research Infrastructure Consortium) on 12th May 2014 following notification in the OJEU (Official Journal of the European Union). UK is one of the founding members of Euro-Argo alongside Finland, France, Germany, Greece, Italy, Netherlands, Norway (Observer) and Poland (Observer).



## **USA Report to AST-16, March 2015. (Submitted by D. Roemmich)**

### ***Organization of U.S. Argo:***

The U.S. Argo Program is supported with major funding provided by the National Oceanic and Atmospheric Administration (NOAA), and additional participation of the U.S. Navy. It is implemented by a U.S. Float Consortium that includes principal investigators from six institutions: Scripps Institution of Oceanography (SIO), Woods Hole Oceanographic Institution (WHOI), the University of Washington (UW), the Atlantic Oceanographic and Meteorological Laboratory (AOML), the Pacific Marine Environmental Laboratory (PMEL), and the Naval Research Laboratory (NRL/Monterey). Float technology development, production, deployment, array monitoring, and data system functions are distributed among these institutions on a collaborative basis.

In addition to U.S. Argo floats, Argo-equivalent floats have been provided from a number of U.S. float groups, programs, and principal investigators. A notable new U.S. Argo-equivalent program is Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM). SOCCOM, with support from the National Science Foundation and in partnership with U.S. Argo, will deploy about 200 floats equipped with biogeochemical sensors in the Southern Ocean in the coming 5 years. The contributions of all Argo-equivalent partners are gratefully acknowledged.

The present 4-year cycle of U.S. Argo implementation began in July 2011, and extends through June 2015. A new 5-year Work Plan for the period July 2015 – June 2020 has been submitted and favorably reviewed.

### ***Objectives:***

During the next 5-year cycle, U.S. Argo will sustain the present contribution of over half of the Argo array while enhancing coverage on a regional basis (high latitudes, western boundary and equatorial regions, marginal seas) as recommended through ocean observing system community activities and endorsed by the AST. These coverage enhancements will only be implemented if sufficient resources are available to maintain the coverage and quality of the original Argo array. Further improvements in data quality, timeliness, and resolution are planned, along with ongoing extensions to float lifetimes and cost-effectiveness.

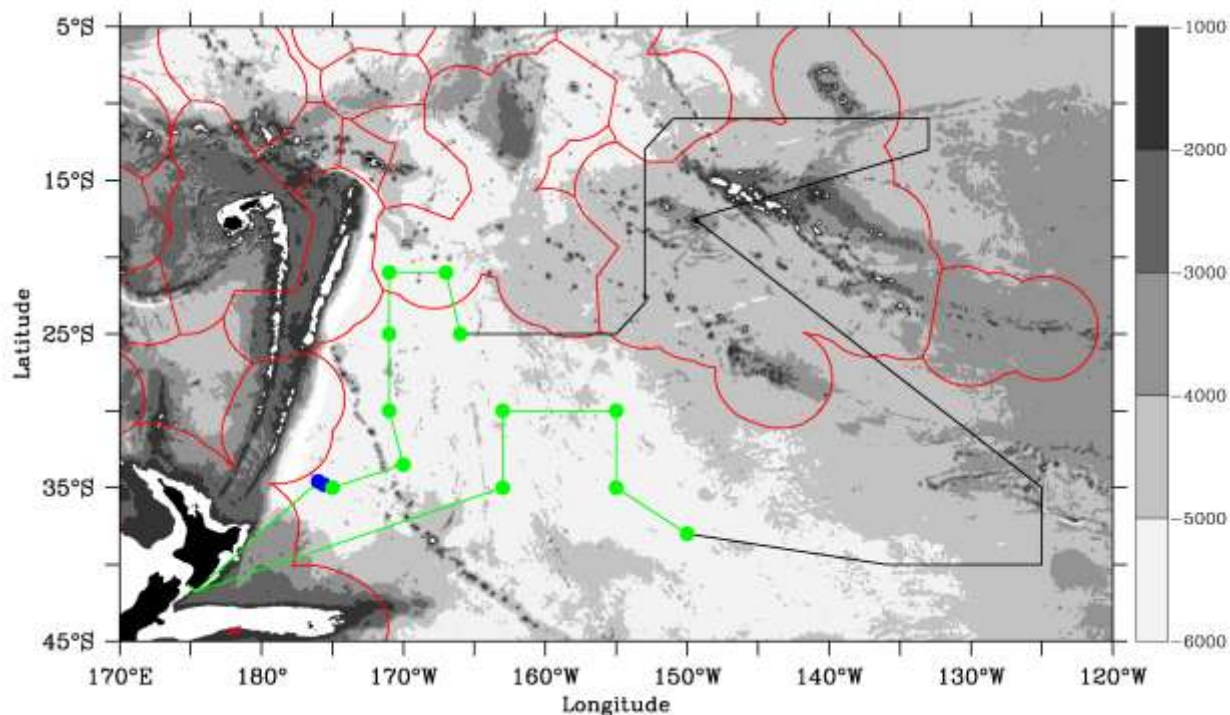
A major enhancement to Argo is the implementation of Deep Argo to extend sampling to the ocean bottom (up to 6000 m). As a key component of the Deep Ocean Observing Strategy (DOOS), Deep Argo is needed to close regional and global budgets of heat, freshwater, and steric sea level, and for exploration of deep ocean circulation. Following two further years (2015 – 2017) of pilot deployments in regional arrays to test floats and sensors and to aid in global array design, U.S. Argo proposes to produce and deploy approximately 100 Deep Argo floats annually, to be integrated with planned contributions of international partners.

