# 12th meeting of the International Argo Steering Team

Buenos Aires, Argentina
March 15-17, 2011

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## Meeting Summary

The 12th meeting of the international Argo Steering Team was held in Buenos Aires, Argentina on March 15-17, 2011. AST-12 focused on how Argo will be sustained and enhanced in the coming years. As Argo begins considering how to implement changes suggested at OceanObs'09, there remains a push for sustained funding and for ensuring the highest possible quality data.

## Implementation issues

The Argo Technical Coordinator reported that Argo is nearly reached its core array goal of 3000 floats but that maintaining this array is going to prove to be quite challenging. Some countries have reached their limit on funding, so new ones need to be brought in to help sustain and grow Argo. On the other hand, most float types have reached original float lifetime goals and the percentage of delayed mode profiles as risen to 86% of eligible profiles. One change over the past year that is likely to occur even more is the expansion of floats equipped with Iridium sensors. In 2010, 18% of floats being deployed had Iridium communications.

Euro-Argo will transition in early 2012 into a long term European research infrastructure with a legal status (Euro-Argo ERIC). ERIC will provide strong visibility for Argo in Europe and will allow European countries to consolidate and improve their contribution to Argo international. Overall, Euro-Argo hopes to contribute 250 floats per year. In addition to the Argo core array requirements, EuroArgo has requirements for marginal seas, high latitudes and additional sensors. There is also a recommendation for a deep float pilot program and design study.

AST members updated the commitments table and the expected number of deployments for 2011 is again large (~1000). About 800 floats were deployed last year, less than the almost 1200 expected. This was mainly due to difficulty finding and arranging deployment opportunities or a lack of available CTDs for floats. SeaBird has said there should no longer be a shortage of CTDs. Even with so many floats in inventory, it will likely take a couple of years to deploy all the backlogged floats.

To help find and coordinate deployment opportunities, the ATC is xploring funding a position to track cruises and make that information available to Argo, DBCP, etc. The *Lady Amber* is now an option, in addition to the *Kaharoa*, for a dedicated ship to deploy Argo floats. It has already taken its first voyage to deploy floats and is ready to accept more in September.

Hosoda presented on beached floats – both those beached on Japan's coasts and Japanese floats beached elsewhere. He noted that several Japanese fishermen have picked up floats and have been unsure what to do with them since the float label does not have Japanese on it. A flyer has been made to hand out to Japanese fisherman to help inform them on Argo floats and to make it easier to notify the owner. Concern was expressed that the procedure to handle beached Argo floats was still not agreed upon among relevant government agencies/institutes in Japan, which may hinder smooth handling and cause trouble between the finders and owners of floats. For Japanese floats beached elsewhere, a technician has been dispatched to retrieve the float and/ or make it safe for redeployment or return to Japan.

Hosoda presented on two forums that were held in Japan in 2010 to build consensus on the future direction of Japan Argo. Two conclusions were agreed upon at the forums. The first being that Japan Argo should continue to contribute the core Argo by sustaining current level of float deployment and data management activities. The second being that Japan Argo should contribute to construct new integrated ocean observing systems, based upon the Argo core array, which will increase the climate monitoring and research capability and provide information on the marine environment to meet society's needs better. To help fulfill the second consensus, twenty-five dissolved oxygen floats will be deployed as Argo equivalent floats in the experimental area of 150 km x 150 km in collaboration with other observational platforms such as moorings, ships and satellites.

H. Claustre reported on the progress of the Bio-Argo working group. As a result of two meetings attended by scientists from complementary expertise, three main classes of bio-optical and / or biogeochemical floats have been proposed. The Bio-Argo float is proposed as a rather simple float with respect to optical package [Chla fluorescence, backscattering (proxy of POC)] that could become part of the Argo array, respecting the core Argo mission rules. Presently ~150 floats are to be deployed within the next 18 months. The Bio-Argo community is also involved in the various aspects of data management and delayed mode quality control.

**Data Management related issues**

Overall, Argo's data management infrastructure is stable, but requires monitoring tools at the AIC, GDAC, and ARC levels and requires manpower at the DACs to correct the detected anomalies. The current ADMT efforts are focused on reducing delays, delayed mode quality control, improving data consistency and completeness and detection and correction of systematic errors/biases. The pressure offset correction and TNPD identification was recognized as the highest priority for DM operators. Much work has been done on this, but it still needs to be finished. The DM file checker is still under validation at the US GDAC. Its completion is critical to reduce the submission of DM files with anomalies. The next priority for the ADMT will be trajectory data. It was agreed that a trajectory workshop for DACs and operators engaged in preparing traj.nc files should be organized alongside the next ADMT.

The Argo DACs are working hard on identifying, correcting and labeling Argo profiles that might be affected by pressure sensor bias. This involves correctly populating technical files with reported pressure offsets, correcting profiles that require it and identifying APEX floats with APF8 or earlier controllers and possibly negative drifting pressure sensors, known as Truncated Negative Drifting Pressure (TNDP) profiles. Great progress has been made by DACs on pressure drifts where known. However, Argo did not achieve its goal of having all corrections and TNDP labeling completed by December 2010. Even so, most large DACs are nearly complete and most egregious cases have been treated. TNDP identification and treatment is not as far along, but is progressing. This may require further focus by the DACs and smaller DACs might need assistance in finishing compliance and improving decoders.

B. King presented a status update on the work of J-P Rannou and M. Ollitrault who continue to re-decode Argos hex files provided by DACs and to correct errors. The goal is to complete all Argo data through December 2009 by the end of 2011. Additionally, work has been done to extract and save extra information not stored in existing traj.nc files. B. King and a small group are working on a proposal for a traj_version2.nc file which will include extra timing information to easily enable users to pull out data useful to velocity calculations. This will be discussed at the trajectory DM workshop in conjunction with the next ADMT.

**Technical issues**

An update was given on PROVOR and ARVOR float technology. Both floats are being equipped with new sensors and communications. As for the PROVOR float, oxygen sensor technology is now considered mature and work is being done to implement a nitrate sensor and a "NOSS" density sensor. Both Arvor and Provor floats have been successfully equipped with iridium transmission**.** The Iridium float is thus currently programmed to acquire 200 to 300 PTS triplets, but this number can be increased to 1000 if required (1 sampling every 2dbar). Argos 3rd generation transmission is being embedded on Arvor. Additionally, a deep Arvor float is being developed that will reach 3500m depth. Finally, developments will be done on PROVOR and ARVOR floats within the French NAOS project to reduce costs and to improve float reliability and lifetime.

S. Riser presented on four developments including APEX air pump solenoid problems, some first tests of ARGOS-3, and SBE conductivity drift. The air pump is controlled by a solenoid, many of which, for reasons unknown, have failed in lab tests at UW in recent months.

A failure would mean the air bladder would not inflate, resulting in the possible loss of the ability to communicate with a satellite. This is especially problematic for Iridium floats. The problem can be corrected by adding a small, inexpensive, printed circuit board near the solenoid. This fix has been added to all UW and PMEL floats since February 2011. As of March 2011, Teledyne/Webb have not instituted the remedy and it is not clear whether or not they intend to add the auxiliary PCB in their production process. UW has developed a prototype float that uses a Kenwood PMT to communicate with ARGOS-3 satellites. The first tests of the Kenwood PMT have shown that energy use is larger than with present ARGOS-2 PTTs. Finally, both Jamstec and PMEL have noted APEX floats with unacceptable conductivity drift after deployment (> 0.01 PSU equivalent). The cause of the problem has been found and new QC procedures have been installed at SBE. It is believed that this problem occurred in an isolated group of floats (CTDs built in late 2010) but all groups should check for this.

D. Roemmich presented an update on the SOLO-II which is now commercially available through MRV Systems (http://www.mrvsys.com). The SOLO-II is engineered to complete around 300 dives anywhere in the world ocean using Iridium. It weighs less and is shorter than the SOLO making it easier to deploy. Two SOLO-II prototypes have been deployed and completed many successful cycles. US production of the SOLO-II will be done by both SIO and MRV. 15 SOLO-II floats have been sent to Papeete for deployment along the equator with more than 150 floats to be built in 2011.

Jon Turton outlined some results from preliminary analysis of data from eight Near Surface Temperature-capable (NST-capable) Apex floats deployed by UK. Although relatively few stratified profiles were observed, the results show the NST-capable Apex floats are able to observe near-surface temperature stratification that would otherwise remain undetected and so do provide useful additional information. More work is needed to further explore the NST-capable floats.

S. Wijffels reported on work done by E. Van Wijk and others on the prospects for extending Argo into the seasonal and fast ice zone. Mortality rates of newer ice floats are now equivalent to those deployed in less demanding conditions, but the short surface time associated with Iridium is also a likely factor. A quick comparison among ice-float deploying groups shows a survival rate of around 80%. Extending Argo into the seasonal ice zone would require an additional ~600 floats. It was suggested that Argo continue to pilot ice-capable floats in order to refine the technology, but to also explore alternative sampling platforms.

**Demonstrating Argo's value**

Dr Juliet Hermes presented the South African Environmental Observation Network education program, of which Argo floats form a key component. This program creates a platform where Marine Science Research can be integrated into School Sciences curriculum (with buy-in from the Department of Education). There are three main thrusts: educator/teacher support through workshops, school based monitoring programs and additional student support in Science Camp. Dr. Hermes also gave details of South African activities of interest to the Argo community and highlighted that all South African marine institutes have potential to be more involved with Argo over the next five years. A new vessel is commissioned for 2012 and there will be more float deployment opportunities aboard ASCLME cruises.

M. Scanderbeg presented on the development of the Global Marine Argo Atlas which uses Ferret to create plots of gridded data. Currently, the PC version of the Atlas comes with the 4-D gridded Argo dataset made at Scripps Institution of Oceanography (Roemmich and Gilson, 2009), the Reynolds SST dataset, and the AVISO dataset. It is possible to create map plots, section plots, time series, line drawings and a few simple products. Both postscript and jpg outputs are available for plots that are created using the Atlas. Both NetCDF and ASCII outputs are available containing the data used to create the plots. Besides giving a quick view of the datasets, the Atlas is a great way to compare datasets quickly. A Mac and Linux version should be available soon.

S. Diggs and the Argo TC presented work done on the Argo layers for Google Earth. The application is ideal for network tracking, searching/ retrieving beached floats, planning float deployments, as well as demonstrating and promoting Argo to the general public. Besides information balloons on each individual float, a layer of float stories has been added and overlays of temperature, salinity and steric height (data from 100% Argo gridded product from Scripps Institution of Oceanography) are now possible. Once the final version is finished, it will be proposed to Google for inclusion into their Google Ocean layer.

## 1 Welcome and introduction

Capitán Javier Valladares, Chairman of the IOC, welcomed the Argo Steering Team to Buenos Aires. He commended the AST on the work they have already done and looks forward to learning how the AST will decide to shape Argo's future. Local arrangements were discussed as well as an invitation to the reception dinner the following evening.

**Action item 1:** AST co-chairs to send a letter of thanks to Ariel Troisi and Servício de Hídrografia Naval for hosting AST-12.

## 2 Objectives of the meeting

S. Wijffels opened the AST-12 meeting by summarizing the main challenges facing Argo:

(i) How will Argo be sustained and enhanced in the next few years?

(ii) What actions are needed to ensure that the quality of Argo data is sufficient for global change studies?

## 3 Action items from AST-11

M. Scanderbeg presented the Action items from AST-11. Most items were completed, with several reported on at the meeting. Some items relating to the data files were still ongoing such as DACs correcting their technical files and completing pressure corrections on APEX floats. Additionally, work still needs to be done on the trajectory files, but a new working group has been formed to begin solving the problems associated with the trajectory files.

## Implementation issues

### 4.1 Status of Argo

The Argo Technical Coordinator. M. Belbeoch reported on the status of the Argo array. He recalled first that the Argo array was basically implemented by a dozen of countries while 20 more were assisting in filling regional gaps. With 54% of the array maintained by the USA who is reaching its contribution limit, the growing involvement of Europe will be crucial. The EuroArgo initiative is starting to be fruitful with a number of new comers and Asia keeps contributing its part. The TC noted however that a number of partners had difficulties to sustain or augment their contribution and underlined the impressive effort happening in Australia, which recently became the first Argo participating country when considering the number of active floats per habitant.

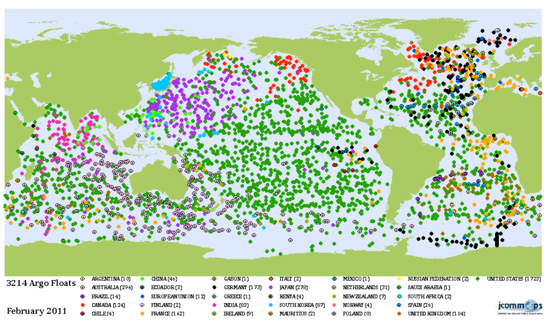
| Country | Active floats | Floats/million habitants |
|---|---|---|
| AU | 295 | 13.71 |
| USA | 1710 | 5.51 |
| CA | 124 | 3.67 |

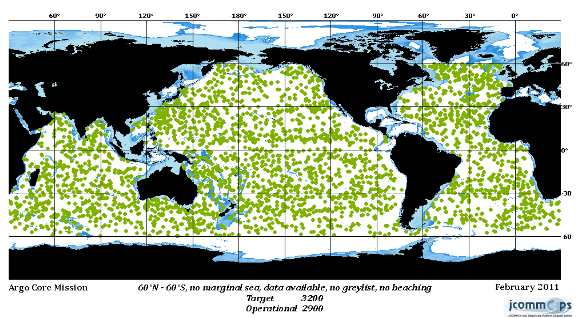
| | | |
|---|---|---|
| FR | 162 | 2.53 |
| JAP | 278 | 2.19 |
| KOREA | 91 | 1.87 |
| GER | 152 | 1.85 |
| NETH | 31 | 1.85 |
| UK | 104 | 1.70 |
| INDIA | 83 | 0.07 |
| CHINA | 45 | 0.03 |

With the meeting being held in Argentina, the TC invited other South American countries to help in a regional effort. It was learned in the meeting that Brazil is working to contribute to Argo with about 30 floats via a multi-disciplinary project.

The TC remarked then that after a drop in 2009/2010, Argo was finally approaching its initial target with the "core mission" being 90% achieved, noting some progress compared to 2010 (85%).

He asked the AST if an "expanded Argo" could be feasible, with about 4000 floats, including high latitudes and main marginal seas.

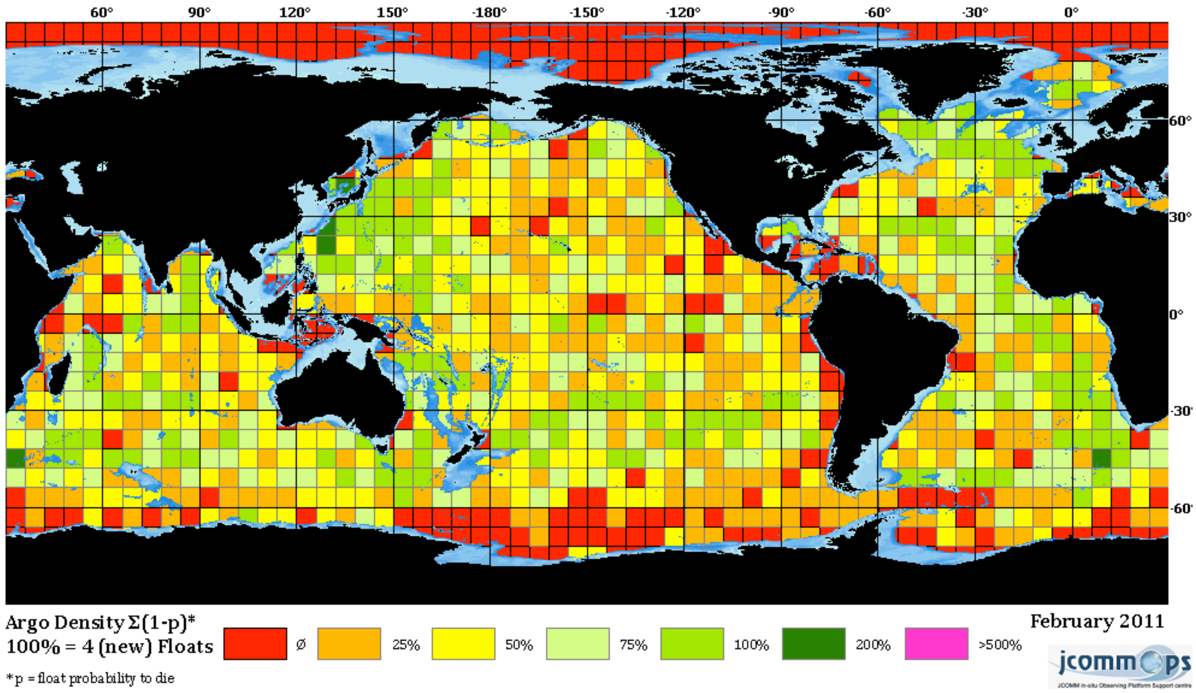



The challenge for Argo in 2011/2012 will be to address the 2009 year deficit in deployments (300 units).

| Deployment / year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Arctic Ocean | 0 | 7 | 1 | 0 | 5 | 5 | 1 | 8 | 12 | 10 | **10** |
| Atlantic Ocean | 65 | 97 | 148 | 190 | 243 | 307 | 301 | 165 | 284 | 139 | **269** |
| Indian Ocean | 13 | 24 | 106 | 124 | 158 | 113 | 149 | 139 | 144 | 147 | **155** |
| Mediterranean Sea | 6 | 4 | 9 | 13 | 18 | 17 | 12 | 7 | 11 | 11 | **5** |
| Pacific Ocean | 32 | 163 | 188 | 345 | 446 | 566 | 470 | 431 | 432 | 228 | **368** |
| Southern Ocean (< -30°) | 0 | 16 | 76 | 145 | 242 | 336 | 254 | 239 | 270 | 148 | **306** |
| Total | **116** | **295** | **452** | **672** | **870** | **1008** | **933** | **750** | **883** | **535** | **807** |

The TC then presented the density of the array. He reminded the AST how vital the notification procedure was to plan all deployments via the central AIC interface so the strategy can be optimized to fill the existing and anticipated gaps.

