15th meeting of the
International Argo Steering Team

Halifax, Canada
March 18-20, 2014

Contents

1. Welcome and Introduction

Jim Hanlon from the IORE welcomed everyone to the AST-15 meeting in Halifax, Nova Scotia in Canada. He mentioned that there were several hundred oceanographers in the local area at both Dalhousie University and at the Bedford Institute. He praised Argo for its contributions to oceanography and wished a productive exchange with commercial partners.

Action item 1: Write letter of thanks to local hosts Denis Gilbert, Jim Hanlon, Marlon Lewis, Cheryl Evans-Crowell. AST co-chairs

2. Objectives of the meeting

The objective of the meeting was to improve coordination and communications, within Argo and with commercial partners. H. Freeland opened the discussion with the commercial partners by noting this was the first time such partners had been invited to a Steering Team meeting. E. Petzrick from Teledyne Webb Research said he came from a background where industry days occurred frequently and he welcomed the chance to interact with the Steering Team. He requested guidance on what the Steering Team was looking for in floats in the next several years to decade and would like the information to be posted some place where it could be referred to over time. In response to this, D. Roemmich stated that Argo would like to optimize the cost per high quality cycle. A long lived float is wonderful, but if the cost per cycle is high, it becomes difficult. As a reminder, the cost per cycle for Argo also includes communication costs which can be quite high depending on the situation and potentially the cost to develop a new decoder at the DACs. For more on the costs from decoders, look later in this section. Related to what Argo wants in floats, it was mentioned that several AST members look at float survival statistics by float type to help them decide what types of floats to purchase.

Several manufacturers were interested in what the future of Argo floats might look like and what type of sensors might be on Argo floats in the future. S. Riser referred the commercial partners to the OceanObs'09 White Paper (http://www.oceanobs09.net/proceedings/cwp/Freeland-OceanObs09.cwp.32.pdf) which included a list of possible Argo extensions over the next five to ten years. Deep Argo was mentioned and the question was raised as to whether there was a CTD capable of going to 6000m for floats. N. Larson from SeaBird said they are building the SBE61 which is made to go down to 7000m. The idea is to make a CTD that will perform at WOCE level for the life of the float. SeaBird feels that right now the temperature measurement is at that level. There are some issues with the conductivity, but they think they understand how to solve these issues. Finally, they are working with a Swiss manufacturer to solve some pressure issues. He ended by saying that it will be possible to integrate an oxygen sensor to the SBE61 CTD.

It was suggested that scientists involved in Argo attend the Oceanology International conference where many of these commercial partners go and explain their products. Unfortunately for many scientists within Argo, this is not possible due to funding restrictions.

Greg Johnson from RBR mentioned that they have developed a CTD which will be available on both APEX and NOVA floats shortly.

H. Claustre mentioned that sensors for biogeochemical Argo are expensive and to offset this cost, the floats need lots of energy capability. He asked for the float manufacturers to provide energy budgets on their floats and the software to adjust them, if needed, to increase longevity of the float.

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

Several AST members stated that Argo is trying to do climate science and that sensor stability and accuracy over a float's lifetime are important. The manufacturers were asked how they ensured the quality of the sensors and parts included in a float. In response, the manufacturers suggested the AST create a list of "Argo approved" sensors which can go in floats.

B. King stated that the actual cost of putting a float in the water included not just cost of the float, but also the costs of creating a new decoder for that float if necessary. For example, there are over 100 decoders at the Coriolis DAC and 168 at the AOML DAC. It was requested that manufacturers think about this when making changes to the float that involve new decoders. One manufacturer stated that perhaps a decoder should be part of the package when buying a float. Another manufacturer responded by stating that changes were requested by the scientist and they were simply responding to that request. S. Riser then agreed that he requested many such changes which resulted in lots of decoders. Still it was suggested that float manufacturers keep this in mind when making a change requiring a new decoder. Another scientist suggested providing a decoder with a float. It is also very important to track changes made which result in new float versions. For more on both of these issues, refer to section 6.1 of the meeting report.

S. Wijffels ended the discussion by thanking the commercial partners for their comments and stated that the AST is still thinking about how better to interact with them. She offered that the AST could help commercial partners organize technical workshops around sensors, float types, etc.

Action item 3: AST can help manufacturers organize technical workshops around sensors/float types/etc. If interested, contact an AST member. Manufacturers

Action item 4: Circulate follow up email to manufacturers who attended AST-15 confirming offer to help organize technical workshops. Alert them to next Argo Science Workshop. AST co-chairs.

Action item 5: Update technical mailing list through the AIC as a way to communicate with manufacturers. M. Belbeoch

3. Action items from AST-14

M. Scanderbeg reported on action items from AST-14 that were still pending. It was noted that the English version of the Argo Wikipedia page was complete and that now we need AST members from different countries to volunteer to become Wikipedia editors and translate the page into their own language. Several AST members agreed to look at this.

Action item 6: Identify AST members to become Wikipedia editors to translate Argo Wikipedia page into non-English languages. T. Suga, B. Klein, L. Zenghong, Euro-Argo

Additionally, there were a couple action items related to educational outreach that had not been completed. M. Belbeoch proposed holding an educational outreach workshop next year in coordination with the AST-16 meeting to further this agenda. People in Argo interested in educational outreach, local educators, UNESCO members and others will be invited to the meeting to discuss ideas like adopt a float, improving the Google Earth layers, developing curriculum, and other items related to Argo and education.

> **Action item 7:** M. Belbeoch, H. Freeland, and M. Scanderbeg to investigate holding an Educational Outreach Workshop in conjunction with the AST-16 meeting in Brest, France.

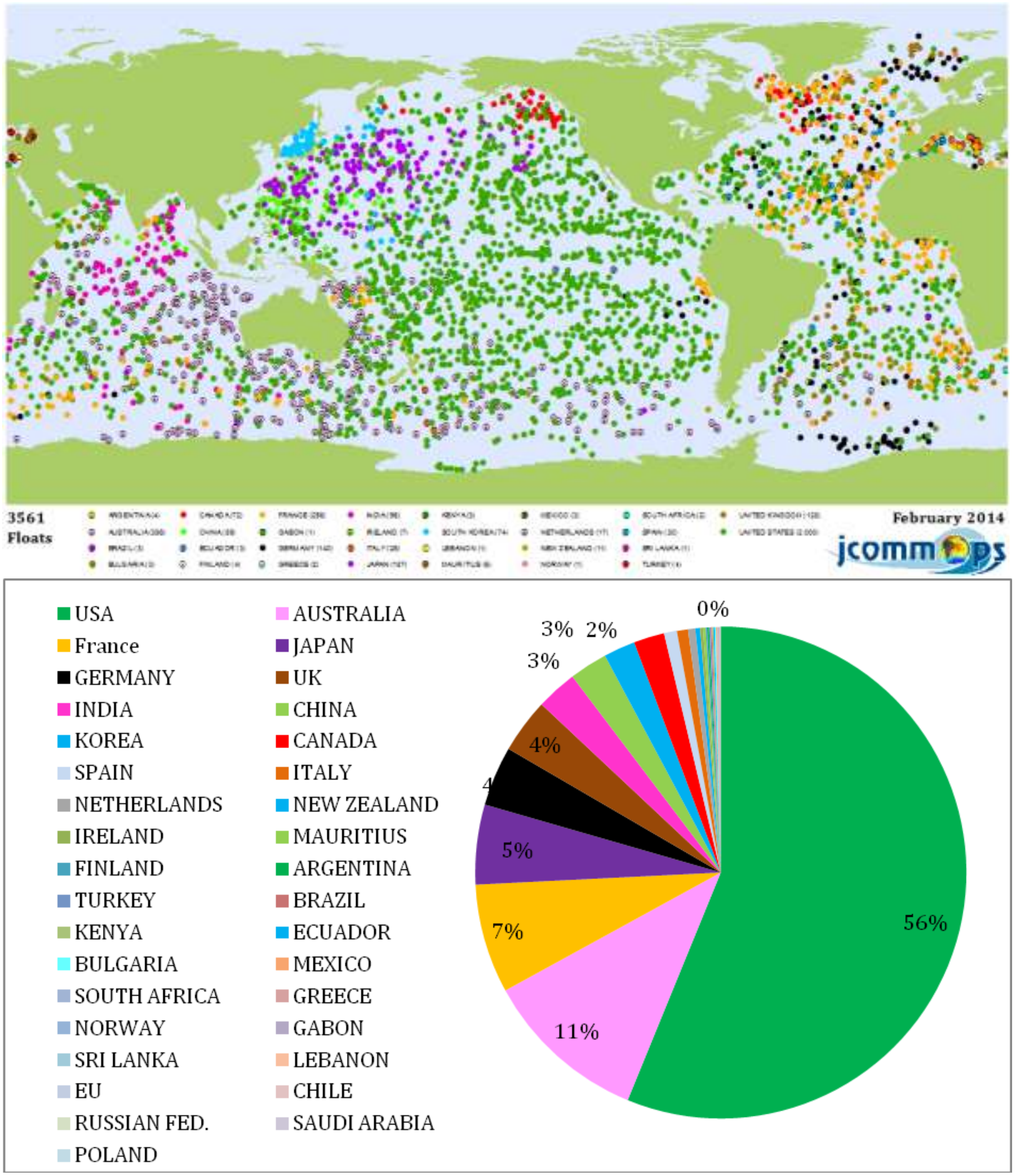
Another unfinished action item from last year dealt with missing Argo focal points. For some countries, having these Argo focal points is extremely important. Several methods were discussed to try and locate focal points in various countries. There was no consensus on how to do this easily. One thing that could be addressed was asking AST members to ensure their country had an Argo Focal Point.

> **Action item 8:** Ask AST members to ensure their country has an active Argo focal point. AST members.

4. Implementation issues

4.1 Status of Argo

The Argo Technical Coordinator, Mathieu Belbeoch, presented the Argo status from the Argo Information Centre perspective. Argo is currently and actively implemented by 30 countries, with a dozen of critical national programmes maintaining 95% of the array.



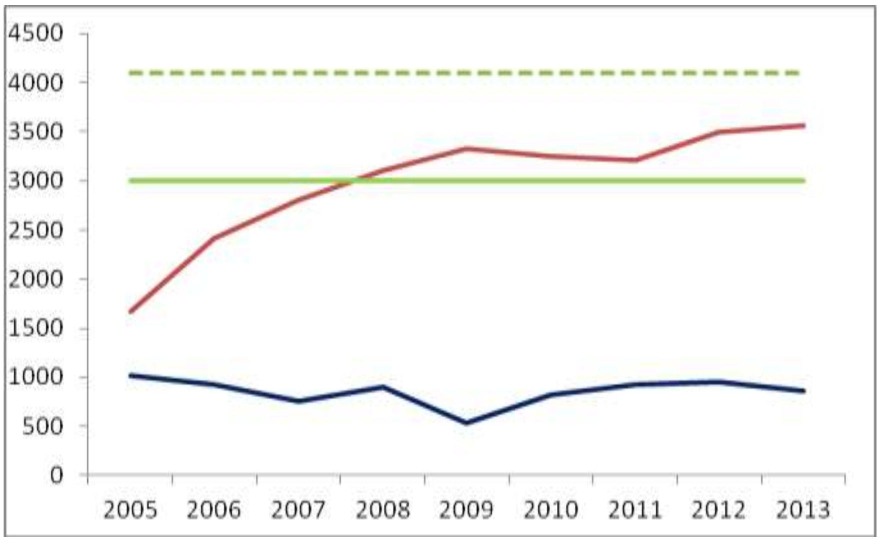
The international Argo cooperation

A number of new national initiatives or donor programmes are gradually showing progress: Brazil, South Africa, Mexico, Indonesia, Russian Fed., Vietnam, Oman, Turkey, Maghreb, Lebanon.

TC asks the AST if an increase of 10-20 % of national budget would be possible to reach the global target (still to be defined). He recalled that if donor programmes are important to e.g. foster participation on the long run of new countries, communicate to coastal states people, access maritime zones, enhance international political support to the program, or raise educational activities, such initiatives can also take ages to succeed.

The AIC/JCOMMOPS will continue to seek funding and floats to contribute to the global target and foster international cooperation. Possibilities with industrial partners, foundations, sponsors, sailing world, crowd sourcing are today under exploited.

Some performance indicators for the array were then presented. The initial Argo design was sustained for seven years, with more than 3500 active units the last two years, and Argo is at mid-way to the global.

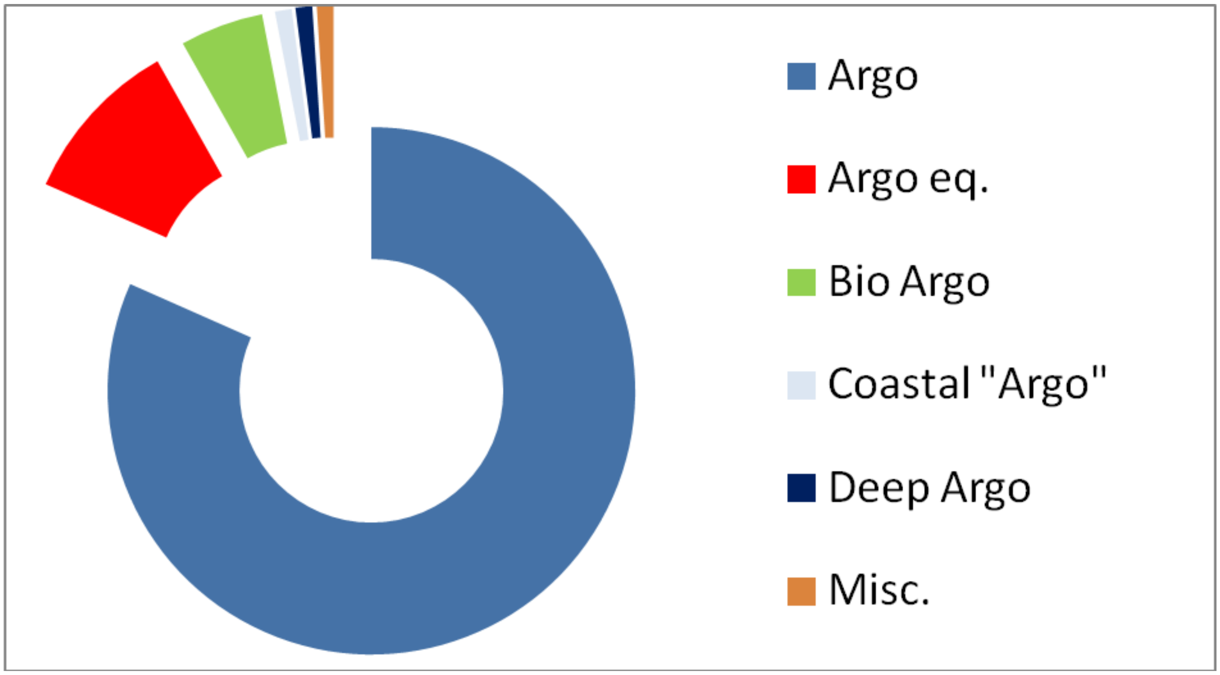


Argo targets (green), active floats (red) and yearly deployments (blue).

TC presented a number of charts on national contributions and showed that decreases of some national contributions are balanced by increases of some others.

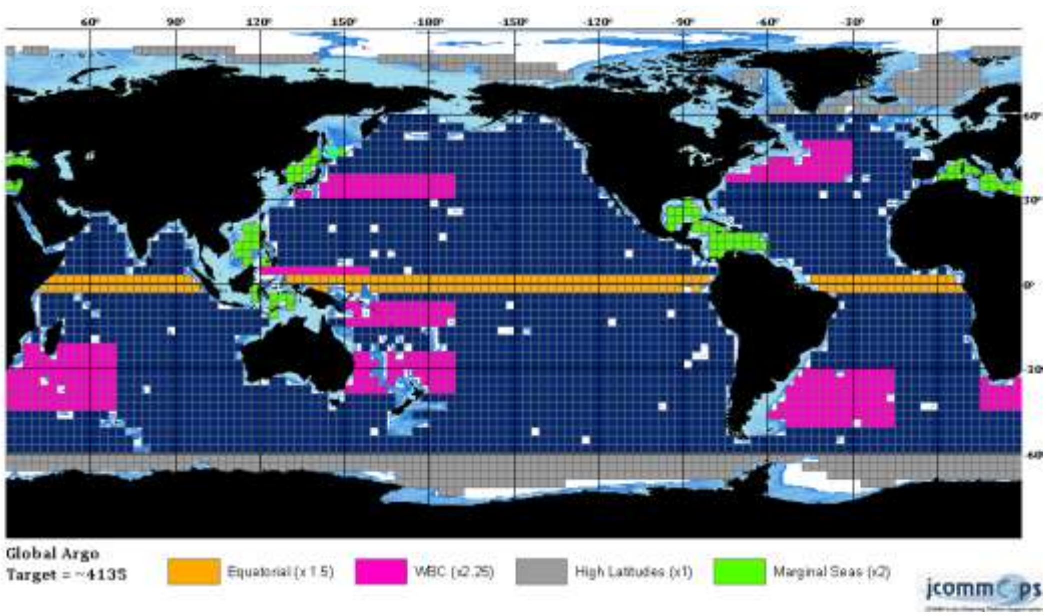
He addressed the question of diversification of the Argo array (BGC floats, ice tethered profilers, coastal or deep floats, acoustic floats, engineering floats, Alamo floats with new CTD sensor, etc) and suggested that such diversification would be acceptable while securing: i) the free data exchange, ii) the resources required, in particular for data management, iii) the data quality (flags) and iv), certifying the "official Argo" floats amongst this diversity through appropriate metadata attributes.

For the future, he proposed building on the "Argo label" (official Argo sticker provided by manufacturers) , to add a charter for new float customers so that we can certify what is Argo, and also welcome and assist new float users, and promote best practices. Argo has experience with setting up models for data exchange that can be shared with others. By growing its user's community it has certainly more to gain than to lose.



~20% of the Argo array is "non core Argo".

TC discussed then the need of performance indicators, in particular in the context and gradual work on the future global Argo design



Draft global Argo design to be refined, in particular in marginal seas.

He recalled that it was not anticipated to populate each box of such gridded target with a float but rather to measure the evolution of indicators in time, through routine calculations and spatial analysis, and global or regional perspectives.

BASIN	Boxes	Initial design	Global	Active	(%)	(%)

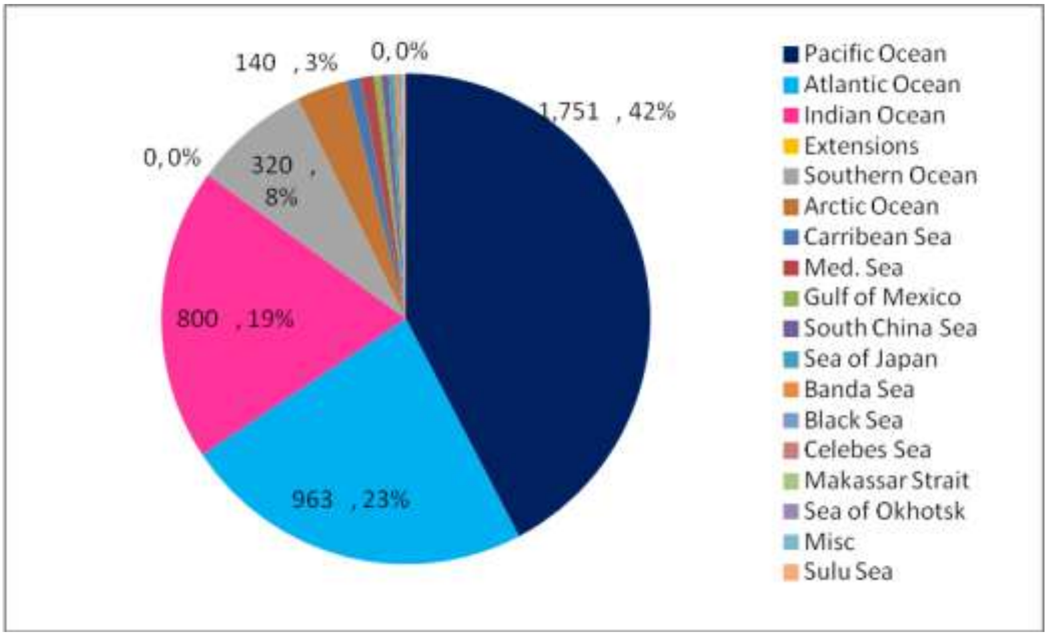
		requirements	design requirements	Floats	initial	global
Initial Design	2952	2952		2970	**101**	**101**
Pacific Ocean	1530	1530	1 751	1671	109	**95**
Atlantic Ocean	757	757	963	729	96	**76**
Indian Ocean	666	666	800	889	133	**111**
Extensions						
Southern Ocean	320	0	320	115		36
Arctic Ocean	140	0	140	63		45
Carribean Sea	19	0	38	4		11
Med. Sea	18	0	36	34		94
Gulf of Mexico	10	0	20	8		40
South China Sea	10	0	20	3		15
Sea of Japan	8	0	16	36		225
Banda Sea	5	0	10	0		-
Black Sea	3	0	6	5		83
Celebes Sea	2	0	5	1		22
Makassar Strait	2	0	4	1		25
Sea of Okhotsk	2	0	4	0		-
Sulu Sea	1	0	2	0		-
TOTAL Global Design	**3493**	**2952**	**4 135**	**3559**		**86**

Summary of initial and global Argo targets (see AST meeting website for full table and additional charts)

The performance indicator shows that, with regard to the number of operating floats, the initial design is achieved, and achieved as well in each basin. The array enhancements implementation is well started; ~600 floats are operating outside this initial design, and 600 more are necessary to meet the global design requirements.

It was suggested by the AST to show clearly this difference on the AST homepage, by providing an appropriate map and legend.

Such table shows as well an excess in the Indian Ocean (but not where needed) and a deficit in the Atlantic Ocean. The Pacific Ocean is particularly well implemented.



Requirements (float number; % to the total), per basin, for the global design.

BASIN	Boxes	Initial design requirements	Global design requirements	Active Floats	(%) initial	(%) global
Marginal Seas	80	0	160	92		**58**
Polar	460	0	460	178		**39**
WBC	384	384	864	454		**53**
Equatorial	162	162	243	154		**63**
TPOS (15N/15S)	494	494	598	558		**93**

Status and targets for some array enhancements or regions.

On the same principle, we can calculate the number of units to be deployed each year in each area, and compare it to the practices, considering a 4.1 years (150 cycles) lifetime for the instruments.

In theory, Argo needs to deploy 1000 units per year to reach this global target (720 for the initial target). So Argo need a ~20% increase in resources.

No important misbalance was detected through this indicator, but TC pointed out that: the Indian Ocean is “living on its reserves“ and has a recurrent deficit in yearly deployments. The Atlantic Ocean has a starting deficit but an excess in yearly deployments. Transfers between both basins that need to be studied further are certainly balancing the total.

TC presented then a set of metrics on the historical deployments, showing the challenges in logistics and EEZ access. He compared finally the practice in 2013 in filling up gaps identified a year earlier.

He mentioned that some areas were implemented without clear gaps identified, which resulted in an oversampling in these zones in 2014.

A new indicator could then be calculated doing the sum of all individual cells status, considering a year of observations, active floats and active aged floats (weighted by the probability to survive a year).

While all agreed this indicator would be impossible to complete, and not appropriate for communicating outside the AST, ¾ of the array that worked optimally in 2013 is not a bad result. The Pacific Ocean is better than the other basins.

It will be interesting to track this metric in time, on a regional basis, and do the sums on a 6x6 grid rather than on a 3x3.

BASIN	**(obs/2013) (%)**	**(active floats) (%)**	**(active /age) (%)**
Initial Design	**73**	**59**	**49**
Pacific Ocean	63	54	45
Atlantic Ocean	51	42	37
Indian Ocean	55	43	37
Extensions			
Southern Ocean	20	25	22
TOTAL Global Design	**53**	**44**	**38**
Marginal	40	23	20
Polar	23	27	23
WBC	24	23	19
EQ	40	36	32

Spatial distribution indicators

Beyond the need to increase density in WBC or equatorial regions, some large gaps are developing in the SW Indian Ocean (and piracy zone), in the Central North pacific, and in the South Atlantic.

TC welcomed the planning information sent by all AST members, and suggested to refine some of these. TC recalled that the new JCOMMOPS ship coordinator was at available to find opportunities, and suggested to send floats outside of areas of routine scientific interest and routes, and set up dedicated chartered cruises.

TC finally presented a few statistics on float models, telecommunication system (60% Iridium vs Argos for yearly deployments) and float lifetime. After a continuous improvement of the float technology from 2000 to 2006, the reliability is decreasing slightly with a particular problematic year in 2012. The average statistics are good because 50% of the floats go beyond the 150 cycles. But we still have many early failures: 10 to 20% die before cycle 50.

Argo Survival Rate, per float generation *(see full excel table on AST 15 meeting website).*

During the discussion following M. Belbeoch's report, S. Wijffels raised two important issues. The first was how Argo will track the scientific utility of the Argo array and the second was how to convey the message that even though there are over 3500 active floats, the initial design has not yet been completed. See further discussion on the tracking of the Argo array in section 12.

The issue of Argo labels was discussed again at the meeting. It was suggested that float manufacturers notify M. Belbeoch if they are unsure if a scientist is part of Argo before applying an Argo float label. The Argo float label implies the float is part of the Argo program and the data sharing policy. Mislabeled floats can be dangerous to the Argo program if they do not follow the guidelines set in place for data distribution. Additionally, if this is a new scientist who wants to be involved with Argo, after being notified, M. Belbeoch can help the scientist become more integrated into Argo.

Links to tables showing the breakdown of Argo instrumentation and Argo indicators can be found on the AST-15 Agenda page at: http://www.argo.ucsd.edu/AcAST-15_agenda.html

> **Action item 9**: PIs consider using M. Belbeoch's text file format to update deployment plans. PIs who deploy floats.

4.2 Update commitments table

M. Scanderberg presented the commitments table. Close to 800 floats were deployed in 2013 which was just slightly under the estimated amount which indicates a good ability to predict deployments for 2014. Almost all countries had reported estimated deployments prior to the meeting, including separating out Argo from Argo equivalent floats. This year, close to 700 Argo floats and almost 140 Argo equivalent floats are estimated to be deployed bringing the total number of floats to over 800.

4.3 Float deployment opportunities

Argo has the challenge to deploy 1000 units per year. It is a continuous and intense effort for the Argo teams: planning cruises, preparing and shipping floats, clearing custom, etc. All these are subject to changes, float delivery, funding rhythms, and various problems. A global array can't be maintained using the same lines and we start to see accumulation zones.

On the other hand, some areas are still to be sampled after 12 years of Argo. The development of co-operations at sea using synergies between GOOS/JCOMM programs will be crucial.

The AST can now count on a dedicated resource at JCOMMOPS, at no direct cost, to help deploy, recover, or service an instrument anywhere in the ocean.

In addition to this focal point, a global cruise information centre is being developed and innovative solutions are being strengthened with a long run vision (10 years).

The justification, paperwork, money engineering, negotiations, and recruitment process were fully driven by the Argo TC. The AST should not hesitate to ask the JCOMMOPS ship coordinator help that will share its activities between i) technical coordination for the SOT and GO-SHIP initiative, ii) general Ship-time service and cruise information management, and iii) cross-sector JCOMMOPS tasks (cooperation, training, communication).

After a year of activity, the Ship TC was immediately operational and productive, and has shown an excellent team spirit. He met key actors in the community, finalized and initialized partnerships with RV focal points, charters, sailing and industry communities.

Argo TC presented then the various opportunities to deploy instruments (see talk) handled by JCOMMOPS. All approaches with the sailing community (charter, rally, race, NGO, individual) have different pros and cons, but all have been established with high enthusiasm, and all were successful or are still underway. A new element is that JCOMMOPS encourages these new actors to fund the instruments. The 2014 Barcelona World Race will be particularly interesting to follow as each one of the 15 ships anticipated will carry and deploy an instrument between Capetown and Perth (by 55° South, filling up important gaps in South Indian Ocean). In addition to the operational efficiency of such opportunity, the educational and outreach value is very promising.

The Lady Amber was upgraded by the Prolarge company to a certified professional and secured charter (including insurance for cargo), with a still optimum pricing strategy. TC urged the AST to commit resources to send the ship and crew at sea and keep operating a golden opportunity in which JCOMMOPS invested a lot of effort. JCOMMOPS recalled it could add resources from its budget (~1 month ship time) to make the cruise more valuable for the community. While JCOMMOPS will continue be creative to support Argo and other in-situ observing programmes, the academic cruise plans, together with all other opportunities will be soon all centralized at JCOMMOPS, and available through the new web services.

Contact mkramp@jcommops.org for any operational questions.

4.4 Tracking progress on original mission

Wijffels and Belbeoch lead a discussion on how to clearly communicate progress towards Argo's still currently accepted original goals. The fact that Argo has over 3500 active floats can lead to the belief that we are oversampling the ocean, while the reality is that most of the 'extra 500' floats are actually operating in pilot extensions, such as the seasonal ice regions, marginal seas and western boundary current regions. To help communicate this important subtlety, it was suggested that maps presented on both the AIC and AST sites be developed that mark and talley floats operating in the original mission areas and those operating in other areas.

Action item 10: S. Wijffels to work with M. Scanderbeg and M. Belbeoch on some simple changes to the existing Status Maps. Changes might include offering two plots – one for Original Argo and one for Global Argo. S. Wijffels, M. Scanderbeg, M. Belbeoch

4.5 Sparseness maps

P.E. Robbins reported on new maps he has created based on sparseness which provides a helpful index for examining the coverage of the Argo float fleet. In this case sparseness is defined as the average distance to the four nearest floats and is a proxy for the question, "For any place in the ocean, how far away, on average, is the closest Argo float?". Maps of sparseness for the global ocean as well as numerous sub-basins are available at http://argo.whoi.edu/maps/sparse/index.html and will be updated on a bi-monthly basis. One advantage of sparseness over usual density measurements of Argo float coverage is the ability to examine coverage of the Argo fleet at smaller spatial scales.

Integrating the sparseness index over the global ocean yields an estimate of the fraction of the ocean which is adequately sampled by the Argo floats. The integrated coverage shows a rapid increase in the initial years of the Argo float program but has been relatively constant since 2008. Based on the sparseness metric, approximately 70% of the ocean (deeper than 1000 m, excluding Arctic and south of 60°S) is covered at the target Argo density of one float per 100,000 square km (sparseness index = 316 km).

4.6 AIC funding

Contributions were received during 2014 from 10 countries. Thank you to all who contributed to support "the Argo Infrastructure". The various national contributions were routed through three agencies:-

1) WMO received the most funds and charges an overhead of 7%
2) IOC received funds from the most countries and charges an overhead of 10%
3) CLS charges no overhead, but eventually if funds need to be transferred from CLS to either the IOC or WMO to be used then an overhead is charged at that point.

For any country that is considering supporting the Argo Information Centre but has administrative difficulties, please think about using the CLS route. Howard Freeland is willing to offer advice on how this might work on a case by case basis. This mechanism requires the least paperwork.

H. Freeland stated he was greatly disturbed that it has been three years since he was able to reconcile accounts with the IOC and WMO, the agencies that host the Argo Information centre. Personal record keeping is done, but these will progressively diverge from the truth. Last year, it was reported that Argo started January 2013 with enough cash on hand to run the AIC through 2013. Since then, it is unclear exactly how much money was contributed and what was withheld by the IOC and WMO. However, estimates of other costs including office and travel are pretty well known. Therefore, the conclusion is that during 2013 income exceeded costs very slightly. Even so, three years since the last financial reconciliation with the hosting agencies is too long and there may well be some surprises in the budgets that we are not aware of.

There seems to be some support within the IOC and WMO to develop a coordinated accounting for the AIC, and this would be a very good thing to happen. However, this promise has been made several times in the past.

Action item 11: If needed, H. Freeland to work with IOC, WMO, and CLS to reconcile AIC finances

4.7 JCOMM Observing Program Support Centre

M. Belbeoch reported on the status of the JCOMMOPS centre development and announced that the structure will be reestablished in Brest, within Ifremer, by the end of 2014, with 5 permanent staff finally regrouped, a new set of products and services, clarified governance and increased means.

In particular Brest and Bretagne local authorities have committed to support financially the center for 3 years at the level of 100keuros /year. The TC explained the 3 years strategy and milestones that led to this positive result, welcomed by the AST. Some more resources are also expected from European Union (EuroArgo, Seadatanet, AtlantOS) which will permit to sustain these increased means.

He recalled briefly JCOMMOPS mandate and activities to the AST, and latest news about staff change. JCOMMOPS is studying the possibility to set up a coordinator position for gliders.

As recognized at the last JCOMM OCG meeting, September 2013, the Argo Technical Coordinator is also ensuring key managerial functions for the office (~30%). He recalled that this working time dedicated to the centre development was also to be considered as a support to Argo.

He presented the prototype of the new JCOMMOPS websites, including for Argo, developed via two students, one engineer, and subcontracts, with a first version to be released in September. The recalled the partnerships established in I.T. domain or ship operations, the development of a strategy to get sponsoring (and bring new floats in the array). JCOMMOPS is as well modestly encouraging some educational initiatives around Argo, with IOC and UNESCO support, and TC proposed to host a first meeting in 2015 in Brest/Oceanopolis, following up on the AST16. Strong synergies will be developed between the centre and its immediate neighbors (Coriolis and Euro Argo teams will be in same building). JCOMMOPS is now well connected to local deciders and opportunities will certainly come beyond this financial support.

4.8 Atlantic Observing System

P.Y. Le Traon, H. Claustre and S. Pouliquen informed the AST on the development of US/Canada/Europe cooperation for the Atlantic Observing System and implications for Argo and Euro-Argo. The EU, USA and Canada have launched a high level political initiative on Atlantic Ocean cooperation "Galway Statement on Atlantic Ocean Cooperation". As a result, the EU opened a series of calls for proposals and, in particular, one call for developing in-situ Atlantic Ocean Observations. An EU consortium was set up and a proposal (Atlantos) is being prepared. There is one Argo task in Atlantos which is led by the Euro-Argo ERIC. The objective is to contribute to the progressive extension of the Argo core mission towards the deep ocean and biogeochemistry. Interaction/coordination with non-EU partners (in particular US and Canada) planning Bio-Argo and deep-Argo activities in the Atlantic is essential. The two main activities will be to organize the deep Argo and Bio-Argo Atlantic pilot experiments (2015-2019) and to develop long term implementation plans. International partners (in particular Bio Argo and Deep Argo PIs) will be contacted in the coming weeks to check that they are willing to contribute to Atlantos and be formally identified in the list of Atlantos international partners.

4.9 Bio-Argo/Biogeochemical Argo

S. Riser gave a presentation on the work he has been doing with Biogeochemical (BGC) floats as part of Argo. He showed a plot with the positions of over 200 Argo floats carrying dissolved oxygen sensors and several other floats with bio-optical, nitrate and pH sensors on them. A breakdown of the costs associated with a BGC float showed that the nitrate sensor was quite expensive, but that the oxygen sensor was not too much of an additional cost. With all the extra sensors, a fully loaded BGC float with Iridium could cost around \$50,000 instead of \$20,000. Next, the energy budget was estimated for BGC floats and it suggested that, with additional Lithium battery packs for four total, a BGC float could be expected to return ~260 profiles.
S. Riser's group plans to deploy 16 BGC floats along P16 during March through May of 2014. Additionally, there is a proposal as part of SOCOM to deploy ~200 floats over the next six years in the Southern Ocean. When asked about data management resources, S. Riser stated that there is a sizeable portion of money allocated to data management in the SOCOM proposal.

H. Claustre reported on the continued development of activities and coordination in the Bio-Argo community since the last AST meeting. A two-day Bio-Argo meeting was held in Liverpool in parallel to the ADMT15 meeting. This meeting was essential to define what should be the best data management system to accommodate the diversity and somewhat complex nature of Bio-Argo data. Real time procedures for Chla and backscattering are nearly complete and the development of real time procedures is underway for NO3. At the same time, procedures for delayed mode are developing too.

At the Ocean science meeting (23-28 February 2014), there was a dedicated session (25 abstracts) on "Towards a Global Ocean Biogeochemical Observing System Based on Profiling Floats and Gliders" (Claustre & Johnson) as well as a 30 minute tutorial on "Towards a Global Ocean Biogeochemical Observing System Based on Profiling Floats" (Johnson, Claustre & Sarmiento)

All together the number of Bio-Argo floats (here defined as oxygen floats plus additional biogeochemical sensors (e.g. NO3 or bio-optics) that are active or that will be deployed within the next year are ~200. This progressive implementation will continue and will be reinforced as two biogeochemical pilot projects are now identified and will likely be implemented.

- The first one concerns the Austral Ocean through the large SOCOM US project (180 biogeochemical floats planed) with expected additional contributions from South Africa, Australia, India and France.

- The second concerns the North Atlantic which is already significantly instrumented and will likely benefit from European contribution (ERIC Euro-Argo) through new Horizon 2020 programs (e.g. AtlantOs) that will favored transatlantic cooperation and exchange regarding Atlantic observation systems.

The Bio-Argo Canada group has now identified Marlon Lewis (Dalhousie University) as acting chairman.