### **Support level:**

The support level for U.S. Argo in the coming 5-year cycle is not yet confirmed. Support levels have remained approximately flat since 2004, when 396 U.S. Argo program (i.e. not including Argo equivalent) floats were deployed. Inflationary erosion has lowered the number of yearly deployments, to an average of 346 floats per year for 2012–2014 U.S. Argo deployments. However, due to increases in the mean lifetime of floats, and with contributions from Argo-equivalent programs, the number of active U.S. floats has increased by about 15% since late 2010.

Support for U.S. Argo includes float production and deployment, technology improvement, communications, data system development and implementation for real-time and delayed-mode data streams, and participation in international Argo coordination, Regional Centers, and outreach activities.

Beginning in 2011, U.S. Argo began development and testing of Deep Argo floats. These instruments will profile to pressures as great as 6000 dbar, and be capable of more than 100 cycles. Deployment of prototype floats has begun, including 2 Deep SOLO instruments that were deployed in June 2014 by RV Tangaroa. These floats have completed about 65 profiles each, to depths of about 5700 m. A multi-national (N.Z., Australia, U.S.) Deep Argo deployment cruise is planned for August 2015, including 10–12 Deep Argo floats in a regional pilot array in the SW Pacific Basin. U.S. Argo will also be a sponsor of the Deep Argo Implementation Workshop in May 2015.



*Fig 1 RV Kaharoa cruise plan, August 2015, for deployment of 10–12 Deep Argo floats (green dots, all > 5000 m depth) and recovery of 2 others (blue dots) in the SW Pacific Basin.*

**Status:**

As of March, 2015, there are 2118 active U.S. Floats (source AIC) and these have completed an average of 129 cycles. Of the active floats (Fig 2), 1900 are provided by U.S. Argo and 218 by partnering Argo-equivalent programs.



Fig 2 Positions of 2116 active U.S. floats (green dots) as of January 2015.

The highest priority for U.S. Argo is to sustain the core global Argo array. Specific plans for float deployments in 2015, as they evolve, are posted on the AIC deployment planning links. A major U.S./New Zealand/Australia deployment cruise from New Zealand to Mauritius and back was carried out in late 2014 on R/V Kaharoa, adding 121 floats, mostly in the South Indian Ocean.

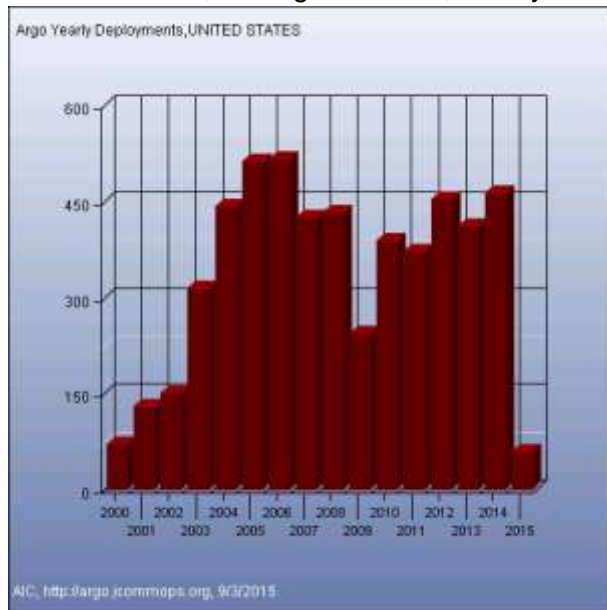


Fig 3. Yearly deployment of U.S. floats, including Argo-equivalent. (Source: AIC)

The U.S. Argo Data Assembly Center is based at NOAA/AOML. Real-time data from all U.S. Argo floats are transmitted via the GTS. GTS transmission uses parallel systems developed at AOML and housed at AOML and at Collect Localisation Satellites (CLS), implementing internationally-agreed quality control tests. The AOML data center serves as the national focus for data management and is the conduit for delayed-mode data to pass between the PIs and the GDACs. During 2014, processing of delayed-mode files continued but was slowed somewhat by adoption of new file formats.

In addition to the national DAC, a Global Data Assembly Center (GDAC) is run as part of the GODAE server, located at the Naval Research Laboratory, Monterey. The two GDACs at NRL/Monterey and IFREMER/Brest are mirror images in their assemblies of Argo data from all international partners, and are responsible for dissemination of the data. Several U.S. institutions participate in Argo Regional Center activities, including AOML's role as focus for the South Atlantic ARC.