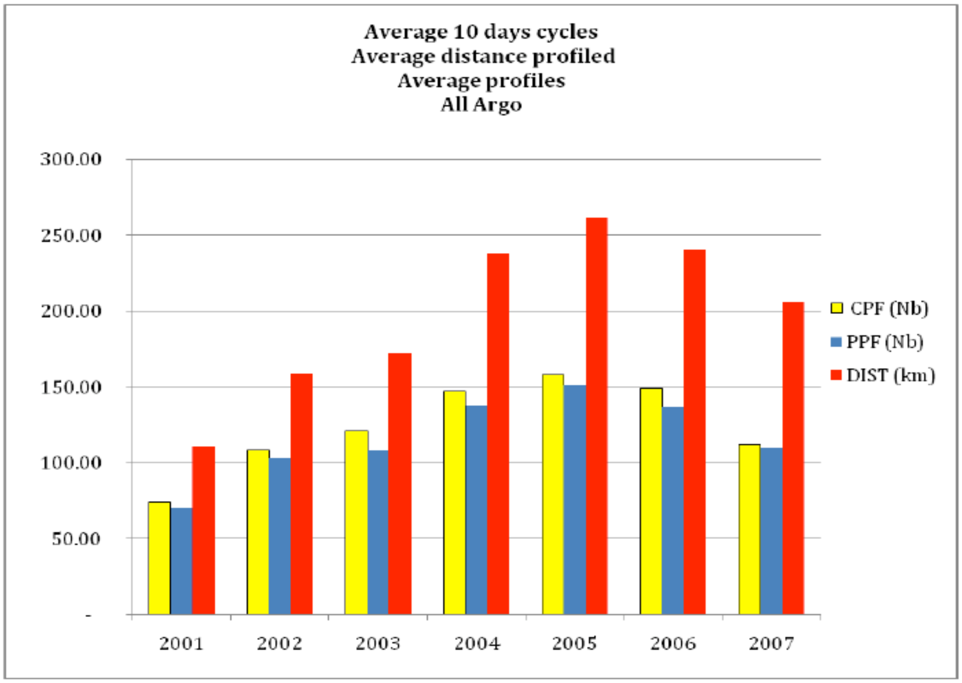


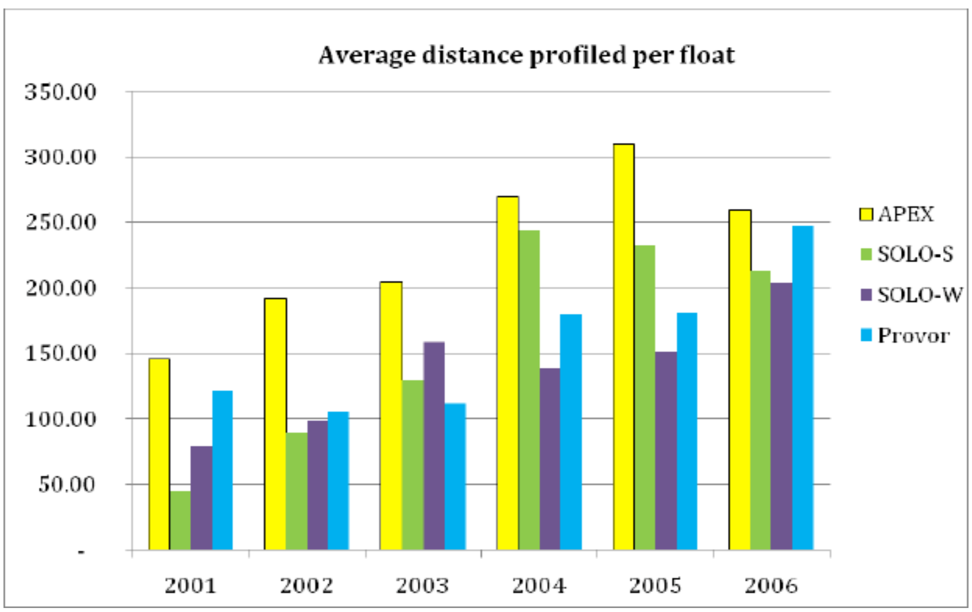

Regarding the Argo data stream, the TC noted that 2010 was the first year since 2000 where we observed a decrease in the number of profiles distributed. However the efforts in processing the backlog of delayed mode files was substantial (83% achieved as of 03/2011 compared to 76% as of 03/2010). In addition, the issue of additional delays introduced by the GDAC Coriolis, seems under control. After a first correction early 2011, Coriolis is preparing a new patch to their collect system that should remove most of this additional delay. The TC requested again that the US GDAC provide appropriate information (detailed index files) so such delays can also be monitored on that mirror.

The TC presented finally a set of metrics showing how float reliability was progressing, for all float models, how iridium telecommunication system is gradually being adopted (18% of yearly deployments), how ARGOS-3 was tested at sea, and how the BioArgo ancillary array is developing (including dissolved oxygen, bio-optics and nitrate sensors).

He concluded by inviting AST members to do better than ever in term of planning so that more than 1000 units can be deployed in 2011. It is still a challenge to maintain Argo at its current level. More international cooperation will be required to secure the core array and is crucial to expand it.

In particular, given the world economy constraints, and given the fact that float reliability is lower in those areas of expansion, the growth of the array to 4000 units will be a huge challenge. If this expansion requires clear commitments for floats and ship time, it will also require resources for the data management and for the infrastructure (Information Centre/Project Office).




In the conversation that followed the presentation, the roughly 30,000 float profiles from Argo equivalent floats in the US that need to be delay mode quality controlled were discussed. The floats were discussed at the US Argo meeting a few months prior and it became clear that it was difficult to quality control these floats within the US program. The only APEX dmode operator is Annie Wong and this is simply too big a task for her to do without any extra funding. D. Roemmich said that it essentially boils down to a time and resource problem for US Argo and any help would be welcomed. B. Klein said she would look at the old temperature only floats in the tropical Atlantic to see if it would be feasible for her group to dmode.

M-S Suk stated that he does not have any Antarctic CTD data to compare to for DMQC and that he is not an expert in the region. The TC confirmed that some countries deploy floats to fill gaps that are not in their area of expertise and suggested looking at sharing dmode across nations.

**Action item 2:** Define more specifically what Argo core means to help the Argo Technical Coordinator make more useful statistics. AST co-chairs

### 4.2 Sustaining and evolving Argo: Following up the OceanObs'09 consensus

Alberto Piola gave Eric Lindstrom's presentation on sustaining and evolving Argo based on follow up work to OceanObs'09. OceanObs'09 goal was to build a common vision for ocean observations. It called for a provision of routine and sustained global information on the marine environment sufficient to meet society's needs for describing, understanding and forecasting marine variability (including physical, biogeochemical, ecosystems and living marine resources), weather, seasonal to decadal climate variability, climate change, sustainable management of living marine resources, and assessment of longer term trends. From OceanObs'09 there were several conclusions to be drawn about Argo. The first was clear recognition of the importance of sustaining Argo at its design network density. There was also a high level of interest in using the profiling float platform with other sensors like rainfall, oxygen and bio-optical sensors. It was recognized that there is a potential tradeoff in float lifetime and array maintenance costs for these additional sensors. New deeper profiling floats could play a key role in deep ocean observations. It was noted that a strategy is needed to meet a wider variety of scientific and societal goals that carry a higher cost.

There were several calls for action from OceanObs'09 with the third one highlighting Argo's role: Invites governments and organizations to embrace a framework for planning and moving forward with an enhanced global sustained ocean observing system over the next decade, integrating new physical, biogeochemical, biological observations while sustaining present observations. Recommendations on this Framework, considering how to best take advantage of existing structures, will be developed by a post-conference working group of limited duration.

This working group was to consider the outcomes and recommendations from OceanObs'09 and recommend a framework to fulfill the goals and report back to sponsors by late 2010. The Framework asks Argo to actively work on interfacing with other communities. For example, to work with teams focused on particular variables such as SST. Also to work with other observing networks on common issues as is already being done through JCOMM. Argo is also being asked to feed information up to OOPC and other bodies working on requirements for societal benefits. Argo is also being asked to be open to new communities that want to explore profiling floats as a platform for observation of new variables beyond the Argo core. Finally, it was noted that Argo has limitations, but to be open to new sources of funding that can achieve multiple sets of requirements. Feedback is to be sent to Eric Lindstrom or Albert Fischer.

In the discussion that followed, several steering team members were worried about the lack of new funding coming into Argo that will make expanding and/ or adding new sensors quite difficult. A. Piola encouraged the AST to make these concerns known to the OOPC.

**Action item 3:** AST co-chairs to send a letter from Argo to the OOPC and E. Lindstrom expressing Argo's concern about a lack of funding to help Argo follow up on enhancements from OceanObs'09. AST co-chairs

### 4.3 EuroArgo update

P.Y. Le Traon gave an overview of Euro-Argo activities. Euro-Argo will transition in early 2012 into a long term European research infrastructure with a legal status (Euro-Argo ERIC). This new European legal structure will provide strong visibility for Argo in Europe and will allow European countries to consolidate and improve their contribution to Argo international. Agreements are at the ministerial level and this will help to ensure long term sustainability. The existence of a European legal entity will facilitate the access to long term European funding through GMES. As of today, Euro-Argo countries contribute to Argo international about 150 floats/year and with an important contribution to the data system. Euro-Argo target is 250 floats/year and plans for the coming years show a significant increase of European contributions to Argo. It is expected that by 2014 new funding from the European commission will provide further improvements.

The long term evolution of Argo was recently discussed by Euro-Argo partners. At European level, we need to meet requirements both from the research and operational oceanography (GMES) communities. There is a strong requirement for marginal seas (Mediterranean and Black Seas) and there are also important European research activities in high latitudes. Implementation is on going and an Argo « extended mission » for marginal seas and for high latitudes should now be defined at the international level. There is also a strong interest for an extension to biogeochemical variables. Several pilot experiments are ongoing or planned. There is a need to work on an international strategy for oxygen and Bio Argo (e.g. agree on a common sensor package, start with pilot experiments to share best practices and develop the data system and technology, define a target for the addition of biogeochemical sensors for the global and regional arrays to be implemented in a second phase). As far as deep floats are concerned, pilot experiments should be organized and design studies conducted.

### 4.4 New Brazil plans

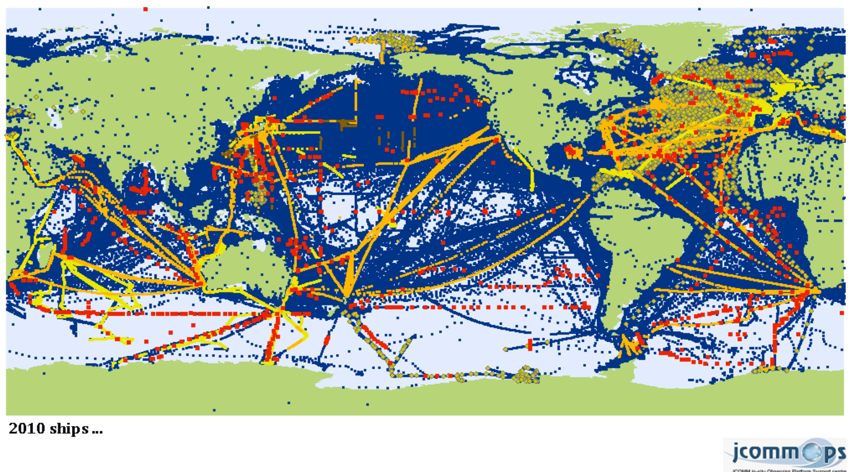
O. Sato and P. Polito presented on their master project submitted to the Brazilian Federal Agency called CARBOM-OCEANS. The main theme of the project is to study the budget of carbon and chemical elements associated with the production of organic matter in the South Atlantic ocean as well as the annual flux between biogeochemical compartments of the Brazilian continental margin and adjacent deep-ocean areas. Argo floats will be used along with CTDs, ADCPs, gliders, moorings, and satellites to try to understand the circulation and material transport. The goal is to deploy groups of Argo floats simultaneously that will be programmed to dive to different depths. This will help to investigate the divergence and convergence of the mass flux. The trajectories at different levels will provide a description of the baroclinicity of the flow responsible for the transport of organic and inorganic materials in the ocean. In particular, Argo floats will be deployed in regions where satellite images indicate the presence of meanders and eddies. The vertical velocity anisotropy of these features can significantly change the final destination of particles carried by the flow from a common geographic point of origin.

After the presentation, the Technical Coordinator asked if Brazil is interested in becoming a sustained funder of Argo floats. Dr. Sato said that this project will hopefully begin a more sustained structure as it calls for the creation of an institute. A few other tips were pointed out such as allocating money for data management as well as using Iridium to keep the floats below surface as much as possible.

### 4.5 Commitments table

AST members updated the commitments table and the expected number of float deployments for 2011 is again large (~1000). The number of estimated float deployments for 2010 was about 1100 and only about 800 ended up being deployed.  This was mainly due to difficulty finding deployment opportunities, difficulty arranging for deployments or a lack of available CTDs. SeaBird has said that there should no longer be a shortage of CTDs, so hopefully that will not slow down deployments this year.  Therefore it becomes even more important for AST members and other float deployers to work together to raise awareness about deployment opportunities. The ATC reminded everyone that he has established an email list to advertize deployment opportunities and he urged everyone to notify him of known opportunities. Even with so many floats in inventory, it will likely take a couple of years to catch up and find deployment opportunities for all the backlogged floats.

### 4.6 Float deployment opportunities




*An attempt to represent a year of ship based observations showing where the ships are not going. (float deployments in red).*

The Argo TC reported on the issue of deployment opportunities and ship time. Ships are the common denominator of all observing systems. They provide observations (e.g. CTD) and are used for deploying instruments or maintenance operations (e.g. ~1000 floats, ~1000 buoys, ~500 moorings). There is a need to optimize the use of existing opportunities (in particular below 40°S) and identify new opportunities to address regional gaps.  While ship time funding is substantial for some countries, it is impossible to deploy all those instruments without a strong cooperative effort (for logistics but also funding).

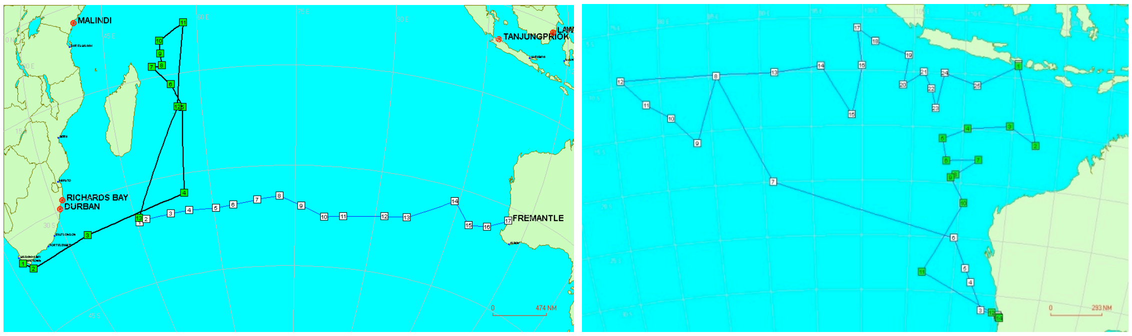
The key issue is that there is no international central node to gather cruise plans enough in advance, even though there are good national resources. In addition, about 2 months are required to deploy a few units, while 6-12 months are needed for a batch deployment of 50 units.

So there is some progress to be made for cruise metadata sharing and the TC proposed some elements of solution:

- **Communication:** JCOMMOPS set up a dedicated mailing list for float/buoy/mooring operators and "deployment managers": ships@jcommops.org

Any opportunity, any new ship recruited should be promoted though this channel in a timely manner.

- **Cross-program cooperation**: while Argo maintains deployment plans on-line, the DBCP is invited to do the same. The Argo TC will encourage the new DBCP TC to address this issue.
- The monitoring of ~3000 SOT ships needs to be improved and Port Meteorological Officers expertise could be used further (professionals of ship recruitment for ocean observations).
- **International cooperation**, (like the "donor programmes") has to be developed so that partners can offer us ship time at regional levels while we can offer instruments, experts, trainers, etc. Such initiatives should be conducted with a JCOMM oriented approach (very "time demanding" for modest results).
- **Specific chartering opportunities** can make the difference. The Kaharoa (28m length, 5 crew) that has deployed more than 800 units is a good example. JCOMMOPS is also chartering a sailing ship (Lady Amber, 20 m, 4 crew) that is operating for now in the Indian Ocean for CSIRO. This charter can operate anywhere for 20k€ per month (overhead included for coordination at JCOMMOPS) or 500€/unit given ship capacity and autonomy. The ship will be ready for new contracts in early September in Perth.
  Similarly and following up on Maria Hood (former IOC/IOCCP Project Office) suggestions and contact points in the sailing community, JCOMMOPS is trying to set up deployment opportunities through sailing races or individuals (Yves Parlier was interested in launching floats on his around-the-world trip in 2012 or 13, and Mike Horn, the Swiss explorer, as well). These connections could be useful in the long run also for instrument retrieval.


*The Lady Amber is deploying about 60 floats for CSIRO in the Indian Ocean. Such initiatives have also a strong outreach potential. The crew flies the flag of global ocean observation, on a green platform.*

- **Dedicated resource:** we will also need a focal point, tracking existing ships, one by one, identifying new ships including charters, coordinating logistics when necessary, and channeling the information as appropriate within the community. Such "Cruise Coordinator" position is being documented and funded.

**Action item 4:** Explore ways to more effectively share deployment opportunities among Argo float providers, including navy ships in pirate prone areas. ATC, float deployers, PIs / AST members with navy connections.

### 4.7 Discussion on beached floats

Handling of beached floats is one of the Argo implementation issues with which many countries have been involved. Some of JAMSTEC floats deployed in the open ocean such as the Pacific and Indian Oceans occasionally are caught by fishermen or beached on the shore not only in Japan but also in foreign countries. On the other hand, since Japan has long coastal lines, foreign PIs' floats are sometimes beached or picked up by Japanese fishermen. Here is a brief report on our experiences, which are categorized into the following two cases:

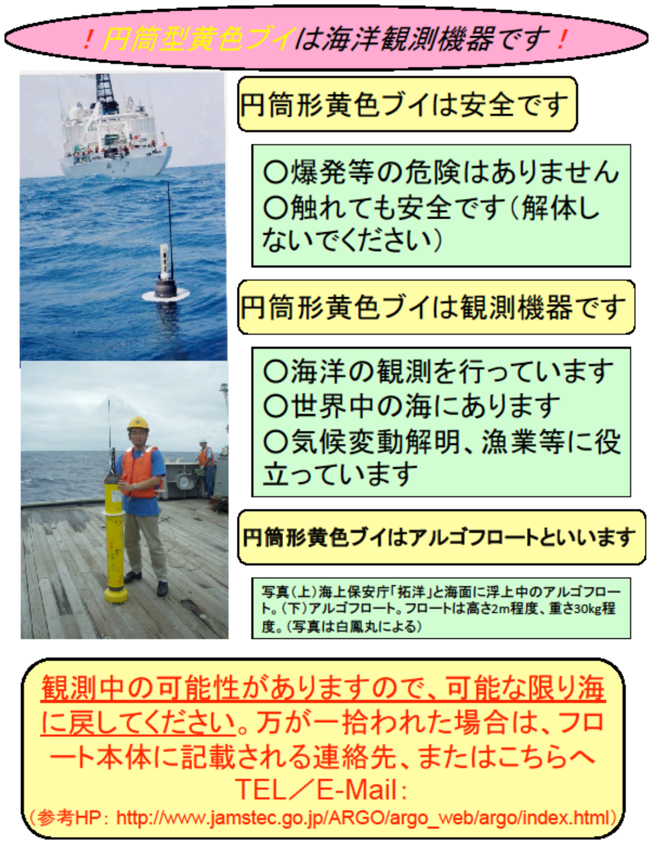
1) Recovery of JAMSTEC's floats at the coast of foreign countries
2) Recovery of the other countries' (foreign PIs') floats at the coast of Japan

As for the case (1), JAMSTEC has three experiences. (a) On March 2006, Coast Guard of Philippines contacted us via AIC to inform us about a beached float which was picked up by a fisherman at the coast of Philippines. JAMSTEC's scientist went to Philippines to switch off the float and received it from the Coast Guard. (b) On March 2007, US Navy contacted us via AIC and informed us about recovery of a float at Hawaii. JAMSTEC's technician went to Hawaii to switch off the float and received it. (c) On April 2009, a fisherman picked up JAMSTEC's float at the coast of Oregon, U.S. and asked to keep it at US NOAA Fisheries service at Oregon. NOAA Fisheries Services contacted us via AIC. Since the battery of the float had already run out, we asked NOAA Fisheries Services to send it back to us under our arrangement of international shipping.