4.10 EuroArgo

P.Y. Le Traon and S. Pouliquen gave a brief status update of Euro-Argo activities. Euro-Argo will set up its new European legal structure (Euro-Argo ERIC) in May 2014. This will allow European countries to consolidate and improve their contribution to Argo international (agreements at ministerial level) and secure long term national funding. For several years, Euro-Argo contribution to Argo has been more than 200 floats/year. Our contribution is improving but is still below our initial 250 floats/year target. This target should be reached in 2015 thanks to EU funding (we recently made major progress to agree on a complementary EU funding for Euro-Argo). Our long term goal is thus a contribution of more than 250 floats/year with about 20 floats/year in the Med/Black Seas, 40 floats/year for high latitudes, 50 deep floats/year (20%) and 50 biogeochemical floats (20%). Pilot experiments for bio Argo and deep Argo have started or are planned (E-AIMS, Remocean, NAOS, Atlantos) and long term plans need now to be discussed and aligned with Argo international.

4.10 Argo Canada

D. Gilbert reported on the Argo program in Canada. He stated that no multi-year funding currently exists for Argo and that each fiscal year begins with no funding, and he must request funds each year. Usually, funds begin to show up in the fall, with most of the money arriving in January and February to purchase floats. Any extra money after buying floats goes to funding satellite telemetry. Argo Canada is starting to become involved in Bio-Argo with Marlon Lewis from Dalhousie University as the leader of a team of six PIs. The group is working closely with H. Claustre's group and the EU initiative Antalos. Funding is still being secured within Canada, but to start with, Argo Canada plans to deploy two Bio-Argo floats in Baffin Bay in July 2014 and two or three POPS (Polar Ocean Profiling Systems) in Beaufort Sea.

Additionally, D. Gilbert spoke about how the Global Ice-Ocean Prediction System (GIOPS) model in Canada which assimilates Argo data will become operational in late 2014. He is hoping this will help secure more long term funding for Argo within Canada.

4.12 Argo France

As the new representative of France, G. Maze first introduced himself to the Argo Steering Team. He then presented an overview of all French activities contributing to the Argo international program and how they are organized at the national level. (i) France contributes to float development and technological improvements for the core and extension missions (Provor/Arvor floats, deep, bio, oxygen, performance). This activity is developed by Ifremer and CNRS through a strong partnership with the NKE manufacturer and within the framework and funding of national and European projects such as NAOS, RemOcean and E-Aims. (ii) France contributes to the network (80 floats/year funded by Ifremer, SHOM and aforementioned projects) and data management (it operates 1 DAC, 1 GDAC, 1 ARC (NA) and is ADMT co-chair). These activities are operated by Coriolis, the operational data center. (iii) France contributes to research and development activities based on the Argo data set. Those scientific activities which include contributing to, improving the quality of and validating the Argo data set, are labeled as a "National Observing System" (SNO) by French CNRS. This national label allows us to foster cooperation and interactions within the French research community. SNO Argo-France is coordinated by two research laboratories (LPO, Brest and LOV, Villefranche/Mer) in close interactions with Coriolis and its R&D group. It receives direct funding from the French National Center for Science Research (CNRS) and the European Institute for Marine Studies (IUEM).

Several examples of recent scientific use of Argo data in France were presented. For instance, global Argo floats displacements were used to reconstruct the absolute velocity field at -1000m depth with an unprecedented horizontal resolution of 100km (Ollitrault and Colin de Verdière, JPO 2014). The analysis was done using one of many high end products based on Argo data and developed in France: the ANDRO atlas (Ollitrault and Rannou, JAOT 2013). Delayed Mode Quality Control consistency analyses conducted by the North Atlantic ARC were also presented. With regard to the Argo bibliography, at least 10 articles are published every year with an author affiliated to a French research group (14 articles in 2013). Additionally, 3 PhDs using Argo data were defended last year in a French university.

4.13 Discussion from National Reports

Unfortunately a representative from Brazil could not attend AST-15 at the last minute and a formal national report from Brazil was not contributed as there is no official Brazilian AST member so it is difficult to communicate such requests. During the meeting a brief report was received from Brazil and read into the record by Howard Freeland, it is as follows:

What follows is not an official or unofficial position from any Brazilian public or private institution. We do not represent any institution but the Vale Institute of Technology.

About the Argo floats we can say for now that we hope in the next five years to deploy at least 20 (twenty) Argo floats equipped with geochemical sensors for pH, nitrate and so on. We are still analyzing the specific regions where to deploy these floats. We want to attend and contribute to the Argo Program and all data produced by our floats will be shared with the Argo Program.

Our intention was to attend to the AST-15 to contact the key experts in Argo and the technologies to mature our design of the project. Unfortunately we could not be there, but at the next opportunity we hope to be present at that meeting.

Until now, only our Institute has been advancing this project in Brazil and we do not have any Brazilian or international partners involved with this project but Professor Edmo Campos from University of Sao Paulo is just beginning to develop a scientific partnership with us. We hope to involve with us other international research institutions.

Luís Aímola, Climate Change Research Group, Vale Institute of Technology

5. Data Management Issues

5.1 Feedback from ADMT-14

S Pouliquen presented an overview of the ADMT status and activities in the past year. The complete ADMT report is available at:
http://www.argodatamgt.org/content/download/20925/144440/file/14th%20ARGO%20DATA%20MANAGEMENT%20MEETINGV1.1.pdf

Current ADMT efforts focus on

- monitoring the Real Time system and further reducing the delays ,
- updating data format to V3 to be able to handle the change in mission from Iridium and Argos3 floats, separate surface and sub-surface profiles, to enhance trajectory data and to have the capability to include new variables .
- improving data consistency and completeness through regular audits and monitoring tools

A DMQC workshop was organized before ADMT14 to review the delayed mode data and to identify discrepancies in the corrections between DM operators. We also saw the ramping up of the Bio-Argo data management activities and a Bio-Argo workshop occurred once again before the ADMT 14 meeting. The first Bio-Argo data will be available on the GDAC before ADMT15.

Both real time and delayed mode activities are working well and monitoring tools are in place to detect anomalies earlier than users. The standardization of technical and metadata files have been finalized and are presently under implementation at the DAC and GDAC level. The issues related to delayed more QC and trajectory are addressed later in the report. Both GDAC are operational again thanks to a close collaboration between France and USA and the level of service is similar from the two sites. Currently, the main focus of the DACS is to move to V3 format by ADM15.

M. Scanderbeg then presented a list of requests from scientists and data managers for float manufacturers. Many of these requests come as a result of the new V3.0 file format which was created to generalize the format to minimize differences in the way the various floats operate and the data they send back, to allow for changes due to two-way high speed communications, and to better describe the trajectory cycle timing information. These new files should lead to improved velocities at 1000 db from trajectory files which are a good check to compare with geostrophy and should lead to a more complete meta data and trajectory data set.

At ADMT-12, M. Scanderbeg was tasked with an action item to contact float manufacturers to ask that all floats send back all cycle timing information. Most of the new floats now send this cycle timing information back which is very positive. However, there are now new requests related to both the trajectory and the meta file for the float manufacturers. M. Scanderbeg was given an action item at ADMT-14 to collate these requests and present them at the AST-15 meeting.

Firstly, we request that all cycle timing measurements are in the same resolution – ideally one minute. See () for the cycle timing variables in the V3.0 trajectory file. Next, if measured, consider sending back some CTD times during descent, drift and ascent. These times will help with delayed mode quality control of the profile data and will help to better understand vertical sheer.

Concerning high speed communications, it was requested that this be a reasonably priced option as it allows more data to be sent, better data resolution, and a shorter surface time. If floats use high speed communications, it was requested that two positions are taken at the surface to improve surface velocity estimates and to help ensure that at least one position is received.

For pressure measurements, it was requested that manufacturers consider keeping all trajectory pressure measurements in the same resolution as profile pressure measurements. For surface pressure measurements, it was suggested that the highest resolution possible is kept to help monitor surface pressure drift.

Concerning clock drift, it was requested that manufacturers consider taking steps to minimize it. Specifically, the following three steps were suggested:

1. For floats that use GPS, use the GPS time, when good, to reset the float's internal clock each time it surfaces
2. If no GPS time is available, consider using the Iridium time to reset the float's internal clock each time it surfaces
3. If using ARGOS, consider resetting the float's internal clock each time it surfaces to zero
4. If the float's internal clock cannot be reset, report internal clock time each time float surfaces, along with the ARGOS or GPS or Iridium time, to track clock drift

Documentation is extremely important to understanding the data sent by the float. It was requested that float manufacturers work with various Argo data processors to improve documentation to make it easier to decode the data and to make these documents available online. Scientists specify what data they want and data processors want to make sure they are decoding this information in the proper manner.

As was mentioned earlier in the meeting, new decoders add stress to the data management system. Therefore, it was requested that we work together to try to find a way to minimize this stress. That could be done by minimizing new decoders, providing decoders, providing better information when changes are made requiring new decoders, etc. Various Argo data processers will be in contact with float providers to try and find the best solution, perhaps on a float type by float type or PI by PI basis.

Additionally, the float version (including the decoder number at each DAC) is being tracked at the AIC and in the new V3.0 Argo meta files. For this reason, we request notification when a change is made and a new float version is created.

It was also suggested that manufacturers consider a new protocol such as SWE (Sensor Web Enable) to communicate the metadata to shore in a more generalized manner.

Finally, it was suggested that all floats consider packing their data in a well designed scheme to allow for a quicker, smoother transfer of data.

The talk was well received by the float manufacturers and it is clear that a dialogue needs to continue between scientists, data processors and float manufacturers. Future Delayed Mode Quality Control workshops and other technical workshops may be the place for some of these dialogues to occur.

5.2 B-Argo file structure

Concerning the storage of Bio-Argo data, after intense discussion during and after ADM14 a consensus solution was reached and three solutions were proposed:

1. Keep Core (CTD) data and Bio data all in the same file
2. Separate Core (CTD) and Bio data completely with measured Pressure as the common variable between the two files
3. Keep Core (CTD) data and the final Bio variables in one file with raw Bio measurements in another file

To address the concerns expressed by DACs who process mainly floats following the core mission, option two is optimal. Therefore DACs will provide one file for the Core (T&S) floats as they are doing now and two files for the bio Floats (R or D files for CTD data and BR or BD -files for Bio-Argo) to the GDACs.

To accommodate the needs of the Bio-Argo community, the GDACs will then merge the CTD (i.e.core) Argo file (R-file or D-file) and the B-file (BR-file or BD-file) for bio floats, creating a merged profile file that will contain the latest version of all the ocean state variables (MR-file or MD-file).

Therefore data from bio floats will be available at the GDACs via 3 files: a core (CTD) file, a bio-file, and a merged file. Users need to be informed of these changes to the data system. It was pointed out that B-files may be big because some instruments return spectra data. It was agreed that since the ADMT & AST predict that b-files will be used mainly by specialists, file size is not presently an issue. In the future, it might be necessary to choose a more efficient format such as NetCDF4.

M. Baringer pointed out that DACs will still have additional work to split the files into Core and B-files if they process floats with BGC data. It is only the delayed mode operators who will not have to do any additional work in the changeover to the new file system.

5.3 Argo BUFR enhancements

Jon Turton recalled action 12 from AST-14, which requested 'development of BUFR templates for real time data distribution on the GTS'. Specifically the intention was to modify the existing Argo BUFR template (3-15-003) to allow for the inclusion of additional near surface data (e.g. unpumped temperature measurements or temperature and salinity from STS floats) and for bio-geochemical variables (e.g. dissolved oxygen). He noted that starting November 2014 the use of TESAC on the GTS was scheduled to cease and from that date on, Argo data should only be distributed on GTS in BUFR. As the Argo NetCDF format develops to allow for the inclusion of these additional measurements it was important that the Argo BUFR should evolve to provide matching capability. Some operational centers are now running ocean forecasting models with biogeochemistry/ecosystem variables so there is a requirement for bio-geochemical data on GTS for use with such models.

He had circulated proposals for modifications to the BUFR format to ADMT and the JCOMM Task Team on Table Driven Codes (TT-TDC) in the autumn, and in February circulated an updated proposal to ADMT and the TT-TDC following feedback received. The proposal was to add new sequences for near-surface temperature and salinity data (with a qualifier to define the measurement type) and an (already agreed) sequence (3-06-037) for dissolved oxygen. These additional sequences would only be used when the additional measurements are made, such that for standard T&S floats (without unpumped or auxiliary near-surface measurements) the existing BUFR template would be used as is. He invited comments on the proposals from AST. The intention was that the proposals would go to the WMO IPET-DRMM in late April with a recommendation to accept the proposals for validation with the aim to be ready for operational use on GTS by November 2014.

At this time it was not possible to include bio-geochemical variables (other than dissolved oxygen) as they are not defined in the overarching BUFR Master Table (MT) 0 for meteorology, although they are included under BUFR MT10 for oceanographic data. However, an individual BUFR message must comply with either MT0 or MT10, but cannot comply with both. As MT10 has not yet been used and few (if any) centers have MT10 compliant decoders, in the short term MT0 would need to be used. WMO and JCOMM had been asked as to what the longer strategy should be: to develop Argo BUFR templates for bio-geochemical floats according to MT10 or to add the extra variables into MT0.

5.3 CTD Reference Data

S. Diggs presented on the CTD reference database on behalf of CCHDO, US-NODC and Coriolis who work together to collect and create the database. He reminded everyone that the GOSHIP program is the follow on to WOCE and is continuing to do repeat hydrography in the world ocean. CCHDO has collected 4490 CTD casts in the past 12 months, with nearly 1200 coming from Japan. US-NODC has added 2502 Deep CTD casts since ADMT-13.

S. Diggs stressed the idea of supply and demand. In terms of the supply side, he stated that there are less CTD data out there since the end of WOCE. He noted that in the national reports this year, countries were asked to supply the number of CTD cruise data being added to the reference database/CCHDO. Almost all reports said that no data had been submitted with the exception being Japan. It is also important to know what is already in the reference database to see if there are updates available and to prevent duplication. As for the demand side, he requested again that delayed mode processors pass on areas where reference CTD is needed. He has established a good relationship with BODC to find out about cruises needed and will respond to a request in the Chinese National Report for CTD in the Kuroshio region. Another example was cited where D. Roemmich mentioned a cruise to S. Diggs and he was able to track it down and get the data for the database.

During the discussion, a question was raised as to the quality of some of the CTD data being include in the reference database. Specifically, it was noted that some CTD data may not be calibrated with bottle data. The AST stated that it is important that bottle data be used to calibrate the CTD data that is included in the reference data base.

> **Action item 12:** Ask that CTD data is included in the reference data base only if it was calibrated with bottle data. CCHDO, NODC, Coriolis

> **Action item 13:** CCHDO requests feedback on known cruises to track down as well as areas where DMQC operators need more recent data. CCHDO, PIs, DMQC operators

> **Action item 14:** When recalibrated CTD data becomes available, replace it in the reference database. CCHDO, NODC, Coriolis

5.4 Status of the trajectory data

M. Scanderbeg reported on the status of the trajectory files since the previous AST meeting. The trajectory V3.0 file format has been approved and included in the User Manual. This includes the agreement to use a two-file trajectory system – one for real time (WMO_Rtraj.nc) and delayed mode (WMO_Dtraj.nc) files, allowing for DACs to continually overwrite the real time trajectory file as new data comes in without fear of losing work done by delayed mode operators. The V3.0 trajectory files will also be split into Core-Argo and B-Argo files in a similar manner to the profile files. The DAC cookbook has been published with instructions on how to create the trajectory V3.0 files and DACs should look there for details by float type. (http://www.argodatamgt.org/Documentation). A webpage has also been created with an explanation of the new V3.0 file format: http://www-argo.ucsd.edu/Traj3files.html

Some DACs and PIs (BODC, CSIRO, J.-P. Rannou and J. Gilson) have already begun creating both real time and delayed mode V3.0 trajectory files in preparation for uploading onto the GDAC. Test V3.0 traj files for Provor floats created by Rannou can be found at: ftp://ftp.ifremer.fr/ifremer/argo/etc/coriolis-custom/argo-andro-data/ Most DACs are focusing on switching to V3.0 profile and meta files before the trajectory files. The GDACs are still not accepting V3.0 trajectory files.

M. Scanderbeg then went into some detail about how 'D' files will be created from the ANDRO work. As a reminder, the work done by M. Ollitrault and J.P. Rannou to make the ANDRO Atlas was done from the viewpoint of creating a velocity field at 1000 db and not to create the best Argo trajectory files. Therefore, some additional steps need to be taken to create 'D' files from ANDRO. Rannou has agreed to check profile files to see if salinity needs to be adjusted and make any adjustments as needed. He will also apply surface pressure adjustments for non auto-correcting floats in a manner consistent with profile files. Bad Pres/Temp/Psal during drift will also be flagged. After doing that, he will create 'D' V3.0 traj files for all the floats in the ANDRO Atlas that do not have recovered cycles and will make them available for DACs to download and distribute for PIs for approval. Upon approval, the delayed mode traj files can be uploaded to the GDACs. Rannou will also make a list of missing/recovered cycles by DAC and ask that DACs look at this information and somehow reconcile it.

M. Scanderbeg then went on to show work done on the current trajectory files to estimate velocities in the North Pacific Ocean. She showed that papers are now being published where Argo trajectory files are being used to calculate velocities. Most of these papers are regional, but there a handful of global studies. She showed a total of close to 2100 floats in the North Pacific, with the majority being APEX floats with ARGOS telemetry. This type of float needs the most work done to estimate cycle timing. Provor, Arvor, SOLO-II, and NAVIS floats in the region all send back cycle timing information. The estimation procedure outlined in the DAC cookbook to find the Transmission End Time for APEX floats with ARGOs transmission was applied to the roughly 1200 floats in the region. This worked well for most of the floats, but there were four main categories of anomalous behavior found that make the estimation difficult to use in real time.

M. Scanderbeg found that 2% of APEX ARGOS floats (~30) in the region had to be excluded, 6% (~70 floats) needed extra time spent to get a good estimate of the TET. In addition, each float's TET estimation plot needed to be looked at. For these reasons, M. Scanderbeg suggested that this is a delayed mode procedure which should not be applied in real time by the DACs. A couple of plots were shown where the current process for estimating TET done by the DACs can also lead to poor estimates of the time – one where the time was clearly during the surface interval and one where the time was clearly hours after the float descended. So, perhaps some simple checks can be introduced into the current system to prevent such bad

TET estimates in real time. Of course as the Argo fleet gets replaced with newer floats that report all the cycle timing information, this problem will disappear over time, but there are still many APEX floats with ARGOS transmission both alive now and still being deployed, so this process will not go away immediately.

M. Scanderbeg ended the presentation with the strong suggestion that DACs switch to the real time V3.0 trajectory files as soon as possible, even without making any additional cycle timing estimates. Simply having each measurement identified through a measurement code will increase the use-ability of the files. Additionally, newer float models report these additional cycle times which do not appear in the V2.3 traj files and so we are losing valuable information that is available right now.

Finally, it is time to begin delayed mode quality control of trajectory files. The procedure for this will vary by float type to accommodate the various cycle timing questions for the older floats that do not report times, but some parts of the process will be the same for all float types. It was suggested that working group be formed to start documenting this delayed mode process.

> **Action item 15:** Ask DACs to look at cycles recovered by J.P. Rannou during his work on ANDRO and reconcile with their files. Report progress at ADMT-15. J.P. Rannou, DACs

> **Action item 16:** Compile list of WMO numbers for floats with anomalous behavior in their traj files and distribute to DACs for further review. M. Scanderbeg, DACs

> **Action item 17:** Ask ADMT to coordinate forming a working group to develop and document a delayed mode process for traj files. ADMT co-chairs

6. Regional science, education and outreach

6.1 Science presentation by G. Smith

6.2 Science presentation by I. Yashayaev

Before his talk on convection, circulation and eddies in the Labrador Sea as seen from Argo floats , I. Yashayaev gave a short presentation with examples of Argo float data he had found where he did not think the Argo flag for quality was well chosen. The AST recommended that information be given to the DACs who can find a way to distribute it to the PIs for feedback.

> **Action item 18:** Ask I. Yashayaev to work with the NA-ARC to relay data quality assessment to DACs. I. Yashayaev, G. Maze

6.3 South African Research Program

T. Morris reported on three experiments deployed within mesoscale eddies south-west of Madagascar. The experiments took place between April and December 2013, with two cyclonic and one anti-cyclonic feature(s) seeded. The objective of the experiments was to determine if these features are capable of transporting biological organisms from Madagascar to South Africa as part of the ACEP III Suitcase Project. Data is still be analyzed but Argo floats are shown to maintain longer within cold-core cyclonic eddies as opposed the warm-core anti-cyclonic eddy. Also, the daily and five-daily cycling these floats were placed in to undertake this experiment realistically capture mesoscale eddy, western boundary current and retroflection dynamics in this region.

T. Morris also presented P. Flanagan's report on The Lady Amber Schooner which presented her capabilities in terms of Argo float deployments in areas of the ocean not covered by ice or dominated by piracy and monsoonal restrictions. She has successfully deployed approximately 6% of the Argo array at 2% of the operating costs for a vessel of her size (20 m Schooner). She has also undertaken the training of volunteers at sea and lectures given to secondary education students on Argo and associated physics principles. She is currently looking to undertake further voyages and connect with schools, teachers and learners wherever she may sail to on behalf of the Argo program.

During the discussion, T. Morris was asked whether the floats in the Mozambique Channel will be reprogrammed to a regular Argo mission once they leave the region. She explained that some of them will after further testing on some technical issues, but that some cannot be reprogrammed because of Argos3.

6.4 Report on PICES Summer School

Argo had been asked to contribute to the PICES Summer School on Ocean Observing Systems and responded by sending Howard Freeland on his first trip as Argo Director.

The students at the summer school were mainly from the PICES nations (Canada, China, Japan, Korea, Russia and USA) but with a small number of students from other countries (Australia, Argentina, India and Philippines).

Topics covered were based around how to measure stuff and interpret it and the course was interdisciplinary. Students were divided into groups carefully chosen so that every group had at least one physics student, one chemist, one fisheries student, one plankton biologist etc.

Much time was spent at sea, sampling nearby, computing mixing diagrams, analyzing fishing catches and analyzing chemical data. Overall, the students were all very pleased with the course and the leader (Jack Barth) but wished it had been 2 weeks as the amount of information delivered in such a short time was very high. One morning talk was given by H. Freeland on how Argo works, and then after a break, how to use Argo data.

Various ways of using Argo data were demonstrated depending on the level and type of user. Some students had high-level computing skills, some medium and some none. Ocean Data View was a popular tool in demonstrations but the most popular demonstration was the Argo Global Marine Atlas.

> **Action item 19:** Put education lecture given by H. Freeland at PICES summer school on the educational section of the AST website. M. Scanderbeg

7 Technical Issues

7.1 Float technology progress

France reported on its activities with regard to float technology. Tests will be conducted on oxygen sensor performance by integrating two different sensors (SBE63 and Aanderaa 4330) on a single Arvor float and comparing them. This float will be deployed in 2014 during the GEOVIDE cruise. The Argos3 satellite transmission performances (high and low rate modes) are also being tested in order to shorten the surface time, to transmit more data and to remotely control the float. This action was initiated for marginal seas applications. Deep and bio float progress were reported in dedicated items on the agenda.

M. Belbeoch also reported on float lifetime statistics by float type. The AST requested these plots be available on the AIC webpage. Feedback was given suggesting that floats be sorted by battery type and mission type and that it might be easier to make see the plots if they started from 2007.

> **Action item 20:** Ask M. Belbeoch to put float lifetime statistics online by float type – including only Original Mission floats and the actual number of floats in addition to percentages. Consider separating APEX floats by alkaline and lithium batteries. M. Belbeoch

> **Action item 21:** At AST-16 report on progress in testing new sensors including RBR, SBE61, and SBE41 below 2000m. AST members

7.2 Plan for Deep Argo deployments

France reports that 2 deep floats (industrial prototypes of deep-Arvor funded by the NAOS project) will be deployed in 2014 in the North Atlantic subpolar gyre during the GEOVIDE cruise.

D. Roemmich reported on plans for a voyage by RV Tangaroa (NIWA N.Z.) for the purposes of (i) comparing CTD measurements by the new SBE 61 Deep Argo CTD with shipboard CTD measurements and (ii) deployment of prototype Deep Argo floats on an abyssal plain in the Southwest Pacific Basin, with depth greater than 5600 m. The voyage will include four days transit from Wellington NZ to the station location near 36°S 177°W to Auckland, and four days on station. This is a collaborative effort, with NIWA (Argo N.Z.) supporting most of the ship cost and additional support from Argo Australia and Argo USA. The CTD validation exercise may include about 10 casts of nine hours each and will test SBE-61 temperature (using an SBE 35 calibration thermometer), conductivity (focusing on cell compressibility characterization and thermal mass), and pressure (focusing on temperature sensitivity of the Kistler pressure sensor). Approximately four Deep Argo floats will be deployed at the station location, including two Deep APEXs and two Deep SOLOs. These floats will cycle relatively rapidly (without parking) to accumulate many profiles, and they may be recovered after approximately 1 year. Further planning by US Argo is for deployment of a regional array of 12 Deep Argo floats in the Southwest Pacific Basin in mid-2015 followed by additional regional arrays in other deep basins.

7.3 Deep Argo float progress

France reported on the progress made in developing a 0-4000db version of the Arvor float. Two models, funded by NAOS and equipped with an oxygen sensor (A4330) have been successfully deployed and operated in the Bay of Biscay. One float performed 60 cycles between 0 and 3500db between August 2012 and February 2013. The second float deployed in November 2013 is still operating and has achieved 56 cycles so far.

During the discussion following the presentation by G. Maze, it was noted that the Deep Arvor will be going to 4000 db using the SBE41 CTD which is rated to 2000m. It was noted that this data below 2000m may be biased and should be studied. Next the AST debated how to indicate this to users. Is a qc flag of '0' enough or should the data be treated as a separate experimental data set? Everyone agreed that the data should be made available as many will want to use it either in models or other scientific work. Therefore, it was suggested that S. Wijffels work with S. Pouliquen to find the best way to indicate to researchers that data below 2000m may not be acceptable to climate research.

S. Riser then presented on the prototype of a Teledyne/Webb 6000m float that was deployed in the Puerto Rico Trench in 2013 and at Bermuda in 2014. He pointed out that the stated accuracy of the new SBE61 CTD designed to go to 6000db is only very slightly higher (0.003 PSU vs. 0.002 PSU) than the SBE41 CTD currently on Argo floats. It was mentioned that this sensor must be tested for accuracy and durability.

T. Suga presented on the Deep NINJA float that has been available from TSK since April 2013. It uses an SBE41CP CTD, goes down to 4000 dbar and can carry additional sensors. It has ice avoidance and grounding avoidance functions and is expected to last more than one year using Lithium batteries. So far, three Deep NINJA floats have been deployed for field test and four for the Southern Ocean observation. There is a plan to deploy another seven this year in the Southern Ocean. The Deep NINJA deployed in 2012 has returned 84 CTD profiles, including 53 deep profiles as of March 14, 2014. The float survived a winter under ice in the Southern Ocean. Comparison of salinity taken on a CTD cast with deployment show bias in all 5 cases. This needs to be studied more.

During the discussion following the talks on deep floats, the issue of sampling on the descent instead of the ascent was raised. It is logistically easier to sample on the way down for both the TWR deep float and the Deep Solo. However, others pointed out that when this data is transmitted nine days later, it may not be of much use to modelers who need that information within a day or so. Further exploration on this issue was suggested.

> **Action item 22:** S. Wijffels, S. Pouliquen to work on approach that is best to indicate to researchers that the data from Deep Argo floats below 2000m may not be acceptable for

climate research. Circulate idea to AST & ADMT for approval. S. Wijffels, S. Pouliquen, AST, ADMT.

7.4 Bio Argo progress

Some recent results and the performances of the PROVOR CTS4 equipped with a suite of biogeochemical sensors were presented as well as the new generation of PROVOR CTS 5, a float with enhanced capabilities especially with respect to mission.

Regarding sensor technology and reliability, examples of good practices with respect to Bio-optical sensor cross-calibration and validation have been presented. Some evidence of slight pressure dependence of the SUNA (NO3) sensor have also been presented. This pressure dependence will have to be accounted for as part of the production of DM datasets.

7.5 Calibration results on pressure sensors used in Argo

S. Wijffels took the opportunity to discuss the calibration of pressure sensors used in Argo. She stated she was aware of a few groups that had been performing their own calibrations on the pressure sensors and thought that this data might be combined within Argo and analyzed. Once studied, it could be written up and posted on various Argo websites as a manufacturer independent measure on the quality of the sensor. D. Roemmich, S. Riser and T. Suga said that such measurements had been going on in various ways for several years in their labs and all agreed to share their data.

> **Action item 23:** Collect independent data on the quality of CTD pressure calibration, analyze it, write it up, and post it on various Argo websites. S. Riser, S. Wijffels, Argo website managers.

7.6 Summary of long-term practice of SBE41 sensor calibration

JAMSTEC conducts calibrations of SBE41 temperature (T) and conductivity (C) sensors as part of the screening process since the Argo program was started, using a calibration bath system manufactured by SBE inc (procedure in JAMSTEC was reported in Yokota et al., 2006). The purposes are to find errors or faults of temperature and conductivity sensors and to re-check T and C accuracies before launching. Based on our results of over 400 CTD calibrations, about 8% of conductivity sensors had some faults, but there is little fault with the T sensor. An exceptional case is met until now, which was caused by electrode failure of the conductivity sensor, as reported at AST-12. In fact, the salinity of four Provor floats without the calibrations had negative biases (0.01-0.05 PSS-78) and were already put on the grey list. All fault sensors found through the screening were re-calibrated or repaired in SBE, or the sensor parameters of SBE41 were modified.

We conclude that performing these calibrations in laboratory before launch is a valid screening for faults in the sensors, especially of conductivity. Also, it is effective to monitor the status of float/sensor products created by the manufacturers.

S. Wijffels wondered if the delayed mode quality control adjustments of salinity were smaller because of all the calibration work done beforehand. She asked whether a single temperature and salinity check would work or if all the temperatures were needed to see the problem.

Hosoda said at least a few points are needed to check the calibration and it does not cost much to do six temperature measurements as done by SBE instead of one or a few. Thus he thinks that there is no benefit to decreasing the number done.

The AST endorses JAMSTEC's calibration test of SBE41 temperature and conductivity sensors in their laboratories. It is vital that the CTDs included on Argo are able to produce high quality accurate data for the float's lifetime and this calibration process helps to ensure this. There are few places that can perform this calibration process and the AST hopes that JAMSTEC can continue doing this to help monitor the CTDs from SeaBird.

7.7 Micro-floats and floats from non-climate programs

S. Jayne reported on a new air-deployable profiling float to be deployed in the Gulf of Mexico. Two novel features in particular were described:

1. The development of a small air-deployable profiling float, initially for the use of observing ocean heat content for hurricane forecasting. The float will be expected to return 100-150 profiles to 1000m and will use Iridium.
2. The use of an inductive conductivity cell for measuring salinity on profiling floats.

The mission plan is for daily profiles to 1000 dbar, but the floats could be set to longer cycle times after hurricane season. Currently the data will go onto the GTS and will be in the same format as the S2A float data currently sent to the AOML DAC by WHOI. Initially, the floats will only have temperature and pressure data, but salinity is planned for the future using the inductive conductivity cell already mentioned.

A lengthy discussion followed debating what data should be included in the Argo data stream. It was suggested that Argo data should be both temperature and salinity and that temperature only data should be not included in the Argo data stream. It was pointed out that some early floats only had temperature and they were included in the data stream, so this is not a perfect point, but perhaps where Argo wants to aim for the future. Not only are the variables an issue, but the profile sampling rate for these micro-floats is also not in agreement with the current Argo standard of one profile every 10 days. Again, it was pointed out that many floats now in the Argo array do not always sample every 10 days and that the Argo data format has been modified to handle changes in sampling scheme.

S. Wijffels also stated that for any data to be incorporated into the Argo data stream, it must be able to be quality controlled (this includes both the scientific test to qc it as well as the funding to perform the qc), it must be possible for DACs to carry this data through time (ie through future changes to the data format) and it must be able to fulfill Argo's standards for climate science. It was suggested that the GTS may be the place for this data stream to live and not within the Argo data stream. Several others said that this data type is crucial for modelers and having it as part of Argo would increase their ability to use it.

Another complication was the issue of introducing a new CTD sensor and how that might affect the data stream. While the AST recognizes that diversifying to more than one CTD sensor is wise, it also cautioned that any new sensor must be proven reliable over time.

D. Roemmich suggested that Argo may not be ready to make a decision about if the data should be included in the Argo data stream. He suggested asking the ADMT for a compromise solution. S. Pouliquen suggested waiting a year for a decision since the floats are not in the water yet and more information might arise in the coming year. Everyone agreed to wait a year and revisit this issue at the next AST meeting.

7.8 DMQC comparisons

B. King showed a few slides which were created in preparation for the DMQC workshop held in Liverpool last fall. There were large differences in both signal and distribution of adjustment size across the DACs. While differences are to be expected, Argo would like to minimize them and so it was asked that J. Gilson and E. van Wijk exchange a few floats and try doing delayed mode on them to compare results. These two were chosen since they have floats in the same region, are both experienced DMQC operators and seemed to have very different distributions. The exchange has not yet happened, but should in time for the ADMT-15 meeting in the fall. It was suggested that B. King could refine his statistics by looking at float deployment period in a six month window to try and reduce the effect of a bad batch of floats. The exercise also pointed out the regionality of adjustments and that the OW software may need to be tuned to the region.

8. Completing the global mission

8.1 Status of Argo enhancements

8.1a Seasonal Ice

B. Klein reported on the plans for Argo floats in the seasonal ice zones. During the preparatory phase of the new EuroArgo ERIC, a roadmap for the evolution of Argo in Europe has been developed. The first priority of the EuroArgo ERIC is to contribute to the global array and the regional enhancements. One of these enhancements is the extension of observations into the seasonally ice-covered high latitudes. Once the ERIC has been put in place, it will start working on a long term implementation plan based on the roadmap. Funding for the activities 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. For the Arctic proper with multiyear ice conditions, national pilot projects such as iAOOS, NAOS and ACOBAR are underway and will be evaluated in the next years. The targets for the Nordic Seas specify an active fleet of 39 floats spread over the entire area. 29 floats are needed for the deep basins and an additional 10 floats for the rim currents.

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. 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 which are needed for this purpose has already been deployed in the Weddell Gyre by the Alfred-Wegener Institute.

8.1b Marginal Seas

The implementation of Argo in marginal seas was presented by P-M Poulain. In early 2014, about 176 floats are 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 each 3° x 3° cell), 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 2014, 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 70% of the target density. Note that some seas are over-sampled (Sea of Japan). In addition, adequately sampled seas, like the Mediterranean Sea, are not necessarily well homogenously sampled in all their sub-basins (most floats are in the northern areas).

	Floats alive in early 2014	**Target density**
Sea of Japan	40	16
South China Sea	8	20
Gulf of Mexico	8	20
Caribbean	8	38
Red Sea/Gulf of Aden	2	10
Persian Gulf/Gulf of Oman	8	10
Nordic Sea*	30*	
Baltic Sea*	1*	
Mediterranean	60	60
Black Sea	10	10
Indonesian Seas	1	21
Sea of Okhotsk	0	4
TOTAL	145 (176*)	209

Table 1. Implementation of Argo in Marginal Seas in early 2014 (*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 most floats cycle every five days, alternating between shallow and deep profiles. This specific mode appears adequate for these seas, although new sensitivity studies of Argo-based products (basin-scale statistics, forecasting skills, etc.) are 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, about half of the floats are using Iridium telemetry and the downlink has been used occasionally to change the cycling and sampling parameters of some floats.

8.1c Deep Argo

S. Wijffels presented on the plans for Deep Argo with the motivation that broad scale abyssal warming has been detected since 1990. There has also been freshening of bottom waters around Antarctica which contributes to both ocean heat content and sea level. She showed that SST is a poor proxy for radiation imbalance but that ocean heat content is an excellent proxy. Ocean heat content can be measured through comprehensive observations of the 0-4000m layer in order to minimize noise associated with natural variability (Palmer et al 2011). Ocean and climate reanalysis and forecasting teams are asking for deeper data as well. She said that several deep floats have already been deployed and that over 60 are planned in future pilot projects, including several that will carry oxygen. It was stressed that for the decadal and longer term climate change issues, a more accurate sensor suite is needed, especially for pressure and salinity. To that end, a new CTD is under development by SeaBird – the SBE61. Field testing of this sensor along with inter-comparisons with ship-board CTDs is necessary. The Argo Data Team is already working on automatic QC tests for deep Argo floats. The design of an array is still uncertain. A possible target is to resolve decadal trends at ~500km scales. This would involve a 30-day cycle with sampling down to 6000m at 5 x 5 degree spacing which translates to about 1200 floats. Another possible target is to explain sea level variability. This would require monthly observations at 2 degree scale which translates to more than 4000 floats. The next steps will be to carry out regional scale pilot projects to prove the technology and sampling strategies as well as to refine the cost basis. The goal is to work with the international community to generate a global array design which is feasible based on sensor, sampling and costs and provides the best value to the largest number of applications. To this end, the profile depth may vary below 2000m.

France indicates that there are no clear recommendations from the AST for the array design of the deep extension (toward observing the ocean below 2000db). Four years after OceanObs'09 white papers, nothing specific has emerged yet at the international and global level. Although at the European level, Euro-Argo countries are starting to work on OSEs and specific roadmaps (E-Aims, SIDERI). S. Riser and G. Maze volunteered to help the AST to determine how recommendations can be drafted for a global design target.

As pilot projects emerge mostly, in the North Atlantic and Southern Ocean, following climate signal penetration toward the deep ocean seems to be the initial motivation for the community. As ocean ventilation mostly occurs at intermediate depths in the North Atlantic (NADW) and deeper ones in the Southern Ocean (AABW) it is not surprising that prototype of deep floats sample down to 4000db or 6000db. AST recommendations should help determine the right balance between both sampling depths and horizontal sampling distribution, for a global array able to meet the scientific goals identified in the OceanObs'09 white paper.