As for the case (2), JAMSTEC has three experiences. (a) On April 2005, a fisherman picked up a float by his fishing net. A regional station of Japan Maritime Self-Defense Force at Hakodate kept it and contacted Japan Fisheries Research Agency at Niigata. Upon request of the Fisheries Research Agency, JAMSTEC found that the PI of the float was KORDI. The Fisheries Research Agency contacted KORDI and sent it back under KORDI's arrangement of international shipping. (b) November 2007, Coast Guard of Japan found a beached float at the coast of Nansei (Ryukyu) Islands. Upon request of the Coast Guard, JAMSTEC found its PI was US NavOcean. Following a request from NavOcean, the float was redeployed off the islands by the Coast Guard. (c) On October 2009, a local fisherman picked up a float at the coast of Japan Sea and notified Japan Coast Guard. The Coast Guard asked JAMSTEC to find its PI and inform to AIC. JAMSTEC contacted PI (PI: KMA) via AIC and advised the PI about shipping procedure.

There may be more beached or picked up floats around Japan because some people who found floats possibly contacted PIs directly or disposed of them without notifying PIs. There are also some JAMSTEC floats beached on the foreign coastal area, which are not found or difficult to be picked up due to unknown correct positions.

A sticker describing Argo and PI information in Japanese is attached to floats deployed around Japan. However, Argo floats are not very well known among Japanese fishermen or local Coast Guard offices. To inform them about the Argo floats, JAMSTEC and the Japan Coast Guard made a leaflet about Argo floats (in Japanese).




The leaflet describes (a) purpose of the Argo program, (b) characteristics of Argo floats, highlighting its non-explosive nature and (c) contact point/person. Most important message is “Argo floats are not dangerous objects” because the shape of floats tends to give an impression that it is something dangerous. The leaflets were distributed to local Coast Guard offices to inform the public about Argo floats.

Smooth communication between finders and owners of floats should be facilitated in order to prevent possible trouble between them. However, the procedure to handle beached Argo floats is still not agreed upon among relevant government agencies/institutes in Japan. Discussions about this matter are ongoing to avoid any trouble that may arise.

**Action item 5:** If a beached float has been reset and is to be redeployed, a new WMO ID needs to be assigned to the float and it needs to be re-notified. If the float has not been reset, it is permissible to redeploy the float with the same WMO ID. ATC, float owner

### 4.8 Forum for the future of Japan Argo

Japan Argo was initiated in 2000 and conducted for five years as an institutional national project (a part of Millennium Project of the Japanese government) aiming to build the core Argo array. After the project was over in 2004, part of its framework such as a “liaison and coordination committee" has been sustained, which facilitated Japanese contribution to the core Argo. However, lack of effective mechanisms to define new clear objectives of Japan Argo tended to cause vulnerable funding situation especially after the "completion" of the 3000 float array. In 2010, two forums were held to build consensus on the future direction of Japan Argo among scientists, governmental officers and relevant private sectors, following the vision built as an outcome of OceanObs`09.

The consensus on the future of Japan Argo developed by the forums is summarized as follows.

1) Japan Argo should continue to contribute the core Argo by sustaining current level of float deployment and data management activities.

2) Japan Argo should contribute to construct new integrated ocean observing systems, based upon the Argo core array, which will increase the climate monitoring and research capability and provide information on the marine environment to meet society's needs better.

As part of efforts in line with the consensus above, in 2011, JAMSTEC will start a project on regional integrated ocean observation, "Western North Pacific Integrated Physical-Biogeochemical Ocean Observation Experiment (INBOX)". The purpose of this project is to investigate effects of mesoscale variabilities on biogeochemical processes by acquiring physical – biogeochemical parameters intensively in space and time in the western North Pacific. Twenty-five dissolved oxygen floats will be deployed as Argo equivalent floats in the experimental area of 150 km x 150 km in collaboration with other observational platforms such as moorings, ships and satellites.

### 4.9 BioArgo update

In 2008, the International Ocean Color Coordinating Group (IOCCG) launched the Bio-Argo working group. Its general objective was to make recommendations in view of implementing optical sensors on profiling floats as a way to increase in situ data acquisition of bio-optical / biogeochemical variables with the ultimate aim to develop synergetic applications with remote sensing of ocean color.

The overarching goal of this effort is to obtain a better understanding of biogeochemical cycles at a regional and/or global scale and of their evolution under a changing climate. Additional goals are to provide more synoptic data to ecosystem modeling activities (data for initialization, validation and assimilation), improve the coverage of ocean color by adding a depth dimension, and providing quality data to evaluate ocean color remote sensing and products derived from it.

As a result of two meetings attended by scientists from complementary expertise with respect to this emerging field, the Bio-Argo WG submitted its report to IOCCG early this year (it should be published within the next few months). Three main classes of bio-optical and / or biogeochemical floats have been proposed.

The Val-float is totally dedicated to Calibration and Validation activities for Ocean Color satellite sensors. The emphasis is put in particular on the radiometric package (downward irradiance and upwelling radiance and on spectral resolution).

The carbon-explorer float is dedicated to carbon flux studies. It emphasizes (1) sensors allowing quantification of various particle carbon pools and (2) on mission configuration (e.g. resolving the diel cycle of these variables to infer carbon fluxes).

Finally, the Bio-Argo float is proposed as a rather simple float with respect to optical package [Chla fluorescence, backscattering (proxy of POC)] that could become part of the Argo array, respecting the core Argo mission rules. Optimally, these measurements should be associated to other key variables whose measurements are already implemented and operational, or nearly so, on floats (i.e. O2, NO3). The purpose of such floats is to increase the profile density of these variables that are of great biogeochemical / ecosystem relevance. Presently the Bio-Argo community is growing steadily with ~150 floats (already funded) to be deployed within the next 18 months. The community is also highly involved in the various aspects of data management and QC. Presently, a prototype of real-time QC for Chla has been developed and implemented at Coriolis. Delayed-mode QC is on the way. The community wishes to participate to the future ADMT meetings to progressively interact and develop synergy with the Argo community at the early stage of Bio-Argo development.

The submitted report to IOCCG can be obtained from Hervé Claustre. A summary of it was presented as a community white paper at the OceanObs09 conference ().

Dean Roemmich welcomed the report and said that scientists within Argo would really like to embrace Bio-Argo and see that it happens, but there are a couple concerns to be addressed before that can happen. The first concern is data management and how can Argo and Bio-Argo work together to ensure that data management costs for new sensors do not eat away at Argo's core data management costs. H. Claustre said that a person is being hired to work full time on data management with Coriolis. The second concern is EEZs and how to deal with floats equipped with bio sensors that drift into EEZs. A discussion followed with no clear outcomes, but with agreement that this issue needs to be explored more within the Bio-Argo community.

**Action item 6:** AST co-chairs to write letter to BioArgo and IOCCG: the AST welcomed the report of the BioArgo group, consistent with the recommended Argo enhancements from OceanObs'09, and endorses the continued development of the technology, data management and the plans in consultation with the AST. AST co-chairs.

### 4.10 AIC and JCOMM Observing Program Support Centre

M. Belbeoch, the AIC/JCOMMOPS manager, reported on the development of the centre. The AST welcomed the new financial support from Japan (JAMSTEC) to the infrastructure. The TC recalled the centre mandate, services, and updated the AST on the staff turnover that was affecting JCOMMOPS functioning. He mentioned that his main collaborator (the DBCP/OceanSITES TC) left JCOMMOPS in August 2010 and the position should be renewed in August 2011.

Nevertheless, the I.T team was strengthened by the arrival of an intern at JCOMMOPS in November (for two years). The team is now fully productive and the Google Earth application is a good example of the progress done.

AST members strongly requested the TC to ensure a regular maintenance of the float database, crucial for implementation planning. The AST requested the TC make the necessary developments to finalize the "EEZ warning system" so that implementers have a minimum of work to notify bilaterally the Member States that requested it. The AST encouraged the TC to finalize the float donation contracts with the IOC.

The TC remarked that the arrangement with SOT, and the cooperation with the DBCP, helped to cover some extras expenses in 2011 for the GIS licenses (30k$) without needing to request AST financial assistance.

The TC also mentioned that JCOMMOPS was starting to sell some services, to cover some functioning expenses and develop some activities. In that line, the AST agreed to have the official Argo sticker (small or large size) sold to manufacturers for a symbolical amount of 3€/unit. To be noted, the ship chartering (Lady Amber) should generate about 40k$ in 2011.

This chartering is also a new step forward for JCOMMOPS that wishes to be further involved in an activity essential to the global array maintenance. What is explored today is a mechanism that could be used more routinely in the next decade.

Regarding the "Cruise Coordinator" position, some TOR's are being drafted by the concerned partners and almost enough funding sources have been identified to start the position. Discussions have been made with JCOMMOPS host (CLS) to potentially start the position as of 2012.

The TC concluded that JCOMMOPS is at a crossroads, and that focal points, supported by a modest functioning budget, are not sufficient to deliver proper services to 4 programmes. The centre must be strengthened in its host country and expand its activities, not only on paper.
JCOMMOPS is working with IOC/UNESCO on the renewal of the MoU with France for the hosting of the centre and will prepare a "strategic plan" in 2011, including clear deliverables, performance targets, and indicators on how those targets are being met. This should help attracting new partners and funds.

For more information, see:
http://www.jcomm.info/index.php?option=com_oe&task=viewDocumentRecord&docID=7097

**Action item 7:** H. Freeland to ask countries who are not contributing to the AIC to consider contributing. H. Freeland to ask countries who are contributing if they can increase and/ or change their contributions to be based on a percentage rather than a flat amount. H. Freeland

**Action item 8:** ATC to add floats to his system and produce a simpler report each month. ATC to produce a more detailed report every 3-4 months. ATC

**Action item 9:** ATC to fully implement the EEZ monitoring system so that implementers can notify Member States bilaterally according to Res. XLI-14. ATC

**Action item 10:** ATC to finalize the float donation contracts with IOC legal experts. ATC

**4.11 Discussion items from National Reports**

D. Gilbert from Canada said that binding resolutions regarding Argo would help secure funding and wondered if any such official resolutions were available. The short answer was no. Some suggested drafting a statement that Argo is officially part of GOOS and no longer a pilot project. J. Bardeem suggested that the AST members work within Argo to construct a resolution and then raise it within their own country's IOC delegation.

## 5 Data Management Issues

### 5.1 Feedback from ADMT-11

S. Wijffels reported on the ADMT-11 meeting for S. Pouliquen and M. Ignaszewski. Overall, Argo's data management infrastructure is stable, but requires monitoring tools at the AIC, GDAC, and ARC levels and requires man power at the DACs to correct the detected anomalies. The current ADMT efforts are focused on reducing the delays, delayed mode quality control, improving data consistency and completeness and detection and correction of systematic errors/biases.

The real time data stream is working well with 91% of data on the GTS within 24 hours. DACs are transitioning to BUFR data transmissions and should be done by the end of 2011. Additional manual QC checks have proven to be very effective at removing egregious errors in the real time version of the dataset. The delayed mode data stream is about 70-80% quality controlled at most DACs except in Korea. The pressure offset correction and TNPD identification was recognized as the highest priority for DM operators. Much work has been done on this, but it still needs to be finished. The technical file name standardization has gone very well and the next task will be to do the same standardization for the metadata files. M. Belbeoch and E. van Wijk will lead this effort. The DM file checker is still under validation at the US GDAC. Its completion is critical to reduce the submission of DM files with anomalies.

The next priority for the ADMT will be trajectory data. A clean-up/consistency check is under way with collaboration between M. Ollitrault / JP Rannou and the DACs for data through 2009. Another mechanism is required to complete the DMQC and maintain high quality delayed mode trajectory files. A first run to check the status of the trajectory files was done by M. Scanderbeg. Several DACs are filling information inconsistent with the data manual. It was also noted that additional timing information is needed in order to make velocity calculations. A team of scientists is being set up to define what is needed in the trajectory files in order to make the best possible calculation of surface and subsurface ocean velocity. The group will provide refinements to the traj.nc files and will try to work with float manufacturers to see if all important data for velocity calculations can be sent back by the floats. It was recognized that a workshop for DACs and operators engaged in preparing traj.nc files should be organized.

No ARC meetings were held this year in conjunction with the ADMT meeting. Some actions have progressed, but most of the ARCs are short on funding. Some new products have been developed and should be added to the table maintained by M. Scanderbeg on the AST website. In Europe, many activities have progressed within the EuroArgo project. Some ARCs have set up monitoring tools and are providing the ATC with the results. Claudia Schmidt will continue monitoring the action item list and animating communication between ARCs.

The ADMT had two recommendations that should by carried by the AST to the scientific community:

> Communicate to the scientific community that not all profilers are Argo or Argo equivalent. If a user has a profiler with an Argo WMO number, the user must notify it through the AIC to be consistent with the IOC resolution.

Ensure that national mirrors of Argo datasets should be of the highest fidelity possible and a copy of the GDACs.

**Action item 11:** Ask float expert for each float type to clearly document how technical data reported by each float matches variables in the technical file. PROVOR: S. LeReste, APEX: A. Wong, SOLO: J. Gilson, P. Robbins, NEMO: B. Klein, NINJA: T. Suga.

**Action item 12:** KORDI requests Australia's help and expertise to perform delayed mode quality control on its floats in the Southern Ocean. Australia, KORDI.

**Action item 13:** Clearly state that in the upcoming Argonautics and on Argo websites, including national websites, that Argo users should download Argo data from the GDACs. M. Scanderbeg, Argo webpage managers.

**Action item 14:** Change wording of how to acknowledge Argo on the AST website to: *These data were collected and made freely available by the International Argo Program and the national programs that contribute to it. (http://www.argo.ucsd.edu, http://argo.jcommops.org). The Argo Program is part of the Global Ocean Observing System.* M. Scanderbeg

### 5.2 Impact of pressure errors on Argo dataset

The Argo DACs are working hard on identifying, correcting and labeling Argo profiles that might be affected by pressure sensor bias. This involves correctly populating technical files with reported pressure offsets, correcting profiles that require it and identifying APEX floats with APF8 or earlier controllers and possibly negative drifting pressure sensors, known as Truncated Negative Drifting Pressure (TNDP) profiles.

See Barker et al, JOAT, 2011 (accepted) for a detailed description of this issue. The aim is to have QC flags and profiles labeled so that users requiring the most accurate pressure readings (e.g. studies of mixed layers or global heat content change) can confidently filter the data according to advice from the AST posted at the GDACs and AST websites.

The DAC's progress in compliance has been checked and assisted through ongoing audits by SIO's John Gilson and CSIRO's Jeff Dunn, who have collaborated with DACs on defining float model behavior. Past CSIRO audits and the most up to date can be found at

http://www.cmar.csiro.au/argo/dmqc/

The most recent CSIRO audit was completed on Feb 22, 2011.

Technical file compliance is now largely good, but there are a few loose ends to tie up, such as correct population of pressure sensor serial number and type.

Surface Offset corrections: In APEX data affected by positive pressure biases, there has been a great improvement, but corrections are not yet complete. Most DACs have corrected the worst cases of uncorrected pressure drift. DACs are slowly treating profiles which fell between the gap of DM processing and when RT pressure correction started. DACs need to work through the remaining disagreements with the audit and focus on cases where no surface correction can be assessed (due to lacking technical/meta data). In the self-correcting float models, much progress has been made in better documenting the technical data/float behavior to improve consistency.

<u>TNDP compliance</u>
The audit identifies around 800 TNPD cases in the 7700 floats (~10%) and about 500/800 of these have been identified by DACs in the comments for at least part of their time series. Only 10% of floats have received an error of 20db for some profiles [sensors with high risk of microleaks-known by sensor SN], while 25% have had a "4" flag at some stage, but of course that may not be related to TNPD.

By DAC we find that:

- BODC does well: 92 TNDP-6month, 87 have some QC=2, 41 have some QC=4, 91 have some comments, only 18 have some without comments, good for min ERROR too.
- AOML is pretty good but has not used ERROR=20db
- Coriolis is quite good, and improving.
- CSIRO is good.
- JMA making good progress but still only have about a quarter of the cases we identify
- MEDS is pretty average for QC, there is no use of COMMENTS (they do have 18 commented, but not with the correct comment string)
- CSIO has done nothing
- INCOIS is doing well.
- KMA also has some incorrect comment strings. The QC=2 and 4 may or may not be related to TNPD flagging - looks like they have made a start but not got too far.
- KORDI has no DM files, so no corrections have been done.

<u>Summary</u>
Great progress has been made by DACs on pressure drifts where known. However, Argo did not achieve its goal of having all corrections and TNDP labeling completed by December 2010. Even so, most large DACs are nearly complete and most egregious cases have been treated.

The few remaining cases of disagreement need to be urgently analyzed and fixed (either at the DAC or in the audit). There are still a substantial number of floats for which the audit cannot assess a pressure offset – these need to be investigated.

TNDP identification and treatment is not as far along, but is progressing. This may require further focus by the DACs. Some smaller DACs might need assistance in finishing compliance and improving decoders.

**Action item 15:** DACs to correctly fill the pressure sensor serial number in the metafiles. DACs.

**Action item 16:** DACs to finish pressure corrections and TNDP identification and labeling on their floats, with assistance where needed. To be completed by ADMT12. DACs

### 5.3 Status of trajectory data

B. King presented on the status of the trajectory files and began with a status update on the work of J-P Rannou and M. Ollitrault who continue to re-decode Argos hex files provided by DACs. Presently they have reprocessed 470,000 cycles with 170,000 cycles remaining in order to complete all Argo data up through December 2009. The goal is to complete all Argo data to the end of 2009 by the end of 2011.

Rannou and Ollitrault are re-decoding Argos hex files and correcting errors, especially where there are different versions of similar float hardware with slightly different engineering messages. Extensive work has been done unpacking PROVOR timing and technical data. They have also spent time identifying extra data like extra surface locations missed in real-time decoding and correcting some cycle number errors. Feedback is given to the DACs which has enabled many errors to be corrected in the traj.nc files and in metadata files (e.g. in park pressure). Additionally, they have spent time extracting and saving extra information not stored in existing traj.nc files. In particular labeling of the time series data (dimension N_MEASUREMENT) with information about cycle stage (drift, rise, surface, etc). Storing this information in an easily retrievable form will greatly simplify use of data for non-expert users.

Rannou and Ollitrault will produce a new Atlas called ANDRO which will be comparable to YoMaHa but with the cleanest possible content. The ANDRO Atlas will not contain all drift measurements. M. Ollitrault has supplied B. King with sample 'displacement' (DEP) files which contain all the information on each float. B. King proposes translating these into a traj_version2.nc file which will be sufficiently different from the traj.nc file that small changes to the traj.nc file will not work.

B. King and a small group are working on a proposal for a traj_version2.nc file which will merge all time series data and identify with a flag variable what part of the cycle each measurement is. Work will also be done to easily enable users to pull out data that are useful to velocity calculations. These files can be considered a product, analogous to the appended prof.nc files and served at the DACs.

It is hoped that traj_version2.nc files for data up to December 2009 can be generated from the DEP files made for the ANDRO Atlas. For data after December 2009, King and Scanderbeg will consider whether the basic information can be populated from existing traj.nc files. If the files can be filled automatically, even if imperfectly, then this could be done in real time, just as the prof.nc files are made in real time. Recall that DACs upload a new single traj.nc file each time a float reports a new cycle. Merging this with data that have had some sort of trajectory DMQC needs care.

For the future, it is important the ANDRO group is able to finish the Atlas through December 2009. BODC has proposed an activity for preparing a trajectory DM manual in the Euro-Argo follow-on proposal SIDERI. This could be the basis for DACs learning to undertake the task themselves. It seems likely that a trajectory DM workshop is needed in conjunction with the 2011 ADMT meeting to progress DAC training. It is expected that DACs will develop the capability to write clean and complete trajectory files with differing amounts of delay. Finally, Iridium-type floats will likely have different problems which should be thought through as much as possible to prevent a similar problem in the future.

**Action item 17:** Form a small scientific group to design a new trajectory file format to present at the upcoming ADMT meeting. B. King, M. Scanderbeg.

**Action item 18:** AST co-chairs to write a letter of support to finish ANDRO through 2009. B. King will draft contents of letter. AST co-chairs, B. King

**Action item 19:** Ask B. King to consider organizing a trajectory workshop alongside the upcoming ADMT meeting to familiarize DACs with new trajectory file format. Consider inviting M. Ollitrault/JP Rannou to attend the meeting. B. King, M. Scanderbeg

### 5.4 Transition to new ARGOS location method

The TC presented, on behalf of CLS, the new method for Argos locations calculation based on Kalman filtering. Basically the method uses historical locations to improve the positioning.

This method provides more positions (+~10%) and better accuracy (+ 100% class 3) than the least squares processing and automatically corrects unrealistic positions. It is to be noted that when this new method fails, the processing is reinitialized with the classic least square system (as for a first location calculation).

Documentation, including a set of tests on 20 floats comparing both methods, is available at: ftp://ftp.jcommops.org/Argo/ARGOS.

The TC invited the AST to decide a date for the community to switch to this new method so that datasets are improved homogeneously. The panel agreed on early June for the switch date and invited trajectory experts to explore further the new method before the deadline.

**Action item 20:** Ask DACs and interested PIs to evaluate the new Argos positioning system to decide if Argo wants to adopt it. ***Report results back to M. Scanderbeg by 20 May 2011.*** Unless a problem is found, all of Argo will switch to the new system in June 2011. DACs and interested PI's, M. Scanderbeg.

**Action item 21:** If Argo decides to adopt the new Argos positioning system, explore the offer of CLS to reprocess all Argos data from 2008 onwards. ATC, AST co-chairs.

### 5.5 CCHDO and NODC activity

**Action item 22:** Coriolis to make a new historical reference database for DMQC purposes on a twice yearly basis. Explore why this has not occurred in the past. S. Pouliquen

**Action item 23:** Ask J. Gilson to repeat his comparison of Argo profile reference database to updated historical reference database to see if it is improving in the Southern Ocean. J. Gilson.

**Action item 24:** Provide CCHDO known upcoming CTD cruise track and dates to enter into the CruiseTracker database. PIs, CCHDO

**Action item 25:** AIC to invite float operators to also give information when notifying deployment plans on whether CTD and oxygen will be done on deployment cruises. ATC.

## 6 Technical issues

### 6.1 Float technology progress

**Float technology progress on PROVOR / ARVOR floats presented by V. Thierry and prepared by S. Le Reste**

**Oxygen sensor:** Thirteen PROVOR floats equipped with Aanderaa optode oxygen sensors have been deployed in the North-Atlantic in June 2010 and are working well. The float technology is now mature. Work is on-going to improve measurements accuracy. A meeting on this issue will be held in May in Brest, France.

**Nitrate sensor:** We are also working on the implementation of a nitrate sensor on a PROVOR float (PROVNUTS float). The ISUS and SUNA sensors have been compared in laboratory and should be implemented on PROVOR floats soon and tested at sea.

**Density sensor:** The "NOSS" sensor is dedicated to get density and salinity of seawater, by measuring the refractive index (position sensing detector) of a laser beam passing through the water sample to analyze. Tests have been carried out to assess its ability to be embedded on a float (accuracy, pressure withstanding, turbidity & temperature & light influence).

**Deep Arvor float:** The objective is to reach 3500m depth with CTD and oxygen sensors. Work has been done to size the subsystems like the hydraulic engine, the pressure hull. The tests of 2 hydraulic endcaps and several hull samples are on going. The CTD endcap has been designed and partially tested in our metrology laboratory.

**Arvor and Provor equipped with iridium transmission:** Three Arvor-I (Arvor- Iridium) have been deployed since Dec 2009. Those deployments have proven the float capability to change its mission parameters and the utility of the "end of life" command that allows the recovery of the float. From a technical point of view, the float transmits 240 PTS triplets in 3 minutes but it stays 30 minutes at the sea surface because it has to increase its buoyancy to improve transmission.

To answer questions from the AST members: the Iridium transmission has been implemented to reduce surface time. The float is thus currently programmed to acquire 200 to 300 PTS triplets. This number can be increased to 1000 if required (1 sampling every 2dbar).

**Arvor with Argos 3 transmission, development and first tests**: Argos 3rd generation transmission is being embedded on Arvor. It is intended to use the interactive mode capability (low data rate) of the MetopA satellite, using its prediction pass tables to meeting the satellite at surface. The objective is to send all the profile data while the MetopA pass. Argos2 standard communication is maintained in case of interactive mode failure. The transmission was successfully tested in the Bay of Brest in October 2010. Two prototypes have been deployed in the Mediterranean Sea at the end of February. Analysis is on going because transmission duration is longer than expected.

**Future developments within the NAOS project:** Some developments will be done on PROVOR and ARVOR floats within the French NAOS project to reduce costs and to improve float reliability and lifetime.

**Recent Technical Developments with APEX Argo Floats by S. Riser**

S. Riser presented on four developments including APEX air pump solenoid problems, some first tests of ARGOS-3, pressure sensor updates and SBE conductivity drift. The Apex air pump is used to inflate the air bladder at low pressures (< 100 dbar) so that the float rides on the sea surface with the antenna well out of the water. The air pump is controlled by a solenoid. For reasons unknown, a number of these solenoids, which cost less than $100, have failed in lab tests at UW in recent months. A failure in the field would mean the air bladder would not inflate, resulting in a possible loss of the ability to communicate with a satellite. This is especially problematic for Iridium floats. So far, the cause was found by D. Swift to be an inability of the solenoid to latch closed over the duration of an applied transient current. If the duration of the transient current was increased, the solenoid would always latch properly. There are no known changes in the controller electronics or the solenoid itself that would lead to this problem. The problem can be corrected by adding a small, inexpensive (less than $50), printed circuit board near the solenoid that regulates the current to the solenoid and insures that it always opens and closes on command. The board was designed by D. Swift and 100 units were built commercially in Seattle. This fix has been added to all UW and PMEL floats since February 2011. Individual floats can be tested for this problem by connecting a laptop prior to deployment and inflating the bladder. Teledyne/Webb has been notified of this problem and the suggested remedy. As of March 2011, they have not instituted the remedy and they continue to build and ship floats with this potential problem. It is not clear whether or not they intend to add the auxiliary PCB in their production process.

UW has developed a prototype float that uses a Kenwood PMT to communicate with ARGOS-3 satellites. There were a couple of reasons for doing this. The first being that ARGOS-3 will someday provide bidirectional communications and could be a possible alternative to Iridium. The second being that the Seimac PTT used in Apex floats is no longer being manufactured so alternative communication methods for Apex ARGOS floats need to be explored. The first tests of the Kenwood PMT have shown that energy use is larger than with present ARGOS-2 PTTs. The PMT float has been running on a simulator at UW for several months and the PMT consumes more than twice the energy per transmission of the present ARGOS-2 Seimac PTT or Telonics PTT units.

Finally, S. Riser presented on SeaBird CTD issues. SBE claims the microleak problem is now understood and fixed at the Druck factory. The glass/metal seals that caused the problem have been re-engineered and will be installed in SBE float CTDs beginning in July 2011. Until then, SBE is screening all Druck pressure sensors that are installed in float CTD units (possibly resulting in continued reduced production of CTD units). Some groups have tried the Kistler pressure sensors with good results so far in a limited number of floats for a limited time. SBE claims lab tests show the Kistler sensor to be as good or better than the new Druck sensors. Both Jamstec and PMEL have noted floats with unacceptable conductivity drift after deployment (> 0.01 PSU equivalent). This problem was traced to erosion of the platinum in the CTD electrodes. The cause of the problem has been found and new QC procedures have been installed at SBE. It is believed that this problem occurred in an isolated group of floats (CTDs built in late 2010) but all groups should check for this.

**Action item 26:** S. Riser to draft a statement concerning solenoid problems on APEX floats to be posted on AST website and sent out on Argo email lists. S. Riser, M. Scanderbeg

**Action item 27:** Ask SBE for serial numbers of CTDs having difficulty with conductivity sensor drift immediately after deployment and for serial numbers of CTDs with new, improved Druck sensor. S. Riser

**SOLO-II**

D. Roemmich updated everyone on the SOLO-II which is the newly redesigned SOLO float that is now commercially available through MRV Systems (http://www.mrvsys.com). The SOLO-II is engineered to complete around 300 dives anywhere in the world ocean using Iridium. It weighs less and is shorter than the SOLO making it easier to deploy.

The first prototype SOLO-II was deployed in September 2009 and completed 20 three day cycles before being recovered. It was redeployed in February 2010 (WMO 4901242) and ran until its batteries were depleted in September 2010. During that time, it completed 324 deep cycles to 1750m with a 2 dbar sampling scheme on the rise all the way up to 3 dbar when the pump was turned off. The rise rate was around 13 cm/s. The second SOLO-II prototype had a new antenna and a redesigned bottom hemisphere and bladder. This one was deployed in

October 2010 (WMO 4901277) and was recovered in January 2011. It completed about 100 deep cycles (2000 m) along with about 30 shallow cycles for engineering tests. It again had a 2 dbar sampling scheme, but the pump was shut off at 1 dbar. This float was refurbished to be identical to production floats and was redeployed in March 2011 (WMO 4901408).

US production of the SOLO-II will be done by both SIO and MRV. 15 SOLO-II floats have been sent to Papeete for deployment along the equator with more than 150 floats to be built in 2011.

D. Roemmich suggested trying to reach an agreed upon sampling scheme for Iridium/ high bandwidth floats that can more easily send back large amounts of data. He suggested sampling every 2 dbar for high resolution sampling which would give ocean mixing researchers more data. For SST and SSS sampling, he suggested turning the pump off closer to the surface, such as at 1 dbar. This can always be changed using Iridium if problems occur. It was agreed that getting measurements closer to the surface like that is better than continuing to take unpumped temperature measurements.

### 6.2 Status of oxygen measurement and QC

There will be an Argo Oxygen meeting in Brest, France 25-27 May 2011. The website is http://wwz.ifremer.fr/lpo/SO-Argo-France/Argo-oxygen-meeting. The conveners are Denis Gilbert, Steve Riser and Virginie Thierry. The topics include technical discussions on the use of dissolved oxygen sensors on floats and gliders, errors in measurement of dissolved oxygen, errors inherent in the various sensor types, correction methods and general QC procedures for float-based oxygen data.

### 6.3 Thermally powered floats and gliders

### 6.4 Update on near surface temperature

There is a need from the SST community for measurements close to the surface to better observe the variation in near-surface temperatures under light winds. The diurnal variation in near-surface temperature is typically 1 to 2 K, but can reach 5 K. Normally, pumping of the CTD sensor on Apex is turned off around 4dbar to avoid contamination by pollutants at the surface. Near surface temperature (NST) capable (Argos) Apex floats continue to sample temperatures after the CTD pump has been switched off. Cross-calibration samples are collected at 20 dbar, 15 dbar, 10 dbar and 5 dbar which consist of a non-pumped PT immediately followed by a pumped PTS. At depths less than 5 dbar, 12 non-pumped PT samples are taken at 6 seconds intervals, this allows for sampling up to (and at) the surface at ~0.6 dbar intervals where the additional data can be transmitted with 2 extra Argos messages.

The GHRSST ‘goal’ (ideal) requirements are 10 cm sampling in the upper 3 m with 2.5 cm depth accuracy, and 50 cm sampling below 3 m to ~10-15 m with 10 cm depth accuracy. But where 50 cm sampling in the upper 3 m with 10 cm depth accuracy, and 100 cm sampling from 3 m to ~10-15 m with 15 cm depth accuracy would be useful. GHRSST have clarified that pressure measurement is appropriate for depth. The largest stratification/diurnal variation is with very low winds, so waves should be small (although there may be longer wavelength swell). With higher waves (stronger winds) depth attribution will be harder but conditions are likely to be well-mixed.

Jon Turton outlined some results from preliminary analysis of data from 8 NST-capable Apex floats deployed by UK. However, only 2 of these floats sampled the near-surface during the afternoon, when surface warm layers were most likely to occur. Comparison of the cross-calibration measurements showed very small differences between the pumped and non-pumped measurements (apart from one float where the non-pumped temperatures were consistently warmer). However, the good agreement was not surprising as in most profiles there was little or no temperature gradient, so any lag in the non-pumped measurements was impossible to identify.

For the 2 floats that surfaced during the afternoon, the data showed the existence of near-surface temperatures up to 2.5 °C warmer than the uppermost pumped temperature (at nominally 4 or 5m depth). Although relatively few stratified profiles were observed, the results show the NST capable Apex floats are able to observe near-surface temperature stratification that would otherwise remain undetected and so do provide useful additional information.

To better quantify the benefit and accuracy of such near-surface temperature measurements, more NST capable Apex floats need to be deployed in regions where stratification is most likely and 'timed' to surface during the afternoon when stratification is likely to be strongest. More such floats are now in the water with 107 NST-capable floats having been deployed in the last 3 years by US, UK, Japan and India. The number is likely to increase over the coming years. It was planned to continue the analysis, either with a soon to be recruited scientist at the Met Office or as a summer MSc dissertation project at the University of Reading (with Jon Turton and Andrea Kaiser-Weiss (GHRSST PO) as supervisors). The AST requested that the NST-capable float data, from all countries, should be assembled and made available on a publically accessible website. AST also requested that an analysis of all the available data should be reported to ADMT-12, to inform a decision on dissemination of the data via the GDACs.

It was recognised the optimum longer-term approach was to report near-surface data from Iridium floats. Iridium floats typically record at 2 dbar vertical resolution; given the response of the T sensor (~½ s) it's possible to sample every second (~0.1 dbar) but with the resolution of the P sensor (0.1 dbar) it is probably not worth sampling faster than every 2 s (~0.2 dbar spacing). Hence with Iridium floats it would be possible to meet the GHRSST 'goal' of 50 cm sampling from 5 to 15m depth and the 'useful' sampling of 50 cm for less than 5 m depth, but unlikely to be possible to achieve the 10 cm 'goal' accuracy above 5m. However, the accuracy of Argo temperature measurements is likely to be better than standard SST measurements from drifting buoys and Voluntary Observing Ships and although Argo would provide fewer reports they are of high accuracy with vertical information, so would be complimentary to these other sources.

**Action item 28:** J. Turton to coordinate gathering unpumped temperature data from Argo PIs and work with GHRSST to place data in a public place and advertise it throughout their community. J. Turton, Y. Chao.

**Action item 29:** J. Turton and GHRSST to analyze pumped and unpumped temperatures. Report back by the time of ADMT. J. Turton, Y. Chao

### 6.5 Argo floats in the ice-zone

S. Wijffels reported on work done by E. Van Wijk and others (see more detailed paper in appendix) on the prospects for extending Argo into the seasonal and fast ice zone.

<u>Seasonal Ice Zone:</u>
There are several options for floats to operate successfully in the seasonal ice zone:
1. Use Iridium/GPS with an ice-avoidance algorithm (AWI or U. Washington)

-Short surface times [older Service Argos/ice floats appear to have shorter lives]
-Store iced-over profiles on board to return on next surfacing –no position
2. Use iridium plus a RAFOS acoustic location network (AWI)

Well over 100 floats are operating poleward of 60° and so Argo already collects a substantial amount of profile data in this high latitude ice-prone region. For the Southern Ocean, Argo has already collected more than 5 times the number of profiles than has been collected from ships. Little of the ship-based data will be from wintertime.

How have these ice floats performed? The failure rate of early floats was high as the ice-capable technology was developed and tested, and they used Service Argos and thus would have long surface times. Mortality rates of newer ice floats are now equivalent to those deployed in less demanding conditions, but the short surface time associated with Iridium is also a likely factor. A number of floats deployed in the Weddell Sea have survived for 7 years. Several ice floats in the Australian array have survived for six winters and of the 43 ice floats deployed, 77% are currently active. Of the 17 floats that have been out for longer than two years, 16 have survived at least two or more winters and a further 7 floats have survived four or more winters. The University of Washington Argo group reports similar statistics with 104 ice floats deployed south of 60 ºS and 83% of these currently active (Riser, pers., comm.). Klatt reported an 80% winter survival rate for the AWI fleet of 58 ice floats deployed in the Weddell Gyre. AWI has reported a slight decline in float reliability in the Weddell Gyre in the last 3 years. This is due to several factors including; more southerly deployments and non ice-related issues such as firmware problems and Druck microleaks (Klatt, pers. comm.).

AWI is working on further improvements to the ice detection algorithm. In addition they have equipped some recent ice floats with light detectors and are hoping to find a correlation between ice cover and light conditions.

<u>What do we need to extend Argo into the seasonal ice zone?</u>
At the nominal design density,
1. 360 active floats would be required in the Southern Ocean (85 floats require acoustic receivers in the Weddell Gyre and 110 floats in the Ross Gyre).
2. 300 active floats in the Arctic.

Calculations are based on the number of floats required to populate the area between 60˚ of latitude and the fast ice edge with an assumed profiling depth of 2000 m in the Antarctic and 900 m in the Arctic. Note –to maintain an array of 300 floats with a 20%/year loss rate requires 100 deployments/year.

<u>Can we extend Argo to the Fast ice zone?</u>
This requires consideration of alternative sampling platforms, as profiling floats require free water to surface and reach satellite communication systems.
A number of instruments have been developed for the fast-ice zone:
-Ice Tethered Profilers (ITP)
-Polar Ocean Profiling System (POPS)
-acoustically-tracked floats with ice thickness sonars.