Action item 24: S. Riser and G. Maze to draft recommendations on a global Deep Argo design target. S. Riser and G. Maze

8.1d Western Boundary Currents

T. Suga reported on increased coverage in the Western Boundary (WB) regions. He defined WB regions as inertial jets, their recirculation gyres, detached eddy and subducted water masses. They are characterized as regions of intense air-sea interactions and carbon uptake. Science questions cover a broad range of spatial and temporal scales including frontal meandering and instability processes, mesoscale eddies and cross-frontal exchanges, upper ocean heat/salt content anomalies, ventilation/subduction processes and their forced vs. intrinsic variability.

Using examples from the KESS experiment, he suggested that doubling sampling in the WB regions will help but will not be sufficient to map synoptic-scale 3-D fields. It will be effective enough to address longer time scale and broader spatial scale issues such as seasonal evolution and interannual to decadal variations of WBC regions.

In the discussion that followed, it was noted that getting funding for globally doubling sampling in the WB regions can be difficult as it is not a new technological development. It might be possible to maintain regional studies, but it might hard to maintain everywhere. Doubling was clarified to mean doubling the number of floats rather than simply cutting the 10 day cycle in half to 5 days. Although some areas might benefit from 5-day sampling if water mass formation is less than 10 days.

D. Roemmich stated that WB regions are areas of high eddie kinetic energy and variability in this might introduce high mapping errors. It was suggested that more study is needed to look at errors in WB regions.

8.1e Equatorial

Increased density of Argo coverage in the equatorial Pacific is recommended for improved observation and prediction of El Niño/Southern Oscillation (ENSO) phenomena. At present, the TAO moored array has declined due to lack of servicing, and improved Argo coverage can partially offset losses of subsurface temperature/salinity data from TAO. The TRITON array is also slated to be thinned out due to a refocusing of priorities in JAMSTEC. Present Argo coverage (i.e. 3° x 3°) is sufficient to capture about 90% of the variance in 10-day averaged subsurface temperature along the equator. However, much of this is in low frequency (periods longer than 100 days) variability with large spatial scale, including the westward propagating annual Rossby wave. For higher frequency variability, periods of 30 to 80 days, including equatorial Kelvin waves that may be important in ENSO triggering and evolution, present Argo coverage captures only 70 – 80% of temperature variance in the equatorial thermocline. At the Tropical Pacific Observing Workshop in January 2014, a white paper on subsurface temperature, salinity, and velocity observations (Roemmich et al., 2014) described the present observing system requirements and implementation, including the role of Argo.

A deployment cruise on S/V Investigator, operated by Pacific Expeditions Ltd, with 41 Argo floats along the equator between 100°W and 155°E is presently underway (35 floats deployed at the time of this report). This enhancement doubles the coverage of Argo along the equator, at a critical time when TAO/TRITON is seriously degraded and when a substantial warm anomaly in the equatorial thermocline has moved eastward to the dateline. Some seasonal prediction models are forecasting development of El Niño conditions later in 2014.

S. Wijffels wondered how many deployments would be needed to maintain the doubling of floats along the equator. D. Roemmich noted that all the floats will be using Iridium, so it was really a question of how long the floats stay in the region. There have been floats there for two years, so it could be as little as 8-10 floats per year.

Ravichandran indicated that the RAMA array has begun in the Indian Ocean which is similar to the TAO/Triton array. The next step is deciding how the Argo array should look in this region based on the science around monsoons, etc. He feels that the array will probably need to be doubled here as well, but studies are ongoing and he would like to report back next year.

Action item 25: Ravi to report on impact studies done in Indian ocean at AST-16. Ravichandran.

8.1f Caribbean Sea and Gulf of Mexico

P.E. Robbins reported on WHOI's efforts to ramp up the seeding of additional floats in the Gulf of Mexico and Caribbean Sea. WHOI currently has six floats operating in the Gulf of Mexico with plans for four additional deployments in Spring 2014 and two deployments in the Caribbean Sea from the educational sailing vessel Corwith Cramer. P.E. Robbins anticipates that two-way Iridium communication will contribute to increased lifetimes in marginal seas by both drastically decreasing surfacing times as well as offering the opportunity to alter mission parameters.

Waters in the tropical Western North Atlantic generally flow westward into the Caribbean Sea but the shallow sill depths of the Lesser Antilles have blocked these floats from entering the Caribbean. Additionally, poleward western boundary currents (and equatorward eastern boundary currents) are especially hazardous to Argo floats because floats in water less than 1000 m depth will get caught in a shoreward bottom Ekman boundary current and be pushed into shallower water. P.E. Robbins is using the ability to reprogram the float mission in order to raise the drift depth when floats are stuck in the waters less than 1000m depth. The hope is this will decrease the high mortality of floats previously observed in the North Brazil Current, along the Lesser Antilles, and in the region of the Bahamas Banks.

Action item 26: Investigate utility of task teams for Argo enhancements and what the AST would ask these task teams to do and how they would interact with the AST. Create a Terms of Reference/expectations for these task teams. Bio-Argo: H. Claustre, Deep Argo: S. Riser/G. Maze, Marginal Seas: P-M Poulain, WBC: B. Qiu, T. Suga, D. Gilbert, P. Robbins. High lat: B Klein can ask for a contact/SOOS for Antarctic.

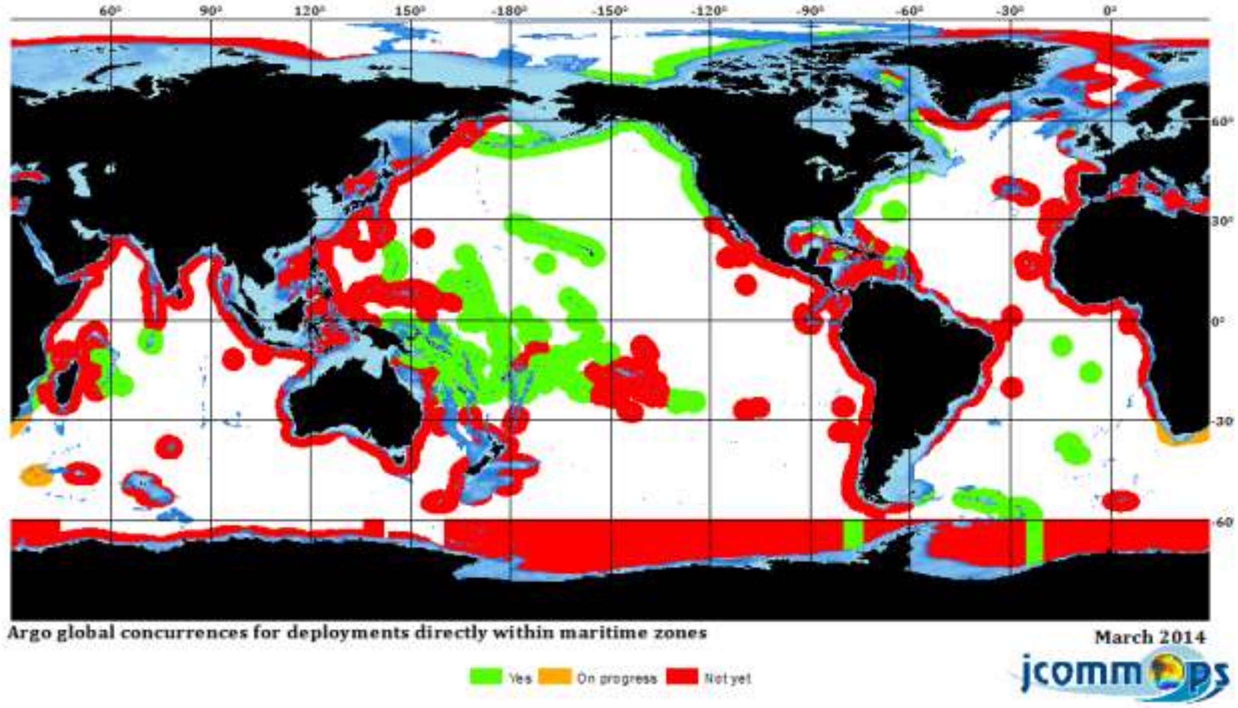
8.2 GOOS and OOPC update

The recent status of OOPC was presented. After a hiatus in its activity for a couple of years, OOPC has been setting up new activities under new co-chairs and secretariat. While OOPC is continued to be sponsored by the Global Ocean Observing System (GOOS), the Global Climate Observing System (GCOS) and the World Climate Research Programme (WCRP), following the adoption of the Framework for Ocean Observing (FOO) by GOOS, OOPC is revising its terms of reference to reflect its role in delivering the ocean component of GCOS and the physics variables for GOOS. The OOPC Work Plan lays out its activities including development of Essential Ocean Variable (EOV) and observing network specifications to support processes for evaluation of EOVs and networks. As examples of GOOS projects for priority observing system evaluations, Tropical Pacific Observing System (TPOS) 2020 and Deep Ocean Observing Strategy (DOOS) were introduced. It was noted that Argo enhancements are closely related to these projects and others and would be more beneficial and effective by being considered as elements of those integrated observing systems.

8.3 What are the EEZ issues for completing the global mission?

Following a meeting of ABE-LOS (Advisory Board of Experts – Law of the Sea), the IOC passed a resolution with new requirements giving nations the right to demand extra notifications if floats are about to enter their EEZ, and also the right to have distribution of data delayed for floats within their EEZ. Argo was worried about this because if every nation asked for those delays, it would destroy the real-time aspect of Argo.

For the core Argo mission there are various standard requirements, such as “complete the notification system”, and do not deploy a float in somebody else’s EEZ without permission. These requirements are obvious and well known. Some countries have declared their EEZs open for Argo launches. So if anyone wants to deploy Argo floats in e.g. Canadian or US EEZ (see map below), then no clearance request is needed or expected. Other countries are encouraged to consider doing this. Argo TC mentioned he was gradually working with some governments to make progress.



Countries with “Global Concurrence” are: Canada, Mauritius, Mozambique, Pacific Islands, UK and USA, and soon (maybe) South Africa

The Argo TC has developed a proximity warning system for floats approaching an EEZ where the owners have requested a special notification. At the moment the list of countries requiring extra notification is: Argentina, Brazil, Chile, China, Ecuador, Egypt, Greece, India, Peru, Tunisia, and Turkey.

This is going well and the mechanism works. There have been no requests that data distribution be delayed. As such, enhancing standard (T&S) Argo coverage in WBC areas, Southern Ocean and equatorial regions should not be a problem.

Transparency and cooperation are the keys to a smooth implementation of the global Argo mission.

9. Demonstrating Argo’s value

9.1 Report on GODAE OV Symposium

Several people from the AST attended this meeting which explored the current status of Global Ocean Data Assimilation modelling. To a large extent this group is one of Argo’s primary clients. So Howard Freeland attended as Argo Director specifically to discuss the state of the Argo array and data system with users and to determine to what extent we meet their needs.

Magdalena Balmaseda was very complimentary about Argo. She makes heavy use of the GTS data feeds and finds those to be timely enough. For the data being deposited at the GDACs, the 80% within 24 hours and 90% within 5 days she found to be adequate, but she had a surprising comment about DMQC. Magdalena is doing reanalysis projects and she wishes we could expedite DMQC considerably; this is, for her, Argo's biggest failing. After outlining the DMQC process and how no datum is examined until it is at least 6 months old, she still did not seem satisfied. A DMQC expert should talk to her more and B. King has volunteered to do this.

H. Freeland talked to the Canadian ocean data assimilation group. They are using the GTS feeds almost exclusively and find it is nowhere near timely enough. They questioned my figure about 90% being available within 24 h and said that when they get data it is at least 3 days old. So, after further investigation, it was realised that they are not at a GTS node and thus data are passed through several hands inside Canada before they see the data. This does not need a response from Argo, it is an internal Canadian problem, but it is highlighted it here because the problem is likely not unique.

Gary Brassington had a comment on one slide concerning Argo, which read "*The latency and coverage of observations is limiting progress.*" So H. Freeland sat down with him to find out what he meant by that. He is concerned about how infrequently Argo floats sample the upper water column, the top 100 metres. This produced a mismatch between the observations (one per 10 days) and the information he wants which has a much faster time scale.

There were other reports (e.g. a very nice talk by Elisabeth Rémy) on the impact of Argo on assimilation and they agreed that Argo is essential. Elisabeth argued that adding more floats will help. Gilles Larnicol said that Argo is the single critical data type for seasonal prediction and is the only data set to constrain salinity.

> **Action item 27:** Ask GODAE OceanView for a list of models that are assimilating Argo data to update the operational use section of the AST website. M. Scanderbeg, P-Y. Le Traon

9.2 Argo bibliography

M. Scanderbeg reported close to 1600 papers have published since 1998 including Argo data with 287 papers in 2013. There have been over 200 papers per year since 2010. 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 come 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 450 papers in those three journals. Several other journals have a sizeable number of papers – between 20 and 50. 10 articles with Argo data have been published in Science and 11 in Nature. 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. 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.

This past year, a thesis citation list was added to the Argo webpage: http://www.argo.ucsd.edu/argo_thesis.html. It contains over 120 doctorate theses using Argo data and is based on both database searches and contributions from AST members. There are decent databases for the US and Canada and parts of Europe. 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 or argo@ucsd.edu.

9.3 Argo's DOI

The publication and citation of data from dynamic data such as Argo that grow and mutate with time was a topic that progressed significantly in 2013. A major advance was the documentation of approaches for publishing dynamic data by DataCite in July 2013 (via time slices, snapshots, or the use of access dates in citation). These methods were subsequently described precisely by the European EUDAT project as part of designing the requirements of a data infrastructure that supports the publication of dynamic data.

The first interim solution for the publication of the Argo data using snapshots of the Argo GDAC at Ifremer via multiple DOIs is operational. The Argo user manual and quality control manuals also now have DOIs assigned to them to ensure their long term availability and potential inclusion of the documentation DOIs in the Argo data files to ensure data are fully self-describing when assimilated into larger datasets. Full details on this are available on the Argo data management pages:
http://www.argodatamgt.org/Access-to-data/Argo-DOI-Digital-Object-Identifier

NODC is planning an approach that potentially allows the data to be published with a single DOI by citing time slices of their accession of Argo snapshots. This approach is being checked with members of DataCite before implementation. This can also potentially be implemented at the GDAC level.

The AST thanked J. Buck for his work on the Argo data set and DOIs and asked for continued updates on progress.

Action item 28: Advertise Argo DOIs among user groups and on Argo websites. M. Scanderbeg, other Argo website managers.

9.4 Argonautics Newsletter

M. Scanderbeg proposed publishing an Argonautics newsletter this summer as it is valued among the community and there are enough articles and items to fill a successful edition. There are several possible education and outreach articles including one on P. Flannegan's outreach work in connection with the Lady Amber as well as H. Freeland's PICES summer school session and P.M. Poulain's work with Lebanese scientists to re-redeploy a float. Perhaps an article on the Mon ocean et moi website will be included as well. Several developments have been made on the Deep Argo front and all are welcome to produce an article for inclusion in the newsletter. The new V3.0 files will be introduced along with the split into Core-Argo, B-Argo and M-Argo files and the data FAQ page that summarizes issues related to the Argo data set. The Argo thesis citation list can be highlighted as well as the Argo DOIs. Work done by G. Maze to develop an API based on data in the North Atlantic may be featured as well.

9.5 Upcoming science conferences and workshops

9.5a GODAE OceanView Workshop Nov 2014

P.Y. Le Traon informed the AST on the forthcoming GODAE OceanView OSE Task Team workshop to be held in Toulouse from November 12 to November 14. The workshop will cover recent OSE (Observing System Evaluation) and OSSE (Observing System Simulation Experiment) activities carried out by GODAE OceanView, CLIVAR/GSOP and E-AIMS group. Argo will be a key component and we expect that new results on Argo (impact, design) will be presented/discussed. AST members are most welcome to participate (please contact G. Larnicol and P. Oke – gilles.larnicol@cls.fr).

9.5b GO-SHIP

B. King presented the possibility of a combined Argo and GOSHIP science workshop sometime in 2015. There are many scientific topics of interest to both groups including:

- combining temporally sparse but exact along-track repeats (GOSHIP) with spatially/temporally distributed data (Argo)
- Use of Argo to inform representativeness of GOSHIP
- Analysis/uncertainty of WOCE/CLIVAR/GOSHIP cross-section transports
- Basin-scale inventories
- Biogeochemical inventories
- Upper half of ocean volume (Argo)
- Lower half of ocean volume (Deep Argo and GOSHIP)
- General ocean circulation

Topics more on the operational side would include investigating how to calibrate both Deep Argo data and Bio-Argo data use GOSHIP data and how GOSHIP data might give insights into the Deep Argo and Bio-Argo array design.

The AST strongly supported the idea and asked the Argo Director, H. Freeland, and B.King to reach out to GOSHIP and begin planning a workshop.

Action item 29: H. Freeland and B. King to investigate an offer from GO-SHIP to hold a joint Science Workshop. H. Freeland, B. King

9.5c Ocean Salinity Science and Salinity Remote Sensing Workshop

B. King drew attention to the Ocean Salinity Science & Salinity Remote Sensing Workshop which will take place at Met Office, Exeter, United Kingdom from 26 to 28 November 2014. The three day workshop is a meeting to the public with the goal to review progress and to identify challenges and benefits of SSS data. The abstract submission deadline is 30 June 2014. The website for the workshop is: http://oceansalinityscience2014.org/

9.6 Google Earth/ Argo API

M. Belbeoch showed the balloons he has developed for the Google Earth Argo layer. Instructions on how to use the layer are at: http://www.argo.ucsd.edu/Argo_GE.html. S. Diggs showed the Google Earth API his group has developed with allows all the same functionality of the Google Earth Argo layer, but without having to download Google Earth on your computer. A couple of other popular layers related to Argo were shown including “Drown your town” which used Google Earth to predict sea level rise and “Heatmap” by the University of East Anglia. There was a meeting between JCOMMOPS and a high level Google Ocean representative at UNESCO/IOC in December where the Argo layers were presented. While there was interest expressed by the Google Ocean representative, it may be difficult for UNESCO to sign off due to privacy concerns.

S. Diggs went on to show that the way that Argo data is served now is using old systems like FTP, HTTP, HTML, etc. He is suggesting moving towards an Application Programming Interface (API) like Argo France has developed for the NA-ARC that provides data mining functionalities for all Argo profiles localized in the NA-ARC region. This is a proof of concept of an Argo API for which the ultimate goal is to help research scientists engage with Argo data by providing mashups of information with regard to profile quality and space/time distribution before the ftp download of netcdf files. In other words, APIs distribute data and metadata. An API can quickly provide the number of temperature profiles in a region with a QC flag of 1. This type of information can be very useful to scientists who do not want to or cannot maintain their own mirror of the Argo dataset. As the number of files and size of files gets larger, an API will become more useful. JCOMMOPS also has an API (http://tinyurl.com/nmzcsba).

APIs are built on top of current data systems and need rich metadata which is already available for Argo. There will be a technical API meeting in Toulouse on 1-2 May 2014 where several groups including JCOMMOPS, CCHDO, NOAA OSMC, IOC, WMO, OOPC, etc. are meeting to analyze the needs and plan for development of APIs. Any AST collaborators are welcome to attend.

Action item 30: Ask for AST members to look at NA-ARC API & ask for scientists and technical people within Argo to go to May workshop to work on this. M. Belbeoch to circulate information on the workshop. AST members, M. Belbeoch

Action item 31: Ask for update on status of API at next AST meeting. M. Belbeoch, S. Diggs, G. Maze

9.7 Argo (review of major findings) in Nature Climate Change?

Originally it had been proposed that a review paper aimed at Nature - Climate Change be written focussing on the 1-millionth profile. This was some time ago and nothing was done. Freeland wrote to the editors of Nature and proposed a review paper using IPCC AR5 as the new "hook" to make the paper interesting and timely. The editors liked the idea and asked for a detailed outline. This was constructed between the co-Chairs, Argo Director and John Gould. The outline has been accepted and it is now time to construct the actual paper. This must be done soon. At AST-15 we decided that Howard Freeland and Steve Riser will draft the paper.

Action item 32: H. Freeland and S. Riser to write first draft of article for Nature Climate Change to circulate among AST. H. Freeland, S. Riser, AST members

9.8 Other Argo outreach activities

A. Fischer would like an Argo talk for the GOOS webinar series. B. King and S. Wijffels agreed to work together on this presentation.

H. Claustre gave a presentation on educational activities Bio-Argo has been involved in including the "mon Ocean et moi" website (http://www.monoceanetmoi.com/) and adopt a float projects. The motivation behind such outreach is that ocean science is not taught in French schools and there is a lack of interest in scientific careers among young French people. The thought was that robots that deliver real time information might be an effective way of engaging students in ocean science. The idea is for classes to adopt a BGC float and follow it along its scientific journey.

Scientists met with teachers to identify objectives and create a website with quizzes and games aimed at students who are 11 – 14 years old. There have been monthly meetings for six months to evaluate the website and improve the content. In addition, there is a social network where students can share their experiences and comment between classes. Five classes have participated in adopting a BGC float so far.

New topics are still being added to the website and graduate students are now being integrated into the program to continue developing resources and to answer student questions. There is interest in translating the website and collaborating at an international level.

Argo Australia along with IMOS have worked with an artist to put together a short educational animation about Argo for primary school children.

http://imos.org.au/argoanimation.html

This is freely available for use by Argo programs. Any interest in translations should contact Esmee.Vanwijk@csiro.au

> **Action item 33:** Give a GOOS webinar on the future evolution of Argo. B. King, S. Wijffels

> **Action item 34:** Add Mon ocean et Moi website to educational section of the AST website. M. Scanderbeg

10. Future meetings

10.1 ADMT-15

DFO, MEOPAR and Bio-Argo Canada have offered to host the ADMT-15 meeting in Ottowa, Canada. The tentative dates for the ADMT15 meeting are Nov 5 -7, 2014 with a Bio-Argo workshop on Nov 3-4, 2014. Contact Anh Tran (Anh.Tran@dfo-mpo.gc.ca) with questions.

10.2 AST-16

France offered to host the AST-16 meeting in 2015 in Brest, France.

11. AST memberships

No items were raised under AST membership at the meeting.

12. Other business

Throughout the meeting, the idea of statistics as indicators of Argo data quality surfaced repeatedly. AST members were asked to think about what these statistics might be and where they could be kept. B. King provided a list of possible ones at the end of the meeting including:

- Percentage of real time or delayed mode observations with QC = 1, 2, 3

- Percentage of observations with PSAL adjustments in ranges (eg -0.05, -0.01, 0.00, 0.01, 0.05)
- Percentage of observations with sizes of PSAL_ADJ_ERROR
- Percentage of observations with sizes of PRES adjustment and _ERROR
- Percentage of profiles reaching various pressures (0, 500, 1000, 1900)
- Indicator of vertical resolution, eg histogram of frequency with which a profile has a certain number of observations in a depth range (Number in upper 100, number in 100-500, number in 500-1000, number in 1000-2000)
- Indicator of longevity of float stability: histogram/cumulative distribution of how many cycles a float completes before the first non-zero adjustment

In the discussion that followed, it was suggested that it would take some work to write programs to create these statistics, but that it would be meaningful. The percentages could be sliced many different ways – eg globally, by basin, by DAC, by platform, by year, etc. There is also a question of where the statistics will be kept with the AIC being one possibility. The discussion ended with an agreement that B. King, M. Belbeoch and S. Pouliquen will decide how these indices will be calculated, how often and where they will be available. If anyone has suggestions for other indices, please send them to B. King.

Action item 35: B. King, Argo Technical Coordinator and S. Pouliquen to work out how to make Argo indices quality plots, how frequently to make them and where they will be stored. M. Belbeoch, B. King, S. Pouliquen

Action item 36: Forward other suggestions for data quality indices to B. King for inclusion in the list. AST members, B. King

Argo Steering Team Meeting (AST-15)
Halifax, March 17-20, 2012
Host: Institute for Ocean Research Enterprise

AST Exec meeting: 17 March 1 pm

AST-15: 18 March 9 am – 20 March 5 pm.

Day 1: Tuesday 18 March. Commercial Argo partners are welcome on Day 1

1. 9:00 Welcome (9 am March 18) (Jim Hanlon)

2. 9:10 Local arrangements

3. 9:20 Objectives of the meeting/adoption of the agenda

   Improving coordination and communications, within Argo and with commercial partners. (Discussion: Freeland)

4. 9:50 Status of action items from AST-14 (Scanderbeg)

10:20 Break

5. Implementation issues
   - 5.1 10:50 AIC Report on Status of Argo (Belbéoch)
   - 5.2 11:20 Update commitments table (Scanderbeg)
   - 5.3 11:40 Float deployment opportunities (Belbéoch)
   - 5.4 12:00 Tracking progress on original mission (Wijffels)
   - 5.5 Sparseness maps (P. Robbins)
   - 5.5 12:20 AIC Funding (Freeland)

12:30 Lunch

   - 5.6 2:00 JCOMM Observing Program Support Centre (Belbéoch)
   - 5.7 2:20 Cooperation US/Canada/Europe for the Atlantic Observing System and implications for Argo and Euro-Argo (P.Y. Le Traon, H. Claustre, S. Pouliquen)
   - 5.8 2:30 Bio-Argo/Biogeochemical Argo (Riser, H. Claustre)
   - 5.9 3:00 European activities: setting the Euro-Argo ERIC in 2014 and long term plans (P.Y. Le Traon, S. Pouliquen)
   - 5.10 3:10 Argo Canada (Gilbert)

3:30 Break

   - 5.11 4:10 Argo France (Maze)
   - 5.12 4:30 Discussion items from National Reports?

6. Data Management and related issues

6.1 4:50 Feedback from ADMT-14 (Thresher/Pouliquen, Scanderbeg)
6.2 5:20 B-Argo file structure (Thresher/Pouliquen/King)
6.3 Argo BUFR enhancements (J. Turton)

End of Day 1 (6:00 evening reception at Prince George Hotel)

6.4 CTD Reference data (Diggs)
6.5 Status of the trajectory data (Scanderbeg, ?)

7. Regional science, education and outreach
   - 7.1 Science presentation- Greg Smith & Denis Gilbert: Assimilation of Argo data into a global coupled air-ice-ocean model
   - 7.2 Science presentation- Igor Yashayaev: Study of Labrador Sea convection and circulation using Argo data
   - 7.3 "The South African Argo Research Program: Developments and educational considerations" (T. Morris)
   - 7.4 Report on PICES Summer School (Freeland)

8. Technical issues
   - 8.1 Float technology progress (Maze, Belbeoch, others?)
   - 8.2 Plan for Deep Argo deployment/calibration cruise (Roemmich, Maze)
   - 8.3 Deep Argo floats progress (Riser, Suga, others)
   - 8.4 Bio Argo progress (H. Claustre and Bio Argo groups)
   - 8.5 Calibration results on Druck pressure sensor (Wijffels, several?)
   - 8.6 Summary of the long-term practice of SBE41 sensor calibration using SBE's CTD calibration system in JAMSTEC (Hosoda)
   - 8.7 Micro-floats and floats from non-climate programs. What data should be included in Argo ? (Jayne)
   - 8.8 DMQC comparisons (King)

9. Completing the global mission
   - 9.1 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)
     - Deep Argo (Wijffels)
     - Western Boundary (Suga)
     - Equatorial (Roemmich, Ravi)
     - Caribbean Sea and Gulf of Mexico (Robbins)
   - 9.2 GOOS and OOPC update (T. Suga)

9.3 What are the EEZ issues for completing the global mission (Freeland, ?)

10. Demonstrating Argo's value
    - 10.1 Report on GODAE OV Symposium (Wijffels, Freeland)
    - 10.2 Argo bibliography (Scanderbeg)
    - 10.3 Argo's DOIs (Buck)
    - 10.4 Argonautics Newsletter (Scanderbeg)
    - 10.5 Upcoming science conferences and workshops –
        - a. GODAE OceanView workshop in Toulouse (12-14 Nov 2014)
        - b. GOSHIP (King)
        - c. Ocean Salinity Science and Salinity Remote Sensing Workshop (26-28 Nov 2014)
    - 10.6 Google Earth/ Argo API (Belbeoch, Diggs)
    - 10.7 Argo (review of major findings) in Nature Climate Change (Freeland)
    - 10.8 Other Argo outreach activities – GOOS webinar,

11. Future meetings
    - 11.1 ADMT-15
    - 11.2 AST-16
    - 11.3

12. AST Membership

13. Other business

Meeting adjourns Thursday 20 March, 5 p.m.

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	Action	Responsibility	Status
1	Write letter of thanks to local hosts Denis Gilbert, Jim Hanlon, Marlon Lewis, Cheryl Evans-Crowell	AST co-chairs	
2	H. Freeland to email float manufacturers and suggest that they make energy budget simulator software available	H. Freeland, Manufacturers	
3	AST can help manufacturers organize technical workshops around sensors/float types/etc. If interested, contact an AST member.	Manufacturers	
4	Circulate follow up email to manufacturers who attended AST-15 confirming offer to help organize technical workshops. Alert them to next Argo Science Workshop.	AST co-chairs	
5	Update technical mailing list through the AIC as a way to communicate with manufacturers	M. Belbeoch	
6	Identify AST members to become Wikipedia editors to translate Argo Wikipedia page into non-English languages.	T. Suga B. Klein L. Zenghong Euro-Argo	
7	M. Belbeoch, H. Freeland, M. Scanderbeg to investigate holding an Educational Outreach Workshop in conjunction with the AST-16 meeting in Brest, France	M. Belbeoch H. Freeland M. Scanderbeg	
8	Ask AST members to ensure their country has an active Argo focal point	AST members	
9	PIs consider using M. Belbeoch's text file format to update deployment plans	PIs	
10	S. Wijffels to work with M. Scanderbeg and M. Belbeoch on some simple changes to the existing Status Maps. Changes might include offering two plots – one for Original Argo and one for Global Argo.	S. Wijffels M. Scanderbeg M. Belbeoch	
11	If needed, H. Freeland to work with IOC, WMO, CLS to reconcile AIC finances	H. Freeland	
12	Ask CCHDO/NODC/Coriolis to include CTD data in the reference data base only if it was calibrated with bottle data.	CCHDO/NODC/ CORIOLIS	
13	CCHDO requests feedback on known cruises to track down as well as areas where DMQC operators need more recent data	CCHDO/AST members/ DMQC operators	
14	When recalibrated CTD data becomes available, replace it in the reference database.	CCHDO/NODC/ CORIOLIS	
15	Ask DACs to look at cycles recovered by J.P. Rannou during his work on ANDRO and reconcile with their files. Report progress at ADMT-15.	J.P. Rannou DACs	
16	Compile list of WMO numbers for floats with anomalous behavior in their traj files and distribute to DACs for further review.	M. Scanderbeg	
17	Ask ADMT to coordinate forming a working group to develop and document a delayed mode process for traj files	ADMT	
18	Ask I. Yashayaev to work with the NA-ARC to relay data quality assessment to DACs	I. Yashayaev G. Maze	
19	Put education lecture given by H. Freeland at PICES summer school on the educational section of the AST website	M. Scanderbeg	
20	Ask M. Belbeoch to put float lifetime statistics online by float	M. Belbeoch	

	type – including only Original Mission floats and the actual number of floats in addition to percentages. Consider separating APEX floats by alkaline and lithium batteries		
21	At AST-16 report on progress in testing new sensors including RBR, SBE61, SBE41 below 2000m	AST members	
22	S. Wijffels, S. Pouliquen to work on approach that is best to indicate to researchers that the data from Deep Argo floats below 2000m may not be acceptable for climate research. Circulate idea to AST & ADMT for approval.	S. Wijffels S. Pouliquen	
23	Collect independent data on the quality of CTD pressure calibration, analyze it, write it up, and post on various Argo webpages	S. Wijffels S. Riser	
24	S. Riser and G. Maze to draft recommendations on a global Deep Argo design target.	S. Riser G. Maze	
25	Ravi to report on impact studies in Indian Ocean	Ravi	
26	Investigate utility of task teams for Argo enhancements and what the AST would ask these task teams to do and how they would interact with the AST. Create a Terms of Reference/expectations for these task teams.	Bio-Argo: H. Claustre Deep Argo: S. Riser/G. Maze Marginal Seas: P-M Poulain WBC: B. Qiu, T. Suga, D. Gilbert, P. Robbins. High lat: B Klein can ask for a contact/SOOS for Antarctic.	
27	Ask GODAE OceanView for a list of models that are assimilating Argo data to update the operational use section of the AST website	M. Scanderbeg P-Y LeTraon	
28	Advertise Argo DOIs among user groups and on Argo websites	AST members M. Scanderbeg	
29	H. Freeland and B. King to investigate an offer from GO-SHIP to hold a joint Science Workshop	H. Freeland B. King	
30	Ask for AST members to look at NA-ARC API & ask for scientists and technical people within Argo to go to May workshop to work on this. M. Belbeoch to circulate information on the workshop.	AST members M. Belbeoch	
31	Ask for update on status of API at next AST meeting	M. Belbeoch, S. Diggs G. Maze	
32	H. Freeland and S. Riser to write first draft of article for Nature Climate Change to circulate among AST	H. Freeland S. Riser	
33	Give a GOOS webinar on the future evolution of Argo	S. Wijffels B. King	
34	Add Mon ocean et Moi website to educational section of the AST website	M. Scanderbeg	
35	B. King, Argo Technical Coordinator and S. Pouliquen to work out how to make Argo indices quality plots, how frequently to	M. Belbeoch B. King	

	make them and where they will be stored.	S. Pouliquen	
36	Forward other suggestions for data quality indices to B. King for inclusion in the list.	AST members B. King	

	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					16							
	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			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	17	79
Japan	116	51	44	82	127	73	40	89	123	54	29	67
Kenya												
Korea (Republic c	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		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		Notes
							Argentina	
60	2	56		3	18		Australia	
					10		Brazil	
	1	1		100		3	Bulgaria	3/yr 2015-2020
34		32		94	14		Canada	
							Chile	
40		8		20	30		China	
							Costa Rica	
							Denmark	
							Ecuador	
4	21	2	2	16		10	European Union	
	4	4		100		3	Finland	3/yr 2015-2020
65	15	65	16	101	70	10	France	80/yr 2015-2020
							Gabon	
38	7	31	7	84	51	20	Germany	40/yr 2015-2020
	3		2	67		6	Greece	5/yr 2015-2020
40		24		60	40		India	40 floats/yr 2012-2017
4		1		25	3		Ireland	3/yr 2015-2020
16	0	12		75		25	Italy	25/yr 2015-2020
70	33	43	35	76	50	38	Japan	
							Kenya	
16	0	16		100	16		Korea (Republic of)	
		1					Lebanon	
2		2		100	2		Mauritius	floats provided by UK, aim for up to 4 per year
							Mexico	
7		4		57	10		Netherlands	7/yr 2015-2020
2		2		100			New Zealand	
	3		1	33	3	3	Norway	3/yr 2015-2020
	1			0			Poland	1/yr 2015-2020
							Russia	
							Saudi Arabia	
10	3	0	2	0	6	0	South Africa	
3	3	1		17	2	3	Spain	3/yr 2015-2020
							Sri Lanka	
		4					Turkey	
38		36		95	38	17	UK	40/yr 2015-2020
							UN (ice tethered profilers)	
320		316	83	125	330		USA	
769	96	661	148	94	693	138		
865		809			831			
2013 estimated	2013 Argo equiv estimated	2013 Argo deployed	2013 Argo equiv deployed	% deployed vs. estimate	2014 estimated	2014 Argo equiv estimated		

Argo Australia – 2013 Activities

Report to the Argo Steering Team

Susan Wijffels, Ann Thresher, Esmee Van Wijk,
Jeff Dunn, Alan Poole, Craig Hanstein

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

Lisa Cowan, Ping Robertson
Australian Bureau of Meteorology

1. Status of implementation

Floats deployed and their performance

Australia currently has 387 floats actively reporting across the Indian, Pacific and Southern Oceans (Figure 1).

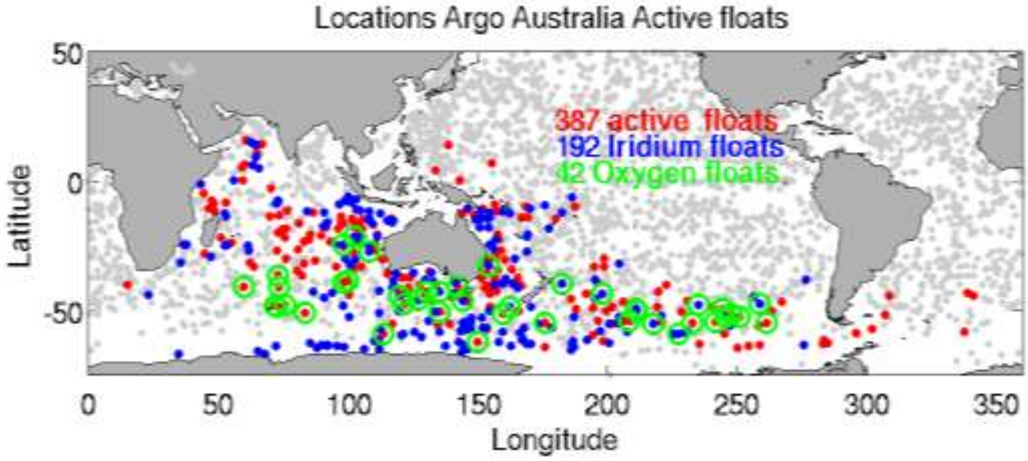

Figure 1. Locations of active Argo Australia floats (colours – defined as float reporting in the last 30 days north of 55°S, in the last year south of 55°S) as of February 2014 with active international floats in gray. Australian floats using Iridium Communications are in blue and those equipped with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

In the calendar year 2013, the program deployed 64 floats mainly spread throughout the South Pacific, Indian and in the Southern Oceans – though 3 failed on deployment. We have deployed a further 11 in 2014. Once again, on a joint US/Australia/New Zealand cruise, RV *Kaharoa* deployed floats for Argo Australia continuing her successful contribution to the program.