<u>Moving forward</u>
Argo should continue to pilot ice-capable floats in order to refine the technology and build experience to improve our understanding of float limitations/strengths in this zone. This is the only means of arriving at a robust implementation plan and budget. The idea was mooted to

hold a Sea Ice/Oceans Observational Strategy Workshop in 2012. Several AST members supported this idea. The newly established Southern Ocean Observing System Project Office in Hobart will be approached to host the workshop.

In the discussion following the presentation, it was suggested that any floats deployed near the ice zone should have the ice avoidance algorithm which is a free feature of APEX floats. It was also noted that both the US and German groups are having more trouble in the Arctic region.

## 7 Demonstrating Argo's value

### 7.1 Upcoming science meetings

#### 7.1.1 IUGG

The IUGG meeting will be held in Melbourne, Australia ( 27 June – 8 July 2011) and there will be a session that will focus on Argo and other ocean observing systems.

#### 7.1.2 WCRP

There is an upcoming WCRP meeting

#### 7.1.3 OSTST

A joint Argo and Altimetry workshop will precede the next Ocean Surface Topography Science Team Meeting which will be 19-21 October, 2011. The workshop, entitled "Jason and the Argonauts: Exploiting the Synergy Between Argo and Satellite Altimetry" will be on 18 October, 2011 in San Diego, CA. D. Roemmich asked for volunteers to serve on the science organizing committee to help with planning and promoting the OSTST/Argo workshop.

**Action item 30:** Create a science organizing committee to help with planning and promoting the OSTST/Argo workshop, P-Y LeTraon, B. Owens, P. Polito, AST members.

### 7.2 Argo bibliography

M. Scanderbeg presented work done in the last year on the bibliography pages on the AST website. Everyone was reminded that now only the Argo bibliography and the Argo in press bibliography pages are maintained. A couple different cases were discussed and it was agreed that papers who use model outputs based on Argo data, but where Argo data are not specifically mentioned in the paper will not be included in the bibliography. This is mainly to equally exclude all such papers since it is a large job to find all the papers based on model outputs where Argo data is used. The second case brought up was where it is mentioned that Argo data will make future work more feasible. M. Scanderbeg said that these papers were also excluded from the bibliography. The reasoning here being that the bibliography is meant to accurately portray the number of papers published using Argo data and not using the possibility of Argo.

M. Scanderbeg also maintains graphs showing the number of papers published per year and the numbers of papers published per country as designated by the country of the first author on the paper. There were almost 90 more papers published in 2010 (202) than in 2009 (114). About half of these additional papers came from OceanObs'09 plenary papers and from articles written in languages other than English. It was also noted that maintaining the in press page is becoming easier as more journals are listing in press citations on their websites.

Several national reports for the AST-12 meeting contained lists of citations which allowed comparison with the Argo bibliography. In most cases, M. Scanderbeg had found the majority of the citations. The exceptions were citations in biological journals, journals within the country, especially in other languages and book chapters. Therefore, it appears that the search criteria are working well for physical oceanographic papers, but work needs to be done to expand to other areas like biological papers and books. Google Scholar should be able to help with this and it has become a main search engine to find Argo citations. To maintain the bibliography and the in press page, all AST members were again encouraged to continue sending any citations of Argo papers to argo@ucsd.edu.

### 7.3 Google Ocean

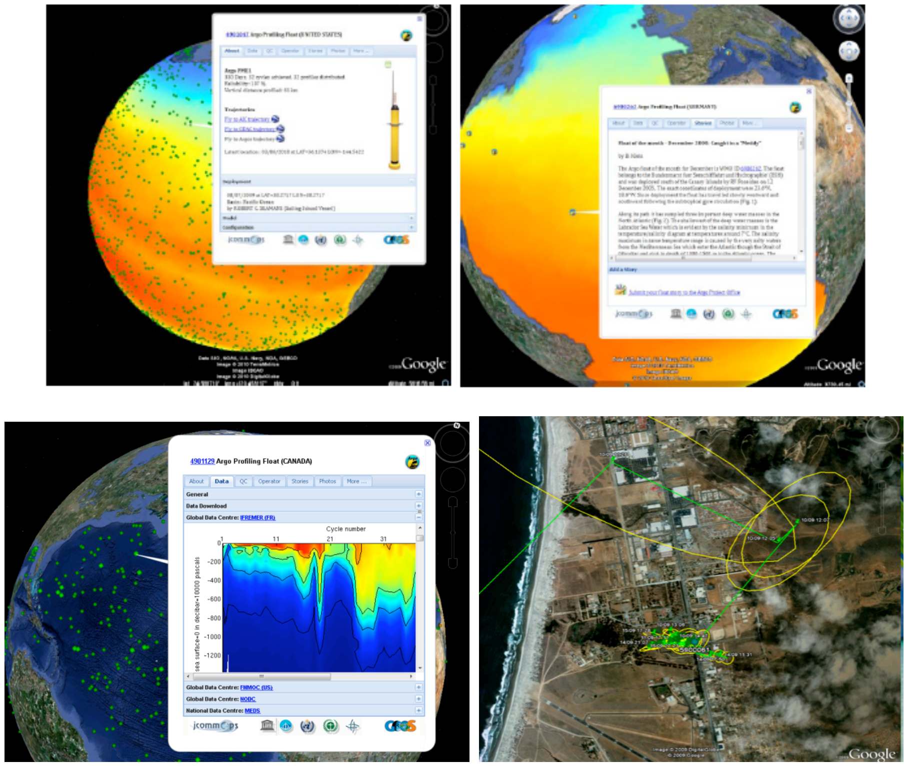
S. Diggs introduced the use of web-based interfaces such as Google Earth to promote ocean observations to a larger public and mentioned the existing partnership Scripps/Google on that regard.

The Argo TC presented the work achieved within JCOMMOPS, in cooperation with Scripps colleagues (M. Scanderbeg, S. Diggs, J. Gilson) on the Argo layers for Google Earth. This application is ideal for network tracking, promotion and demonstration to a lager public. It is also used extensively by Argonauts to retrieve beached floats, plan their deployments, relay feedback on data QC, etc. In addition the application provides map access to the Argo Marine Atlas (data source: Scripps, 100% Argo) with temp, salinity, steric height and anomalies layers, over ten depth levels and since 2004.

In addition to assembling all web tools available for floats and related observations on the web (made by Argo PIs, agencies, global/regional data centres) it provides a set of “float stories” ( “float of the month” news items), forming gradually a rich educational content. Some “climate change” oriented stories could also be added along with the T/S/SH layers and the application could be linked with e.g. OOPC ocean climate indices.

The work will soon be ready to be presented to Google for a potential partnership. The AST thanked the TC and the team for making this tool available to the community.

On a different outreach note, the BBC World News, following an IOC/GOOS initiative, has set up a 30 minute movie to tell the story of GOOS and Argo in particular. The movie includes sequences in Hobart (CSIRO, with S. Wijffels as “earth reporter” and movie focal point), Toulouse (JCOMMOPS office, Argo TC, and a duplex with Hobart), and Buenos Aires (AST meeting 2011, key AST members). This is great promotional material for GOOS and Argo. The Google Earth displays have been used throughout the movie.



*[http://argo.jcommops.org/argo.kml](http://argo.jcommops.org/argo.kml)*

*see demo videos at:* [http://w3.jcommops.org/FTPRoot/Argo/TMP/Google](http://w3.jcommops.org/FTPRoot/Argo/TMP/Google)

**Action item 31:** EuroArgo to identify someone to enter educational stories into the Google Earth Argo layer.  M. Scanderbeg

**Action item 32:** Finish the Google Earth Argo layer development and approach Google to include it in Earth layers.  Diggs, ATC, Japan

### 7.4 Argonautics Newsletter

M. Scanderbeg presented ideas for the next Argonautics Newsletter which will likely be published by the end of June. Proposed articles include trajectory work done by M. Ollitrault and JP Rannou, the new Google Earth layer showcasing Argo and a surface pressure offset updated.  Additional articles include float technology updates for the ARVOR, SOLO-II and Deep NINJA floats, an explanation of the EuroArgo educational website, meeting summaries and a description of the newest ship to deploy floats – the Lady Amber.

### 7.5 Argo outreach activities

#### 7.5.1 Education outreach in South Africa

Dr Juliet Hermes of the South African Environmental Observation Network (SAEON), gave a presentation on Argo Outreach activities in South Africa (and a quick SA/regional update!) on behalf of Thomas Mtontsi, SAEON; Isabelle Ansorge and Chris Reason, University of Cape

Town and South African National Antarctic Program and Johan Stander, South African Weather Service. Juliet focussed on the SAEON education program, of which Argo floats form a key component. This program creates a platform where Marine Science Research can be integrated into School Sciences curriculum (with buy-in from the Department of Education). There are three main thrusts:

- Educator/teacher support through workshops and forum meetings (train the trainer)
- School based monitoring programmes similar: *Argo Floats* and *Adopt a Drifter Programme* and weather and climate monitoring with weather station.
- Additional learner/ student support in Science Camp = Short leg sea cruises

The program currently works with 5 previously disadvantaged schools, 4 of which are from coastal communities, we aim to add a further coastal school by end of this year. The schools work on individual projects but monitoring groups get together at weekend camps to exchange ideas and problems. Since SAEON has 6 different focal nodes with similar education programs (1 is coastal) the aim is to take the program to inland schools some of which have no concept of the oceans.

The education program provides a focal point for marine education activities and collaborates with all marine institutes to provide support and prevent duplication. There is also active involvement in marine awareness activities, reaching 1000's of learners, as well as the general public.

Juliet went on to describe who works with the data, highlighting areas of the South African curriculum where Argo floats and the data could be integrated:

- Focused groups at the school community – monitoring teams and the teacher/educator are responsible for downloading data
- For use in Mathematics, physical science, life sciences, Geography and Natural Science activities
- Grade 10 and 11 (ages 15 & 16)
- Excellent, fun tool for awareness activities

Juliet described in detail some of the key activities as well as giving information about awareness programs, the staff involved and the technology used (Magic Planet). Juliet finished up with brief details of South African activities of interest to the Argo community and highlighted that all SA marine institutes highlighted their potential to be more involved with Argo over the next 5 years:

- New vessel commissioned for 2012
- Further ASCLME cruises – looking for floats to deploy along Kenya/Somalia all floats received from NOAA
- Government focus – Global Change Grand Challenge, shift in Departments and a new Department of Environmental Affairs - with focus on ocean research in particular operational oceanography
- Southern Ocean Carbon Monitoring – 6-8 gliders this year
- Continue to support Argo activities where possible and continue to deploy Argo floats when requested


### 7.5.2 Global Marine Argo Atlas

M. Scanderbeg presented on the development of the Global Marine Argo Atlas which uses Ferret to create plots of gridded data. Currently we have a PC version of the Atlas which comes with the 4-D gridded Argo dataset made at Scripps Institution of Oceanography (Roemmich and Gilson, 2009), the Reynolds SST dataset, and the AVISO dataset. The Argo grid and the Reynolds grids are available from 2004 to the previous month, with updates available after the 15$^{th}$ of the month. The AVISO dataset covers the period of 2004 to October 2009 (soon to be updated through March 2010). Additionally, there is a near real time Argo dataset available with the most recent data in the past 10 days for the equatorial region. It is possible to create map plots, section plots, time series, line drawings and a few simple products. Both postscript and jpg outputs are available for plots that are created using the Atlas. Besides giving a quick view of the datasets, the Atlas is a great way to compare datasets quickly. The user can easily create similar plots with different datasets within the Atlas or the user can output a plot similar to one from another dataset. The intended audience for the Atlas includes teachers and students, government officials and scientists. To make the Atlas more appealing to classrooms, we are developing a MAC version which should be available soon. Another new feature that will be ready soon is the option to create an output file in ascii or netcdf that contains the data used to make the desired plot. We are also working on maps of temperature and salinity on density surfaces. To find out more details, visit the website at: http://www.argo.ucsd.edu/Marine_Atlas.html. Feedback is always welcome.

### 7.6 1-page document on sustaining Argo

D. Roemmich reminded the AST of the 1-page document on sustaining Argo that was prepared for AST-11. He said that he had used it during the year and that it had been recently updated after other AST members had reviewed it. He acknowledged that it was very dense and not appropriate for a lay person and wondered if Argo needed something else that could be simpler and given out to lay people. A few AST members agreed to review the document further and to see if a separate document could be created for lay people.

**Action item 33:** M. Scanderbeg to post updated document (word version) on AST meeting website. Interested PIs can review the 1 page document and report back to D. Roemmich. AST members are encouraged to develop a separate document for lay people.

## 8 Future meetings

### 8.1 ADMT-12

ADMT-12 will be hosted by KMA in Seoul, Korea in November 2011.

**Action item 34:** Discuss with ADMT co-chairs and Korea to set the dates of the ADMT meeting in November. S. Wijffels, Korea/KMA

### 8.2 AST-13

AST-13 will be hosted by EuroArgo in Paris in March 2012.

## 9 AST Membership

After several requests for some countries to have more than one AST member, mainly for funding purposes, it was recognized that two people can now be listed on the AST website as AST members for one country. It will still be important to have one main person who will be the point of contact for the country, so the first name listed will be the main contact. If a country wishes to add another AST member, please contact M. Scanderbeg.

**Action item 35:** Institute a shared AST membership for countries who so desire. The first name listed on the AST website will be the main point of contact. AST countries, M. Scanderbeg

## 10 Other business

It was recognized that the issue of a float sampling scheme is becoming more important as more floats are being equipped with Iridium and other high bandwidth communications. It would beneficial to have as many Argo floats following the same sampling protocols as possible and so it was asked that AST members come to AST-13 ready to discuss this.

**Action item 36:** AST members to consider to discuss at AST-13 harmonizing sampling protocols. AST members.

Additionally, it was recognized that many groups are interested in extending Argo to other areas, like the marginal seas, the ice zones, and to add other sensors. These groups are interested in proceeding with the acceptance of Argo at the international level. To that end, it was requested that groups wishing to expand Argo need to prepare specific scientific plans on how to do this.

**Action item 37:** Ask EuroArgo and others to prepare presentations on science plan for marginal seas for AST-13. EuroArgo and others interested in marginal seas.

Argo Steering Team Meeting (AST-12)
Regente Palace Hotel, Buenos Aires Argentina March 15-17, 2011
Host: Argo Argentina

1. Welcome (9 am March 15)
2. Local arrangements (Troisi)
3. Objectives of the meeting/adoption of the agenda
   *How will Argo be sustained and enhanced in the next few years?*
   *What actions are needed so that Argo data quality is sufficient for global change studies?*
4. Status of action items from AST-11 (Scanderbeg)
5. Implementation issues
   - 5.1 Status of Argo (Belbéoch)
   - 5.2 Sustaining and evolving Argo: Following up the OceanObs'09 consensus. (Lindstrom)
   - 5.3 EuroArgo update (LeTraon)
   - 5.4 New Brazil plans (Polito, Sato)
   - 5.5 Update commitments table (Scanderbeg)
     Will the missed 2009/2010 deployments be made up in 2011?
   - 5.6 Float deployment opportunities (Belbéoch)
   - 5.7 Discussion on beached floats (Hosoda)
   - 5.8 Forum for the future of Japan Argo (Suga)
   - 5.9 Bio-Argo update (Claustre)
   - 5.10 AIC and JCOMM Observing Program Support Centre (Freeland, Belbéoch).
   - 5.11 Discussion items from National Reports?
6. Data Management related issues
   - 6.1 Feedback from ADMT-11 (Ignaszewski/Pouliquen)
   - 6.2 Impact of pressure errors on the Argo dataset (Wijffels)
   - 6.3 Status of trajectory data (B. King/Ollitrault)
   - 6.4 Transition to new ARGOS location method (Belbéoch)
   - 6.5 CCHDO and NODC activity (S. Diggs, T. Boyer)

7. Science talks:
   - 7.1 M. Ravichandran "Recent sea level trend in the Indian Ocean revealed from Argo, Altimetry and GRACE"
   - 7.2 Phil Sutton "Decadal Steric and Sea Surface Height Changes in the Southern Hemisphere"
   - 7.3 Martin Saraceno "Argo and satellite observations of the anticyclonic circulation around the Zapiola Rise in the South Atlantic"

8. Technical issues
   - 8.1 Float technology progress (Riser, Thierry, Suga, Roemmich)
   - 8.2 Status of oxygen measurement and QC (Riser, Thierry/Gilbert/Kobayashi)
   - 8.3 Thermally-powered floats and gliders (Chao)
   - 8.4 Update on near-surface temperature (Turton)
   - 8.5 Argo floats in the ice-zone (Wijffels)

9. Demonstrating Argo's value/evolving for Argo's future
   - 9.1 Upcoming science meetings: IUGG, WCRP, OSTST
   - 9.2 Argo bibliography (Scanderbeg)
   - 9.3 Google Ocean (Diggs/Belbeoch)

9.4 Argonautics Newsletter (Scanderbeg)
9.5 Argo outreach activities – (J. Hermes), (Scanderbeg on Atlas progress)
9.6 1-page document on sustaining Argo (Roemmich)

10. Future meetings
    10.1 ADMT-12
    10.2 AST-13
11. AST Membership – proposal for “shared” memberships
12. Other business