We have monitored Webb APF11, MRV Solo II and Seabird Navis floats which we deployed in 2012 as part of a 'Proof of Concept' (POC) trial of new float technologies. All of these floats were set to a 3 day mission. The Seabird floats were later reset to 10 day missions as a test of communications. The analysis of the POC floats is underway now and will determine our near-term future procurements.

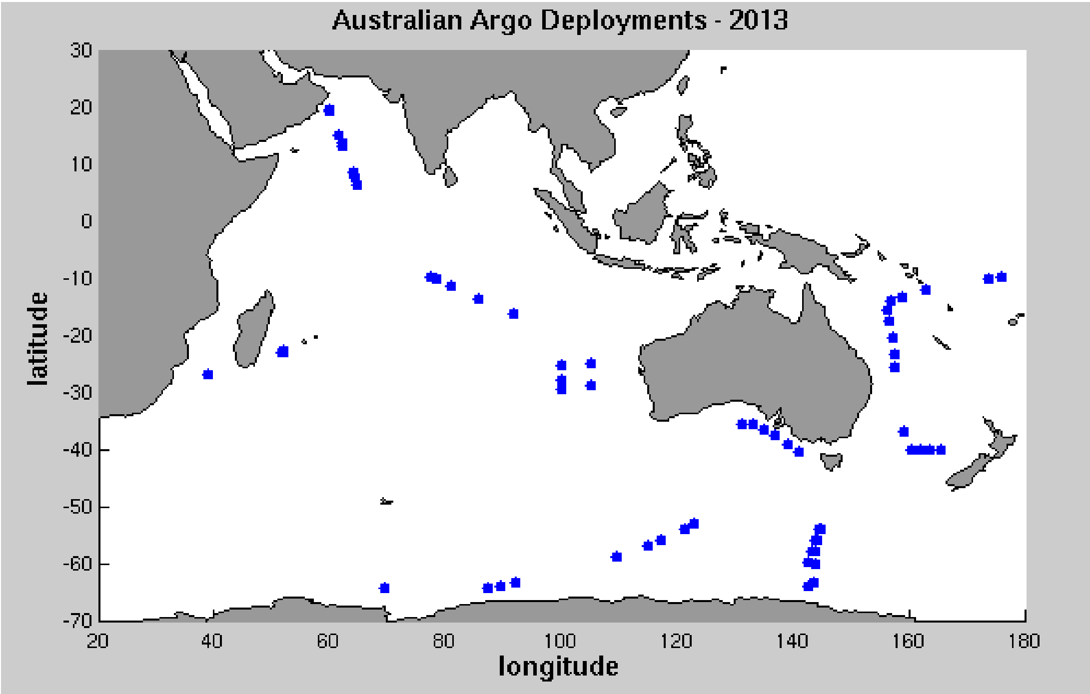

Figure 2. Locations of float deployments in 2013

Production of format version 3.0 files: Technical files in the V3.0 format were finished early in 2013. We began delivering V3.0 Profile files late in 2103 and are now about to begin production of V3.0 split Core and Bio files where applicable. Delivery will commence as soon as the GDACs are ready to accept these files. We are also making good progress towards production of V3.0 Trajectory files. Metadata files will be finished shortly, completing our transition to the new format.

Technical problems encountered and solved

Only 47 floats in our Iridium fleet have not been switched to RUDICS communications (they will be changed shortly – it was a provider issue and took us a long time to set up the RUDICS server with the local service). The changeover has decreased our costs significantly. Technical problems in the core fleet have been very few this year, aside from the Proof of Concept floats. 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.

We received credit from Seabird for 13 CTD heads as a result of the Druck microleak issue and those floats are being manufactured for delivery now.

<u>Float Failure Mode Analysis</u>

As of the 20th of February 2013, the Australian Argo program had deployed 620 floats. From the total number of floats deployed; 193 are dead. Of the remaining 427 operational floats, more than 95% are returning good data, 17 floats are producing suspect or bad data. Of the dead floats, 40% ceased to operate due to normal end of life when they ran down their battery packs. A further 13% died of unknown causes and 8% died on deployment. The remainder of floats ceased working mainly due to environmental reasons such as grounding (12%), leakage

(13%) or were lost in the ice (4%). Other contributing factors are summarized in the table below (note – these will not sum to 100% because some floats had multiple failure modes).

Float failure mode for dead floats	**Number of floats** (193)	**% of dead floats**
End of life	78	40.4
Grounded	27	14.0
Unknown	26	13.5
Leak	23	11.9
Died on Deployment	16	8.3
Lost under ice	13	6.7
Mechanical or software malfunctions	24	12.4
Float preparation errors	4	2.1

Summary of Technical Issues

We have returned 2 floats to the manufacturer (Teledyne Webb Research) with a pump piston over extension fault. Another had oil in the bottom of the float. These are being/have been repaired under warranty.

Except for some issues with the Proof of Concept trial, we have had a very good year with respect to technical performance.

Status of contributions to Argo data management

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

Collaboration with Argo India: The program has continued to work with the Indian Argo program, helping them code for new data formats and install DMQC processes. New and updated code is being shared as it is developed. They have now begun encoding BUFR messages as well.

Collaboration with KORDI: As with Argo India, we are delivering software with new formats as they are finalized. They are now using ArgoRT operationally and beginning the process of DMQC, after Esmee van Wijk worked with Moon-Sik during his visit at CSIRO.

Pressure Bias Audit: Most DACs are now compliant through a few small remaining issues are being chased up. Jeff Dunn retires shortly so pressure audits will probably cease. This means the DACs will need to be more vigilant as new float models come on line.

Metadata Standardisation: Esmee van Wijk, Ann Thresher and Matthieu Belbeoch (with the help of the broader Argo community and manufacturers) have been 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.

Status of delayed mode quality control process

Australian DM Statistics (as at 15/03/2013)		05/03/2014
D files submitted to GDAC	35796	38094
Total R files	35586	47971
R files eligible for DMQC	20150	32934
Total eligible files for DMQC	55946	71028
Total files at GDAC	71382	85905

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

The Australian Argo array continues to grow rapidly with a 50% increase in the total number of profiles delivered to the GDAC over the past two years. A total of 620 floats have been deployed to date since the beginning of the Argo program and 427 floats are still operational. As of 11/03/2014, 54% of eligible profiles (those that are greater than 12 months old) have been processed through delayed mode quality control.

In the next 12 months we will focus on revisiting the difficult floats that experience some type of salinity drift. We will also spend time on ensuring the software is robust enough to cope with new float types (Seabird Navis and Solo II and APEX APF11 floats) and data formats. More floats with biogeochemical sensors are being deployed and our data system needs to handle the data from these. Many new metadata and configuration variables are required for new float and sensor types. We also need to be able to process multi-profile files, and trajectory files through our software. With the increasing number of available Argo profiles globally we would like to invest more time into the development of Argo products.

The fraction of Delayed Mode profiles at the GDAC is decreasing each year, in line with the static resources for DMQC and the increase in the number of profiles to be assessed over the past few years. We are in the process of hiring a new person to work half time on Delayed Mode quality control and half time on the construction of a float database . This person will require training and some lead time to get up to speed. In addition, Tom Trull is hiring a new person (1 year contract) to QC oxygen data from the 62 floats with oxygen sensors. As our array size is now stabilizing (deaths =deployments), with the new manpower we hope to reach Argo delivery requirements.

In total 480 floats have been assessed through the DMQC process for drift of the salinity sensor, many of these are now assessed in routine maintenance mode. Of these, 10 floats (2%) returned no data from deployment and 10 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 460 assessable floats, 410 (85%) show no salinity drift for the life of the float. A further 40 floats (or 8%) show a positive salinity drift. Ten floats (2%) are affected by a fresh offset or biofouling. Most floats with either a salty or fresh drift were able to be corrected using the OW software. A further 16 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.

Detailed descriptions of the quality control process, including the data and plots for each float are available at the following CSIRO website:
http://www.cmar.csiro.au/argo/dmqc/index.html

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

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) 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 Division of Marine and Atmospheric Research, the Australian Climate Change Science Program, in kind assistance from the Bureau of Meteorology and also logistical assistance from the Royal Australian Navy. The renewal of the Antarctic Climate and Ecosystem Cooperative Research Centre will restore a key Southern Ocean contribution to Argo Australia through around 10 deployments per year, some of which may include deep Argo floats in the future.

EIF funding for Argo Australia ended in June 2013. The Australian government provided a lower level of bridging funds for July 2013-Dec 2014 under a stop-gap CRIS program (resulting in preserving the core activity but the loss a team member). Late in 2013 a new NCRIS program restored funding out to June, 2015. However, this remains short-term -18 months, with no guarantee beyond June 2015. This has been difficult to manage, particularly around maintaining staff. The new NCRIS funds have provided for much needed additional help with DMQC, though it has taken an excessive amount of time to get permission to hire someone due to an Australian government hiring freeze. Interviews will be held shortly and we hope to begin improving our DMQC throughput statistics this year. With IMOS funding and various partner contributions the program aims to achieve a deployment rate of 50 floats per year.

Through a new joint research project, Australia and India will deploy around 10-20 bio-Argo floats in the Indian Ocean in 2014-2015. These data will be passed through the Argo data system and will build our understanding of the sensors and data management challenges. PI's are Nick Hardman-Mountford and Tom Trull, CSIRO.

We will collaborate with US Argo, NIWA, New Zealand and SeaBird P/L in a test deployment and sensor comparison cruise for deep Argo floats and CTDs in June 2014.

Argo Australia has about 2FTE in data management, 1 FTE in technical support and preparation and 0.3FTE in leadership and management.

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

After a large deployment year, we have only 8 floats the laboratory and with only 2 with identified deployment opportunities. Once we take delivery 38 that are on order (3 as part of the Druck Microleak warranty replacements) we will work towards preparing and deploying these. RV *Kaharoa,* in partnership with US Argo and New Zealand's NIWA, will play a large part in our plans, deploying 18 floats into the South Indian Ocean. We will also rely on *l'Astrolabe* and *Aurora Australis* to deploy floats in the Southern Ocean. Our focus will be on the Indian Ocean this year after targeting the South Pacific Ocean last year.

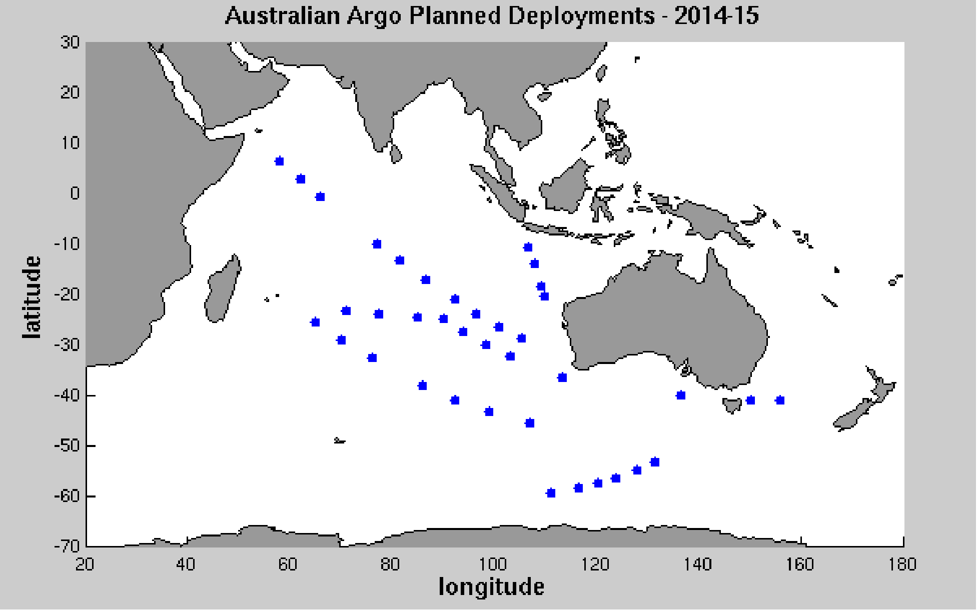

Figure 3. Proposed Locations of planned float deployments over the next year

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 great improves the analysis – Oscar Alves, Australian Bureau of Meteorology
- CSIRO Marine and Atmospheric Research, 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.
- Jeff Dunn is refining a global ocean climatology based on Argo data - http://www.marine.csiro.au/~dunn/cars2009/

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

Bio-Argo remains a challenge to our current data system. Splitting the files will definitely help.

6. CTD cruise for Argo calibration purposes

We've located a small number of CTD casts (max depth 1000m) from 2 voyages to the Southern Ocean Time Series mooring south of Tasmania. No other new data was available in the past year. In Australia we are between BlueWater research ships at present with the recent departure of the *RV Southern Surveyor* and delayed delivery of the new research vessel RV *Investigator*.

7. Argo Publications

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

2013 Argo Canada report of activities
(submitted by Denis Gilbert)

15th meeting of the Argo Steering Team (AST-15)
Halifax, Nova Scotia, Canada
March 2014

1. Status of implementation (major achievements and problems in 2013)

- floats deployed and their performance

In 2013, Argo Canada deployed 33 NOVA floats (14 in the northeast Pacific, 19 in the northwest Atlantic). Of these 33 floats, 2 did not report any data, and 5 floats died prematurely. The 26 remaining floats are still active and functioning properly.

- technical problems encountered and solved

We do not know the cause of premature float depths. This is unsolved.

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

ISDM (formerly MEDS) continues to acquire data from 100 active Argo floats. Of which 33 floats seemed to be in trouble and have not reported data for at least 6 months. Data are issued to the GTS and GDACs every 6 hours in TESAC, BUFR and netCDF format. We increase the frequency of data acquisition from the Argos server to hourly if we fail to access the system at a specific 6 hour interval. In 2013, Canada deployed 33 Nova floats from MetOcean. The data of all Canadian floats together with some graphics are posted on a website and updated daily:
http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/argo/index-eng.html.

On average 74% and 62% of data from January 2013 to February 2014 data were issued to the GTS within 24 hours of the float reporting in TESAC and BUFR format, respectively.

Since AST 14, we completed the following tasks:

- Developed the general decoder to handle old APEX format in order to reprocess data using Michel Ollitrault's method.
- Modified the current profile, technical, meta NetCDF format from version 2.0 to 3.0.
- Regenerated all of the profile and technical NetCDF files and resubmitted to GDAC.
- Migrated Canadian Argo product website from Pacific region to ISDM website.

- Modified the BUFR encoder to read NetCDF profile version 3.0 instead of version 2.0.
- Modified the density inversion QC test.
- The pressure is corrected automatically in real-time if needed.
- ISDM provides ADMT with quarterly reports on the performance of Argo data on the GTS in TESAC and BUFR formats.

\- <u>Status of delayed mode quality control process</u>

As of March 2014, 16% of all eligible floats, active and inactive, had their profiles QCed visually and adjusted for pressure and salinity according to the latest delayed-mode procedures. The salinity component of DMQC had been performed on 60% of all eligible cycles at least once.

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

<u>Financial resources</u>

Unlike some other countries participating to Argo, 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. Though the crystal ball for Argo Canada funding in 2014 and beyond remains opaque, we see more reasons for being optimistic than pessimistic. This cautious optimism has to do with the development of closer links between the Argo program and both the operational meteorology and operational oceanography R&D activities at the Canadian Meteorological Centre (Dorval, Québec). We are now starting to see some tangible benefits in terms of inter-departmental (Environment Canada, Department of National Defence, Fisheries and Oceans) cooperation and flow of money under the umbrella of the CONCEPTS (Canadian Operation Network of Coupled Environmental PredicTion Systems) memorandum of understanding. Environment Canada and Fisheries & Oceans Canada are collaborating in a pilot project to deploy POPS (Polar Ocean Profiling Systems) in the Arctic Ocean in August 2014.

<u>Human resources</u>

Five persons from the Department of Fisheries and Oceans perform the bulk of the work related to running the Argo Canada program. But all five have other work commitments in addition to Argo. In FTE (Full-Time Equivalent) units, these five persons are:

Anh Tran (ISDM, Ottawa, 0.9 FTE)
Mathieu Ouellet (ISDM, Ottawa, 0.1 FTE)
Igor Yashayaev (BIO, Halifax, 0.3 FTE)
Doug Yelland (IOS, Sidney, 0.3 FTE)
Denis Gilbert (IML, Mont-Joli, 0.9 FTE)
Howard Freeland (IOS, scientist emeritus, 0.2 FTE)

In addition to the above persons, we benefit from the technical support of sea-going staff (Marie Robert and Svein Vagle at IOS, Adam Hartling and Andrew Cogswell at BIO) that follow pre-deployment protocols and perform the float deployments.

As of now, we have not yet identified someone who would commit to maintaining some of the data products developed by Howard Freeland, such as surface circulation maps of the Gulf of Alaska, Argo data interpolated to station Papa and projected onto Line P. Howard is continuing to update these products, and recently reported a very warm SST field (+4 s.d.) in the Gulf of Alaska.

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 2014, we plan to deploy 14 floats. Four floats will be deployed in the Gulf Stream's northern recirculation gyre. Four floats equipped with oxygen sensors by Roberta Hamme (U Victoria) are planned for deployment in the Labrador Sea. Two Bio-Argo floats equipped with oxygen, nitrate, fluorescence, backscattering and optical sensors will be deployed by Marcel Babin's Takuvik group in Baffin Bay in July. To avoid being crushed by overlying ice, these two floats will have altimeters and shock sensors. Anh Tran plans to continue to provide ADMT with quarterly reports on the performance of Argo data on the GTS in TESAC and BUFR formats. Three POPS were ordered in December 2013 and are scheduled for August 2014 deployment from CCGS Amundsen in the Beaufort Sea. We currently have a single float left in inventory for deployment in the Gulf of Alaska.

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.

Environment Canada scientists Greg Smith and Mateusz Reszka 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 is expected to occur in October or November 2014. From that moment and onwards, Argo data will thus become part of the data assimilation schemes that are used in the production of weather forecasts in Canada. 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.

Nothing to report this year.

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, but ISDM hasn't done any update since 2012. In addition, when Steve Diggs finds that recent data from particular monitoring surveys are missing, he gets in touch with data management staff working at individual laboratories from the Department of Fisheries of Oceans. Scientists from BIO send data to CCHDO on an ongoing basis.

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

1. Donohue, S.M. and Stacey, M.W., 2013. Simulation of the 2001–02 Anomalous Intrusion in the Northeast Pacific. Atmosphere-Ocean, **51**, 541-560.
2. Freeland, H. J. 2013. Vertical velocity estimates in the North Pacific using Argo floats. Deep-Sea Res. II, **85**, 75-80. doi : 10.1016/j.dsr2.2012.07.019 (a special issue of Deep-Sea Research for Tom Rossby)
3. Freeland, H.J., 2013. Evidence of Change in the Winter Mixed Layer in the Northeast Pacific Ocean: A Problem Revisited, Atmosphere-Ocean, **51**, 126-133, doi:10.1080/07055900.2012.754330
4. Takeshita, Y.; Martz, T. R.; Johnson, K. S.; Plant, J. N.; Gilbert, D.; Riser, S. C.; Neill, C. & Tilbrook, B., 2013. A climatology-based quality control procedure for profiling float oxygen data J. Geophys. Res., **118**, 5640-5650.

Argo Chinese National Report 2013

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

1. The status of implementation

- floats deployed and their performance

From March 2013 to January 2014, China deployed 18 APEX floats in the northwestern Pacific and Indian Ocean. Among these floats, 16 were deployed by the Second Institute of Oceanography, SOA (CSIO), and 2 were deployed by the South China Sea Institute of Oceanology, Chinese Academy of Sciences (SCSIO, CAS). All these floats were manufactured by Teledyne Webb Research, in which 6 floats have the capability of two-way communication with Iridium satellites, and the other 12 floats use Argos satellites. All of the floats are installed SBE41 or SBE41 CP CTD sensors, in addition, 7 floats have the capability of sampling near-surface temperature. These floats were deployed through three cruises, i.e., 2 floats (purchased by SCSIO) were deployed by R/V "Shiyan-3" in last April; 6 floats (purchased by CSIO) were deployed by R/V "Haiyang-6" during 31 May-3 June 2013; 10 floats (purchased by CSIO) were deployed by R/V "Kexue" during December 2013-January 2014. One Iridium float (WMO number: 2901539) deployed during the second cruise failed to get GPS positions since its first cycle, the other floats can receive data and location information normally.

China Argo has deployed 171 profiling floats since 2002, and 83 floats were still active as of 5 Feb 2014.

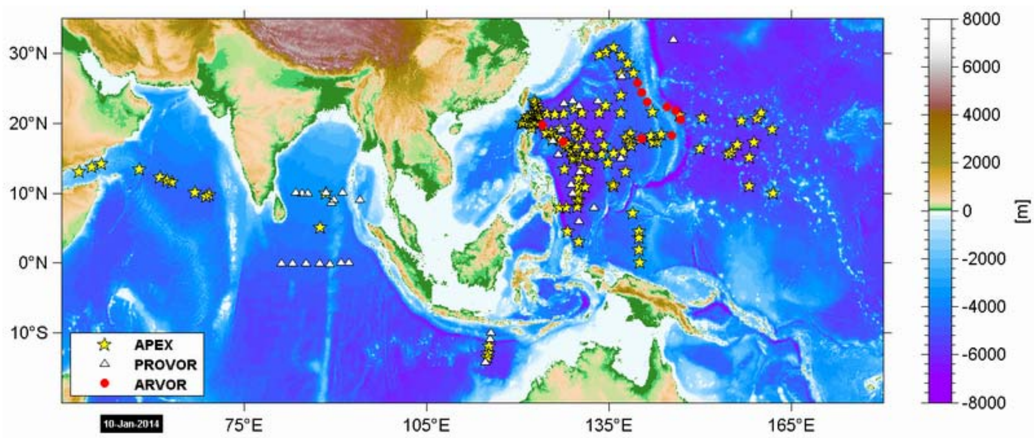

Fig.1 Launch positions of China Argo floats as of February 2014.

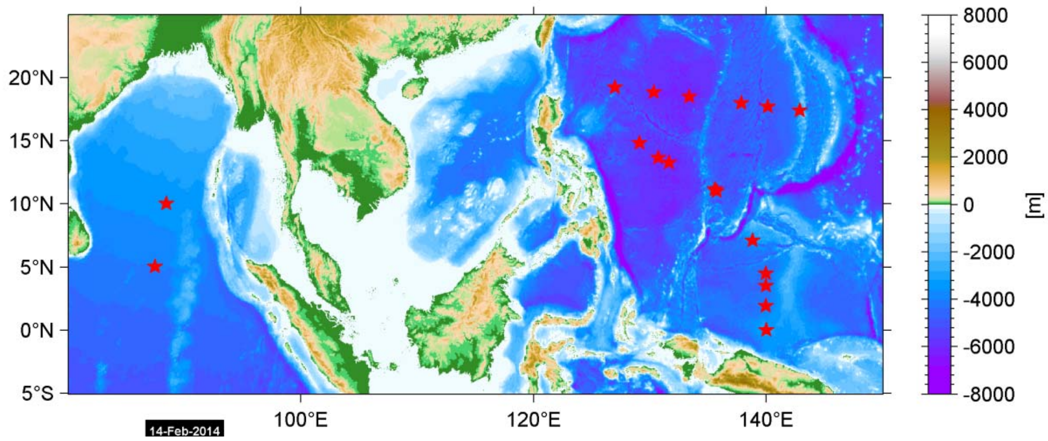

Fig.2 Launch positions of China Argo floats from March 2013 to January 2014.

- technical problems encountered and solved

No technical problems encountered except that two APF9a floats equipped with SBE41 CTD sensor (WMO number: 2901512 and 2901489) which were deployed in the Indian ocean in November 2011 and in the Pacific ocean in September 2012, respectively, were still reporting bad salinity measurements from their first profile. One Iridium float above mentioned (WMO number: 2901539) failed to get GPS positions. It seems that these faults of missing positions and bad salinity data are resulted from the problem of hardware. We hope that these problems could draw more attentions from the float or sensor's manufacturers. It's expected that the manufacturers could looking for and solve the problem in order to improve the use effect of the float.

In addition, different profiling floats have different encoding formats, which make us spend a lot of times to develop corresponding decoding software. Furthermore, it's easy to cause incorrect decoding problems and reduce the quality of observations. For example, the 17 Iridium PROVOR-DO-I floats (with O2 sensor) purchased by Ocean University of China (OUC) from NKE Instrumentation deliver data via SBD files (binary file) to user, so the user is forced to develop the appropriate software to decode those messages. Meanwhile, the SBD files are sent to user via email, which is bound to increase the difficulty and workload when user processes the data, and make it difficult to submit data to GDACs and GTS in real time. In addition, although ARVOR float that also developed by NKE uses hexadecimal encoding format, but it has a quite different and complicated format with PROVOR float from Metocean. Currently, the data decoding for those two types of float has got help from the technicians at Coriolis DAC. We take this opportunity to thank them all.

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

In 2013, China Argo submitted 3573 TS profiles (including 207 O2 profiles) to GDAC. Coriolis still helped us decode Argos messages from 8 active ARVOR floats because we haven't corresponding decoding software. All data were distributed on GTS by CLS.

From January 2014, CSIO updated most of the technical files and started to submit new version (format version 3.0) of profile files. The DOXY and near-surface temperature data have been incorporated into new profile files. CSIO also started to carry out real-time pressure adjustment from December 2013.

- status of delayed mode quality control process

Last October, China submitted 5,107 D-files to GDACs, and a total number of 11,673 D-files have been submitted from the beginning of China Argo. The DMQC operator of China carries out DMQC for all Argo data generally once per year. The surface pressure, CTM and OW corrections have been applied in our DMQC system. The lack of historical CTD data in the western boundary current region (e.g. Kuroshio) is the largest difficulty we encountered when we carry out DMQC.

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 still funded by research programs from Ministry of Science and Technology (MOST), State Oceanic Administration (SOA) and National Natural Science Foundation of China (NSFC). In 2013, some funds from China Academy of Sciences (CAS). So the number of yearly deployment is unstable because the purchase funding is depended on the actual allocated funding, usually in the 20-30. There are two groups maintained by CSIO and NMDIS, respectively. The China Argo Real-time data centre at CSIO is in charge of float purchasing, data receiving, processing and donating to AIC. Currently, there are 5 staffs working for this group. The China Argo data centre at NMDIS is in charge of processing data from floats deployed by East China Sea Branch, SOA, and data archives from Chinese floats.

In recent years, one problem that who will pay the satellite communication fee for the active floats after the research programs were finished was encountered. We are discussing solutions to the problem with the related operating division of SOA. The primary solution is that the operating division will allocate special funding each year used for continuing to receive and process data from those active 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.

We estimate that about 30 floats will be deployed in 2014. Of these floats, 17 floats are provided by a national basic research program from MOST undertaken by OUC, and the other 13 floats are provided by a national special key program for basic work from MOST undertaken by CSIO. One cruise has been confirmed, and will be undertaken by R/V "Dongfanghong-2" from OUC. It is scheduled that 17 PROVOR Iridium DO floats will be deployed in the North Pacific Ocean during March-April. In addition, CSIO will also deploy about 8 standard APEX floats through this cruise. All the data from these floats will be received and processed by CSIO, and shared with other countries.

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.

In order to prompt the research on ocean data assimilation and its operational use, as well as the application of the Argo data in oceanic and atmospheric sciences, CSIO held the 8th

workshop of Chinese ocean data assimilation & the 2nd Argo science workshop at Zhoushan, Zhejiang from 5 to 8 November 2013. 106 representatives from the 26 organizations participated in the workshops. Focused on the development of ocean data assimilation system, the study on theoretical methods and techniques of ocean data assimilation, the operational use of ocean data assimilation techniques, the progress on Argo ocean observing system, the application use of Argo data in the basic research, ocean data assimilation system and operational predicting and forecasting system, the development of Chinese autonomous profiling float, etc., the participants made conferences through oral presentations and posters. Among them, 23 representatives gave speeches. About 40 conference papers were submitted to the workshop, and more than 10 posters were put up. Abundant results acquired from the study on ocean data assimilation techniques and application use of Argo data in recent years were fully exhibited in this workshop.

Besides in the basic research of oceanic and atmospheric sciences, the Argo data and its products are also operationally used in the ocean and atmosphere predicting and forecasting models. 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. OVALS system has also been operationally applied in National Marine Environment Forecasting Centre (NMEFC), SOA, and also played an important role in operational El Nino monitoring and analyzing system. In October 2013, in China first global operational oceanographic forecasting system developed by NMEFC, the main data source of Argo data is assimilated into the system.

China Argo hasn't taken part in the activities of Pacific Argo Regional Center (PARC) until now. Currently, it looks like PARC didn't hold any meetings and activities.

There are two websites routinely maintained by China, one is maintained by NMDIS (www.argo.gov.cn) at Tianjin (China Argo data center), and another is maintained by CSIO (www.argo.org.cn) at Hangzhou (China Argo Real-time data center). Through them, 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

In November 2013, the AIC TC asked for comments about how to correctly use Argo label through email, and hoped to reach an agreement as soon as possible and drew up an implementation plan. We highly agreed with the opinion that "the Argo label should be used in agreement with the Argo programme". It's necessary to restate the principle and purpose of an earlier design Argo programme, so that the programme can be always along the right track for its sustainable development, this requires the efforts from all participating countries and PIs. Earlier, we have suggested China float producers not to call profiling float in development simply as "C-Argo". Only those floats purchased and used by China Argo project or the international Argo program participants are eligible to called "Argo profiling float". In other words, the floats that haven't participated in the Argo programme or haven't promised to share their data with the other member states are not allowed to paste Argo labels. As for the Argo label is pasted by the float suppliers, or by the manufacturers, we estimate that they are difficult to understand the real intention of purchasers. Therefore, we suggest that the PIs are responsible for the allocation of these labels, and supervise the float observations on which Argo label is stuck to be shared with all members. In order to help PIs and AIC coordinator effectively monitor the labeled floats, we suggested that a serial number should be printed on each label, and allocated to each member country in accordance with segmentation. As for the seven basic “best practices for Argo” TC mentioned that Argo operator should adhere to, it is very important for Argo’s sustain in a long term. For this reason, we suggest that not only the float operator who doesn’t adhere to the seven basic “best practices for Argo” is not allowed to paste Argo label, but also treated differently in terms of purchasing float and paying for satellite service in order to attract more countries and PIs to joining the Argo community.

In addition, considering the status of different data format used for different types of float, and confused use of hexadecimal and binary encoding, we suggest AST could urge float manufacturers to use the same data format, or use hexadecimal encoding at least, with adequately considering the limited human resource at each DAC.

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 the past year, we didn’t obtain any CTD casts because all of the float deployments were carried out by the opportunity ships. In 2014, we plan to conduct CTD observing during the North Pacific Ocean cruise which will be implemented by R/V "Dongfanghong-2". We will also take water samples, and measure water salinities using Lab salinometer to verify the reliabilities of CTD and conductivity sensors of the floats. All the CTD data will be timely submitted to CCHDO.

7. Keeping the Argo bibliography

Argo related academic papers:

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(2) Han, G., W. Li, X. Zhang, X. Wang, X. Wu, H. Fu, X. Zhang, L. Zhang, and D. Li, 2013: A new version of regional ocean reanalysis for coastal waters of China and adjacent seas, *Adv. Atmos. Sci.*, **30**(4), 974-982,**http://dx.doi.org/10.1007/s00376-012-2195-4**

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(4) Liu, Z., J. Xu, C. Sun, 2013: Combining sea surface height data with temperature profile data to estimate global upper ocean heat content anomaly, Journal of Tropical Oceanography (in Chinese), **32**(6), 9-15.

(5) Pan, J., and Y. Sun, 2013: Estimate of Ocean Mixed Layer Deepening after a Typhoon Passage over the South China Sea by Using Satellite Data, *J. Phys. Oceanogr.*, **43**(3), 498-506, http://dx.doi.org/10.1175/JPO-D-12-01.1
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(10) Zhang, H., G. Chen, C. Qian, and H. Jiang, 2013: Assessment of Two SMOS Sea Surface Salinity Level 3 Products Against Argo Upper Salinity Measurements, *Geoscience and Remote Sensing Letters, IEEE*, **10**(6), 1434-1438, http://dx.doi.org/10.1109/lgrs.2013.2259792
(11) Zhang, Z., D. Yuan, and P. C. Chu, 2013: Geostrophic meridional transport in tropical Northwest Pacific based on Argo profiles, *Chinese Journal of Oceanology and Limnology*, **31**(3), 656-664,http://dx.doi.org/10.1007/s00343-013-2169-0.
(12) Zhang, Z., Y. Zhang, W. Wang, and R. X. Huang, 2013: Universal structure of mesoscale eddies in the ocean,*Geophys. Res. Lett.*, **40**(14), 3677-3681, http://dx.doi.org/10.1002/grl.50736
(13) Zhang R., J. Zhu, J. et al., 2013: Argo global ocean data assimilation and its applications in short-term climate prediction and oceanic analysis, Chinese Journal of Atmospheric Sciences (in Chinese), **37** (2), 411–424.
(14) Zhang, W., R. Zhang, Y. An et al., 2013: Diagnostic calculation of three dimensions sea flow in the Pacific by P vector method on isopycnal surface, Chinese Journal of Hydrodynamics (in Chinese), **28**(1), 72-80.

Some Argo related doctoral dissertations:

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(2) AN Yuzhu, 2013. Study on the Upper Ocean Temperature and Salinity Characteristics Based on Argo Data, PLA University of Science and Technology, Nanjing, Jiangsu, China.
(3)ZHANG Weitao, 2013. Three-dimensional current field reconstruction based on Argo float data and satellite remote sensing data, PLA University of Science and Technology, Nanjing, Jiangsu, China.
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(5)WANG Huizan, 2011. Global temporal-spatial salinity variability, gridded salinity reconstruction and freshwater flux retrieval based on Argo network, PLA University of Science and Technology, Nanjing, Jiangsu, China.
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(7)ZHOU Hui, 2006. A study of some characteristics and variability of the North Pacific Western Boundary Current System, Ocean University of China, Qingdao , Shandong, China.
(8)CHEN Yide, 2006. Application Researches of Argo Data, PLA University of Science and Technology, Nanjing, Jiangsu, China.
(9)PAN Aijun, 2005. Subtropical Mode Water and its Formation Mechanism in the North Pacific, Ocean University of China, Qingdao, Shandong, China.

French National Report on Argo - 2013

Present status and future plans

Mar. 20th, 2014

G. Maze, C. Cabanes, C. Coatanoan, F. D'Ortenzio, N. Lebreton, S. Le Reste, P.Y. Le Traon, E. Mamaca, S. Pouliquen and V. Thierry

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1 BACKGROUND, ORGANIZATION AND FUNDING OF THE FRENCH ARGO ACTIVITIES

1.1 Organization

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

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

1.2 Funding

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

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

Since 2000, more than 757 French floats have been deployed in a number of different geographic areas. Deployments have been focused on meeting specific French requirements while also contributing to the global array.

To complement Argo, the NAOS[8] project (Novel Argo Ocean observing System, 2011-2019) has been funded by the Ministry of Research to consolidate and improve the French contribution to Argo and to prepare the next scientific challenges for Argo**.** The project provides an additional funding of 10 to 15 floats per year from 2012 to 2019, which allows Ifremer to increase its long-term contribution to Argo from 50 to 60-65 floats/year. NAOS will also develop the new generation of French Argo floats and set up pilot experiments for biogeogeochmical floats (Mediterranean Sea, Arctic) and deep floats (Atlantic). A European Research Council (ERC) advanced grant has also been obtained by LOV to work on the development of a biogeochemical component for Argo, the REMOCEAN[9] project (REMotely sensed biogeochemical cycles in the OCEAN, 2010-2015). Overall, as part of the NAOS and REMOCEAN projects, 150 additional floats should be deployed before 2019.

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

Year	**Funding**	**Man/Year**	**French floats**	**Co-funded EU floats**	**Total**
2000	300k€		11		11
2001	633k€	3	12		12
2002	980k€	6	7	4	11
2003	900k€	9	34	20	54
2004	1400k€	15	85	18	103
2005	450k€	15	89	11	100
2006	900k€	12	51	14	65
2007	900k€	12	36		36
2008	1200k€	12	90		90
2009	1200k€	12	35	8	43
2010	1400k€	12	55		55
2011	1400k€		53		53
2012	1400k€	12	82		82
2013	1400k€	12	81		81
Total (2000-2013)			*721*		**796**
2014	**1400k€**	**12**	**80**	**2**	**82**

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 2014.

1.3 Long term evolution of Argo

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

Based on Ifremer expertise in acoustically tracked Lagrangian floats named "Marvor", the PROVOR profiling float has been developed in the late 90s. In collaboration with the NKE[11] manufacturer, Ifremer has designed the ARVOR float to complete the float offer meeting the Argo requirements to the Argo community. When PROVOR leads toward a "multi-sensors" configuration, ARVOR tends to agree with performances improvement, easy deployment (lighter weight < 20kg) and costs reduction.

Since 2011, Ifremer together with NKE and CNRS is working on PROVOR/ARVOR floats improvement within the NAOS project in order to develop, validate and deploy the next generation of French Argo profiling floats. The new float capabilities include: longer life-time, more efficient design of the vehicle, improved transmission rates, integration of biogeochemical sensors, deeper measurements and under ice operations in the polar seas. In 2013, new prototypes have been completed.