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| Phil | SUTTON | NIWA, 301 Evans Bay Parade, Greta Point, Wellington, New Zealand, 6021 | p.sutton@niwa.co.nz |
| Virginie | THIERRY | IFREMER, Laboratoire de Physique des Oceans, BP70, Plouzane, France 29280 | vthierry@ifremer.fr |
| Ariel | TROISI | Servicio de Hidrografia Naval, A. Montes de Oca 2124, Buenos Aires, ARGENTINA C1270ABV | ahtroisi@gmail.com |
| Jonathan | TURTON | Met Office, FitzRoy Rd, Exeter, Devon EX1 3PB UK | jon.turton@metoffice.gov.uk |
| Susan | WIJFFELS | Centre for Australian Weather and Climate Research, CSIRO, Castray Esplanade, Hobart, Tasmania, 7004 Australia | susan.wijffels@csiro.au |

| | Action | Responsibility | Status |
|---|---|---|---|
| 1 | AST co-chairs to send a letter of thanks to Ariel Troisi for hosting AST-12 | AST co-chairs | |
| 2 | Define more specifically what Argo core means to help the Argo Technical Coordinator to make more useful statistics | AST co-chairs | |
| 3 | AST co-chairs to send a letter from Argo to the OOPC and Lindstrom expressing Argo's concern about a lack of funding to help Argo follow up on enhancements from OceanObs'09 | AST co-chairs | |
| 4 | Explore ways to more effectively share deployment opportunities among Argo float providers, including navy ships in pirate prone areas. | ATC, float deployers, PIs/AST members with navy connections | |
| 5 | If a beached float has been reset and is to be redeployed, a new WMO ID needs to be assigned to the float and it needs to be re-notified. If the float has not been reset, it is permissible to redeploy the float with the same WMO ID | ATC, float owner | |
| 6 | AST co-chairs to write letter to BioArgo and IOCCG: the AST welcomed the report of the BioArgo group, consistent with the recommended Argo enhancements from OceanObs'09, and endorses the continued development of the technology, data management and the plans in consultation with the AST. | AST co-chairs | |
| 7 | H. Freeland to ask countries who are not contributing to the AIC to consider contributing. H. Freeland to ask countries who are contributing if they can increase and/ or change their contributions to be based on a percentage rather than a flat amount. | H. Freeland | |
| 8 | Argo TC to add floats to his system and produce a simpler report each month. Argo TC to produce a more detailed report every 3-4 months | Argo TC | |
| 9 | Argo TC to fully implement the EEZ monitoring system so that | Argo TC | |

| | | | |
|---|---|---|---|
| | implementers can notify Member States bilaterally according to Res. XLI-14. | | |
| 10 | Argo TC to finalize the float donation contracts with IOC legal experts | Argo TC | |
| 11 | Ask float expert for each float type to clearly document how technical data reported by each float matches variables in the technical file. | PROVOR: S. LeReste<br>APEX: A. Wong<br>SOLO: J. Gilson, P. Robbins<br>NEMO: B. Klein<br>NINJA: T. Suga | |
| 12 | KORDI requests Australia's help and expertise to perform delayed mode quality control on its floats in the Southern Ocean | Australia, KORDI | |
| 13 | Clearly state that in the upcoming Argonautics and on Argo websites, including national websites, that Argo users should download Argo data from the GDACs | M. Scanderbeg, Argo webpage managers | |
| 14 | Change wording of how to acknowledge Argo on the AST website to:<br>*These data were collected and made freely available by the International Argo Program and the national programs that contribute to it. (http://www.argo.ucsd.edu, http://argo.jcommops.org). The Argo Program is part of the Global Ocean Observing System* | M. Scanderbeg | |
| 15 | DACs to correctly fill the pressure sensor serial number in the metafiles | DACs | |
| 16 | DACs to finish pressure corrections and TNDP indentification and labeling on their floats, with assistance where needed. To be completed by ADMT12 | DACs | |
| 17 | Form a small scientific group to design a new trajectory file format to present at the upcoming ADMT meeting | B. King, M. Scanderbeg | |
| 18 | AST co-chairs to write a letter of support to finish ANDRO through 2009. B. King will draft contents of letter. | AST co-chairs, B. King | |
| 19 | Ask B. King to consider organizing | B. King, M. | |

| | | | |
|---|---|---|---|
| | a trajectory workshop alongside the upcoming ADMT meeting to familiarize DACs with new trajectory file format. Consider inviting M. Ollitrault/JP Rannou to attend the meeting | Scanderbeg | |
| 20 | Ask DACs and interested PIs to evaluate the new Argos positioning system to decide if Argo wants to adopt it. ***Report results back to M. Scanderbeg by 20 May 2011.*** Unless a problem is found, all of Argo will switch to the new system in June 2011. | DACs and interested PIs, M. Scanderbeg | |
| 21 | If Argo decides to adopt the new Argos positioning system, explore the offer of CLS to reprocess all Argos data from 2008 onwards. | ATC, AST co-chairs | |
| 22 | Coriolis to make a new historical reference database for DMQC purposes on a twice yearly basis. Explore why this has not occurred in the past. | S. Pouliquen | |
| 23 | Ask J. Gilson to repeat his comparison of Argo profile reference database to updated historical reference database to see if it is improving in the Southern Ocean | J. Gilson | |
| 24 | Provide CCHDO known upcoming CTD cruise track and dates to enter into the CruiseTracker database | PIs, CCHDO | |
| 25 | AIC to invite float operators to also give information when notifiying deployment plans on whether CTD and oxygen will be done on deployment cruises | ATC | |
| 26 | S. Riser to draft a statement concerning solenoid problems on APEX floats to be posted on AST website and sent out on Argo email lists | S. Riser, M. Scanderbeg | |
| 27 | Ask SBE for serial numbers of CTDs having difficulty with conductivity sensor drift immediately after deployment and for serial numbers of CTDs with new, improved Druck sensor | S. Riser | |
| 28 | J. Turton to coordinate gathering unpumped temperature data from | J. Turton, Y Chao | |

| | | | |
|---|---|---|---|
| | Argo PIs and work with GHRSST to place data in a public place and advertise it throughout their community | | |
| 29 | J. Turton and GHRSST to analyze pumped and unpumped temperatures. Report back by the time of ADMT. | J. Turton, Y Chao | |
| 30 | Create a science organizing committee to help with planning and promoting the OSTST/Argo workshop | P-Y LeTraon, B. Owens, P. Polito, possible G. Han, AST members | |
| 31 | EuroArgo to identify someone to enter educational stories into the Google Earth Argo layer | M. Scanderbeg | |
| 32 | Finish the Google Earth Argo layer development and approach Google to include it in Earth layers | Diggs, ATC, Japan | |
| 33 | M. Scanderbeg to post updated document (word version) on AST meeting website. Interested PIs can review the 1 page document and report back to D. Roemmich. Could also develop a separate document for lay people. | M. Scanderbeg, PIs, D. Roemmich, B. Owens | |
| 34 | Discuss with ADMT co-chairs and Korea to set the dates of the ADMT meeting in November. | S. Wijffels, Korea/KMA | |
| 35 | Institute a shared AST membership for countries. First name listed on website is main point of contact. | AST countries, M. Scanderbeg | |
| 36 | AST members to consider to discuss at AST-13 harmonizing sampling protocols | AST members | |
| 37 | Ask EuroArgo and others to prepare presentations on science plan for marginal seas for AST-13 | EuroArgo, others interested in marginal seas | |

| | 2004 Argo deployed | 2004 Argo equiv | 2005 Argo deployed* | 2005 Argo equiv | 2006 Argo deployed | 2006 Argo equiv | 2007 Argo estimated | 2007 Argo deployed | 2007 Argo equiv | % deployed vs. estimated | 2008 estimated | 2008 Argo deployed | 2008 Argo equiv deployed | % deployed vs. estimated |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Argentina | | | | | 12 | | | | | | | | | |
| Australia | 4 | | 64 | | 45 | | 65 | 47 | 0 | 72 | 55 | 65 | | 118 |
| Brazil | 0 | | 3 | | | | | 4 | | | | | | |
| | | | | | | | | | | | | | | |
| Canada | 30 | | 29 | | 38 | | 25 | 18 | | 72 | 22 | 25 | | 114 |
| Chile | 0 | | 2** | 2 | | 4 | | | | | | | 4 | |
| China | 8 | | 0 | | 6 | | 50 | | | 0 | 32 | 16 | | 50 |
| Costa Rica | 0 | | 2*** | | | | | | | | | | | |
| Denmark | 0 | | 0 | | | | | | | | | | | |
| Ecuador | | | | | | | | 3 | | | | | | |
| European Union | 15 | | 7 | | 3 | | | 8 | | | | | | |
| | | | | | | | | | | | | | | |
| France | 85 | | 89 | | 51 | | 65 | 36 | | 55 | 68 | 90 | | 132 |
| Gabon | | | | | | | | | | | | | | |
| Germany | 27 | 18 | 56 | 19 | 35 | 1 | 37 | 22 | 13 | 95 | 50 | 61 | 10 | 142 |
| Greece | | | | | | | | | | | | | | |
| India | 33 | | 43 | | 15 | | 50 | 38 | | 76 | 40 | 15 | | 38 |
| Ireland | 0 | | 0 | | | | | | | | 4 | 4 | | 100 |
| Italy | | | | | | | | | | | | | | |
| Japan | 119 | | 98 | 12 | 98 | 18 | 95 | 80 | 15 | 100 | 95 | 76 | 16 | 97 |
| Kenya | | | | | | | | | | | | | | |
| Korea (Republic o | 32 | | 37 | | 33 | | 27 | 13 | | 48 | 29 | 29 | | 100 |
| Mauritius | 2• | | 0 | | 2 | | | | | | | | | |
| Mexico | 0 | | 2° | | | | | | | | | | | |
| Netherlands | 3 | | 4 | | 4 | | 6 | 4 | | 67 | 9 | 13 | | 144 |
| New Zealand | 2 | | 1 | | 3 | | 2 | 2 | | 100 | | 2 | | |
| Norway | 0 | | 0 | | 2 | | | | | | | | | |
| Poland | | | | | | | | | | | | | | |
| Russia | 2 | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| South Africa | 0 | | 0 | | | | | | | | | | | |
| Spain | 2 | | 4 | | 1 | | | | | | 20 | | | 0 |
| UK | 45 | | 28 | | 24 | | 45 | 31 | 2 | 73 | 35 | 29 | | 83 |
| | | | | | | | | | | | | | 10 | |
| USA | 396 | 38 | 455 | 38 | 475 | 21 | 410 | 381 | 29 | 100 | 360 | 326 | 42 | 102 |
| Subtotals | 803 | 56 | 854 | 71 | 847 | 44 | | 687 | 59 | | | 751 | 82 | |
| Total | 859 | | 925 | | 891 | | 877 | 746 | | 92 | 819 | 833 | | 112 |
| | 2004 Argo deployed | 2004 Argo equiv | 2005 Argo deployed* | 2005 Argo equiv | 2006 Argo deployed | 2006 Argo equiv | 2007 Argo estimated | 2007 Argo deployed | 2007 Argo equiv | % deployed vs. estimated | 2008 estimated | 2008 Argo deployed | 2008 Argo equiv deployed | % deployed vs. estimated |
| ·Donated by UK | | | ***Donated by Spain | | | **Donated by Canada | | | | | | | | |
| *Numbers compiled from AIC website | | | °1 float donated by Spain | | | | | | | | | | | |

| 2009 estimated | 2009 Argo deployed | 2009 Argo equiv | % deployed vs. estimated | 2010 estimated | 2010 Argo deployed | 2010 Argo equiv deployed | % deployed vs. estimated | 2011 estimated | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 4 | Argentina | |
| 50 | 35 | | 70 | 95 | 72 | | 76 | 90 | Australia | at least 50/year until 2011 |
| | 4 | | | | | | | 16 | Brazil | 16 possible in 2012 |
| | | | | 2 | | | 0 | 3 | Bulgaria | |
| 28 | 23 | | 82 | 25 | 28 | | 112 | 16 | Canada | |
| | | | | | | | | | Chile | |
| 60 | 16 | | 27 | 50 | 23 | | 46 | 50 | China | 50 per year 2008-2012 |
| | | | | | | | | | Costa Rica | |
| | | | | | | | | | Denmark | |
| | | | | | | | | | Ecuador | |
| | | | | | | | | | European Union | |
| | | | | | 2 | | | | Finland | |
| 65 | 35 | | 54 | 95 | 55 | | 58 | 80 | France | Could deploy 20 more but hard to find opportunities in Atlantic Ocean in 2011. Plan for 65 floats/year for 2012 and beyond |
| | 3 | | | | | | | | Gabon | |
| 57 | 33 | | 58 | 110 | 41 | | 37 | 48 | Germany | 50 floats per year during 2007 to 2012 |
| | | | | 1 | 1 | | 100 | 3 | Greece | |
| 40 | 7 | | 18 | 40 | 26 | | 65 | 45 | India | 40 floats per year during 2008-2012 |
| | 4 | | | 3 | 3 | | 100 | 3 | Ireland | |
| | | | | 2 | 1 | | 50 | 30 | Italy | funding for 30, may not get all out in 2011 |
| 101 | 55 | 18 | 72 | 116 | 51 | 44 | 82 | 127 | Japan | |
| | 5 | | | | | | | | Kenya | |
| 18 | 17 | | 94 | 12 | 12 | | 100 | 14 | Korea (Republic of) | 15 in 2012 |
| | | | | 2 | | | 0 | 4 | Mauritius | 4 in 2012 |
| | 1 | | | | | | | | Mexico | |
| 6 | 4 | | 67 | 8 | 9 | | 113 | 7 | Netherlands | |
| 2 | 2 | | 100 | 2 | 2 | | 100 | 2 | New Zealand | |
| | | | | 4 | 4 | | 100 | 8 | Norway | |
| | 2 | | | 3 | | | 0 | 2 | Poland | |
| | 2 | | | | | | | | Russia | |
| | | | | | 1 | | | | Saudi Arabia | |
| | 2 | | | | | | | 2 | South Africa | |
| 20 | | | 0 | 12 | 10 | | 83 | 5 | Spain | |
| 35 | 20 | | 57 | 40 | 25 | | 63 | 40 | UK | 40 floats per year during 2011 |
| | | | | | | | | | UN (ice tethered profilers) | |
| 360 | 148 | 61 | 58 | 500 | 333 | 28 | 72 | 450 | USA | |
| | 418 | 79 | | 1122 | 699 | 72 | | 1049 | | |
| 842 | 497 | | 59 | | 771 | | 62 | | | |
| **2009 estimated** | **2009 Argo deployed** | **2009 Argo equiv** | **% deployed vs. estimated** | **2010 estimated** | **2010 Argo deployed** | **2010 Argo equiv deployed** | **% deployed vs. estimated** | **2011 estimated** | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

# Argo Australia – 2010 Activities

Report to the Argo Steering Team

Susan Wijffels, Ann Thresher, Esmee Van Wijk, Vito Dirita

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

## *1. Status of implementation*

### Floats deployed and their performance

Australia currently has 297 active floats distributed across the Indian and South Pacific Oceans (Figure 1)

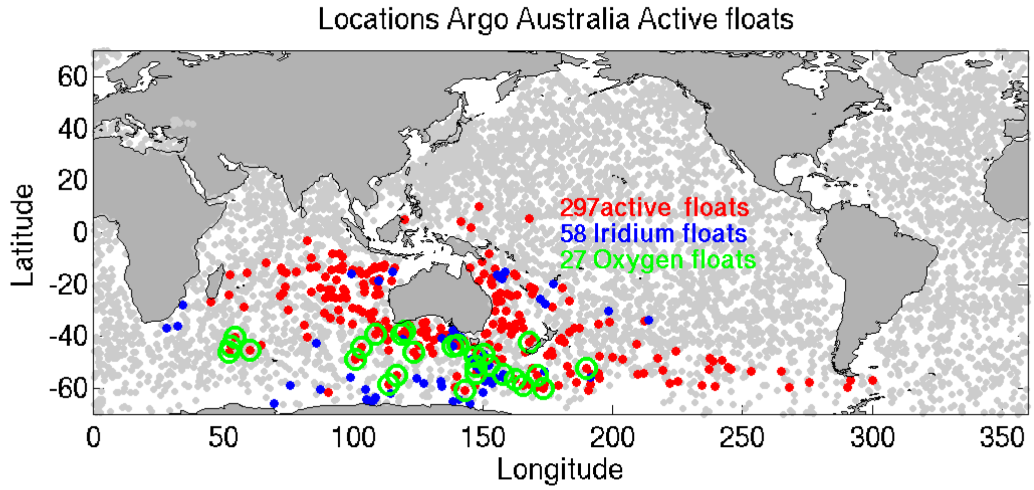


Figure 1. Locations of active Argo Australia floats (colours) with active international floats in gray. Australian floats using Iridium Communications are in blue and those equipped with oxygen sensors are in green.

In the calendar year 2010, the program deployed 78 floats in the South Pacific, Indian and Southern Oceans. Of those deployed in 2010, 46 were equipped with Iridium transmitters and the rest had standard Argos transmitters, reflecting a move towards the increased use of Iridium communications to about 50% of new acquisitions. Ice-avoidance algorithms are active on 21 of these. Oxygen sensors are on 11 floats (optodes).

We continued to partner with the US and New Zealand programs to secure deployments of both US and Australian floats into the Pacific and Indian Oceans. The program also worked with the AIC to do test deployments of a small vessel out of South Africa, *Lady Amber*. Deployments went well, and the program is proceeding with further leases of this inexpensive vessel to help overcome the float backlog caused by the 2009 deployment hiatus (see below).

### Technical problems encountered and solved

Our use of Iridium communications has risen sharply as we plan on 50% of new acquisitions to use this system. Problems encountered in the second half of 2010 with our Iridium fleet have largely been solved. These included expensive and incomplete calls (solved by reducing the log file size), unpredictable costs (solved by changing suppliers) and the need to build more redundancy into the data stream (we are solving this by moving to RUDICS). We now feel that using Iridium is extremely good value and past reliability issues are hopefully behind us. Using Iridium in the floats being piloted in the sea-ice zone in particular looks very promising, with winter profiles taken over many months below the ice returned to us in spring.

The program is also working with Seabird P/L on testing Kistler pressure sensors. These sensors may show superior stability, accuracy and the ability to be deployed on deep reaching floats. A CTD equipped with a Kistler sensor acquired data in parallel with a standard SeaBird CTD on a recent full depth repeat hydrographic cruise between Australia and the Antarctic. We are currently analyzing this data set to look for and characterize and differences between the sensors.

**Float Failure Mode Analysis**

As of the 24th of Feb 2011, the Australian Argo program had deployed 389 floats. From the total number of floats deployed; 57 are dead. Of the remaining 332 operational floats, 319 are returning good data, a further 11 are producing suspect or bad data and are under review and a further 2 floats are confirmed as suffering from the Druck microleak issue. Of the dead floats, 19% ceased to operate due to natural causes when they ran down their battery packs. A further 16% died due to unknown reasons. The remainder of floats ceased to operate prematurely mainly due to environmental reasons such as grounding (21%) and loss or damage under sea ice (10.5%). Other contributing factors were hardware failures such as communications problem, CTD/pressure sensor damage or fault and leakage (12%); software issues such as firmware bugs (10.5%) or human error (e.g. turning on the float too early resulting in buoyancy problems and subsequent loss, picked up by fisherman or deployed in the plastic bag (10.5%),.

| **Float failure mode for dead floats** | **Number of floats** (57) | **% of dead floats** |
|---|---|---|
| Unknown | 9 | 16 |
| Grounded | 12 | 21 |
| End of life | 11 | 19 |
| Firmware issues | 6 | 10.5 |
| Lost under ice | 6 | 10.5 |
| Turned on too early – went too deep | 4 | 7 |
| CTD failure/damage | 2 | 3.5 |
| Communications failure | 1 | 1.75 |
| Leak | 1 | 1.75 |
| Deployed in plastic bag | 1 | 1.75 |
| Druck snowflake | 1 | 1.75 |
| Potentiometer failure | 1 | 1.75 |
| Picked up by fisherman | 1 | 1.75 |
| Transmissometer leak | 1 | 1.75 |

| **Float failure mode for floats with** | **Number of** | **% of suspect** |
|---|---|---|

| suspect or bad data | **floats** (13) | **floats** |
|---|---|---|
| Unknown | 3 | 23 |
| Grounded and contaminated CTD | 3 | 23 |
| Biofouling | 2 | 15 |
| Druck microleak | 2 | 15 |
| Suspect conductivity cell | 1 | 8 |
| Buoyancy problems | 1 | 8 |
| Ice damage | 1 | 8 |

## Summary of Technical Issues

### Faulty Solenoids

We have been having problems with the solenoid switch on the air pumps not working properly so that the valve does not shut off and does not maintain air pressure in the bladder. The problem can be identified in the lab when the bladder pressure equals the vacuum pressure. A couple of floats (2-3) have been identified with this problem in the lab during pre-deployment testing. The problem cannot be easily identified once floats are in the field as it is not possible to determine the difference between a failed air pump and a failed air pump switch.

The failure rate for solenoids from the Italian supplier went up drastically after they changed their manufacturing process to eliminate oil on the switch (previously Webb had been cleaning this off themselves). The manufacturing process has now been changed but at least 54 of our floats are potentially affected. Solenoids will be replaced where possible, depending on the amount of replacement solenoids available from the manufacturer. Priority for replacement will be given to Iridium floats and those deployed in the tropics.

### Miscellaneous Float Problems:

- Two floats had faulty CPUs, the boards were returned to Webb. This seems to be a relatively rare problem.
- One oxygen calibrated float had a corroded seal; the source of corrosion was unclear.
- One float delivered with the wrong model GPS hardware that was not compatible with the version of firmware and did not work at all. This was picked up in the lab before deployment and was replaced.
- Two Iridium floats have had GPS problems – they had low signal strength and the GPS units were replaced in the lab.
- One float had a weak Iridium signal caused by an unreliable low frequency band transmitter not communicating with the CPU and resulting in poor uplink.
- Poor Iridium communications – we reduced the log file size from 60K to 5K which has helped make the communications more reliable but sometimes results in not all the diagnostics we need being transmitted if the message file doesn’t arrive.
- We have also had problems with inadequate fluorometer calibrations on the Fluorometer Backscattering Meter (FLBB) sensors. Testing in the lab when the floats arrived showed the sensors were not calibrated properly. We found differences between the data readings from the sensor and those transmitted through the float. Also, there was a significant warming up period required before the readings stabilised. The problem sensors were sent back to Webb for recalibration and in some cases were sent back a second time.

- Three floats were received with incorrect CPU IDs programmed into the floats, these were detected in the lab and re-programmed here.

## Status of contributions to Argo data management

Collaboration with Argo India: The program has continued to work with the Indian Argo program in the continuing bedding down of their use of the Australian realtime data processing software (http://www.marine.csiro.au/~gronell/ArgoRT/). Unresolved issues being worked on include processing some kinds of PROVOR data and encoding TESAC messages so that GTS insertion by the Indian Meteorological Service can begin. India's DM operator, Uday, also visited with us for several weeks in March for training on and to help modify our DM software and tools in order to process the Indian Argo float data.

Collaboration with KORDI: We are working with KORDI on installing Australia RT software. While still not operational due to software bugs, much progress has been made. It was realized that some older hex data (from around 10 floats over a period of a few years) was distributed with the wrong number of bytes by CLS Argos. CLS has reprocessed this data and now we expect that we can decode and deliver a fuller error and gap-free data set.

Pressure Biases in the Global Argo data set: An analysis and correction of pressure drift errors in the global data set as available at the end of 2008 has now been accepted by the Journal of Atmospheric and Ocean Technology (soon available as an online early release at http://journals.ametsoc.org/loi/atot )

Jeff Dunn has applied the methods described in the above paper in building software that checks pressure corrections carried out by DACs and also compliance with ADMT recommendations around the treatment of Truncating Negative Drifting Pressure floats. This audit can be carried out monthly, and its latest results will be reported on at AST-12. The latest audit can be accessed at

http://www.marine.csiro.au/argo/dmqc/audits_2011_02_22/tnpd_report.html

Technical Naming Table: Ann Thresher has been working with the DACs to build and maintain a fixed table of technical parameter names for use in Argo data files. A common approach to naming these parameters is vital if these files are to be machine parseable. Previously each DAC had an almost non-overlapping set of names for parameters.

## Status of delayed mode quality control process

Comprehensive documentation of float data and quality control decisions is available at: http://www.cmar.csiro.au/argo/dmqc/index.html

Australian DM Statistics (as at 31/12/2010)

| | |
|---|---|
| D files submitted to GDAC | 27552 |
| Total R files | 12641 |
| R files eligible for DMQC | 5486 |
| Total eligible files for DMQC | 33038 |
| Total files at GDAC | 40193 |

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

The Australian Argo array continues to grow rapidly with an 18% increase in the total number of profiles delivered to the GDAC in the past quarter. A total of 399 floats have been deployed to date since the beginning of the Argo program and of these, 332 floats are still operational. As at 31/12/2010, 82% of eligible profiles (those that are greater than 6 months old) have been processed in delayed mode quality control.

The re-write of the DMQC processing software is now largely complete and the integration of the SIO GIO and OW software is fully implemented. The next 12 months will see effort focusing on incorporating new formats, variables and multi-profile files into the DM process as well as trajectory files, oxygen data and delivery of Argo products.

A total of 285 floats have been assessed through the DMQC process for drift of the salinity sensor. Of these, 6 floats (2 %) returned no data from deployment and 8 floats (3 %) returned bad data for the entire record due to pressure sensor issues or other hardware problems. Of the remaining 271 assessable floats, 235 (87 %) show no salinity drift for the life of the float. A further 33 or 12% of floats show a positive salinity drift. These floats can be subdivided into those floats that drift gradually towards the end of life (18 floats or 7 %) and those that are salt offset from the start of the record (15 floats or 5 %). A small number of floats (3 instruments or 1 %) are affected by a fresh offset or biofouling. Of the floats that are either salt or fresh offset, most were corrected using the OW salinity drift correction. 15 floats (5 %) 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.

## *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 National Collaborative Research Infrastructure Initiative (NCRIS) and now the Education Infrastructure Fund (EIF). EIF funding for Argo Australia is now secured through June 2013 and work is beginning on the follow-on.

Through IMOS, and if levels of support from our partners remains steady, Argo Australia will sustain deployments of 50-60 floats per year and maintain an array of around 220-240 active floats. However, longer float lifetimes may mean the standing array size could grow much larger. If this is the case, increased communication costs may require a slight reduction in the numbers of floats deployed in future years.

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

We aim to deploy over 90 floats in 2011, most in the Indian and Southern Oceans, and some in the Pacific Ocean (Figure 2). We plan to lease the *Lady Amber* for many deployments in the Indian Ocean. However, we have had to modify plans to deploy in the northwestern sector due to the expanding activities of pirates in the region. Navy and very large container ships may be the only means of deploying floats into this dangerous region at present. On completion of her tour out of Fremantle, the *Lady Amber* may be available for follow-on leases by other Argo programs.

In the Pacific, floats will be deployed from both ships of opportunity but also the RV *Kaharoa*, in partnership with US Argo and New Zealand's NIWA.

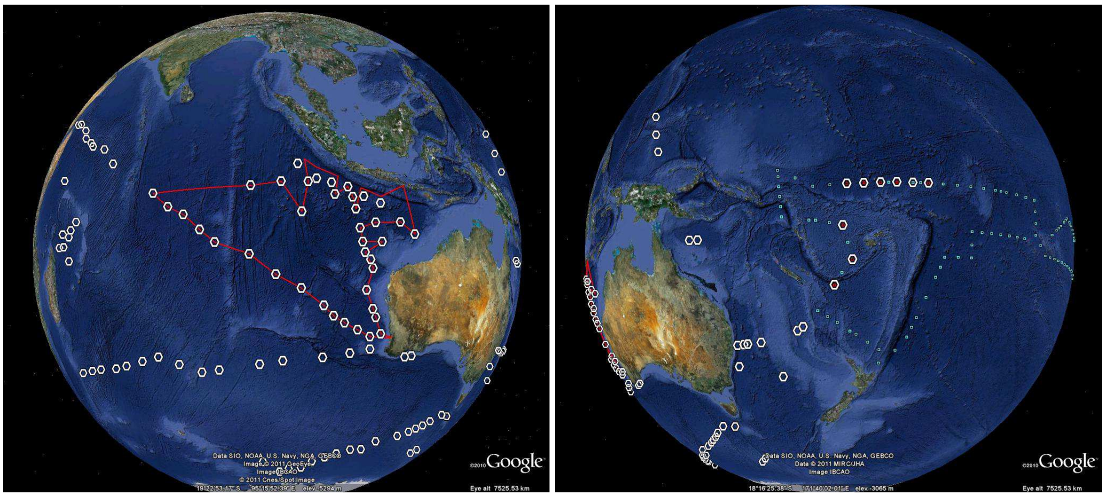

Figure 2. Locations of planned float deployments over the next year – white open pentagons. Red marks the proposed track for the deployment vessel *Lady Amber*. Blue squares indicate US Argo deployments on the RV *Kaharoa*.

## 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 of Neville Smith at the Australian Bureau of Meteorology (http://www.bom.gov.au/bmrc/ocean/results/climocan.htm). These analyses are also used to initialize an experimental seasonal rain forecasting system.
- The dynamical seasonal forecasting system POAMMA heavily uses Argo data – 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. Ocean forecasts and reanalysis products are now routinely published and are available via the Bureau of Meteorology website or the PI ( www.marine.csiro.au\~griffin): David.Griffin@csiro.au
- Many students in the CSIRO/University of Tasmania graduate program are utilizing Argo data in their thesis studies. It's use is becoming widespread for studies of subduction in the Southern Ocean (Sallee, Sloyan, Rintoul), generation of modern era climatologies (Ridgway, Dunn, Barker, McDougall), ocean warming and its role in sea level rise (Church, Domingues, Wijffels, Barker), in ocean observing system studies (Oke and Schiller), Ocean salinity changes (Durack/Wijffels)
- Developing model-based gridding techniques to produce an Argo-gridded data set (Dunn, Monselan, Wijffels,Church)

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

**Pressure Bias Corrections:** The national DACs have made tremendous progress in removing the pressure errors in float data, improving their technical files and their identification and treatment of TNDP floats. Many were also very helpful in improving the pressure bias auditing system. We urge them to complete this task as soon as possible so that Argo may be confidently be used to track the evolution of the global ocean heat content.

## 6. CTD Data Delivered to CCHDO

Data from one Tasman Sea hydrographic cruise (ss2010_v01) was tracked down and permission gained from the PI for its release to Argo. These data were then delivered to CCHDO.

Data from the recently completed Tasmania to Antarctic repeat hydrographic line will also be sent to CCHDO soon.

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# Canadian National Report on Argo-2010

(Submitted by Denis Gilbert; email: denis.gilbert@dfo-mpo.gc.ca)

**1. Status of implementation** (Major achievements and problems encountered in 2010)

1.1 Floats deployed and their performance

During 2010, Canada deployed 28 floats: of these 16 were deployed in the Atlantic and 12 in the Pacific. All were APEX floats with ARGOS telemetry. Eight floats had oxygen sensors, 4 in the Atlantic and 4 in the Pacific. The Atlantic effort focussed on the Slope Water and Labrador Sea, whereas the Pacific effort focussed on the Gulf of Alaska. Significant financial support (15 floats) from the Canadian Ice Service, Environment Canada, permitted enhanced coverage of the northern Labrador Sea. As of writing in February 2011 none of the floats deployed in 2010 failed.

1.2 Technical problem encountered

One peculiar incident with a float (WMOID 4901112, APEX sn 4503, apf9a controller) is worth sharing with other Argo groups. We set that float for launch on pressure activation and it somehow decided that it had been launched while it was still in its wooden case. It started its mission, retracted the piston to try and dive, and fully retracted because it was having difficulty getting to 2000 decibars while still in the box. The result was that when it was launched, it had started itself 4 days earlier and on launch it dropped like a stone. Miraculously it did not get beyond its crushing pressure and supplied a perfect profile 6 days later.

1.3 Status of contributions to Argo data management

ISDM (formerly MEDS) continues to acquire data from 127 active Argo floats. Data are issued to the GTS and GDACs every 6 hours in TESAC, BUFR and netCDF formats. We increase the frequency of acquiring data from the Argos server to hourly if we fail to access the system at a specific 6 hour interval. On average 85% of 2010 data were issued to the GTS within 24 hours of the float reporting. The observation time and location for all the profiles reported by APF9 floats since January 2011 were calculated based on Michel Ollitrault's methods as discussed at ADMT11. The observation time and location of profiles reported before January 2011 has not been updated. Data are corrected for pressure and salinity drifts in real-time. The trajectory netCDF files with format version 2.3 are ready to be sent to GDACs. However, currently, GDACs only accept version 2.2. The transition of our system to handle 6 digit Argos ID numbers back in March 2010 went smoothly. We also received and processed Argo BUFR files from other data centers via GTS for GTS monitoring purposes.

Our website, http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/index-eng.html, is updated daily automatically. The website is currently in the process of moving to CLF2.0 to be compliant with Canada's Treasury Board requirements.

1.4 Delayed mode quality control

Since May 2010, a total of 62 floats were delayed-mode quality controlled (DMQC) for salinity and pressure. Prior to this DMQC, the individual profiles (over 8000) from the floats were visually and individually quality controlled for the first time since the implementation of a procedure to record changes in raw quality flags. The percentage of eligible profiles which have been DMQCed for salinity (and sometimes pressure) at least once is currently 61%. However, only 22% of all eligible floats (20% of all eligible profiles) have been corrected with the latest pressure correction method. One reason for this delay is that ISDM is currently migrating its DMQC environment to a platform with increased memory, in order to successfully run the latest DMQC software.

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

2.1 Funding

During 2010 the Canadian Argo program was primarily funded as a research effort. It has been our early intention to move funding to a more routine or operational basis but that has not yet occurred. We are continuing to pursue this. In the present Argo Canada funding scheme, funds to purchase floats typically appear very late in our fiscal year. The funding in 2010 including the much appreciated contribution from the Canadian Ice Service was adequate to maintain the Canadian contribution to the international Argo effort.

Funding to cover recurring Argos communications costs is not provided as a line budget item at the beginning of fiscal years. This requires frequent and time-consuming requests to Argo data users in Canada to contribute small amounts of money for satellite communications. We are thankful that the Department of National Defence and individual DFO scientists made voluntary, vital contributions to our communications costs from their operations or research budgets.

An Argo Townhall meeting was held in Ottawa on June 3, 2010 during the annual congress of the Canadian Meteorological and Oceanographic Society (CMOS). About 40 attendees from federal government departments (DFO, Environment Canada, National Defence) and universities across the country participated. Several ideas were then proposed for consolidating the Argo Canada program and we will explore some of the most promising ones in the coming years.

2.2 Human resources

Five persons from the Department of Fisheries and Oceans Canada (DFO) work part-time on the Argo project. Anh Tran (Ottawa, Ontario) is responsible for decoding the data, performing the real-time quality control, uploading the data to the GTS and GDACs and maintaining the Argo Canada website. Mathieu Ouellet (Ottawa, Ontario) conducts the delayed mode quality control on eligible floats. Howard Freeland (Sidney, British Columbia) plans float deployments, develops and maintains oceanographic products in the northeast Pacific. Igor Yashayaev (Halifax, Nova Scotia) plans float deployments, develops and maintains oceanographic products in the northwest Atlantic. Denis Gilbert (Mont-Joli, Québec) is the overall program coordinator.

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

We have 16 floats available for launch starting March 31st, 2011. However, 15 of them are targeted for deployment in the Labrador Sea at the request of the Canadian Ice Service that purchased these floats. This leaves us with a single float for deployment in the Gulf of Alaska and zero float available for deployment in the Slope Water region of the northwest Atlantic. But we do have ship surveys going to the latter two areas and would be happy to receive floats from other Argo groups to avoid gaps from appearing as old floats stop functioning.

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

Argo temperature and salinity data are assimilated in operational meteorological and oceanographic forecasts at Environment Canada (Dorval, Québec) and at the Department of Fisheries and Oceans. Numerous researchers at Canadian universities regularly download Argo T & S data for scientific projects.

**5. Issues that Canada wishes to be considered and resolved by AST regarding the international operation of Argo.**

The delivery of delayed mode, quality controlled Argo data to GDACs has improved significantly in the past 12 months. Despite this, we believe that there is still some room for improvement in the timely delivery of delayed mode data.

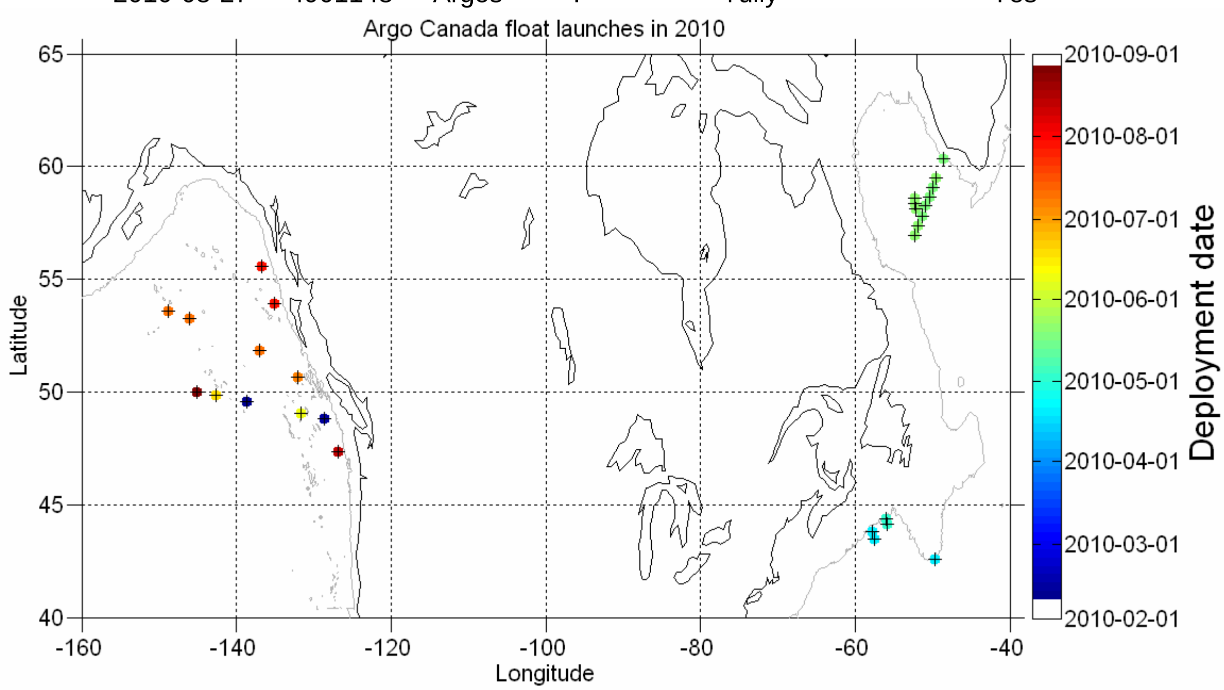
International governance issues or programs (IPCC, GOOS, GCOS, ICES, PICES, etc.) that require Argo temperature and salinity data would need to be formally identified and clarified, as this may help consolidate Argo funding in Canada.