The ARVOR 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. Improvements also include user driven possibilities such as being able to bind on a single float two missions (for Argos transmission system) with different parameters. 5 of these ARVOR floats will be tested at sea in 2014. The implementation of an oxygen measurement on ARVOR is still on going. As part of the E-AIMS[12] EU project, a 4330 Anderaa optode and a SBE63 oxygen sensor will be mounted on a single float for comparison.

Improving Argos satellite transmission has been one of our concerns, with the objective to transmit a complete Argo profile on a single satellite pass and to remotely control the float. Confirmation of this capabilities has been given by the experiment of an ARVOR fitted with Argos3 in the bay of Biscay during one year: at the end of 2013, about 140 cycles have been done by synchronizing its surface time with satellite pass and transmitting Argo profiles (CTD 100 points) spending 10 minutes. Energy balance is divided by five compared to an Argos-2 transmission, the transmission cost is reduced and the battery life is increased by 25%. The next step is to assess this transmission in marginal seas (e.g Mediterranean area).

The development of the ARVOR deep model has continued in 2013. The 2nd deep ARVOR prototype, deployed at sea in October 2012, was recovered in February 2013 after presenting an intermittent communication failure due to a manufacturing defect on the Iridium antenna. The profiler was reintegrated and then redeployed in November. At the end of February 2014, 50 cycles (two days period) have been performed. 2 other prototypes made by NKE will be delivered in March and will be deployed in the Atlantic Ocean during the GEOVIDE cruise (June-July). The expected performance of the deep ARVOR is at least 150 cycles to 4000 m depth. Deep ARVOR is fitted with an Aanderaa optode as well as high sampling capabilities. A pilot experiment will start from the end of the year using about 20 deep ARVOR floats in North Atlantic Ocean.

Another main aspect of the development concerns the bio-geochemical applications which are embedded on the PROVOR float. These developments focused on the addition of extra sensors by designing electronic architecture evolution (separation of vector management board from measurement board). This work first led to the PROVOR CTS4 (named ProvBio float). Then, additional work has been done by CNRS and NKE in order (i) to have a float being able to perform different cycle schemes than the standard Argo ones, and (ii) to modify its programmed mission itself depending on measurements or on results of mixed measurement computations. This PROVOR CTS5 float has been successfully tested at the end of 2013 and will be used in the Arctic area next year.

3 THE STATUS OF IMPLEMENTATION*

3.1 Floats deployed and their performance

81 floats have been deployed in 2013 (see Figure 1 and Figure 2). The deployment areas are chosen to meet French requirements in terms of research and operational activities (Atlantic, Indian and Southern Oceans) but also to contribute to establishing the global array (especially in the Southern Ocean).

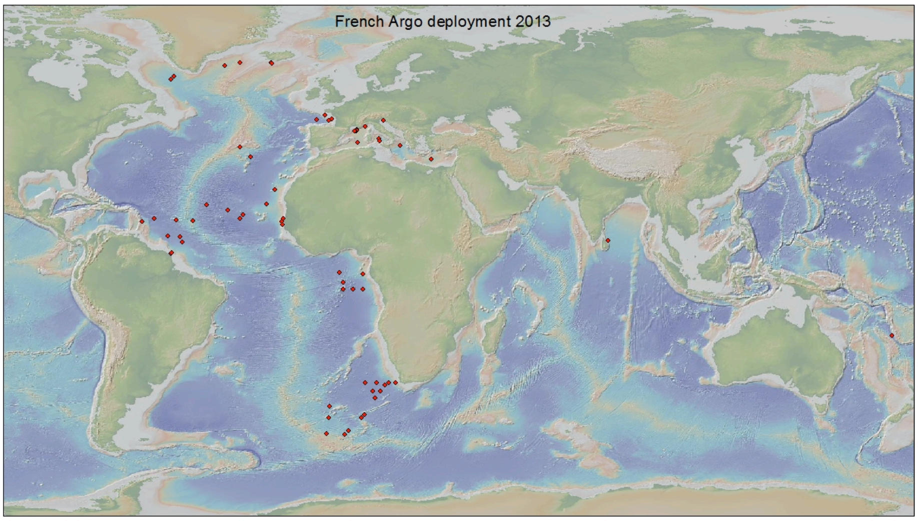


Figure 1: Deployment positions (red marks) of the 81 French floats deployed in 2013.

* Major achievements and problems in 2013

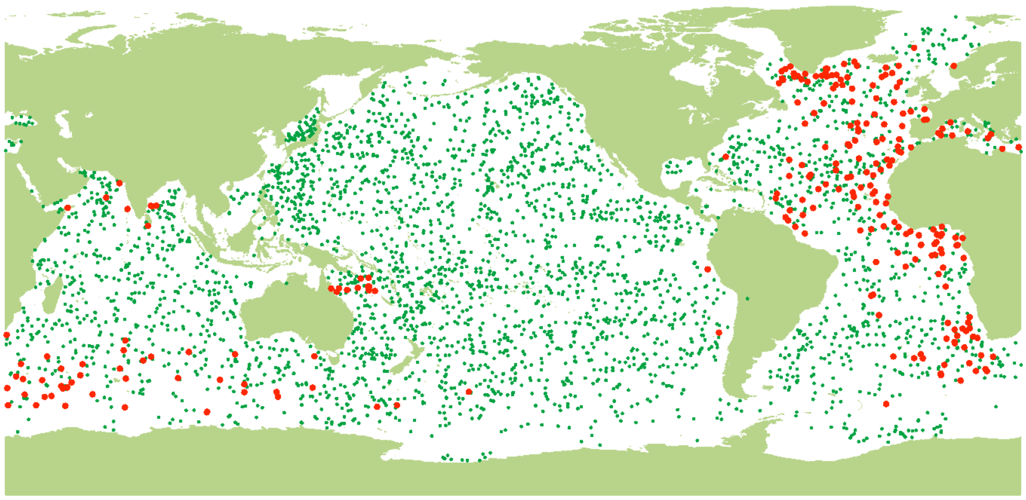


Figure 2: Positions (red marks) of the French active floats as of Feb.10th, 2014.

3.2 Technical problems encountered and solved

In 2013, ARVOR floats bought by IFREMER (30), SHOM (13) and project NAOS (30) were equipped with a new software version. This version turned out to be carrying a bug between date management and response of SBE sensors. This resulted in the loss of 10 ARVOR floats early in 2013, most of which deployed in the South Atlantic during the annual Goodhope cruise.

This problem led to the temporary suspension of the deployment of floats equipped with this software version. A new software version with the bug fixed, has been developed and ported to all the floats already received and accepted. Deployments have resumed once possible.

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[13] (French only).

Since October 2013, data from the PROVOR Remocean project are processed in real-time. A work is underway among Argo data management group to integrate these data in the Global Data Assembly Centre (GDAC). The data from Provor Remocean floats are available by ftp:

ftp://ftp.ifremer.fr/ifremer/argo/etc/coriolis-custom/probio-draft

In December 2013 the ftp server counted 40 floats and 3421 vertical profiles. The data available from the above ftp server are a first trial to manage data from advanced bio-Argo floats. A series of Probio-Remocean floats are deployed and sending data.

3.3.1 Data Assembly Center[14]

Coriolis processes in Real Time and Delayed Mode float data deployed by France and 7 European countries (Germany, Spain, Netherlands, Norway, Italy, Greece, Bulgaria). Coriolis data center processes data coming from 21,954 profiles from 657 floats including 116 active floats in February 2014 (see Figure 3). In addition to these 657 floats, Coriolis is 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 biogeochemical measurements. Data are processed and distributed according to Argo recommendations.

Real time profiles are available in Argo NetCDF V3.0, delayed mode profiles are still in Argo NetCDF V2.4 format. Since May 17th 2013, the new profile files from Coriolis DAC are distributed in Argo NetCDF version 3.0. On October 7th 2013, all the existing real-time profile files from Coriolis DAC where transformed into version 3.0 files (43 964 files resubmitted). To convert the remaining delayed-mode profile files to version 3.0, a patch is under development. In version 3, profile files report a vertical sampling scheme. On October 2013, Coriolis data files reported 14 different vertical sampling schemes.

More details on the new format an its adoption process by Coriolis DAC can be found here:

News from May 17th, 2013: http://www.argodatamgt.org/Data-Mgt-Team/News/Coriolis-DAC-real-time-data-distributed-in-Argo-NetCDF-3.0

News from Oct. 9th, 2013: http://www.argodatamgt.org/Data-Mgt-Team/News/Coriolis-DAC-all-real-time-profiles-converted-in-Argo-NetCDF-3.0

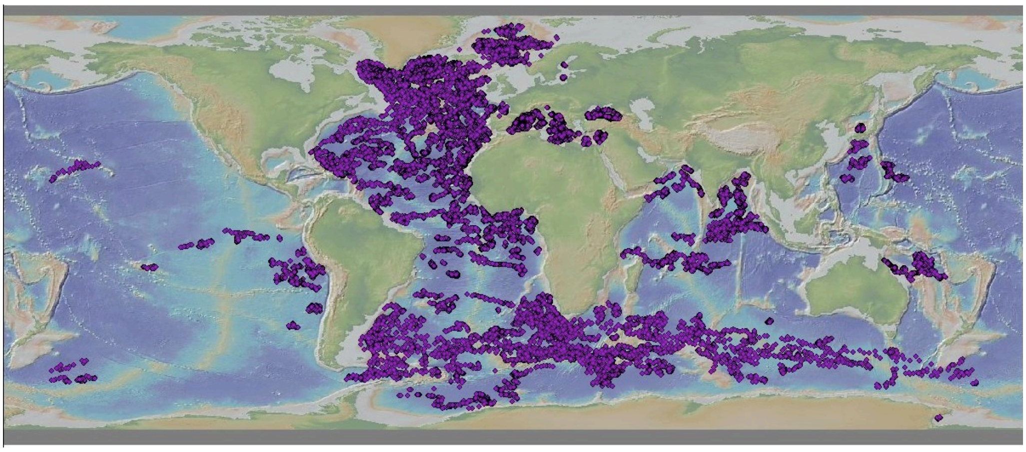


Figure 3: Maps of the 21 954 profiles from the 657 floats managed by Coriolis DAC in 2013.

3.3.2 Global Argo Data Centre[15]

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 4).

From January to November 2013 the ftp server was available for 99.992% of the time (compared to 99.98% last year). The 0.008% of failure represents 31 minutes of interruption (compared to 1 hour 52 minutes and 54 seconds last year).
The main problem occurred on week 34, in August 2013. The ftp server failed down, but was reactivated on another node of the cluster.

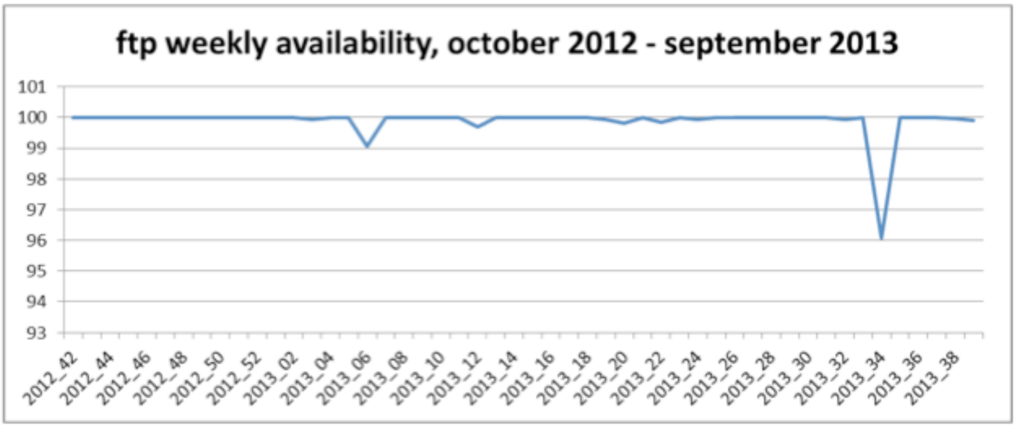


Figure 4 : Nagios monitoring: between October 2012 and September 2013.

3.3.3 North Atlantic Argo Regional Centre[16]

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 meta data about Argo profiles in the North Atlantic region (http://api.ifremer.fr/naarc/v1).

3.4 Status of delayed mode quality control process

In 2013, a total of 16 429 new delayed mode profiles where produced and validated by PIs. The number of delayed mode profiles increased by 15%. A total of 111 595 delayed mode profiles where produced and validated since 2005 (see Figure 5). In February 2014, 71% of the floats and 74% of the profiles processed by the Coriolis DAC were in delayed mode, compared to 69% and 73.6% last year, respectively (see Figure 6).

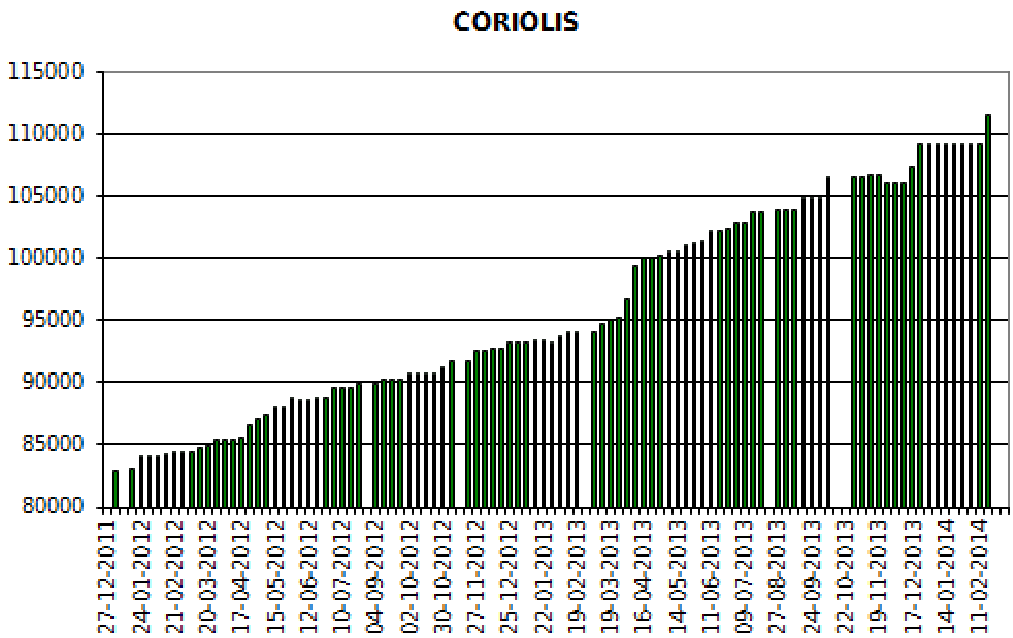
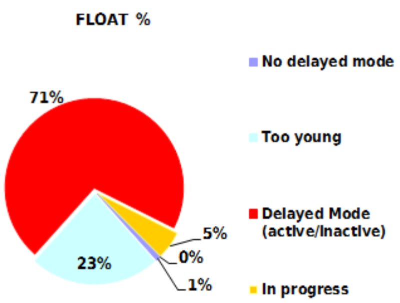


Figure 5: Evolution of the DM profiles' submission versus dates



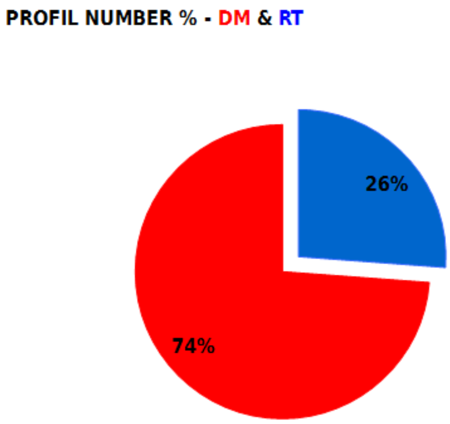


Figure 6 Status of the floats processed by Coriolis DAC. Left: in terms of float percent and right: in terms of profile percent (DM : delayed mode – RT : real time).

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

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

According to the current deployment plan, 80 floats will be deployed in 2014. They will be deployed in 2014 in the Mediterranean Sea, in the North and the South Atlantic Oceans, in the Southern Ocean and in the Indian Ocean. during the following cruises:

- GMMC PIRATA: Guiny Gulf (6 floats)
- "Voiles sans frontières": Bay of Biscay and West Africa (10 floats)
- GMMC ZEBRE: New Caledonia (7 floats)
- GMMC AMOP: Off the coast of Peru (9 floats)
- GMMC GEOVIDE: North Atlantic (11 floats)
- GMMC MOOXY: Mediterranean Sea (7 floats)
- GMMC SAGAR: Gulf of Bengale (6 floats)
- GOODHOPE Opportunity: Southern Ocean, Atlantic sector (10 floats)
- SHOM Opportunity: Persian Golf (2 floats)
- Opportunity: Atlantic Ocean (12 floats)

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.

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

5.1 Operational ocean forecasting

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

5.2 Support to the Mercator and Coriolis scientific activities

Coriolis has developed together with MERCATOR (The French operational oceanography forecast center) a strong connection with the French research community via the Mercator-Coriolis Mission Group (GMMC). It consists of about one hundred researchers (with some turnover each year) following a scientific announcement of opportunities and call for tender. Its task is to support the Mercator and Coriolis scientific activities and to participate in product validation. The call for tender proposes to the community "standard"

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

Argo floats as well as floats equipped with oxygen and biogeochemical sensors. These new opportunities strengthens ties between the French scientific community and Coriolis with regard to the development of qualification procedures for "Argo extensions" floats.

In 2012, MERCATOR-Ocean support organisms ask the GMMC scientific committee for a prospective report covering all national operational efforts. The goal was to identify a common vision of the challenges and research activities to conduct over the next 10 years, taking into consideration the European context and previous national efforts. The final prospective report was publicly released in October 2013. The report contains about 20 recommendations and 10 new challenges, among which one can note the strong proposition to develop the multidisciplinary dimension of operational oceanography through: an improved and more homogeneous multiscale integration, an extension of the essential variables to estimate toward biology and biogeochemistry, and a shift from forced to coupled systems. More details on the prospective can be found here (in French):
http://www.mercator-ocean.fr/fre/science/gmmc/Prospective-Oceanographie-Operationnelle

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 2013's publications involving Argo data and a scientist from a French laboratory is reported. We cannot report here on all those studies' results, so we selected three of them particularly highlighting French activities on Argo data use (i) to reconstruct the 3D velocity field, (ii) to validate satellite data and (iii) to improve phytoplankton phenology.

➤ A significant research effort has been toward the description and analysis of the ocean circulation inferred from Argo data. They are synthesized in a study published by M. Ollitrault and A. Colin de Verdière in Journal of Physical Oceanography this January 2014. The mean ocean circulation near 1000-m depth was estimated with 100-km resolution from the Argo float displacements collected before 1 January 2010 (see Figure 7). After a thorough validation, the 400 000 or so displacements found in the 950–1150 dbar layer and with parking times between 4 and 17 days allowed the currents to be mapped at intermediate depths with unprecedented details. The Antarctic Circumpolar Current (ACC) is the most prominent feature, but western boundary currents (and their recirculations) and alternating zonal jets in the tropical Atlantic and Pacific are also well defined. Eddy kinetic energy (EKE) gives the mesoscale variability (on the order of 10 cm2 s22 in the interior), which is compared to the surface geostrophic altimetric EKE showing e-folding depths greater than 700 m in the ACC and northern subpolar regions. Assuming planetary geostrophy, the geopotential height of the 1000-dbar isobar was estimated to obtain an absolute and deep reference level worldwide. This was done by solving numerically the Poisson equation that results from taking the divergence of the geostrophic equations on the sphere, assuming Neumann boundary conditions.
For more details: Michel Ollitrault and Alain Colin de Verdière. (2013). The Ocean general circulation near 1000 m depth. *Journal of Physical Oceanography*. doi:10.1175/JPO-D-13-030.1

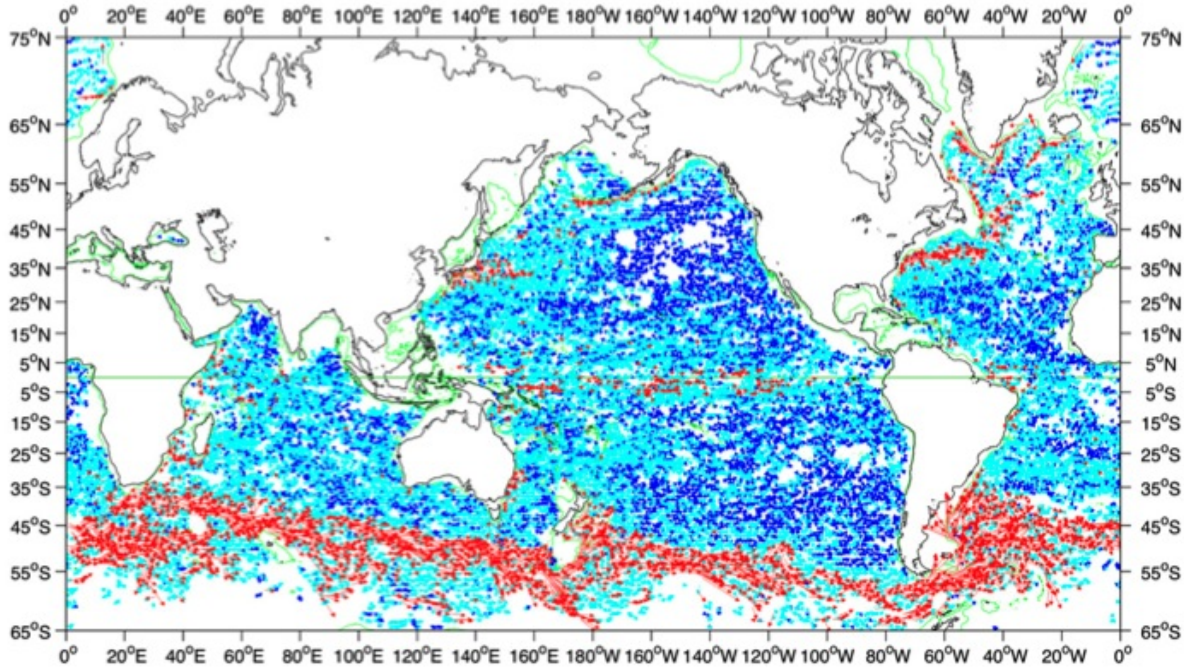


Figure 7: Average currents within 150-km-diameter disks, in the layer 950–1150 dbar and with at least 90 float days. Currents with speed greater than 5 cm.s^{-1} (red) are represented as 45-day displacements. Currents with speed less than 1 cm.s^{-1} (blue) are given as 90-day displacements. Currents with in between speeds (cyan) are shown as 45-day displacements.

➤ Argo data are also used intensively by Jacqueline Boutin and the Soil Moisture and Ocean Salinity (SMOS) scientific team to validate salinity measurements from the satellite mission and also surface drifters. They showed that biases close to land and ice from the sea surface salinity (SSS) measured from space by the SMOS mission greatly decrease with respect to the previous version. The accuracy of SMOS SSS averaged over 10 days, 100 × 100 km^2 in the open ocean and estimated by comparison to ARGO SSS is on the order of 0.3–0.4 in tropical and subtropical regions and 0.5 in a cold region. The averaged negative SSS bias (−0.1) observed in the tropical Pacific Ocean between 5◦ N and 15◦ N, relatively to other regions, is suppressed when SMOS observations concomitant with rain events, as detected from SSM/Is (Special Sensor Microwave Imager) rain rates, are removed from the SMOS–ARGO comparisons. The SMOS freshening is linearly correlated to SSM/Is rain rate with a slope estimated to −0.14 mm^{-1} h, after correction for rain atmospheric contribution. This tendency is the signature of the temporal SSS variability between the time of SMOS and ARGO measurements linked to rain variability and of the vertical salinity stratification between the first centimeter of the sea surface layer sampled by SMOS and the 5 m depth sampled by ARGO. However, given that the whole set of collocations includes situations with ARGO measurements concomitant with rain events collocated with SMOS measurements under no rain, the mean −0.1 bias and the negative skewness of the statistical distribution of SMOS minus ARGO SSS difference are very likely the mean signature of the vertical salinity stratification. In the future, the analysis of ongoing in situ salinity measurements in the top 50cm of the sea surface and of Aquarius satellite SSS are expected to provide complementary information about the sea surface salinity stratification.

For more details: J. Boutin, N. Martin, G. Reverdin, X. Yin, and F. Gaillard. (2013). Sea surface freshening inferred from SMOS and ARGO salinity: Impact of rain. *Ocean Sci.* doi:10.5194/os-9-183-2013

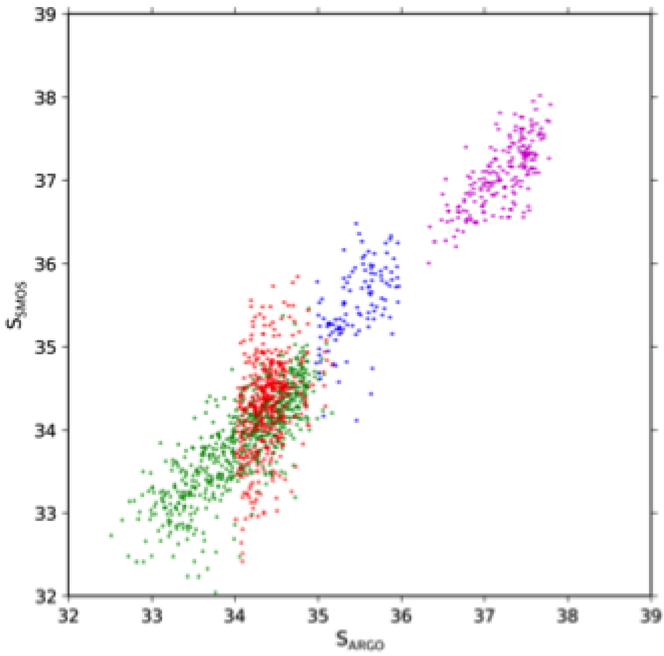


Figure 8: Scatter plot of SMOS SSS versus ARGO SSS for various regions (green: tropical Pacific Ocean; purple: subtropical Atlantic Ocean; blue: Soutern Indian Ocean; red: Southern Pacific Ocean).

➤ Phytoplankton phenology is primarily affected by physical forcing. However, its quantification is far from being completely understood. Among the physical forcing factors, the mixed layer depth (MLD) is considered to have the strongest impact on phytoplankton dynamics, and consequently, on their phenology. The role of MLD variations in shaping the phytoplankton phenology was explored in the Mediterranean Sea, a basin displaying contrasting phenological regimes. A database of MLD estimations was merged with ocean color chlorophyll concentrations ($[Chl]_{SAT}$) to generate concomitant annual MLD and $[Chl]_{SAT}$ cycles. Several indices were calculated to quantitatively analyze these cycles. The relevance of indices summarizing the temporal difference between main characteristics of MLD and $[Chl]_{SAT}$ cycles was emphasized. As previously observed, two dominant phenological regimes coexist in the Mediterranean Sea (see Figure 9). The first is marked by a typical spring bloom, as in temperate regions. The second displays a low seasonality and an absence of an intense $[Chl]_{SAT}$ peak as in subtropical areas. The MLD is shown to play a key role in determining the dominant phenological regime in a given area. Results also show that regions having low seasonality display concomitant MLD and $[Chl]_{SAT}$ maxima, whereas $[Chl]_{SAT}$ peaks are generally observed 30 days after MLD peaks in regions with strongest seasonality. Over the whole basin, $[Chl]_{SAT}$ increase starts 1 month after the initiation of MLD deepening. Finally, after examining the impact of MLD on light and nutrient availability for phytoplankton, mechanisms were proposed to explain the time lags between MLD and $[Chl]_{SAT}$ increase and MLD and $[Chl]_{SAT}$ maxima.

For more details: Lavigne, Héloïse and D'Ortenzio, Fabrizio and Migon, Christophe and Claustre, Hervé and Testor, Pierre and d'Alcalà, Maurizio Ribera and Lavezza, Rosario and

Houpert, Loïc and Prieur, Louis (2013): "Enhancing the comprehension of mixed layer depth control on the Mediterranean phytoplankton phenology", *Journal of Geophysical Research: Oceans*, doi: 10.1002/jgrc.20251.

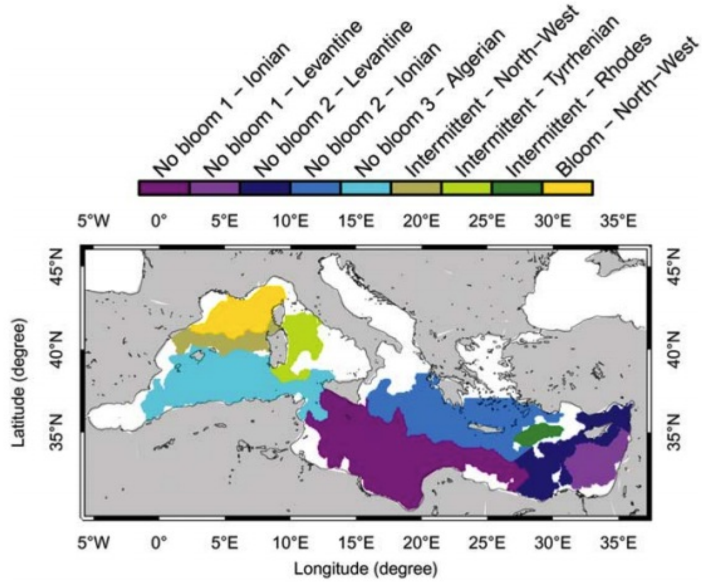


Figure 9: Spatial bioregions distribution of D'Ortenzio and Ribera d'Alcala (2009), redrawn for the purpose of the Lavigne et al. (2013) analysis.

French-Argo meeting: The French Argo Users' Group provides a forum for engagement between these scientists and the French Argo program. In 2013, French Argo Users met as part of the 4th Euro-Argo Science Meeting that was held in Southampton 18-20 June 2013.

5.4 Argo-Regional centre: North Atlantic

In 2013, we continued to investigate the performance of the OW method in the North-Atlantic. Our objective is to propose a cookbook on how to use OW to detect and correct salinity sensor bias or drift in the North-Atlantic.

We have modified the OW method in order to better take into account the large decadal/ interannual variability that was shown to induce spurious corrections with the standard OW method settings. Particularly, we have added a Gaussian decay with a time scale of 2 yr when computing the covariance matrix that is used to estimate the large scale field at the float profile position. Thus it is given greater weight to contemporaneous reference data. The original OW method takes into account the temporal variability but only when the small scale field is estimated and the large scale field is assumed to be constant. We have also modified the way the error on the best linear piecewise fit is computed. Indeed, errors on the fit are more realistic when a lateral covariance of mapped errors is taken into account.

The modified OW method was run for a subset of unbiased floats with a time scale of 2 years. The corrections proposed are less systematically biased (see Figure 10) although in some regions it may have been necessary to modify the configuration parameters (i.e. chosen θ levels) to obtain corrections closer to zero. Most of the offset proposed by the method are now close to zero within the error bar, which is much more consistent with the PI's decision for these floats.

Finally, we have checked again the correction for 186 floats corrected in delayed mode for a salinity offset or drift. Among these floats, we have found 32 floats for which we think it is necessary to revise the DM correction. 21 floats have been checked again by the PI, the correction has been modified and transmitted to the DAC. 15 floats have been checked again by the PI, the correction has been modified but not yet transmitted to the DAC. The others floats have not been checked again yet. The full list of these floats will be found soon on the NA-ARC website.

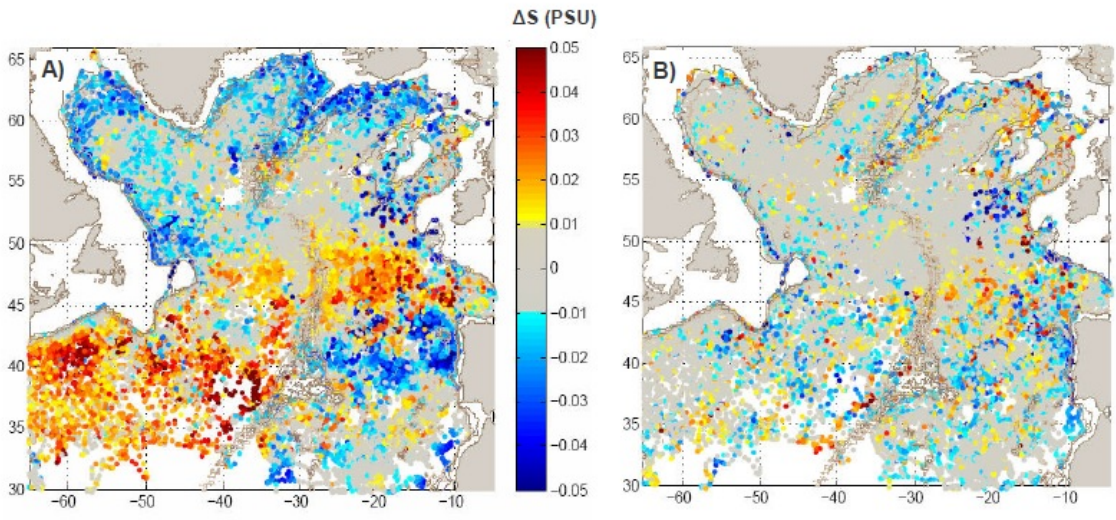


Figure 10: Corrections proposed by the OW method for all floats for which no salinity correction was judged necessary by the PIs. A) CTD reference database is used for calibration. B) Argo and CTD reference databases are used for calibration and a Gaussian decay with a time scale of 2 yr is added when the large scale field is estimated.

The expertise acquired during this study is also being used at Coriolis and LPO for delayed mode quality control of French Argo floats localized in the Southern Ocean. A diagnostic of the OW method under two different configurations is performed and improvements will be proposed in 2014.

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.

None.

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.

The number of CTD cruise data uploaded by PIs within France in 2013 to the CCHDO website is not known.

In March 2013, a new version of the Argo CTD reference database[17] (2013V01) was made available on the ftp site. This version takes into account update from WOD2009 and some corrections on data (see Figure 11).

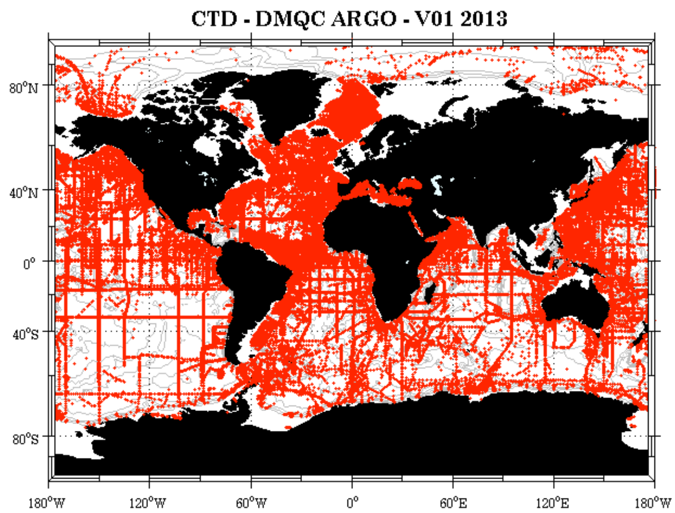


Figure 11: CTD reference database (2013V01)

The Coriolis reference database CORA[18] has been updated with ICES data from Coriolis database for V3 of MyOcean. An updated version (3.4) of the reference database was provided to the Argo community in April 2013.

8 BIBLIOGRAPHY

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

In 2013, at least 14 articles with a French scientist as a coauthor have been published in peer reviewed journals. The list is reported herefater. Note that the list of all publications in a which a scientist from a French laboratory is involved is available on the Argo France website[19] and on the Argo Bibliography[20] webpage. To date, 153 articles have been listed (see Figure 12).

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, 25 PhDs have been reported. The form is available here: http://goo.gl/XjBxC0. In 2013, 3 PhDs using Argo data have been defended.

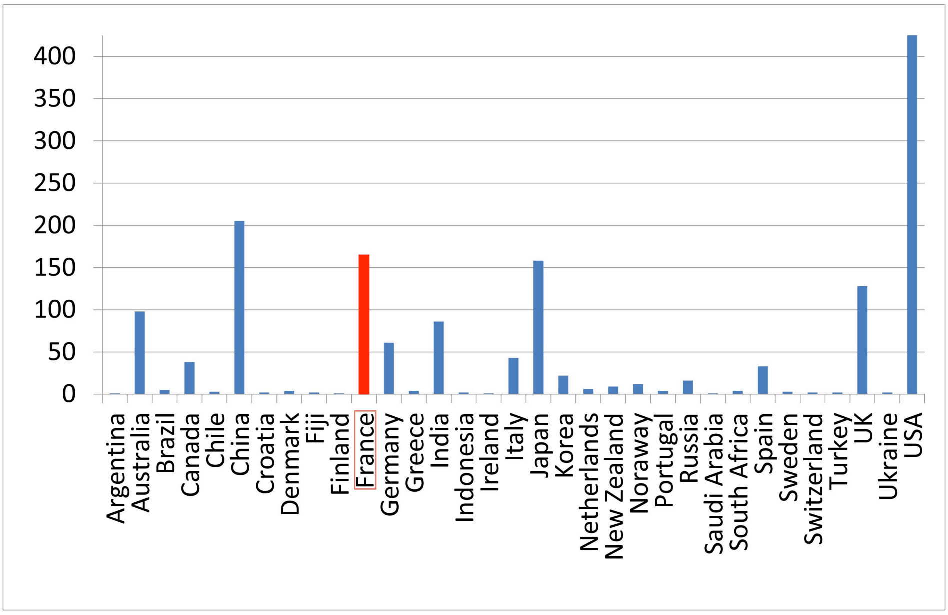


Figure 12: Number of paper using Argo data as function of the country of the lead author. France contribution is highlighted in red.

2013 French scientific bibliography:

1. Boutin, J. and Martin, N. and Reverdin, G. and Yin, X. and Gaillard, F. (2013): "Sea surface freshening inferred from SMOS and ARGO salinity: impact of rain", Ocean Science, DOI: 10.5194/os-9-183-2013.
2. Cabanes, C. and Grouazel, A. and von Schuckmann, K. and Hamon, M. and Turpin, V. and Coatanoan, C. and Paris, F. and Guinehut, S. and Boone, C. and Ferry, N. and de Boyer Mont\'egut, C. and Carval, T. and Reverdin, G. and Pouliquen, S. and Le Traon, P.-Y. (2013): "The CORA dataset: validation and diagnostics of in-situ ocean temperature and salinity measurements", Ocean Science, DOI: 10.5194/os-9-1-2013.
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4. Da-Allada, C. Y. and Alory, G. and du Penhoat, Y. and Kestenare, E. and Durand, F. and Hounkonnou, N. M. (2013): "Seasonal mixed-layer salinity balance in the tropical Atlantic Ocean: Mean state and seasonal cycle", Journal of Geophysical Research: Oceans, DOI: 10.1029/2012JC008357.
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modelling (1990–2009)", Ocean Dynamics, DOI: 10.1007/s10236-013-0596-2.
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9. Kolodziejczyk, Nicolas and Gaillard, Fabienne (2013): "Variability of the Heat and Salt Budget in the Subtropical Southeastern Pacific Mixed Layer between 2004 and 2010: Spice Injection Mechanism", Journal of Physical Oceanography, DOI: 10.1175/JPO-D-13-04.1.
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11. Le Traon, P. Y. (2013): "From satellite altimetry to Argo and operational oceanography: three revolutions in oceanography", Ocean Science, DOI: 10.5194/os-9-901-2013.
12. Lellouche, J.-M. and Le Galloudec, O. and Dr\'evillon, M. and R\'egnier, C. and Greiner, E. and Garric, G. and Ferry, N. and Desportes, C. and Testut, C.-E. and Bricaud, C. and Bourdall\'e-Badie, R. and Tranchant, B. and Benkiran, M. and Drillet, Y. and Daudin, A. and De Nicola, C. (2013): "Evaluation of global monitoring and forecasting systems at Mercator Ocean", Ocean Science, DOI: 10.5194/os-9-57-2013.
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14. Reverdin, G. and MARIE,Louis, L. and Lazure, P. and d'Ovidio, F. and Boutin, J. and Testor, P. and Martin, N. and Lourenco, A. and Gaillard, F. and Lavin, A. and Rodriguez, C. and Somavilla, R. and Mader, J. and Rubio, A. and Blouch, P. and Rolland, J. and Bozec, Y. and Charria, G. and Batifoulier, F. and Dumas, F. and Louazel, S. and Chanut, J. (2013): "Freshwater from the Bay of Biscay shelves in 2009", Journal of Marine Systems, DOI: http://dx.doi.org/10.1016/j.jmarsys.2011.09.017.

2013 French PhD:

1. C., Da Allada (2013): "Rôle de la salinité océanique de surface sur la dynamique du Golfe de , Guinée – apport des données satellitales", Université Paul Sabatier et Université d'Abomey Calavi. http://tel.archives-ouvertes.fr/tel-00925720.
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Footnotes

[1] Argo France: http://wwz.ifremer.fr/lpo/SO-Argo
[2] Euro-Argo: http://www.euro-argo.eu
[3] Coriolis: http://www.coriolis.eu.org
[4] Laboratoire de Physique des Océans: http://wwz.ifremer.fr/lpo
[5] Laboratoire d'Océanographie de Villefranche: http://www.obs-vlfr.fr/LOV
[6] Mercator: http://www.mercator-ocean.fr
[7] IUEM OSU: http://www-iuem.univ-brest.fr/observatoire
[8] NAOS project: http://www.naos-equipex.fr
[9] REMOCEAN project: http://www.oao.obs-vlfr.fr
[10] SIDERI project: http://www.euro-argo.eu/EU-Projects-Contribution/SIDERI2
[11] NKE manufacturer: http://www.nke-corporate.com
[12] E-AIMS project: http://www.euro-argo.eu/EU-Projects-Contribution/E-AIMS
[13] 2013 Coriolis report as DAC/GDAC: http://www.coriolis.eu.org/All-news/News/Argo-data-management-Coriolis-DAC-GDAC-report-2013
[14] Coriolis DAC: http://www.coriolis.eu.org/Observing-the-ocean/Observing-system-networks/Argo
[15] Coriolis FTP: http://www.coriolis.eu.org/Data-Services-Products/View-Download/Download-via-FTP
[16] NA-ARC data mining website: http://www.ifremer.fr/lpo/naarc
[17] Argo CTD reference database: http://www.argodatamgt.org/Reference-data-base/Latest-Argo-Reference-DB
[18] CORA database: http://www.coriolis.eu.org/Science/Data-and-Products/CORA2
[19] French bibliography: http://wwz.ifremer.fr/lpo/SO-Argo-France/Publications
[20] Argo PhD list: http://www.argo.ucsd.edu/argo_thesis.html

Argo Germany National Report 2013

February 2014

Birgit Klein, BSH

1. The status of implementation (major achievements and problems in 2013)

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 28 floats in 2013, 10 floats purchased in 2013 were kept in store because the deployment cruises were delayed. Some of these floats are presently deployed in the sub-polar and the tropical Atlantic by a Navy ship (see Fig.4a). The Alfred-Wegener-Institute (AWI) deployed additional 43 floats in the Atlantic Sector of the Southern Ocean and in the Weddell Sea between December 2012 and January 2013 by. 16 of the 43 AWI floats were deployed in 2013, which gives a total of 44 German float deployments in 2013.

Currently (February 19th, 2014) 155 German floats are active (Fig.1) and the total number of German floats deployed within the Argo program increased to 602.

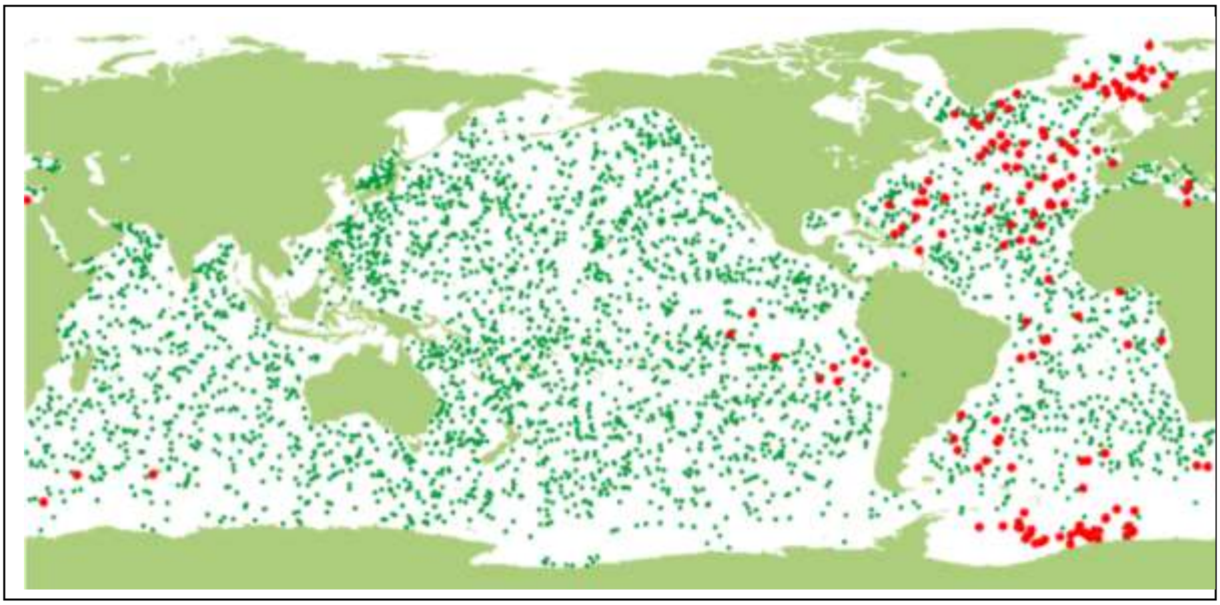


Fig. 1: Locations of active German floats (red) with active international floats (green) (Argo Information Centre, February 2014).

Most of the German floats are APEX floats purchased from Webb Research, but a smaller amount of floats are 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. Most of the German floats are equipped with the standard Seabird CTD but occasionally additional sensors as Aanderaa optodes and RAFOS acoustic receivers are installed. The two NOVA (New generation Oceanographic Variable-buoyancy Autonomous) profiling floats bought from MetOcean in 2012 are functioning well and send good profiles.

The successful collaboration with our Mediterranean colleagues concerning the recovery of beached floats has been continued. In 2012 our Greek colleagues helped with recovery of a beached float. The float was damaged during the beaching and has been converted to a technical display after it was send back to BSH. A second float (6901084) found in the port of Beirut (Lebanon) was secured by the Lebanese Navy. With the help of MEDARGO a contact was established with the local oceanographers at the Institute of Aquaculture and Aquatic Science (Dept. of Biology) at the American University of Beirut and they could retrieve the float from the Navy. Pierre-Marie Poulain visited Beirut in April 2013, tested the float and showed the local oceanographers how to operate it (Fig.2). The float was donated to Lebanon and our Lebanese collaborators redeployed the float (new WMO-Id 6900895) about 10 nm off southern Lebanon on 27 August 2013. Its current position and trajectory are shown in Fig. 3.

Fig.2: Pierre-Marie Poulain (MEDARGO) and local oceanographers during technical tests of the beached float 6901084.

We discovered major technical problems with the alkaline batteries in our APEX floats deployed in 2011. More than 30 floats expired early with life cycles of about 700-800 days. The technical data send back from the floats indicate a sudden loss of battery voltage to values of around 7 Volt during the last profile and increased battery consumption during the previous cycles. We have contacted TELEDYNE/WEBB about the problem and hope to solve the issue soon.

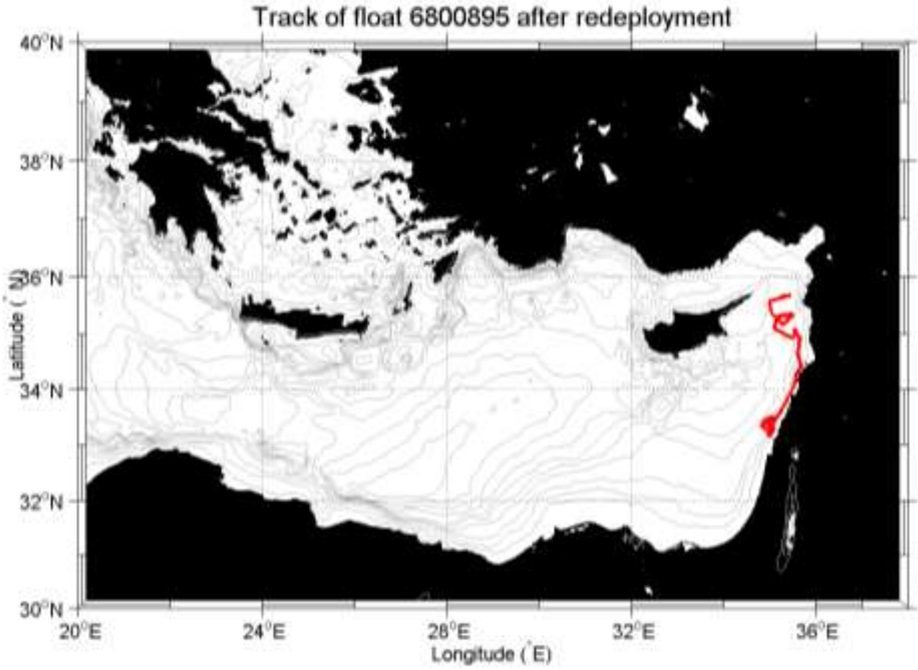


Fig. 3: Float track for float 6900885 after redeployment on 27 August 2013.

2. Deployment plan for 2014

The deployment plans for 2014 will comprise 44 floats from BSH in the Atlantic, the Nordic Seas and the Southern Ocean. Additionally 7 floats will be deployed by GEOMAR in the eastern subtropical Pacific and about 20 floats by AWI in the Southern Ocean and the Weddell Sea during the Antarctic summer season 2014/2015. The intended deployment positions for the BSH floats are shown in Fig. 4 a-g.

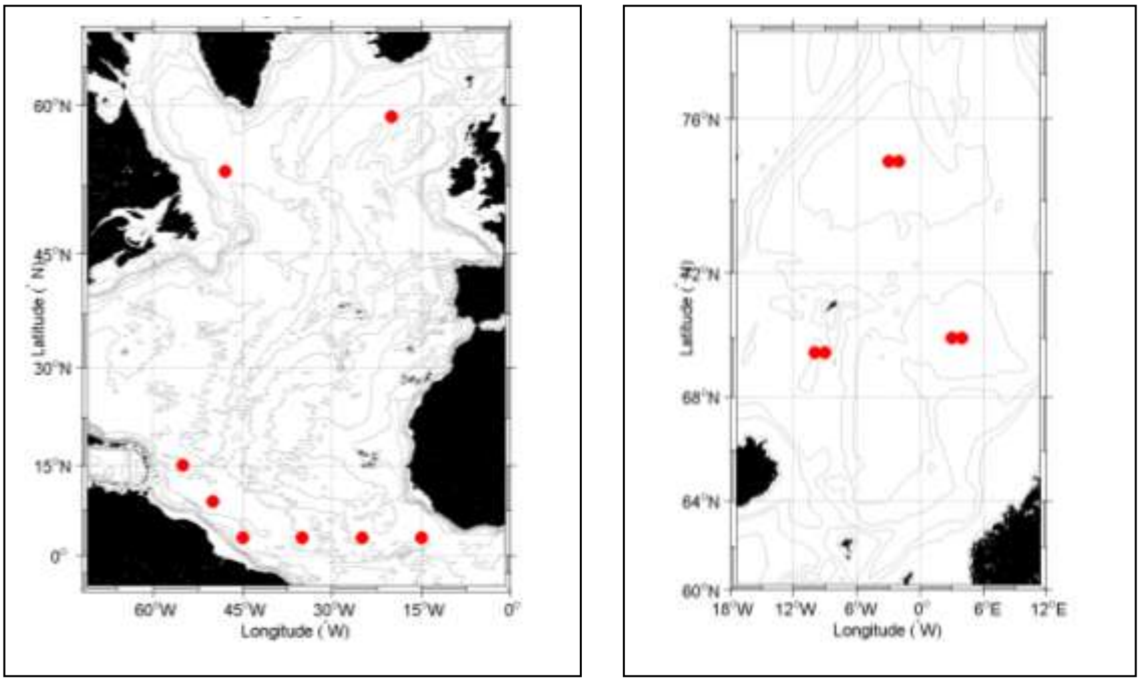
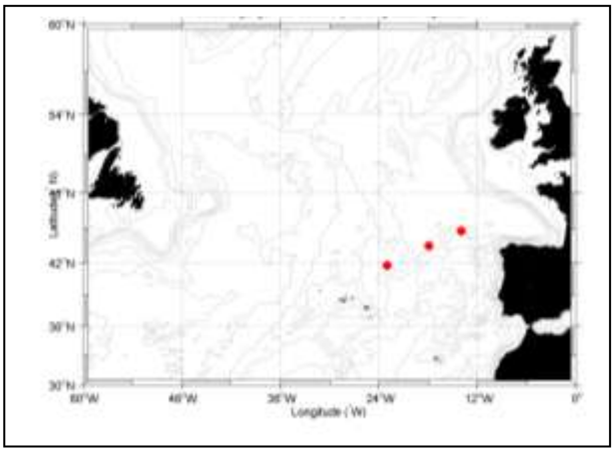


Fig. 4a, left: Deployment positions for 8 floats deployed by Navy vessel 'Bonn' in February-March 2014 and 4b, right: 6 deployment positions in the Nordic Seas in May/June 2014.



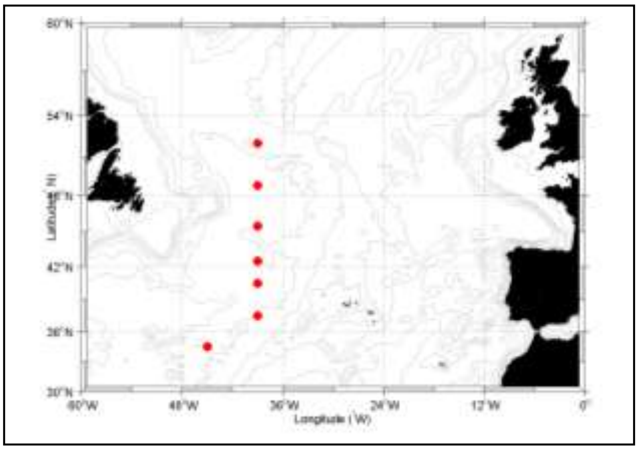
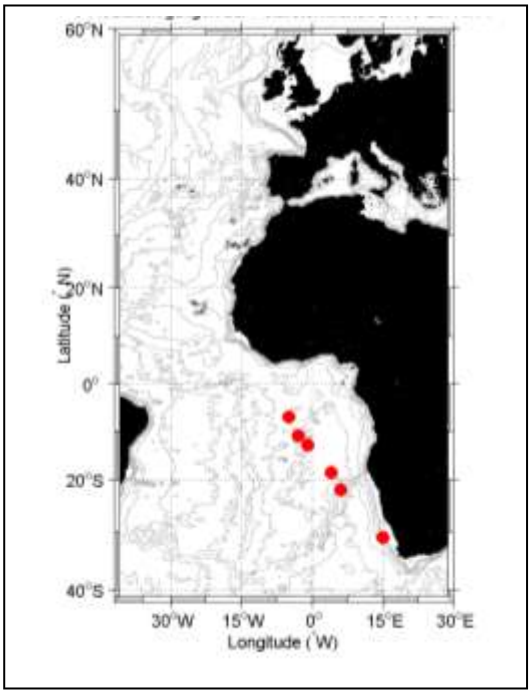


Fig. 4c, left: Deployment positions for 3 floats in the Northeast Atlantic and 4d, right: 7 deployment positions in the sub-polar North Atlantic.



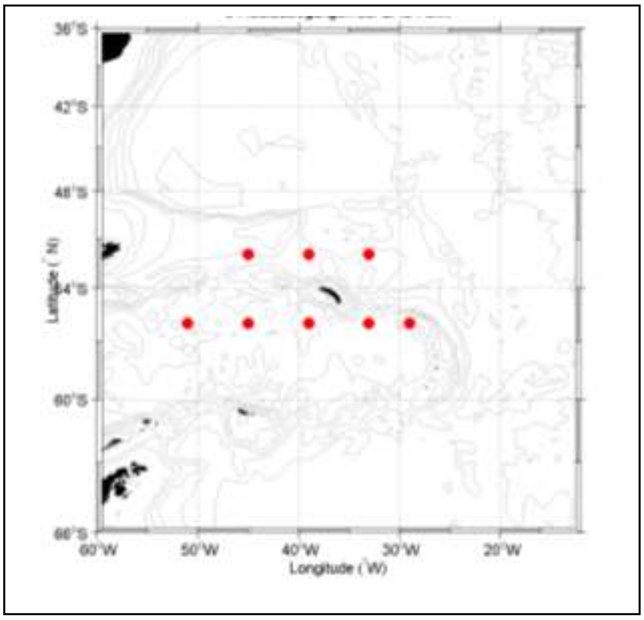


Fig. 4e, left: Deployment positions for 6 floats in the Southeast Atlantic and 4d, right: 8 deployment positions in the Southern Ocean.

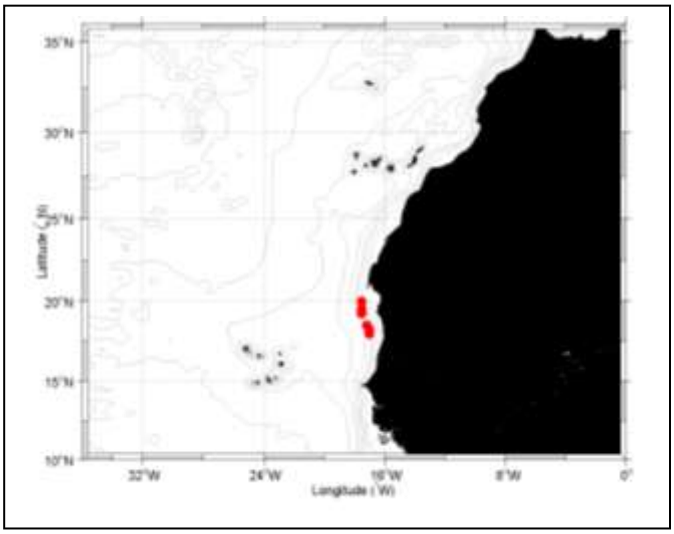


Fig. 4g, left: Deployment positions for 6 floats with oxygen sensors in the tropical Atlantic.

The floats to be deployed in the tropical Atlantic (see Fig. 4g) are all equipped with oxygen sensors and are a joint operation of BSH and GEOMAR. In total there are plans to deploy 71 floats in 2014 up to early 2015. Germany owns deployment capabilities for all oceans including the ice covered areas but foreign research cruises will be used as well to cover all intended deployment areas. The deployments in the Southern Ocean for example will be carried out on cruises conducted by the British Antarctic Survey (BAS). The main goal of our deployments is to support the global array in the Atlantic Ocean and we focus on data sparse regions, specifically in the Southern Ocean, the North Atlantic and the Nordic Seas.

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 monthly 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 BSH floats is 45181 (February 19th, 2013), the number of DM profiles is 39511. The percentage of DM profiles with respect to the total number of profiles is about 87%.

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.

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.

GREEK ARGO PROGRAMME

PRESENT STATUS AND FUTURE PLANS

G. Korres and D. Kassis
HCMR
January, 2014

1. Background and organization of GREEK ARGO activities

Greece has established national contribution to the ARGO project.

1.1 Deployed floats

During 2010, HCMR procured (using internal funds) and deployed a PROVOR-CTS3 float initiating the Greek Argo programme. The float was deployed in the Cretan Sea during June 2010 using R/V AEGAEO. In August 2011, the float stopped operating, found by fishermen and was delivered back to HCMR premises by the porting authorities of Kassos island (southeastern Aegean). The float was sent back to NKE Electronics for the necessary maintenance (changing batteries, replacing bladder housing) and in November 2011 was successfully re-launched in the Cretan Sea by HCMR stuff.

During 2013 two new deployments were achieved in a month's period from HCMR's Argo operational team in the framework of PERSEUS FP7 and IONIO Interreg-III projects under Greek Argo Infrastructure coordination. The first deployment took place on 30th of October in the Cretan Sea at approximately 15nm north-west of Heraklion port. The float is a PROVOR DO type being the first float in Aegean equipped with a dissolved oxygen sensor additional to standard CTD float's instrumentation. On the 28th of November, a NOVA type standard CTD float was deployed in the Northern Ionian basin, being the first Greek Argo float in Ionian Sea. The float integrates an Iridium satellite telemetry system which provides a dual telecommunication capability allowing modification of the configuration in real-time.

All floats have been integrated in the MedArgo project. Taking into account the proposed sampling strategy for the Mediterranean Sea and the bathymetry of the deployment site and the adjacent areas, the mission parameters of the floats were set as follows: The parking depth of the floats was set to 350m, its profiling depth to 1000m and the cycle period to 5 days. The raw data of the Greek float are delivered at the Coriolis data Centre where the real time quality control takes place while the delayed mode quality control of the data will be processed by the MedArgo Centre at OGS.

1.2 Float Development

HCMR has constructed an Argo float's detection system after the process of locating a float has been described and the various approaches have been indicated. A prototype active locator unit has been developed, and the principle of operation has been demonstrated. The unit has been tested successfully in land and at sea at the SIDERI workshop at 17-18 September 2013 that took place at Heraklion, Greece. The deck unit communicates via bluetooth with any mobile phone which is used for interface and control. Future work includes the study of a pressure housing and antenna design. This activity was under the task of proposing and testing simple methods of tracking and recovery Argo floats in short time and range scales in the framework of SIDERI FP7 project.

1.3 Data management

HCMR has run an extended network of buoys within the Aegean and Ionian Seas including the multi-parametric M3A observatory of the Cretan Sea and a deep sea (2000m) bottom platform deployed in the Ionian Sea (POSEIDON & POSEIDON-II monitoring, forecasting and information systems). HCMR also operates the Hellenic National Oceanographic Data Centre (HNODC) established in 1986, as part of the National Centre for Marine Research (NCMR). HNODC operates as a National Agency and is responsible for processing, archiving and distributing marine data. HNODC is also developing techniques for oceanographic data processing and data base maintenance. Furthermore it promotes the International Exchange of Data in the frame of its cooperation with the "Intergovernmental Oceanographic Commission IOC) of UNESCO as it is responsible for the coordination of International Data Exchange (IODE) in Greece. The HNODC manages a variety of oceanographic data and information collected by several Hellenic Marine Research Laboratories and in particular from the Institute of Oceanography of the Hellenic Centre for Marine Research-HCMR as well as from HNODC's participation in international projects (MTP-II MATER, MEDAR/MEDATLAS II, HUMBOLDT, SEADATANET). Moreover within the My Ocean project (GMES MCS) HCMR will consolidate and improve its in-situ data services for the Eastern Mediterranean region building on the capacity developed under POSEIDON, MFSTEP (coordination of M3A time-series network, analysis and provision of basin scale data), and MERSEA projects (coordination of Mediterranean in situ observations).

Delayed-mode data processing. HCMR has not developed yet a delayed-mode quality control capability for the Greek Argo data. The delayed mode quality control of the data delivered from the Greek Argo float will be processed by the MedArgo data centre. HCMR considers the possibility of developing delayed-mode data processing for ARGO profiles collected within the Eastern Mediterranean region. HCMR may also contribute to the improvement of the delayed mode quality control processing conceding CTD data collected through several HCMR research cruises. HCMR operates the Med Sea data portal that was set up for the needs of MyOcean project. Within this framework HCMR is in charge of validating biochemical data from Argo floats that are operating in the Mediterranean.

1.4. Operational and scientific use of Argo data

A very important activity, in the frame of the Greek Euro-Argo programme (which will demonstrate the Argo value) is the development of the capabilities in order to exploit Argo data for operational forecasting as well as for research applications. Along this direction, HCMR established a network of relevant Greek scientific groups mainly from Universities and Research Institutes which constitute the Greek Argo Users group/network. These different groups are already using or will be using ARGO data in ocean/atmospheric forecasting, climate studies and for educational purposes. On January 2014 the first Greek Argo Users meeting was hosted by HCMR aiming to present the activities of the national network to coordinate present and future actions that will take place at national level. There were 10 scientists participating from HCMR Institute of Oceanography and 6 scientists and researchers from different Universities and departments from all over Greece. It is expected that the Greek Argo Users Group will further grow and expand its activities concerning the scientific exploitation of Argo data and the cooperation among Greek scientists. Additionally, it is foreseen that the establishment of the E-A ERIC will increase the interaction of the Greek Argo Users Group with the European and international ARGO scientific community in the near future.

Operational ocean forecasting:

Med-Argo data have been already used as independent data in order to assess the impact of remote sensed and Ferrybox SSS data assimilation into the Aegean Sea hydrodynamical model component of the POSEIDON system running operationally at HCMR within the framework of POSEIDON-I system.

Med-Argo data are routinely assimilated (using localized Singular Evolutive Extended Kalman filtering techniques) on a weekly basis in one of the operational forecasting systems that are currently operating at HCMR involving the Mediterranean basin at $1/10^{o}$ resolution (POSEIDON-II system) and the Aegean Sea at $1/30^{o}$ resolution.

The results of the works described above are included in the following scientific publications:

[1] Korres, G., K. Nittis, I. Hoteit, and G. Triantafyllou, 2009: **A high resolution data assimilation system for the Aegean Sea hydrodynamics.** *Journal of Marine Systems*, **77,** 325-340.

[2] Korres, G., K. Nittis, L. Perivoliotis, K. Tsiaras, A. Papadopoulos, I. Hoteit and G. Triantafyllou, 2010. **Forecasting the Aegean Sea hydrodynamics within the POSEIDON-II operational system**. *Journal of Operational Oceanography*, Vol. 3, nu. 1, 37-49,

[3] Korres, G., I. Hoteit, G. Triantafyllou, K. Nittis and K. Tsiaras. **An operational data assimilation system for the Mediterranean Sea hydrodynamics** (in preparation).

as well as in a poster presentation for the 2nd EURO ARGO users meeting (OGS, Trieste - Italy)*:*

G. Korres, K. Nittis, L. Perivoliotis, G. Triantafyllou and M. Chatzinaki, 2009. **The Aegean Sea –Poseidon model.** Hellenic Centre For Marine Research, Greece.

Ocean science

Med-Argo data are currently used by a small group of researchers in Greece for studies of water mass characteristics of the different deep basins of the Mediterranean Sea and as a continuous record of T/S characteristics providing insight in the seasonal and inter-annual variability of the Mediterranean Sea and its sub-basins. Additionally, Argo data are used for educational purposes in some Greek University Departments. Due to HCMR initiatives within Euro Argo, Greek Argo and SIDERI programmes to contact potentially interested Greek and other scientists from the eastern Mediterranean region and inform them about the benefits of Argo programme. An increasing demand for Argo data along the Aegean and Ionian Sea for both scientific and educational purposes has been registered.

2. Funding

2.1 Existing funding for Greek Argo

The procurement, deployment and operation costs of the first Greek float launched in 2010/2011 were covered by HCMR internal funds. Last year, Greece established national funding to the Greek Argo programme through the General Secretariat of Research and Technology (GSRT), Ministry of Education, Lifelong Learning and Religious Affairs (funding agency). A major achievement is that Greece participates to the future European infrastructure E-A ERIC as a full member. A tender regarding the procurement of 25 new floats during the next 3 years period has been accomplished. During March 2014 the first 5 floats will be delivered and will be deployed afterwards.

2.2 On the future funding and organization for Greek Argo – links with Euro Argo PP

As part of the Euro-Argo preparatory phase, HCMR has undertaken all necessary efforts and managed to establish long term national funding for the E-A ERIC infrastructure and to meet the standards of a full member.

Greece has deployment capabilities for the Aegean, the Ionian Sea and the central Levantine basin. Float deployment in 2014 will be performed according to the plans of the Greek-Argo research infrastructure and one EU project (IONIO). The main goal within 2014 is to initiate the development of the Greek-Argo infrastructure array in accordance with MEDARGO and the EuroArgo infrastructure. It is planned to start deployments in spring 2014 and deploy 6 floats in total (5 from Greek Argo national funding and 1 from IONIO project) in the Ionian (2 floats), in the Aegean Sea (3 floats) and South of Crete (1 float).

3. Dissemination activities of the Euro-Argo infrastructure

By the end of 2013 Greek Argo has launched its web page: www.greekargo.gr that demonstrates and promotes Greek-Argo and Euro-Argo activities. The Euro-Argo infrastructure is also demonstrated on the POSEIDON updated web page, http://www.poseidon.hcmr.gr/article_view.php?id=57&cid=28&bc=28. The POSEIDON system is the operational monitoring and forecasting system for the Greek Seas and many of its forecasting components use T/S Argo profiles for data assimilation purposes. The POSEIDON web page is also hosting the links to the EuroArgo educational web site as well as to the floats from each European country. The above links along with other informative material (Euro Argo leaflet, focused questionnaire) were forwarded directly to all active and potential users of Argo data in Greece. Many research groups filled and sent back the questionnaire providing valuable feedback to HCMR team. Furthermore, the EuroArgo poster and leaflet translated in Greek and they are hosted in the POSEIDON website. A press release was sent after the deployment of the Greek float. The press release is permanently hosted in the HCMR's Greek webpage, http://www.hcmr.gr/listview4_el.php?id=1110.

The HCMR Argo team is planning to upgrade Greek-Argo web portal by providing information and data access from all floats operating in the Mediterranean and presenting all Greek Argo activities, news and data from Greek Argo floats.

<u>**Argo Steering Team Meeting (AST-15)**</u>
National Report – India
(Submitted by M Ravichandran)

1. The status of implementation

1.1a Floats deployment

India has deployed 23 floats during Mar 2013 to Feb 2014 in the Indian Ocean taking its tally to 307 floats so far. The new deployment includes 8 Bio-Argo floats with additional sensors like Doxy, FLBB, Chl-a. Another 20 floats could not deploy due to cancellation of two ship cruises. These floats will be deployed during next year (2014-15). The deployment locations and all active floats in the Indian Ocean are given below.

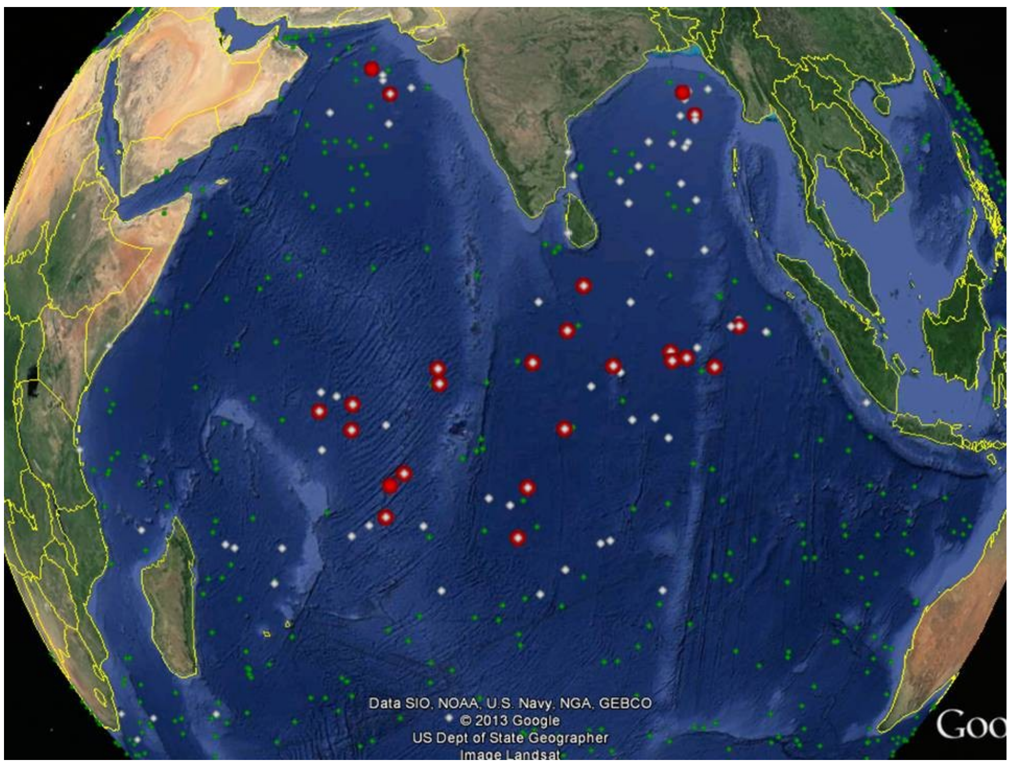


Fig. Location of Argo floats deployed by India during last one year (red), active Indian floats (white) and active floats in the Indian Ocean (green)

1.1b performance Analysis of Floats deployed

Out of the 307 floats deployed so far, 102 floats are active. All the active floats data are processed and sent to GDAC.

1.2 Technical problems encountered and solved

None

1.3 Status of contributions to Argo data management

1.3 a Data issued to GTS

All the active floats data is being distributed via RTH New Delhi. However there seems to be a problem in these messages being received by some centres. BUFR transmission will start once this issue is resolved.

1.3 b Data issued to GDACs after real-time QC

All the active floats data are subject to real time quality control and are being successfully uploaded to GDAC. RT s/w obtained in collaboration with CSIRO is extensively used for the same. The support of CSIRO in term of the Real Time S/W is highly acknowledged.

1.3 c Delayed Mode QC

- INCOIS started generating and uploading D files to GDAC form July 2006, and as of today, profiles belonging to all eligible floats have been subjected to DMQC.
- Advanced Delayed Mode Quality Control s/w developed by CSIRO is being put to use successfully. Using this s/w all the eligible floats are reprocessed to tackle pressure sensor offset problems, salinity hooks, thermal lag corrections, salinity drifts.
- Lack of enough historical background data is hindering the DMQC processing. But majority of the Indian floats are found not to have significant drifts in the salinity sensors.
- About 69% of the eligible profiles are subjected to DMQC and the delayed mode profiles are uploaded on to GDAC.

1.3 d Trajectory

A total of **307 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. Finally a visual check is performed to verify that there are no missing cycles without cycle numbers and to check the surface time intervals.

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 from 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.

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 for the next five year (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. Two more floats in the Arctic and 4 more bio-argo floats in the Arabian Sea also planned during 2014-15. After ascertaining the gap region and cruise plan of MoES research vessels, these floats will be deployed. The existing data management resources will continue for the next 4 year term.

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)

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, thermosteric component of sea level and validation of OGCM by various Indian institutions and university students.

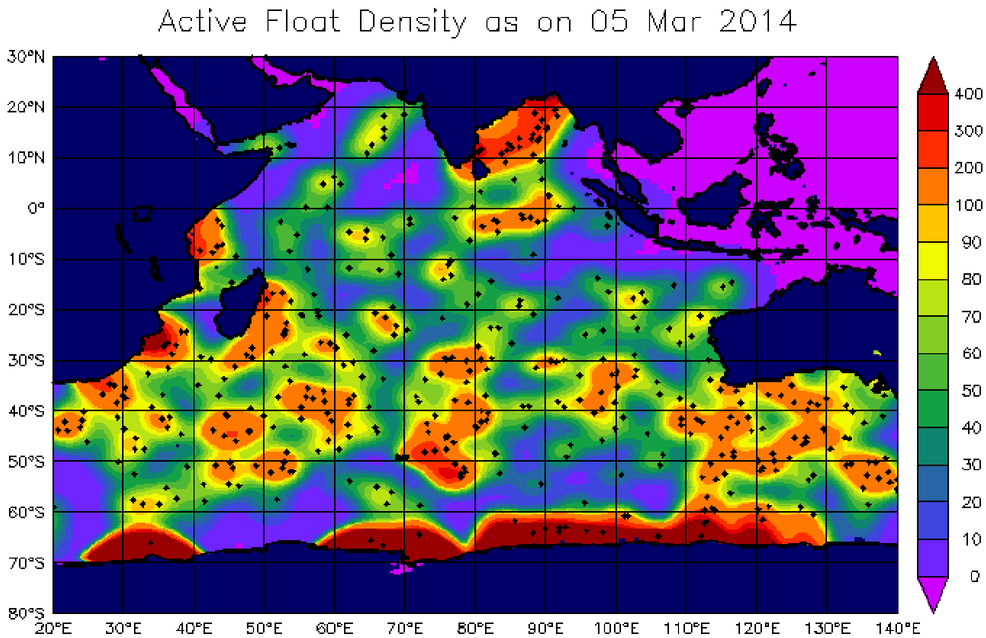
Argo Regional Centre (ARC) - Indian Ocean

- 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.
- Additionally SST from TMI, AMSRE and Wind from ASCAT, Chla from MODIS and OCM-2 are also made available on daily and monthly basis.
- 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 following link http://www.incois.gov.in/Incois/argo/products/argo_frames.html

- Regional Co-ordination for Argo floats deployment plan for Indian Ocean. The float density in Indian Ocean as on 05 March 2014 is shown below.



- **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. Apart from the floats deployed by India, data from floats deployed by other nations in the Indian Ocean are received from the Argo Mirror and made available in the INCOIS website. User can download the data based on his requirement.
- Statistics of Indian and Indian Ocean floats are generated and maintained in INCOIS web site. The density maps for aiding people for new deployments are made available on a monthly basis. For full details visit http://www.incois.gov.in/Incois/argo/argostats_index.jsp.

INCOIS Argo web page statistics (for the past one year) are as shown below

Page	Hits	Visitors
Argo Web-GIS	1803	37012
Data download	15729	1084
Live Access Server	99248	118549
Argo products	1209	1178

- **Products generated from Argo data**
  - Value added products obtained from Argo data are continued. The methodology for generating the gridded product is changed to variational analysis method. Many products are generated using Argo temperature and salinity data. The Argo T/S data are first objectively analysed and this gridded output is used in deriving value added products. More on this can be see in the RDAC functions.
  - Version 2.0 of DVD on "Argo data and products for the Indian Ocean" is released to public for use with data corresponding to 2012 being updated. This DVD consists of ~ 2,00,000 profiles and products based on the Argo T/S. A GUI is provided for user to have easy access to the data. As many as 250 DVDs were supplied to various users from institutions and universities.
  - Updation to Mixed Layer Climatology based purely on Argo observation is completed. All the profiles from 2001 – 2012 are used for generating this.
  - To cater to many users of INCOIS LAS, it is enhanced in term of capacity. New Server is procured and new products viz., model outputs, new wind products (ASCAT), fluxes are made available. We plan to add more and more products as per the request received from the users in future. For further details visit http://las.incois.gov.in.

5. Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo. These might include tasks performed by the AIC, the coordination of activities at an international level and the performance of the Argo data system. If you have specific comments, please include them in your national report.

None

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

None

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Fiona Grant, Ocean Science & Information Services (OSIS), Marine Institute, Ireland.
Glenn Nolan, Oceanographic Services, OSIS, Marine Institute, Ireland.
Mick Gillooly, Director OSIS, Marine Institute, Ireland.

1. The status of implementation (major achievements and problems in 2013)
- floats deployed and their performance
No floats were deployed in 2013. Delayed delivery and technical issues with the floats procured meant that the trans-Atlantic cruise they were to be deployed on had departed.

- technical problems encountered and solved
Floats borrowed from Coriolis had to be returned to have the firmware checked so scheduled cruise for deployment had departed.

- status of contributions to Argo data management (including status of pressure corrections, technical files, etc)
Carried out by BODC for us.

- status of delayed mode quality control process
Carried out by BODC for us.

2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.
Ireland is seeking candidate membership of the Euro Argo ERIC (legal consortium) and has made a commitment to a contribution of €10k per annum to the central coordinating office as part of an oceanographic capacity building initiative at national level. There were some technical/legal difficulties with the ERIC framework at national level but these are beginning to be resolved. The importance of the Atlantic Strategy[1] in Ireland is recognised and it is hoped that Ireland will apply for full membership of the ERIC in the coming year. In the interim, it is our intention to continue to deploy three floats per annum, subject to funding availability.

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.
Subject to funding availability, three floats will be procured and deployed per annum. They are typically deployed in the North Atlantic as this is the primary operational area of the national research vessel the R.V. *Celtic Explorer*. The procurement overhead (staff time) required to tender for three floats per annum is not ideal. Multi-annual funding for this programme is not yet available, although it is hoped that as part of the oceanographic capacity building initiative at national level, a multi-annual commitment will be forthcoming.

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 is primarily used to validate ROMS models in the Oceanographic Services section of the Marine Institute.
http://www.marine.ie/home/services/operational/DeepSeaResearch/EuroArgo.htm

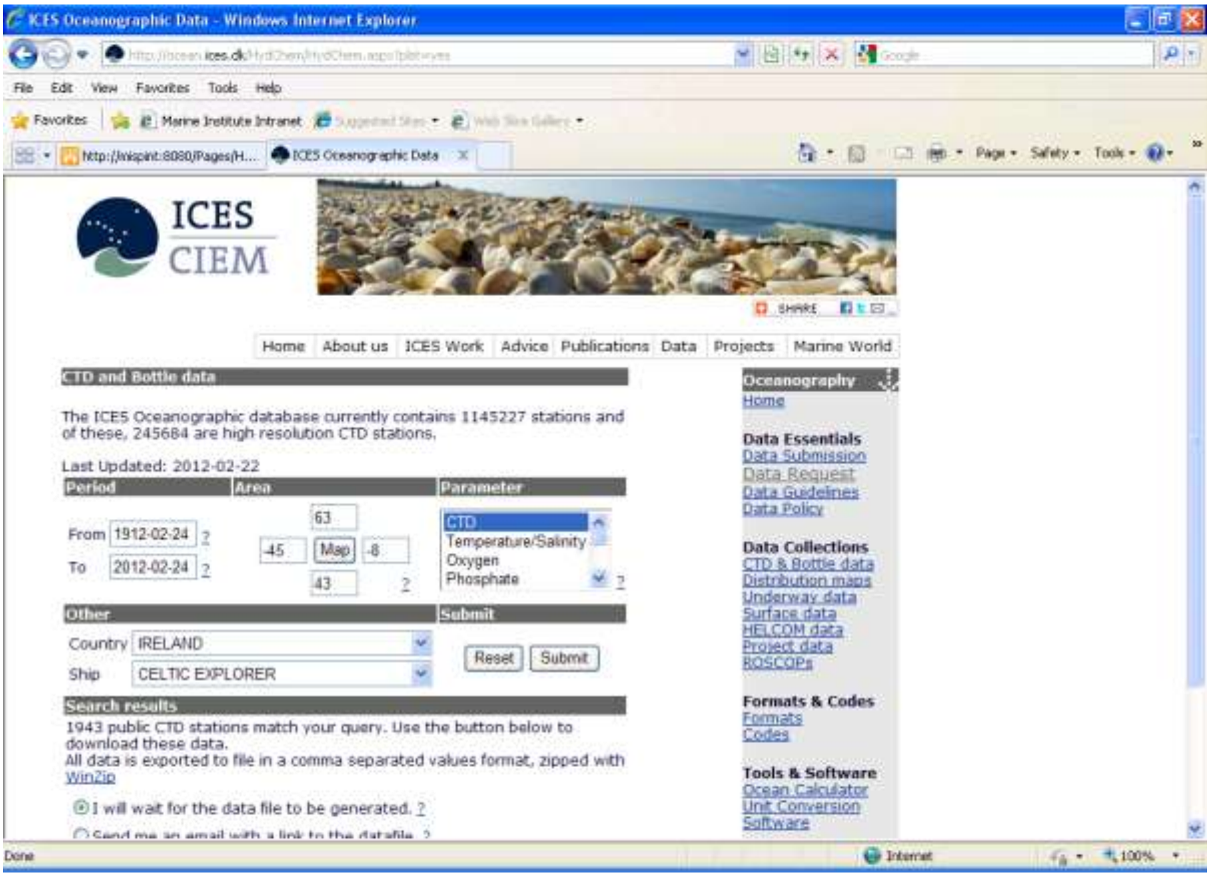
5. Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo. These might include tasks performed by the AIC,

[1] http://ec.europa.eu/maritimeaffairs/policy/sea_basins/atlantic_ocean/documents/com_2013_279_en.pdf

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.
N/A as can be dealt with through Euro-Argo office.

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.
No CTD data are uploaded to the CCHDO website. However, all CTD data are emailed to Else Juul Green (else@ices.dk) who checks the data before it is uploaded to the ICES Oceanographic data portal annually:
http://ocean.ices.dk/HydChem/HydChem.aspx?plot=yes

Data from 2013 will be uploaded to ICES in the coming weeks.



7. Keeping the Argo bibliography (http://www.argo.ucsd.edu/Bibliography.html) up to date and accurate is an important part of the Argo website. This document helps demonstrate the value of Argo and can possibly help countries when applying for continued Argo funding. We are almost to 1000 papers published using Argo data! So, please include a list of all papers published by scientists within your country in the past year using Argo data, including non-English publications.
Unfortunately, no peer reviewed articles have been published that I am aware of.

A small, popular science article appeared in the national newspaper recently describing Argo floats and the Coriolis data centre: http://www.irishtimes.com/news/environment/another-life-gathering-flotsam-jetsam-and-itp47-1.1675260

8. I am also attaching a spreadsheet of the commitments table which I updated on January 17,2013 using the AIC website. Almost 100% of estimated floats were actually deployed (881 estimated vs 854 Argo only deployed).

No floats were deployed in 2013 for logistical reasons. It is the intention of the MI to deploy two-three floats in the North Atlantic in 2014.

Report on the Italian Argo Program for 2013

1. The status of implementation (major achievements and problems in 2013).

- floats deployed and their performance:

In total, 11 Italian floats were deployed in 2013 (see Tables 1 and 2 for details). These floats were Arvor designs manufactured by NKE (France), some with Iridium (Arvor-I) and others with Argos telemetry (Arvor-L). In the Mediterranean and Black Sea, 8 units were deployed (Table 1). Except for float WMO 6901821, all the instruments were still operating at the end of February 2014. They have a parking depth at 350 dbars and profiling depths alternating at 700 and 2000 dbars. They all have cycles of 5 days, except that WMO 6901826 and 6901827 had daily cycles during approximately the first month after deployment in the Southern Adriatic Sea. Most floats were deployed from research vessels of opportunity (e.g., R/V Urania and Explora) with the help of colleagues from Italy and Cyprus. Float WMO 6901828 corresponds to a float which was recovered, refurbished locally in Varna, Bulgaria and redeployed in the western Black Sea.

Model	WMO	Deploy Date	Lat	Lon	Cycles	Last Date	Lat	Lon	Status	Cycle
Arvor I - 2	6901821	04-Mar-2013 07:56	39.25	18	53	01-Dec-2013 00:14	36.55	15.52	D	5
Arvor I - 2	6901822	23-Mar-2013 15:58	41.52	18.08	70	05-Mar-2014 00:11	41.69	17.82	A	5
Arvor I - 2	6901826	10-May-2013 04:10	42.02	16.18	102	04-Mar-2014 00:10	41.71	17.19	A	5
Arvor I - 2	6901827	11-May-2013 01:04	42	18.6	101	04-Mar-2014 00:12	40.7	18.87	A	5
Arvor-L	6901828	29-Sep-2013 21:20	42.83	28.82	32	01-Mar-2014 12:50	41.28	37.41	A	5
Arvor I - 2	6901824	04-Nov-2013 16:20	33.9	32.76	20	28-Feb-2014 23:58	34.78	31.88	A	5
Arvor I - 2	6901825	04-Nov-2013 19:05	34.24	33	24	28-Feb-2014 23:56	34.2	32.73	A	5
Arvor I - 2	6901816	18-Dec-2013 09:26	42.22	10.86	17	05-Mar-2014 00:19	41.3	9.92	A	5

Table 1. Status information for the 8 Italian floats deployed in the Mediterranean and Black Sea during 2013.

Three 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 the South Korean R/V Araon. Unfortunately, float WMO 6901813, which was tethered to act as a virtual mooring had transmission/floatation problems and died prematurely after only 29 daily cycles on 11 Feb 2013 (last GPS position available on 7 Feb 2013). The other two floats had cycles of 10 days, parking depth of 1000 m and maximum profiling depth of 2000 m and were still operational at the end of February 2014. However, GPS positions problems occurred for 6901815 starting 8 Nov 2013 and no positions are available for the profiles after that date.

Model	WMO	Deploy Date	Lat	Lon	Cycles	Last Date	Lat	Lon	Status	Cycle
Arvor I - 2	6901813	06-Jan-2013 19:20	-75.09	164.88	29	11-Feb-2013 01:43	0	0	D	1
Arvor I - 2	6901814	10-Jan-2013 07:55	-61.5	178.67	41	26-Feb-2014 00:11	-58.26	-161.46	A	10
Arvor I - 2	6901815	10-Jan-2013 15:24	-60	178.26	41	26-Feb-2014 00:26	0	0	A	10

Table 2. Status information for the 3 Italian floats in the Southern Ocean during 2013.

- technical problems encountered and solved

As stated above, one float in the Mediterranean failed after only 53 cycles for unknown reasons. In the southern Ocean, the GPS locations for float WMO 6901815 failed prematurely after cycle 30. Tests with a tethered float in Ross Sea were not successful and only 29 profiles were obtained. In general, the reasons for theses failures are still unknown. They will be investigated in collaboration with the manufacturer NKE.

- 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 10 floats. OGS will continue this activity in 2014 as part of the EC FP7 E-AIMS and MyOcean-2 projects. Note that OGS is responsible for the DMQC of all the floats operated in the Mediterranean Sea. The temperature and salinity data of 122 floats (over a total of 202 floats) have been quality controlled following the standard Argo procedure, covering the period 2000-2013.

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 47 floats in 2013, including 7 instruments with biogeochemical sensors. In addition, the Italian human resources devoted to Argo-Italy per year amounts to about 50 man-months for technical, administrative and scientific personnel involved in the project in 2013. It is expected that the same level will maintained in 2014, including the procurement of 20 additional floats. The Italian Ministry of Research is committed to provide funding in order to sustain the Italian contribution to Argo beyond 2014 as member of the Euro-Argo Research Infrastructure Consortium. In addition to the Italian national funding, OGS has funding from the EC FP7 PERSEUS, SIDERI and E-AIMS projects, for multiple 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	
2014	15 2 7	Mediterranean Black Sea Southern Ocean	3 1	Mediterranean Black Sea	**28**
2015	15 2 10	Mediterranean Black Sea Southern Ocean	3	Mediterranean	**30**
2016	15 3 10	Mediterranean Black Sea Southern Ocean	0	Mediterranean	**28**

Table 3. Italian deployment plans for 2014-2016.

OGS is committed to carry out DMQC on all the Argo floats of the Mediterranean Sea as part of the E-AIMS and MyOcean-2 projects over the next years.

The website for the Italian contribution to Argo (Argo-Italy) was developed (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 Gruppo Nazionale di Oceanografia Operativa (GNOO). 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 2013.

N/A

7. Italian contribution to Argo bibliography in 2013.

Bensi M., Cardin V., Rubino A., Notarstefano G., and Poulain P.-M., 2013: Effects of winter convection on the deep layer of the Southern Adriatic Sea in 2012. *Journal of Geophysical Research: Oceans*, **118**, 1-12, doi:10.1002/2013JC009432

Dobricic, S., 2013: An Application of Sequential Variational Method without Tangent Linear and Adjoint Model Integrations, *Mon. Weather Rev.*, **141**(1), 307-323.

Griffa, A., A. Haza, T. M. Özgökmen, A. Molcard, V. Taillandier, K. Schroeder, Y. Chang, and P. M. Poulain, 2013: Investigating transport pathways in the ocean, *Deep Sea Research Part II: Topical Studies in Oceanography*, **85**(0), 81-95.

Nardelli, B. B., 2013: Vortex waves and vertical motion in a mesoscale cyclonic eddy, *Journal of Geophysical Research: Oceans*, **118** (10), 5609–5624.

Japan National Report

(Submitted by Toshio Suga)

1. The Status of implementation (major achievements and problems in 2013)

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 46 Argo and Argo equivalent floats from January to December 2013: 43 ARVOR and 3 NEMO floats. All the floats were deployed with the aid of R/Vs of 10 domestic organizations.

The 3 NEMO floats were deployed near the coast of Philippines in June 2013 in order to investigate oceanic mixed layer structure and tropical air-sea interaction. All the floats profile the depth range from sea surface to 500dbar every day. Two of them are now active, but one of them had already been inactive since July 2013.

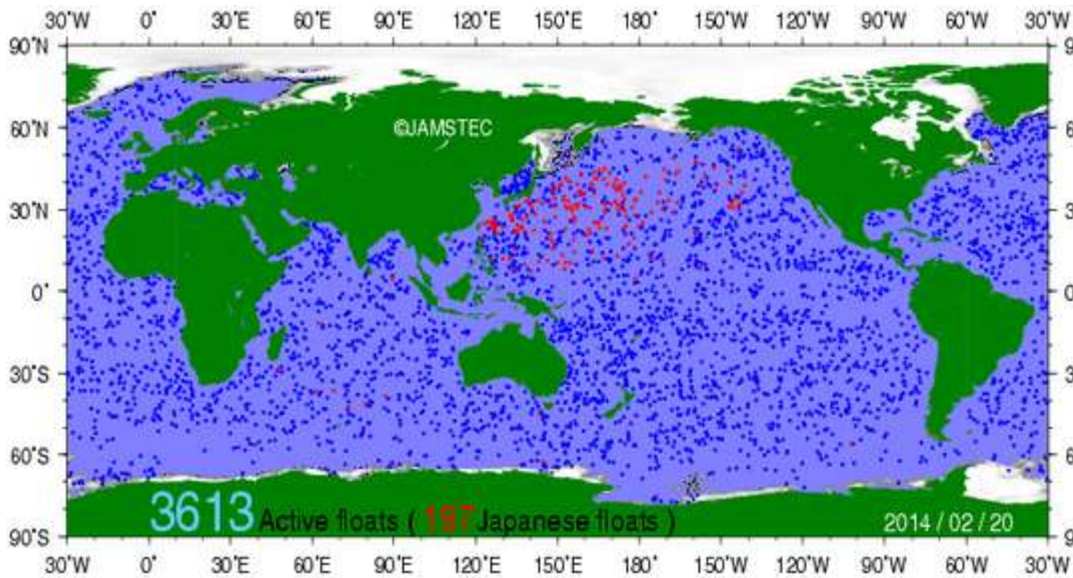


Figure 1: The distribution of active Argo floats. The red dots represent active Japanese floats.

Four floats were deployed voluntarily from cargo ships owned by a Japanese merchant ship company (NYK Line) in 2013. This was done under the cooperative relationship between JAMSTEC and NYK line, which was established in 2011 to increase float deployment opportunity. 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 2013, JAMSTEC deployed 995(1048) 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: 738 (764) APEX, 141 (143) PROVOR, 81 ARVOR, 14 (39) NEMO, 11 NINJA, 4 Deep NINJA and 6 POPS floats. As of the end of December 2013, 166(189) floats [48 (68) APEXs, 34(36) PROVORs, 78 ARVORs, 2(3) NEMOs, and 4 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 16 floats (10 ARVOR, 5 Deep NINJA, and 1 Navis) in January 2014.

The Japan Meteorological Agency (JMA) deployed 25 Argo equivalent floats (25APEX floats) in the seas around Japan from January to December 2013. All the floats get 2,000 dbar T/S profiles every 5 days for operational ocean analysis and forecast.

Among 166 floats (16 PROVORs, 123 APEXs and 27 ARVORs) which JMA has deployed from 2005 to 2013, 40 floats (31 APEXs and 9 ARVORs) are active as of the end of December 2013, while 32 floats (21 APEX and 11 ARVOR floats) terminated the transmission in 2013. JMA deployed 5 APEX floats in January 2014.

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 July 2013, one Deep NINJA float was deployed at a mooring station (S1, 30N, 145E) in the subtropical North Pacific by R/V Mirai. It was set to drift at 4000 dbar depth and measure PTS profiles every 10 days and has been operating well until now. Four Deep NINJA floats deployed in the Southern Ocean in 2012 has been also operating well. One of them deployed south of New Zealand has measured 33 CTD profiles (including 17 deep profiles) until now. The others off the Adelie Coast lost contact in June 2013 probably due to sea ice extension there. One of them resumed data transfer at the end of November, which means that Deep NINJA succeeded to survive Antarctic winter and observe the Antarctic deep layer under sea ice throughout the winter. In January 2014, five Deep NINJA floats were deployed off the Budd Coast by R/V Umitaka-maru and two more will be deployed off the Adelie Coast soon. The data measured by these Deep NINJA floats will be transferred to GDAC by the end of March 2014.

Okinawa Institute of Science and Technology Graduate University (OIST) has deployed 7 NEMO floats near Ishigaki Island as Argo equivalent floats during 2013. Most of those floats measure P, T, and S from 1000 dbar to surface every 6 hours.

1.1.1 Floats deployed as part of INBOX

Besides floats deployed in 2013 as described above, JAMSTEC deployed 4APEX floats equipped with dissolved-oxygen sensors (Aanderaa Optode4330) and 4 EM-APEXs. The floats were launched as part of Western North Pacific **IN**tegrated Physical-**B**iogeochemical Ocean **O**bservation E**x**periment (INBOX); the purpose is to investigate physical-biogeochemical processes associated with meso- and submeso-scale variability by integrating physical and biogeochemical ocean observations in collaboration with ship, satellites and/or mooring observations. The floats measured temperature, salinity and dissolved oxygen from surface to 2000 dbar every 2 days, telecommunicating with iridium transmitter. As reported in the Japan National Report of AST-14, two target areas are set: one is around the biogeochemical observation mooring site S1 (30N, 145E; named S1-INBOX) ; another is within an anti-cyclonic eddy in the Kuroshio-Oyashio mixed water region (42N, 146E; named ACE-INBOX).

JAMSTEC conducted pre-deployment calibration for the Optode4330 sensors in the laboratory, using the calibration formula proposed by Uchida et al. (2008). With the pre-deployment calibration along with the post-deployment adjustment based on the comparison with shipboard CTDO measurement, the accuracy of dissolved oxygen data has been greatly improved. Such quality-controlled data of the S1-INBOX floats launched in 2011-2012 will be added to Argo data by the end of 2014, if the Argo data format accommodates information of pre-deployment calibration and the post-deployment adjustment.

1.2 Technical problems encountered and solved

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 floatss), had terminated their missions before 100 cycles, which were clearly shorter than the specification (150 cycles). The problem was observed as rapidly decreasing battery voltage. The manufacturer, Teledyne Webb research inc., reported that the trouble was probably caused by energy flu because of troubles in some battery cells. While they recommended us to use lithium batteries for future purchasing float to avoid energy flu, JAMSTEC asked further investigation for this problem.

Among the 73 APEX floats with APF9 controllers deployed by Japan before the SBE41 and 41cp recall due to micro-leak problem, 8 floats have the negative surface pressure drift larger than -2.4 dbar. Among these floats, 4 floats have the extreme negative surface pressure drift, exceeding -10 dbar. The floats recalled or those purchased after the problem was fixed have either a Kistler pressure sensor or a Druck pressure sensor. While both pressure sensors show little drift, Kistler pressure sensors have some spikes.

It is worth to report a salinity bias found in Deep NINJA measurements. Comparisons with high-quality CTD data by R/V Mirai show that float salinity is less saline at deeper depth besides having a constant bias, which means the bias possibly depends on pressure. The bias was verified in all of the 5 floats in which the CTD measurements at float deployment are available for the comparison. Some of them showed the bias varying in time. The value set for the parameter to correct pressure effect on conductivity measurements with the SBE41CP model for deep float was the same as that with the standard SBE41CP model. Readjustment of the value possibly reduce the bias.

JAMSTEC routinely conducts CTD sensor calibration of SBE41 and 41cp using almost the same calibration system as that used at SBE inc. Since SBE conducts the CTD sensor calibration as the product check in their factory before shipping, the purpose of our calibration is to find sensor drift caused by any damage or contamination possibly during long-distance transport or any handling processes in float manufacturer/SBE/JAMSTEC. From 2001 to the present, we have checked over 400 CTD sensors, that is about 40% of the total number of the floats we deployed. We had already analyzed the result of calibration in our laboratory for 2001-2006, which was summarized on the technical paper by Yokota et al. (2007). After 2007, 214 of 423 CTD sensors (about 50%) has been calibrated on a random check basis. As a result, about 6% of the calibrated sensors showed conductivity values that did not match that of calibration result by SBE, with excluding a exceptional case that large number of sensors were contaminated for some reason. When we found CTD sensors with serious problem, we sent them back to SBE for re-check, re-calibration or repair, which successfully prevent us from deploying floats with fault CTD sensors. According to our long-term re-calibration experience, we consider that the CTD sensors of SBE 41 and 41cp are fairly reliable. Nevertheless, we think that the calibration of CTD sensors after long-distance/overseas transportation is useful to ensure the quality of CTD for the reliability of Argo float data.

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 197 active floats as of February 20, 2014. 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.

1.4 Status of delayed mode quality control process

JAMSTEC has submitted the delayed-mode QCed data of 88,247 profiles to GDACs as of December 2013.

As of December 2013, according to the new definition of APEX Truncated Negative Pressure Drift decided at the 12th Argo Data Management Team Meeting, JAMSTEC is nearing completion to re-create D files for some APEX floats.

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 will continue the operation but in the scale somewhat lower than ever before (about 50 floats to be deployed every year with delayed-mode data management) under its new mid-term program FY2014-2018. JAMSTEC will also seek additional research fund for enhancement of Argo. 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 FY2014, it has been proposed that JAMSTEC will deploy about 50 floats in total in the Pacific Ocean for the Argo core mission. One EM-APEX will be deployed near the Kuroshio Extension as part of INBOX. Some Deep Argo float will be deployed in 2014. Two S3A floats, manufactured by MRV Systems inc., equipped with RINKO (ARO-FT) sensor will be deployed in the central North Pacific. The RINKO sensor is an optically-based sensor and measures dissolved oxygen. Its response time is 1 sec. As the first trial experiment of float-based RINKO, JAMSTEC will calibrate the sensor in advance in the lab and monitor drift/error of its DO data after launching, to contribute to develop a QC method. JMA plans to deploy 27 Argo equivalent floats around Japan in FY2014 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://goos.kishou.go.jp/) 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), 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), 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). JAMSTEC has plan to release two new products. One is the ascii files of temperature and salinity profile data of Argo which are converted from the netcdf profile files. The other is Argo temperature and salinity profile data put through more advanced automatic checks than real-time QC.

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.

JCOPE2 (Japan Coastal Ocean Predictability Experiment 2) is the model for prediction of the oceanic variation around Japan which is operated by Research Institute for Global Change of JAMSTEC. JCOPE2 is the second version of JCOPE1, developed with enhanced model and data assimilation schemes. The Argo data is used by way of GTSPP. 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.

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.

As mentioned in Section 1.1.1, JAMSTEC is almost ready to release dissolved oxygen data obtained with the Optode4330 sensors after pre-deployment calibration using the calibration formula proposed by Uchida et al. (2008) and post-deployment adjustment. But it is not clear whether the Argo oxygen data format being considered will accommodate data calibrated and adjusted in that way. The pre-deployment calibration and post-deployment adjustment using Uchida's formula or similar ones were recommended by several participants in Argo-oxygen meeting in 2011. While such calibration may not be always available, Argo oxygen data format should be capable of keeping data processed in that way and the information on the calibration/adjustment.

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

Data of 1160 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

Doi, T., S. K. Behera and T. Yamagata (2013): Predictability of the Ningaloo Nino/Nina, *Scientific Reports*, 3, 10.1038/srep02892.

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ARGO National Report 2014 – The Netherlands

1) **Status of implementation**

The Dutch Argo program, run by the Royal Netherlands Meteorological Institute (KNMI), started with three deployed floats in 2004. Since then 60 floats have been purchased and deployed, 17 of which are still working correctly.

KNMI is a founding member of the EURO ARGO ERIC .

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

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

In the framework of CMIP5 KNMI performed decadal prediction runs with their EC-Earth climate model. The ocean initialization is taken from an ECMWF product (NEMOvar) that heavily relies on Argo data.

Building on these decadal prediction runs KNMI will, within the EU-funded E-AIMS project, perform sensitivity experiments to find ocean regions where initialization is particularly important for decadal predictions.

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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1. Background and organization of Norway Argo activities

The Norwegian Argo programme is carried out by the Institute of Marine Research (IMR) (http://www.imr.no/) as part of their environmental monitoring activities. The Norwegian Argo programme focus on the Nordic Seas regarding climate monitoring and research and seek to include users with focus on the ecosystem monitoring and research. Float deployment are done with IMR's research ships and often in collaboration with the German Argo.

1.1 Deployed floats

Float deployment started in 2002 with three floats deployed in the Norwegian Sea. In 2006 IMR also started to deploy floats with additional sensors, such as fluorescence and oxygen sensors. In 2013 IMR deployed 2 floats and one float is deployed in 2013. Total 18 floats are deployed, all in the Norwegian Sea. Two European biogeochemical floats were additional deployed in 2014. The Norway Argo interest is the Nordic Seas, trying to maintain an optimally number of floats there.

1.2 Float Development

Two floats, deployed in 2006, were equipped with fluormeter and oxygen sensors for ecosystem monitoring and research. Four floats were deployed in 2010, one in 2013 and one in 2014 that all have Iridium telemetry, and fluormeter and oxygen sensors. IMR is also involved in the EU-project E-AIMS and leads the subtask regarding test of new biogeochemical floats.

1.3 Data management

In agreement with the French Argo Data Centre, Coriolis (www.coriolis.eu.org), all real time data processing and quality control are perfomed at the Coriolis.

1.4. Operational and scientific use of Argo data

A key aspect of the Norway Argo programme is to develop the capabilities to fully exploit all Argo data for operational use as well as research applications. The use of the data to more ecosystem applications will be explored.

2. Funding

2.1 Existing funding for Norway Argo

The Norway Argo Project has been mainly funded by the IMR. Floats purchase and personnel for data and floats management were provided by the budget of the IMR while scientific use are mainly provided by research projects financed by the Norwegian ministry of Education and Research and the EU. However, IMR has recently received funding from the Norwegian Research Council (Ministry of Education and Research) for funding of three Argo floats per year during 2013-2015.

2.2 On the future funding and organization for Norway Argo – links with Euro Argo PP

As part of the EURO-Argo preparatory phase Norway obtained funding from the national research council to join the Euro-Argo ERIC as an observer from 2014.

Report on the status of the Argo-Poland

Waldemar Walczowski, Ilona Goszczko
IO PAN, Sopot, Poland
March 2014

1. The status of implementation

After 3 years of deployments on behalf of the Argo-Poland, with the last float launched in summer 2012, there were no Argo floats deployed in 2013 due to lack of assigned funds.

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

The Polish Roadmap for Research Infrastructures developed by the Ministry of Science and Higher Education includes the Argo-Poland project. In autumn 2013 Polish Ministry of Science and Higher Education signed a request letter to contribute to the Euro-Argo European Research Infrastructure Consortium (E-A ERIC). Poland will have observer status. Since 2015 Poland is obligated to launch at last 2 Argo floats per year. Also 2 days of ship-time in the Arctic Mediterranean and 6 person-months per year will be devoted to the Argo project.

Institute of Oceanology Polish Academy of Sciences (IO PAN), the Polish representative in Euro-Argo, has submitted the proposal to update the status of the Argo-Poland in the Polish Roadmap for Research Infrastructures. We are going to develop the Polish resources devoted to Argo to a certain degree (float testing and deployments, developing specifications and algorithms for sea ice detection and positioning under the ice, usage of a certain telecommunication system, QC implementation, advancement of Argo data assimilation techniques in OGCMs, and so on). The proposal is currently under consideration.

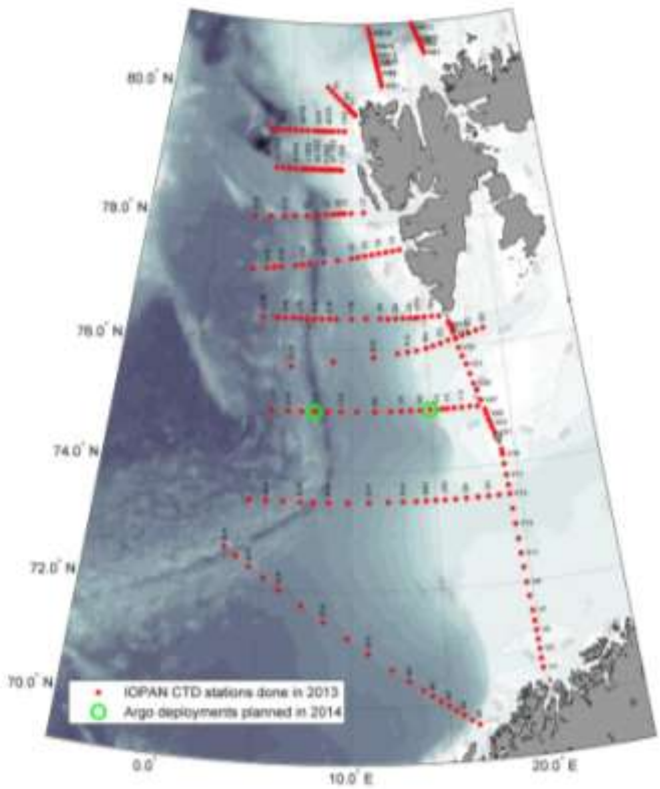


Figure 1. Planned locations of the Argo-Poland deployments in 2014 and CTD stations performed during AREX 2013 cruise of R/V Oceania (similar coverage grid is planned for AREX 2014) in the area of interest.

3. Summary of deployment plans

In 2014 IO PAN is going to deploy two floats in the subpolar North

Atlantic, particularly in the West Spitsbergen Current area to trace the Atlantic water inflow into the Arctic Ocean (Fig. 1). The floats will be deployed under the E-AIMS project, during the IO PAN cruise. The two floats are currently undergoing the purchase procedure. Plans of deployments of these floats will be soon added to the AIC coordination system.

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

The unique Argo floats trajectories as well as profiles collected west of Svalbard during the late summer, autumn and early winter are being used in the analysis concerning the amount, properties and average velocities of the Atlantic Water circulating in the Greenland Sea. The obtained results will be also used in a nascent PhD thesis comparing data sets received from various sources.

The Argo-Poland website is constantly maintained by IO PAN: http://www.iopan.gda.pl/hydrodynamics/po/Argo/argo.html

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

We do not have any wishes as for now.

6. The number and location of CTD cruise data uploaded to the CCHDO website in the past year.

Until now all the Argo-Poland deployments (in 2009, 2010 and 2012) were a part of the IO PAN summer Arctic experiments - AREX – under which ca. 200 CTD stations are performed, including the casts performed just after float launching. However, the data have not been submitted to the CCHDO website yet. It may be done this year.

7. The Argo bibliography

Scientific papers are planned concerning the usage of Argo data. However, nothing was published last year except the workshop and conference materials. There were no PhD theses using the Argo data completed in the past year in Poland, either.

Argo National Report – South Africa

Report to Argo Steering Team Meeting: March 2014

Tamaryn Morris[1], Isabelle Ansorge[2], Christopher Jacobs[2], Marcel van den Berg[3], Mthuthuzeli Gulekana[3], Sandy Thomalla[4], Sebastiaan Swart[2,4], Thomas Mtontsi[5], Juliet Hermes[5], Peter Flanagan[6], and Bjorn Backeberg[2,7]

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), Bayworld Centre for Research and Education (BCRE)[1], University of Cape Town (UCT)[2], the Department of Environmental Affairs (DEA)[3], The Council for Scientific and Industrial Research (CSIR)[4], The South African Environmental Observation Network (SAEON)[5], the Research Schooner *Lady Amber*[6] and the Nansen-Tutu Centre for Marine Environmental Research[7].

1. Status of implementation / Deployments undertaken in 2013:

<u>Southern Ocean and South Atlantic Ocean:</u>

Lady Amber Research Schooner – Decmber 2012-March 2013

26 SOLO floats: Woods Hole Oceanographic Institutde with Lady Amber (SOLO II WMO #'s: 1901620, 1901621, 1901623, 1901624, 1901601, 1901602, 1901603, 1901618, 1901619, 1901637, 1901638, 1901639, 1901640, 1901641, 1901642, 1901643, 1901644, 1901645, 1901646, 1901647, 1901666, 1901649, 1901650, 1901652, 1901653, 1901665)

Gough Island Cruise (RV SA *Agulhas II*) – September 2013

8 SOLO floats: Woods Hole Oceanographic Institute with UCT / DEA (SOLO I WMO #'s 1901651, 1901654, 1901655, 1901660, 1901656. SOLO II WMO #'s: 1901657, 1901658, 1901659)

5 ARVOR / PROVOR floats: University of Brest with UCT / DEA (serial #'s outstanding)

6 APEX floats: UK Met Office with UCT / DEA (serial #'s: 5557, 5558, 6616, 6617, 6618, 6619)

SANAE Cruise (RV SA *Agulhas II*) – November 2013-February 2014

5 SOLO floats: Woods Hole Oceanographic Institute with UCT / CSIR (SOLO II WMO #'s: 1901697, 1901698, 1901699, 1901700, 1901701)

11 ARVOR floats: University of Brest with UCT / CSIR (OIN: AR 1302, AR 1213, AR 1303, AR 1202, AR 1201, AR 1312, AR 1304, AR 1203, AR 1210, AR 1311, AR 1213)

2 PROVOR Bio-Argo floats: University of Brest with UCT / CSIR (OIN: 12S434, 12S35)

Indian Ocean:

ASCLME Alliance Cruise (RV *Algoa*) – April 2013

5 SOLO floats: WHOI with BCRE (WMO#'s: 1901676, 1901677, 1901678, 1901679, 1901680)

ACEP III Suitcase Cruise (RV *Algoa*) – July 2013

4 APEX floats: UK MetOffice with BCRE (WMO#'s: 1901309, 1901310, 1901311, 1901312)

Meteor Cruise – December 2013

5 APEX floats: CSIRO with ZMT-Bremen and BCRE (WMO#'s: 1901333, 1901334, 1901335, 1901336, 1901337)

East Coast Mooring Cruise (RV *Algoa*) – December 2013

3 SOLO floats: WHOI with BCRE (WMO#'s: 1901663, 1901664, 1901696)

Technical issues encountered and resolved:

None

Argo Data Management contributions:

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 not currently available in South Africa, but it is a goal for the South African Argo group to work towards. 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.

3. Summary of deployment plans and cruise deployment opportunities for 2014:

Southern Ocean:

Marion Island Cruise (RV SA *Agulhas II*) – April/May 2014

3 floats: DEA (if ready for deployment)

14 Bio-Argo floats: LOV with UCT – to be deployed in 2 mesoscale eddies and along 2 transects

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

3 floats: DEA (if ready for deployment)

available for deployments

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

available for deployments

Indian Ocean:

Walter Shoal (south of Madagascar – RV *Algoa*) – May-June 2014

available for deployments

East coast mooring cruise (RV *Algoa*) – June-July 2014

available for deployments

East coast mooring cruise (RV *Algoa*) – November-December 2014

available for deployments

Cape Town to India and Southern Indian Ocean(*Lady Amber* Research Schooner) – dates to be confirmed

available for deployments

Atlantic Ocean:

SAMBA Mooring Array (RV SA Agulhas II) – September 2013

available for deployments

Lady Amber Research Schooner – funding required to undertake voyage

10 floats: AOML with *Lady Amber* (plotted in green in Figure 1 below)

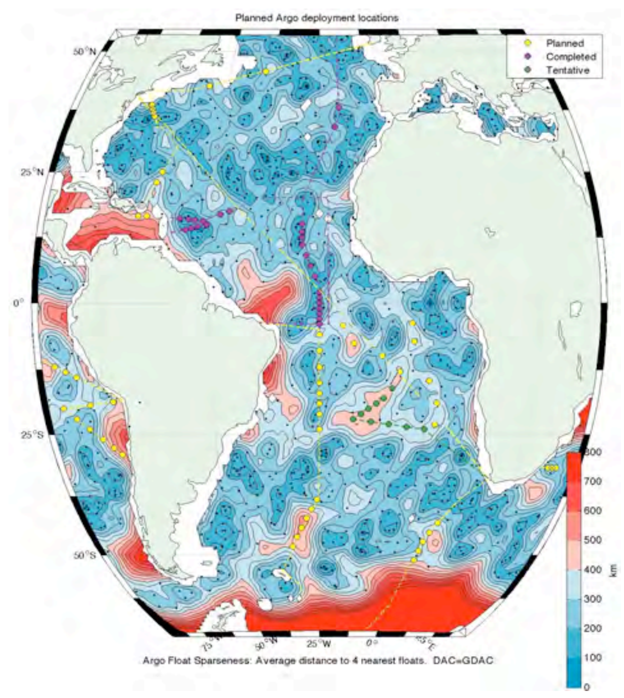


Figure 1: Proposed deployment positions for *Lady Amber* for South Atlantic Ocean (green dots).

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

Four research and two outreach project are noted below:

a) SOBOM:

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 in 2014. The first of these will see 14 Bio-Argo floats be deployed in two mesoscale eddies and along two transects to and from Marion Island on the Marion Island cruise in April 2014. For more information:

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

b) SOSCEx:

The Southern Ocean Carbon-Climate Observatory (SOCCO) group of the CSIR have developed a program to study carbon flux dynamics in the Southern Ocean through the SOSCEx experiment. Three carbon-flux biogeochemical floats were developed by Provor specifically for the CSIR and two were deployed on the Good Hope Line for this project in 2013. For more information:

www.csir.co.za/nre/coasts_and_oceans/osc.html

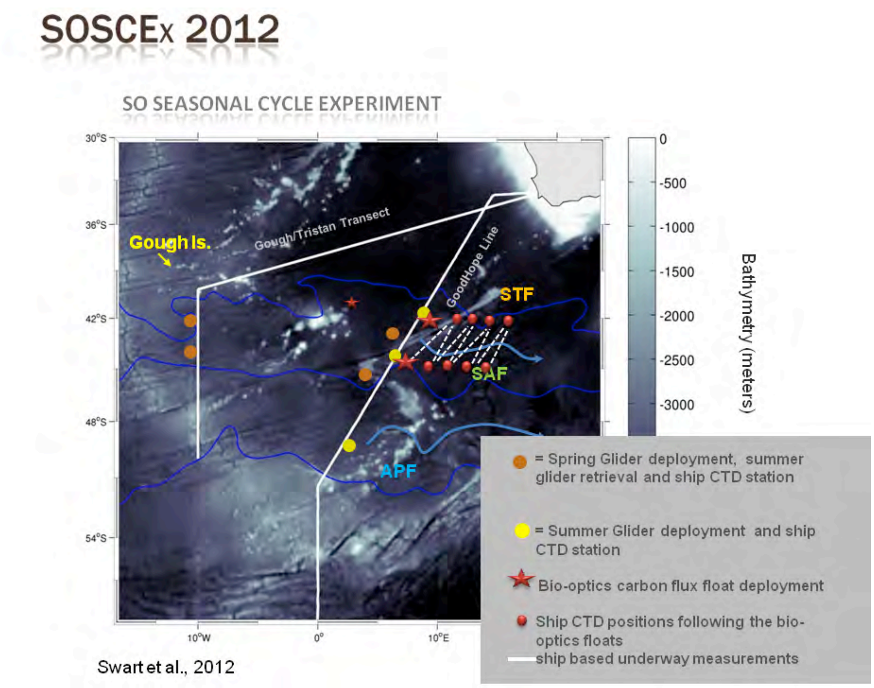


Figure 2: Complete SOSCEx experiment configuration.

c) Eddy Aging Dynamics:

Mesoscale eddy dynamics in the Mozambique Channel have been investigated over a number of years. However, the understanding of how these eddies age over time and space, and how this affects the upper-trophic levels, has yet to be determined. This project will use floats deployed off the Madagascan coast on a daily profile basis to sample the water column within an eddy to monitor its "collapse" as it progresses across the Mozambique Channel mouth. Four experiments were sucessfully undertaken in 2013 and looked at both cyclones and anti-cyclones. Data is currently being analyzed and written up.

d) The Nansen-Tutu Centre for Marine Environmental Research

The Nansen-Tutu Centre (NTC) is a non-profit research institute hosted at the Marine Research Institute and the Department of Oceanography at the University of Cape Town (UCT). Among its research priorities is the development of ocean modeling and prediction capabilities in South Africa. To this end, data assimilation of ocean observations, and in particular Argo profiles, can minimize model inaccuracies by constraining the ocean model to the observations providing better estimates of the ocean state and improving its prediction. Research is currently being undertaken to assess the benefit of assimilating Argo profiles in a regional model of the greater Agulhas Current system.

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

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 2013 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

f) Research Schooner *Lady Amber* and her ship cat Argo:

The *Lady Amber* Research Schooner, while waiting for funding to undertake further voyages to the South Atlantic and Indian oceans to continue deployment of Argo floats for the community, has not been lying idle. Along with GLOBE (Global Learning and Observations to Benefit the Environment) have hosted lectures for 40 students in Cape Town and another 80 students and educators in Mossel Bay on the Argo program. They have also initiated collaborations between GLOBE, the SEREAD program, Mauritius and western Australian schools to bolster Argo program training initiatives at primary and secondary school levels. Figure 3 (at the end of this report) highlights this collaborative work courtesy of a newspaper article from a local Mossel Bay publication.

5. Issues that your country wishes to be considered (and resolved) by the Argo Steering Team regarding the international operation of Argo:

None at this stage.

6. CTD data to be added for data quality comparisons:

All CTD, where collected, can be sent for uploading to the data quality centres. We need to confirm the process to do this at the AST-15 meeting.

7. Bibliography:

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. Submitted to Deep Sea Research. Special issue editor Igor Belkin.

8. Thesis citation list:

None at this stage

GLOBE brings The Lady Amber to Mossel Bay

TERSIA MARAIS

Mossel Bay is very fortunate to have the '*Lady Amber*' drop in. She has spent the past couple of years traversing the Indian Ocean, launching drifting monitoring devices into deep waters to help map the ocean we know so little about.

At 38 tonnes and 20 metres long, with her own desalination plant on-board, the South-African flagged Lady Amber is the only yacht from the southern hemisphere to have helped scientists from UNESCO's Intergovernmental Oceanographic Commission (IOC) complete research.

The journey began in June 2010, when Captain Peter Flanagan volunteered his expertise and his boat to the IOC's Global Ocean Observing System (GOOS). The programme asks merchant and research ships to deploy 'Argo' drifting robots into the ocean at specific points.

An Argo has amazing accuracy and releases pressure to sink 2 000m below the surface where it can stay for up to 10 days at one or varying depths. Data about ocean health, particularly pressure, salinity and temperature are transmitted by satellite to reception stations and used for numeric modelling and climate forecasting. The Argo robots are also used to research and better understand ocean conditions (currents, sea surface heights) and hazards (internal waves), associated coupled climate hazards like cyclones and rainfall, and patterns in climate variability and climate change.

While submerged, they can be programmed to stay at one depth or change depths. The Argo can repeat the data relay for between three and seven years, depending on its design. Currently there are more than 3 400 active floats in the ocean, however, most of them are deployed in the northern hemisphere.

Captain Peter Flanagan and Mark Bretteny at the Lady Amber in Mossel Bay Harbour.
Photo: Tersia Marais

Captain Flanagan has also used this as an opportunity to train young people and has shown that such a programme could be used as a basis for the development of a scholarship program. He also works very closely with GLOBE and a number of students will sail with Captain Flanagan in the Lady Amber whilst in Mossel Bay.

For more information about GLOBE and the works Capt Flanagan does on the Lady Amber, contact Mark Bretteny at 072 273 7997

Figure 3: The *Lady Amber* in Mossel Bay with the GLOBE program hosting lectures on the Argo program.

National Report on Argo-2013

by Republic of Korea

Deployment in 2013 and Future Plan

Korea Meteorological Administration (KMA) and Korea Institute of Ocean Science & Technology (KIOST) are involved in the International Argo Program since 2001. In 2013, KMA deployed an additional 16 floats in the East Sea (11 floats) and southwestern region of Kamchatka Peninsula (5 floats).

KMA has a plan to deploy 16 floats in the Northwestern Pacific Ocean (5 floats) and the East Sea (11 floats) in mid-July 2014. One float equipped with DO sensor will be deployed in the East Sea. It is expected that KMA is able to continue the float deployment.

KIOST's strategy regarding the Argo program is under revision in terms of the contribution toward the global ocean observation.

Status of Argo data management

During Jan. - Dec. 2013, 2,546 R-files from KMA were sent to GDAC.

National Fisheries Research and Development Institute (NFRDI)/Korea Oceanographic Data Center (KODC) is responsible for DMQC. NFRDI/KODC executed DMQC for 15,083 profiles (~87.8% of total profiles).

Research and operational uses of Argo data

KMA conducted planning research for maintaining the optimum Argo observational network in the East Sea (Sea of Japan). When considering correlation length scale (i.e., about 60 Km) in the East Sea, it is considered that a simultaneous observation by uniformly distributed 82 floats is proper to construct a real-time monitoring system in the sea. Thus, it is concluded that about 27 floats should be deployed every year when considering the life time of the float in the East Sea (i.e., about 3.6-year). The location of deployment is also discussed to achieve spatially uniform observing system in the East Sea.

KMA has developed Regionally Adapted Quality Control (RAQC) for the global ocean. This year, we apply it to the Argo data observed in the marginal sea (i.e., East Sea) by adding several QC procedures into RAQC. The verification of RAQC results were done by the comparison with DMQC data during 2003-2011. When DMQC results are assumed to be true value, the success rate of RAQC reaches about 99.8%. The newly developed RAQC possibly contribute to the improvement of DMQC procedure in the East Sea.

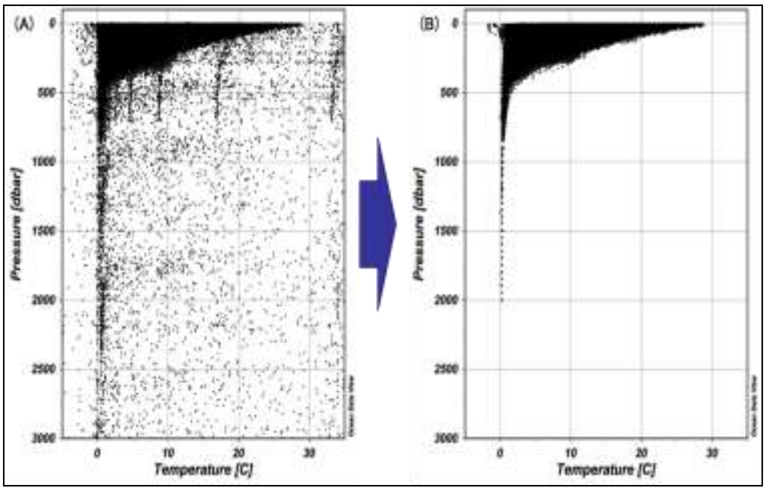


Fig. 1. ARGO temperature profiles from 1997 to 2013 in the East Sea (a) before the RAQC (b) after the RAQC.

UK ARGO PROGRAMME

REPORT FOR ARGO STEERING TEAM 15TH MEETING, MARCH 2014

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 after March 2015 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 and 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 by November 2014 (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) used 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 430 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 3 years where 119 floats have been deployed, with 38 floats deployed in 2013.

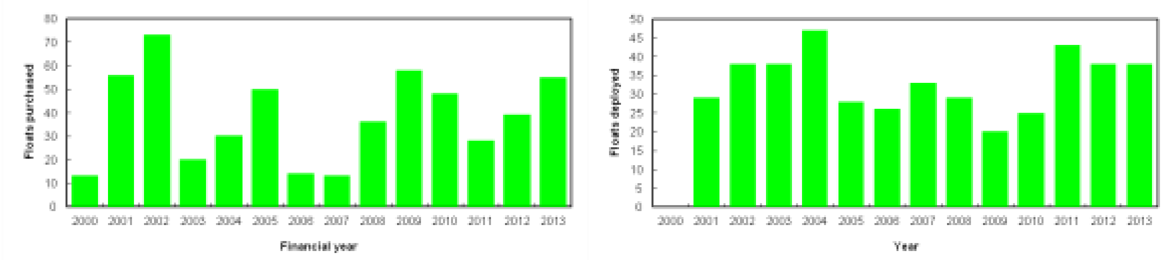


Figure 1. Showing (left) the number of floats procured each financial year (Apr-Mar) and (right) the number deployed in each calendar year.

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.

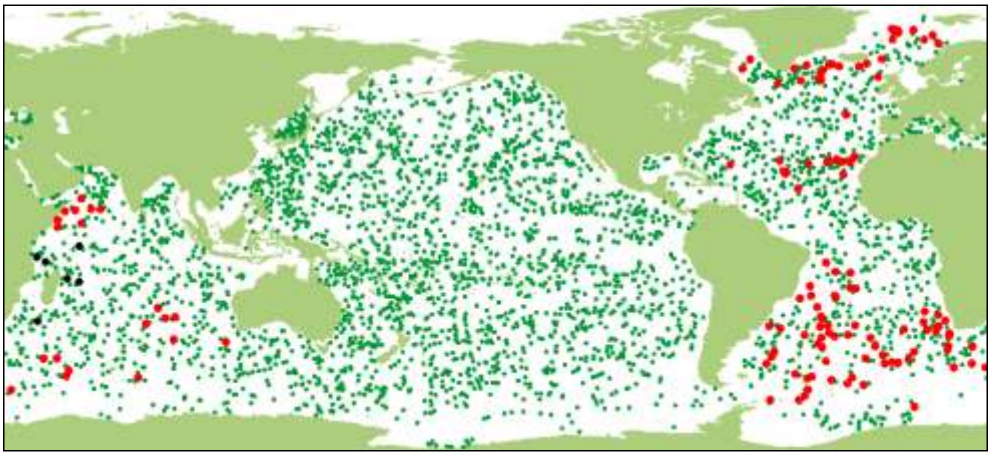


Figure 3. Showing the locations of operating UK floats (in red) and the six Mauritius floats (black) at mid-February 2014.

<u>Float lifetime</u>. 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 8 floats still going strong after 200 profiles. For floats deployed in 2010-2012, 93% have reached the 1 year mark.

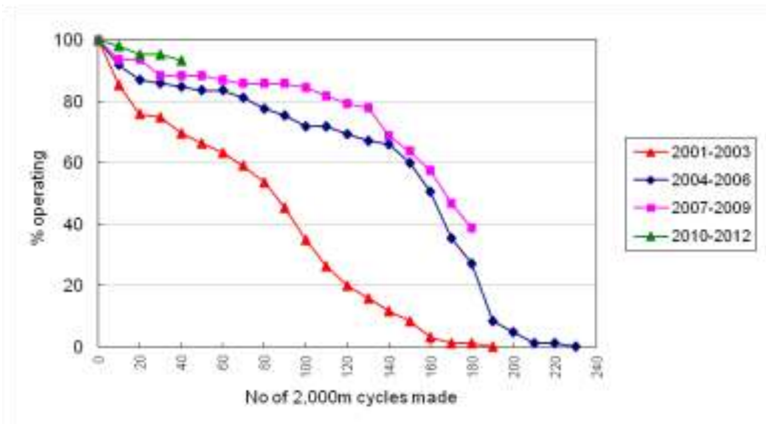
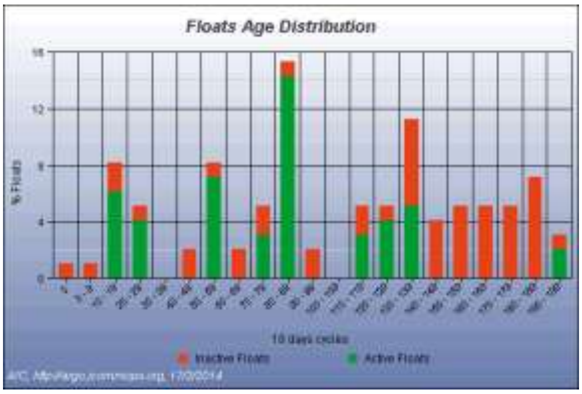


Figure 4. Number of (normalised) cycles made by UK Apex floats deployed in 2001-2003, 2004-2006, 2007-2009 and 2010-2012.

The lifetime of floats can be extended beyond the nominal 4 years by fitting lithium batteries. In 2007 we deployed our first Apex floats with lithium batteries and have since installed lithiums in over 100 Apex floats. Figure 5 shows lifetime figures from AIC for our floats deployed since 2007. This shows that with alkaline batteries the longest living floats expire after 110 – 200 cycles, while with lithiums a significant number of floats are operating beyond 180 cycles.



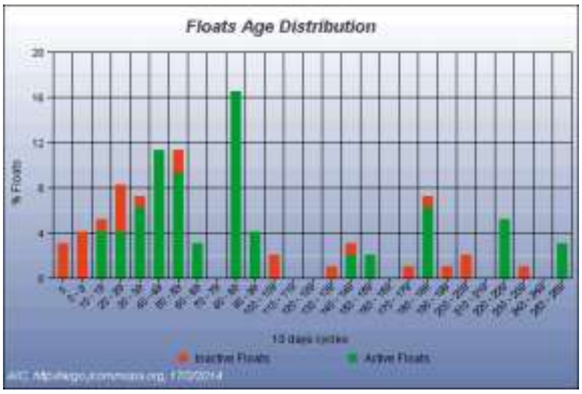


Figure 5. Number of cycles made by UK Apex floats deployed since 2007 with (left) alkaline and (right) lithium batteries. Note the horizontal scales are different.

Float enhancements. Following some early float losses in 2007 to ice damage, since 2008 all Southern Ocean floats considered at risk of ice have been specified with ice-avoidance capability. In 2008 our first 2 Apex Argos floats with near surface temperature measurement capability (un-pumped measurements) were deployed. All our Apex Argos floats (other than those with ice-avoidance) are now ordered with near surface temperature capability.

In 2012 we deployed 13 Webb Apex floats with Iridium communications in the Nordic Seas, 4 of these also carried sensors for dissolved oxygen and chlorophyll fluorescence. In 2013 we deployed (in addition to 27 standard Webb Apex Argos floats) 2 Webb Apex (Iridium) floats, 4 SeaBird Navis floats, 1 MetOcean Nova float (provided free-of-charge by MetOcean), 2 NKE E-AIMS BGC floats and 2 SeaBird Navis (E-AIMS equivalent) BGCi floats. The Navis, Nova and NKE floats all have Iridium communications. During the year the 13 Webb Apex Iridium floats in the Nordic Seas were all switched, using the 2-way communications, to report full (2m) resolution CTD profiles to 2,000m depth.

Deployment plans for 2014

At mid Feb 2014 we have around 45 Apex floats available for deployment, with a further 50 floats expected to be delivered by end March. This should 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.

At present, outline deployments in 2014 include:

- 8 floats Southern Ocean/Drake Passage (March/April)
- 6 floats Western Indian Ocean south of Madagascar (May/June)
- 4-8 floats Rockall Trough/Iceland basin (Ragnarroc cruise, June/July)
- 4-6 floats SE Atlantic (SA Agulhas, Sept)
- 4-10 floats S Atlantic (AMT cruise, autumn)
- 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. We expect to deploy the deep floats in the North Atlantic later in 2014, on a suitable research cruise with full-depth CTDO.

In addition PML have successfully bid for NERC funding for bio-geochemical floats, and have 11 NKE E-AIMS BGC floats presently on order that. It is expected that these will be deployed from the AMT cruise in the autumn, classed as Argo-equivalents and handled through UK Argo (telecoms and data management).

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. In December 2013 Clare Davis moved on to a post-doc and she has been replaced with 2 members of staff (Charlotte Williams and Katherine Gowers) to provide more resilience when staff change.

Real-time
An automatic system processes the data in real-time and generates the profile data in WMO TESAC and BUFR and Argo netCDF formats. Data from all UK floats are received at BODC by automatic download from the CLS database every 12 hours. The TESAC/BUFR messages are relayed to GTS via the Met Office (EGRR). Almost 100% of GTS messages are available within 24h. Occasional disruptions happen due to email server failures and server problems. Data in netCDF format are also sent (by FTP) to the two GDACs. The real-time processing system operates every 12 hours and delivers data twice daily. The data are also available from the UK Argo Data Centre web-site via an interactive map interface. In addition the technical files are updated once a week.

Delayed-mode
Delayed-mode processing is carried out by BODC using the OW software and the most recent CTD climatology and Argo climatology reference datasets. These are updated when new versions are made available. As of mid February 2014 the percentage of eligible (greater than one year old) profiles on the GDACs in delayed mode is ~80%.

Southern Ocean
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/).

On-going development activity
In addition to maintaining progress of previous years on-going development at BODC is focusing on the following:

- Improving the quality of trajectory data distributed by BODC. This is based on the actions decided by the ADMT and output from the ANDRO Atlas.
- Implementation of real-time quality control procedures for un-pumped near surface temperature data from Apex.
- A switch to Argo V3 formats including the real time processing and distribution of data from floats with bio-geochemical sensors and near surface temperature data firmware. The deadline for this to be delivered for an EU project is June 2014. This work will help evaluate the proposal for splitting core Argo and non-core Argo data into different data files.

- Investigation into how persistent identifiers can be assigned to Argo data. This has resulted in an initial proposal that was accepted by the ADMT in 2013 and on-going development to improve this approach with NODC.

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. It comprises a global ¼ degree model (ORCA025) and nested $^{1}/_{12}$ degree North Atlantic, Mediterranean and Indian Ocean limited area models. The system is run operationally at around 0500 UTC every day. The latest description of FOAM is given by: *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. Discuss., 6, 6219-6278, doi:10.5194/gmdd-6-6219-2013, 2013*. Also, a paper describing the impact of Argo, and other data types, in FOAM has been accepted and is awaiting publication: *Lea, D.J., M.J. Martin, and P.R. Oke. Demonstrating complementarity of observations in an operational ocean forecasting system. Accepted for publication in Q. J. R. Meteorol. Soc*.

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.

As part of the FP7 E-AIMS project work is ongoing to assess the impact of Argo data on the predictions from weather, seasonal and decadal forecasting models. This will be done by performing Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs) by withholding Argo data from the models. It is expected that the near-surface ocean is most important for short-timescales, for medium-range to monthly prediction it is likely that the upper few hundred metres of the ocean will be more important than the deeper ocean and the longer the prediction horizon becomes (from seasonal to decadal) the more important the deeper ocean becomes. Also under the E-AIMS project work will be carried out to assess the impact of Argo observations on the validation of satellite SST observations and joint in-situ/satellite SST analyses (e.g. the Met Office OSTIA product and the GHRSST Multi-Product Ensemble (GMPE)).

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.

During the year the “EN” database was updated to EN4. This is a database of ocean temperature and salinity profiles obtained across the global oceans over the period 1900 to the present to which a series of quality control checks have been applied. Associated with this are monthly objective analyses with uncertainty estimates. See *Good, S. A., M. J. Martin and N. A. Rayner, 2013. EN4: quality controlled ocean temperature and salinity profiles and monthly objective analyses with uncertainty estimates, Journal of Geophysical Research:*

Oceans, 118, 6704-6716, doi:10.1002/2013JC009067 for details of how the dataset was constructed. The data are available from: http://www.metoffice.gov.uk/hadobs/en4/.

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) has agreed to co-fund UK Argo with DECC and a MoU has been signed off. NERC will continue to fund its Argo support activities at NOCS and BODC. However the committed funding is only sufficient to pay for support activities and does not include provision for procuring floats, although additional funding for float purchases has been made available in both 2012 and 2013 (as shown in Figure 1). While the current agreement provides some stability for the 3 years to March 2015, there is still a risk that by April 2015 there is no longer term agreement.

The funding outlook for data management is potentially very good. On-going national capability support from NERC has been sustained and the European E-AIMS project is supporting the development needed for Bio-Argo. In addition to this further resource at the bidding or proposal stage includes Bio-Argo support as part of the EU AtlantOS proposal and Core Argo support to host the processing of Euro-Argo floats for DG-MARE.

Euro-Argo

The Euro-Argo ERIC is expected to be formally established within the next 6 months. The Met Office, under delegated authority from BIS, has committed the UK to becoming a full member of Euro-Argo.

Work on the Euro-Argo FP7 SIDERI project continued to the end of the project in December 2013, with a number of reports prepared on legal and policy (e.g. UNCLOS, EEZ) issues, how Argo should relate to (or interface with) the emerging WIGOS (WMO Integrated Global Observing System) and with further contributions to the Euro-Argo Roadmap. Also through the Euro-Argo E-AIMS FP7 project 50% funding was provided for 2 floats with bio-geochemical sensors and 2 floats with new (Iridium) communications (all deployed during autumn 2013), developing the data processing capability at BODC (as noted above) for these floats and evaluation of the data for the bio-geochemical floats (via a contract with PML) and capability of the Iridium floats. As noted earlier, E-AIMS is also supporting work on assessing the impact of Argo data on forecasts using a coupled ocean-atmosphere model and for validation of satellite SST products and SST analyses.

USA Report to AST-15, March 2014. (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 and programs, including the University of Hawaii, PMEL, AOML, NAVOCEANO, and Florida State University. These contributions are gratefully acknowledged.

The present 4-year cycle of U.S. Argo implementation began in mid-2011, and extends to mid-2015.

Objectives:

Primary objectives identified in the present Work Plan (2011-2015) for U.S. Argo are:

i. In float technology, an evolution of the Argo array toward bi-directional communications (Iridium, ARGOS-3) will provide energy savings, reduction of surface time and hazards, greater data throughput and enhanced profile resolution, and new applications.

ii. Float lifetime will continue to be extended beyond 4 years[1] by deployment of next generation floats (SOLO-II), through improvements to existing (APEX) float models, and by evaluating new commercial floats (Navis). The technology improvements will also result in a greater fraction of active float cycles providing high quality profile data.

iii. Working together with international Argo partners, overall data quality will be improved by insuring the completeness and consistency of metadata, technical, profile, and trajectory files.

iv. U.S. Argo will respond to community consensus recommendations regarding enhancements in float coverage and new sampling protocols to meet user requirements. Recommendations are made through recognized community forums such as OceanObs'09, or by the major Argo user groups including CLIVAR, GODAE OceanView, and the operational centers, and are endorsed by the AST. Enhancements will only be undertaken if they do not compromise the present core Argo sampling of 3^o resolution every 10 days between 60^{o}N and 60^{o}S

Support level:

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[1] The 517 U.S. floats deployed in 2006 have completed an average of 187 cycles (= 5.1 years mean lifetime), with 104 floats (20%) still active as of 03/2014. Source: Argo Information Center

The support level for U.S. Argo is aimed at providing half of the global Argo array. The target level is 1500 active floats, and was based on a deployment rate of about 412 floats per year. Due to level funding, the number of floats has decreased to less than 350 per year. However, with increases in the mean lifetime of floats, the actual number of active floats has increased.

The U.S. Argo effort 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 from pressures as great as 6000 dbar, and be capable of 100+ cycles. Deployment of initial prototypes has begun, including both Deep APEX and Deep SOLO instruments. A multi-national (N.Z., Australia, U.S.) Deep Argo cruise is planned for June 2014, including further prototype deployments and testing of the SBE-61 CTD. A regional pilot array of Deep Argo floats is planned for deployment in 2015.

Status:

As of March, 2014, there are 2000 active U.S. Floats (source AIC) and these have completed an average of 127 cycles. Of the active floats (Fig 1), 1817 are provided by U.S. Argo and 183 by partnering Argo-equivalent programs. The number of US Argo float deployments (not including Argo-equivalent) decreased slightly in 2013 to 320 from 332 in 2012 (Fig 2).

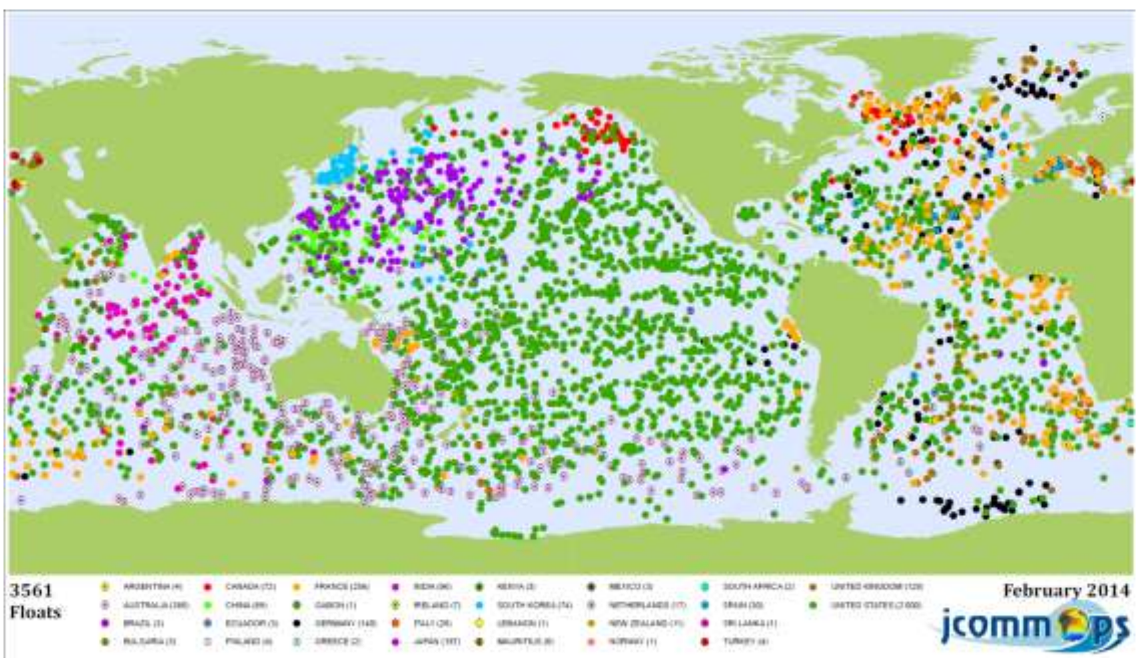

Fig 1 Positions of 2000 active U.S. floats (green dots) as of March 2014.

The highest priority for U.S. Argo is to sustain the core global Argo array. Specific plans for 2014 float deployments, as they evolve, are posted on the AIC deployment planning links. A major U.S./New Zealand/Australia deployment cruise in the Southwest Pacific Ocean was carried out in mid-2013 on R/V Kaharoa, adding 75 floats to the western boundary region of that ocean. A deployment voyage to the South Indian Ocean is planned beginning in October 2014. R/V Kaharoa has deployed 1215 Argo floats since 2004.

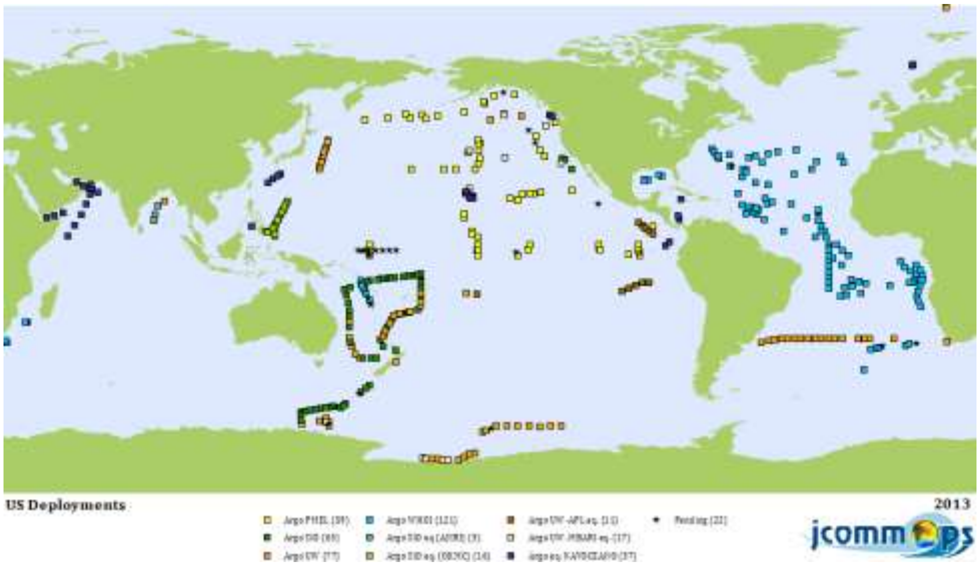

Fig 2. 2013 deployment of U.S. floats, including Argo-equivalent. (Source: AIC)

The U.S. Argo Data 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 2013 further progress was made in delayed-mode quality control (Fig 3).

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.

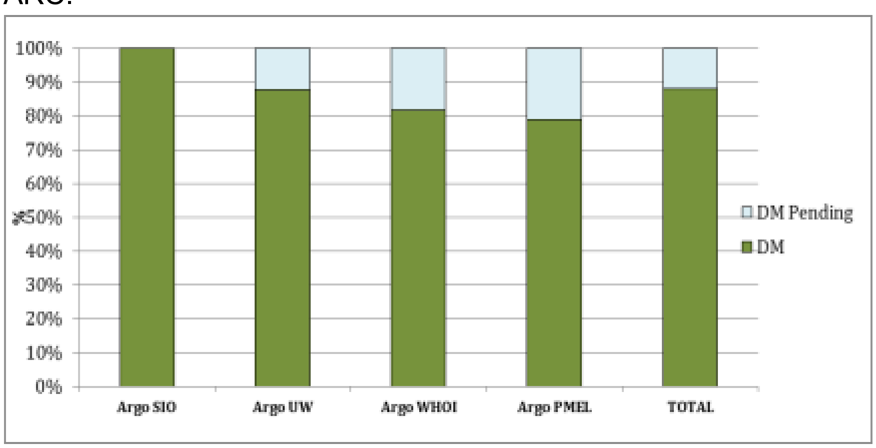

Fig 3. Percentage of DM-eligible profiles for U.S. Argo floats for which DMQC is completed (green) or pending (light blue). Source: AIC