**6. Bibliography**

N/A

## Appendix – summary of Canadian float launches during calendar 2010.

| | Launch Date | WMO-ID | Comms | Ocean Basin | Launching Vessel | Still Operating? |
|---|---|---|---|---|---|---|
| 1 | 2010-02-08 | 4901135 | Argos | P | Tully | Yes |
| 2 | 2010-02-11 | 4901134 | Argos | P | Tully | Yes |
| 3 | 2010-04-18 | 4901139 | Argos | A | Hudson | Yes |
| 4 | 2010-04-20 | 4901155 | Argos | A | Hudson | Yes |
| 5 | 2010-04-21 | 4901143 | Argos | A | Teleost | Yes |
| 6 | 2010-05-03 | 4901140 | Argos | A | Hudson | Yes |
| 7 | 2010-05-03 | 4901149 | Argos | A | Hudson | Yes |
| 8 | 2010-05-17 | 4901156 | Argos | A | Hudson | Yes |
| 9 | 2010-05-17 | 4901142 | Argos | A | Hudson | Yes |
| 10 | 2010-05-18 | 4901141 | Argos | A | Hudson | Yes |
| 11 | 2010-05-18 | 4901150 | Argos | A | Hudson | Yes |
| 12 | 2010-05-19 | 4901158 | Argos | A | Hudson | Yes |
| 13 | 2010-05-20 | 4901157 | Argos | A | Hudson | Yes |
| 14 | 2010-05-21 | 4901154 | Argos | A | Hudson | Yes |
| 15 | 2010-05-21 | 4901153 | Argos | A | Hudson | Yes |
| 16 | 2010-05-21 | 4901159 | Argos | A | Hudson | Yes |
| 17 | 2010-05-21 | 4901151 | Argos | A | Hudson | Yes |
| 18 | 2010-05-22 | 4901152 | Argos | A | Hudson | Yes |
| 19 | 2010-06-09 | 4901137 | Argos | P | Tully | Yes |
| 20 | 2010-06-18 | 4901138 | Argos | P | Tully | Yes |
| 21 | 2010-07-08 | 4901136 | Argos | P | Laurier | Yes |
| 22 | 2010-07-09 | 4901144 | Argos | P | Laurier | Yes |
| 23 | 2010-07-10 | 4901145 | Argos | P | Laurier | Yes |
| 24 | 2010-07-11 | 4901146 | Argos | P | Laurier | Yes |
| 25 | 2010-07-28 | 4901112 | Argos | P | Tully | Yes. Began its mission in the wooden crate |
| 26 | 2010-07-29 | 4901117 | Argos | P | Tully | Yes |
| 27 | 2010-08-13 | 4901118 | Argos | P | Tully | Yes |
| 28 | 2010-08-27 | 4901148 | Argos | P | Tully | Yes |



# Chinese National Report

**(submitted by Xu Jianping)**

## 1. The status of implementation in 2010

### 1.1 Float deployed and their performance

In 2010 China deployed 23 floats in the Indian Ocean and the northwest Pacific Ocean, in which 15 PROVOR floats were deployed by the East China Sea Branch, State Oceanic Administration (SOA) and the rest 8 APEX floats by the Second Institute of Oceanography, SOA. Of these floats, 2 were iridium floats first used by China Argo, in which one is still active. The operator successfully changed its sampling cycle and continuous profiling depth. But the other one did not report data after deployment. Generally the deployment was delayed because of no suitable cruise in 2010.

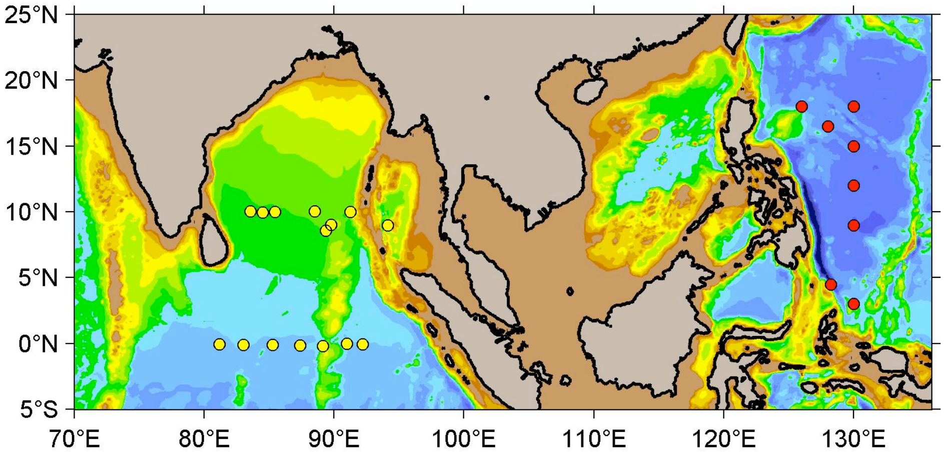



Fig.1 Launch positions of Chinese Argo floats in 2010.
Red dots are Apex floats, and yellow dots are PROVOR floats.

We installed lithium battery packs in 15 APEX floats in which two were deployed and are performing normally.

Since 2002, China has deployed totally 89 Argo floats, and 48 are still active as of Jan. 14, 2011, in which 2 are equipped with Aanderaa Optode. Fig. 2 shows the survival rate of China Argo floats, from which you can see that about 50% floats could make 40 cycles.

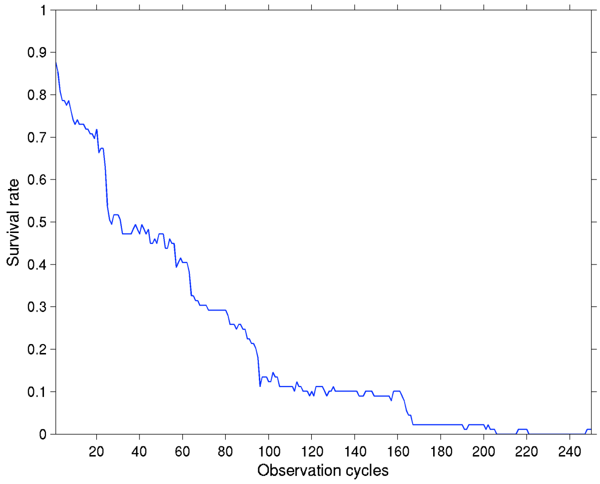



Fig.2  Survival rate estimated for all Chinese Argo floats as of 14 January, 2011.

### 1.2 Technical problems encountered and solved

The 10 APEX floats called back for Druck pressure sensor microleaks were sent back to Hangzhou in 2010. No technical problems were met so far.

### 1.3 Argo data management

In 2010, China Argo Real-Time Data Center received 1069 temperature and salinity profiles and a few oxygen profiles, which were submitted to GDAC, France within 24 hours after real-time QC, and further to the GTS by CLS. At the end of the last year, we deployed 2 iridium floats and successfully acquired and processed data from one of the floats. Assistance of Mr. Dana Swift from UW and Mr. Bill Woodward from CLS America is greatly appreciated. Data acquisition and processing of 15 PROVOR floats deployed by the East China Sea Branch, SOA is done by Coriolis data center.

So far pressure correction has not been carried out at China Real-Time Data Center, and we plan to begin this work before May this year.

### 1.4 Status of delayed mode quality control process

China Argo Real-Time Data Center has submitted 3305 D-files to GDAC, which make up 72% of the total. OW method and thermal mass correction were used for salinity adjustment.

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

China Argo is financially supported by the Ministry of Science and Technology and the State Oceanic Administration. The deployment of 50 floats each year will be funded for the next two years. At present there are 59 floats in storage (including 35 from the East China Sea Branch). Besides, 20 APEX floats and 10 ARVOR floats were ordered at the end of 2010, which makes the storage up to 90 totally. Just like before, the funding of Argo deployments is from scientific research projects.

## 3. Summary of deployment plans

Because of something out of our own control, a special cruise for Argo deployments has to be cancelled in 2010. We plan to make a deployment cruise before May this year in the northwestern Pacific Ocean, but there are still something uncertain such as ship availability and fund. We also plan to get onboard the Navy convoy ship to deploy 10 Argo floats in Gulf of Aden.

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

Argo data have been widely used in the study of ocean circulation, water mass, heat content and tropical cyclone, and some marine and atmospheric operational centers have used Argo data in their data assimilation system. For example, the National Marine Data and Information Service has used Argo data in its assimilation system and developed reanalysis products of temperature, salinity and current for the coastal seas of China and their adjacent waters, which is named as CORA; the reanalysis data sets of the Indian and western Pacific Oceans developed by the Institute of Atmospheric Physics, Chinese Academy of Sciences also use Argo data; and Argo data is widely used in the operational forecasting system of the tropical Pacific Ocean at the National Marine Environmental Forecasting Center.

China Real-Time Data Center is still collecting global Argo data every month, which are shared through FTP and network database (http://ww.argo.org.cn) after visual QC. This is well received by many domestic users in China.

## 5. Collection of CTD data

China Argo Real-Time data Center continues to make CTD observation at the site where each Argo float is deployed. 8 CTD casts were made in 2010. Since the data were obtained in Jan. 2011, they have not been submitted to CCHDO.

## 6. List of publications in which Chinese scientists are involved

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(11)Xu X.H., Liao G.H., Xu D.F.. Analysis of the Anticyclone eddy in the Northwest Pacific with Argos Drifters Data.(in Chinese).2010,Journal of Marine Science,28(4):1-13.
(12)Wu X.F., Xu J.P., A summary of upper ocean heat content in the tropical western Pacific and its distribution features, variations and observations(in Chinese),2010, Journal of Marine Science, 28(1):46-54.

# ARGO National Report 2011 – 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 41 floats have been purchased and deployed, 30 of which are still working correctly.

KNMI is involved in EuroArgo and has decided to join a European Argo consortium that will probably be founded in 2011.

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 sustain a fleet of approx. 30 floats. Given a lifetime of about 4 years for a float this means purchase of about eight floats per year, plus communication. This level of funding appears on the regular budget of KNMI and is thus semi-permanent.

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).

4-8 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**

Nothing done yet.

**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**

Unknown.

**7) Bibliography**

-

# French National report on Argo – 2010
# 12th Argo Steering Team meeting
# March 2011

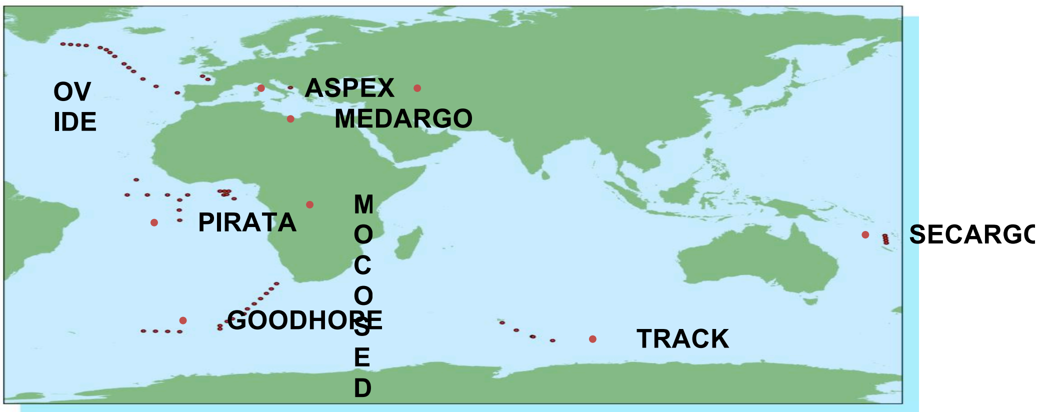
## 1. Organization of the Argo France program

Argo France gathers all the French activities related to Argo and its extension toward biogeochemical measurements. Argo France is the French contribution to the Euro-Argo European research infrastructure that organizes and federates European contribution to Argo. Euro-Argo will evolve in 2011 into a sustained long-term European organization and legal structure (Euro-Argo ERIC) that will be hosted by France. Euro-Argo and its French component (Argo France) is part of the Ministry of Research national roadmap on large research infrastructures (TGIR). To complement Argo France and Euro-Argo ERIC, the NAOS project has been recently funded by the Ministry of Research to consolidate and improve the French contribution to Argo and to prepare the next scientific challenges for Argo. At national level, Argo France is organized through the Coriolis partnership (CNES, Ifremer, INSU, IPEV, IRD, Météo-France et SHOM) and has been recognized in January 2011 as a long-term research observatory. The agreement is valid for 10 years. At regional scale, Argo France is supported by the IUEM Observatory and funded by the Brittany region. A European Research Council (ERC) advanced grant has also been recently obtained by LOV to work on the development of a biogeochemical component for Argo.

## 2. The status of implementation (major achievements and problems in 2010)

### - floats deployed and their performance

**59 floats** have been deployed in 2010. The current position of the French floats deployed in 2010 and of the French active floats are displayed Figure 1.



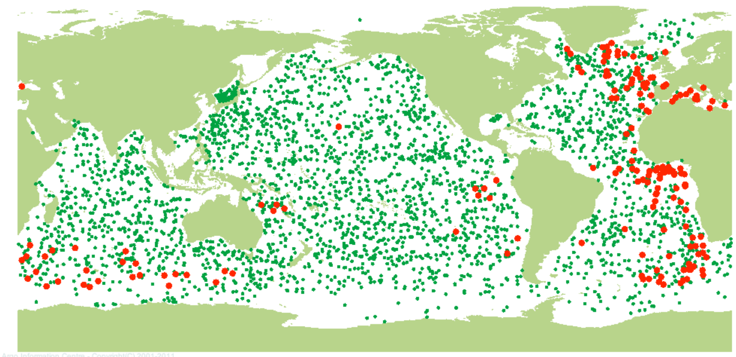



**Figure 1: Floats deployed in 2010 and french active floats (red dots).**

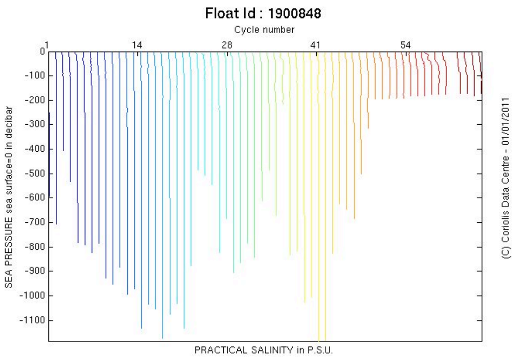
- **technical problems encountered and solved**

*At Sea Monitoring Tool:* A monitoring tool has been set up to follow PROVOR and ARVOR performances while at sea. This tool provides alert on monthly basis and one person is in charge of the analysis of those alerts. This person is also in charge of understanding premature float death to help improve PROVOR and ARVOR lifetime.

*ARVOR-I floats:* A first Arvor float (6900794) has been fitted with an Iridium modem coupled with a GPS receiver and a high pressure antenna, for Argo marginal seas requirements:

- Extra information about the behavior of the float is sent
- A last CTD raw data is acquired before stopping the CTD pump at the end of the rising profile (useful for the knowledge of the surface properties)
- Improved vertical resolution (2 dbars), improved power balance
- Remote control available during operation (modification of cycling period, parking depth, profile depth)
- Capability to manage seabed stationing proven at sea.

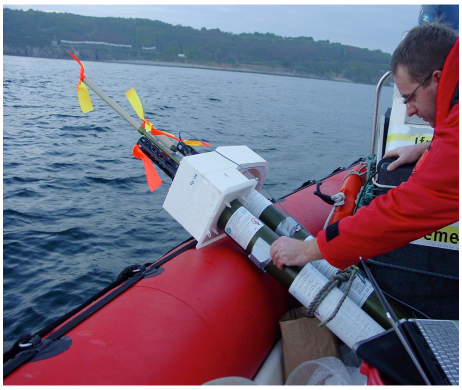

A 2nd Arvor-I (WMO 1900848) was launched in Adriatic sea by OGS team (Feb. 2010). Initially, the float was programmed to cycle every 5 days, drifting at 350m and profiling from700m depth. Every 10 cycles it was programmed to dive at 1100m depth.
Several remote commands have been sent to the float in order to modify the cycling period and the profile depth. At the end of the year, the float has drifted northward, moving away from the south Adriatic Basin. In December, in order to reverse this drift, the parking and starting profile depths have been reprogrammed to respectively 150m and 200m. This float is cycling in an area where depth changes very often from shallow to deep scheme. The float "follows" the ground and samples all the water column, proving its good capability to manage very frequent grounding behavior (53 on 66 cycles). In early 2011, this float has done 66 cycles.




A third Arvor-I (WMO6900800 then 1901203) has been bought by OGS and deployed in the Ligurian sea in July 2010. Several remote commands have been sent to the float in order to modify the cycling period and the profile depth. Particularly, the float has been recovered 2 times and redeployed thanks to a new specific remote command allowing the float to stay at surface at the end of a cycle.

The three ARVOR-I floats are able to better sample the water column. They have been programmed to transmit 240 PTS (pressure, temperature, salinity) triplets between 2000m depth and surface, instead of 100 triplets for standard Argo float. Particularly, the upper area is sampled every 2m. When the float has reached the surface, only 3 minutes are needed to transmit the profile. The total time at surface is approximatively 30 minutes, including the time to increase the buoyancy for good satellite transmission, and afterwards to reduce buoyancy to start a new cycle. This performance has to be compared to more than 8 hours with Argos2.

*ARVOR with Argos-3 satellite transmission*: Argos 3rd generation transmission is being embedded on Arvor. It is intended to use the interactive mode capability (low data rate) of the MetopA satellite, using its prediction pass tables to make a meeting point at surface. Argos2 standard communication is maintained in case of interactive mode failure. The issue of the double band antenna has been resolved and the new design has been successfully tested in our pressure tank. Two floats have been assembled and tested in pressure tank and in seawater pool. Then, satellite transmission has been tested at sea, near Ifremer institute, in order to get results in real environmental conditions (sea water, buoyancy, satellite visibility,…) in October 2010. Some trouble on the electronic PCB of the float (Eeprom default), and a default on one antenna (RF wire solder) have been detected and corrected. The two Arvor A3 floats are now ready to be deployed at sea for a real mission. This will be done by OGS in Mediterranean Sea when an opportunity vessel will be found. After deployment, we will have to analyze all the data transmitted by the floats, including specific statistic messages that are generated by the float to assess the quality and performance of the transmission.



*Arvor fitted with Argos3 satellite transmission during tests at sea in October 2010*

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

Within Argo-France, Coriolis plays three roles in the Argo data management organization: Argo Data Assembly Centre, Global Data Centre, and leader of the North Atlantic Argo Regional Centre.

As Argo Data Assembly Center, Coriolis processes in Real Time and Delayed Mode float data deployed by France, by 5 European countries (Germany, Spain, Netherlands, Norway, Italy) and by 3 non European countries (Chili, Costa Rica, Mexico). Coriolis data center processes data coming from 1246 floats (562 Provor, 554 Apex, 119 Nemo and 11 Metocean floats) including 376 active floats in February 2011 (151 Provor, 204 Apex and 21 Nemo floats). Some floats are deployed as part of scientific projects. Data are processed and distributed according to Argo recommendations.

Coriolis also coordinates the North-Atlantic ARC activities and in particular the float deployment in Atlantic. France has taken the lead in establishing the NA-ARC, which is a collaborative effort between Germany (IFM-HH, BSH), Spain (IEO), Italy (OGS), Netherlands (KNMI), UK (NOCS, UKHO), Ireland (IMR), Norway (IMR), Canada (DFO), and USA (AOML). Work has concentrated on acquiring recent CTD data to improve the reference data set for the North Atlantic Ocean needed for scientific QC of the float data and setting up the delayed mode processing in the different institutes. Work on consistency of the Argo dataset over the basin has started and it's promising and will be finalized within EURO-ARGO. Collaboration with the Southern Ocean and South Atlantic Ocean ARCs is also performed.

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

Statistics on all delayed mode data loaded in the Coriolis database for beginning of February (02/08/2011) are presented on Figure 2. 71244 delayed mode profiles are present in the Coriolis DAC that represents about 72% of the total number of profiles available at the Coriolis DAC.

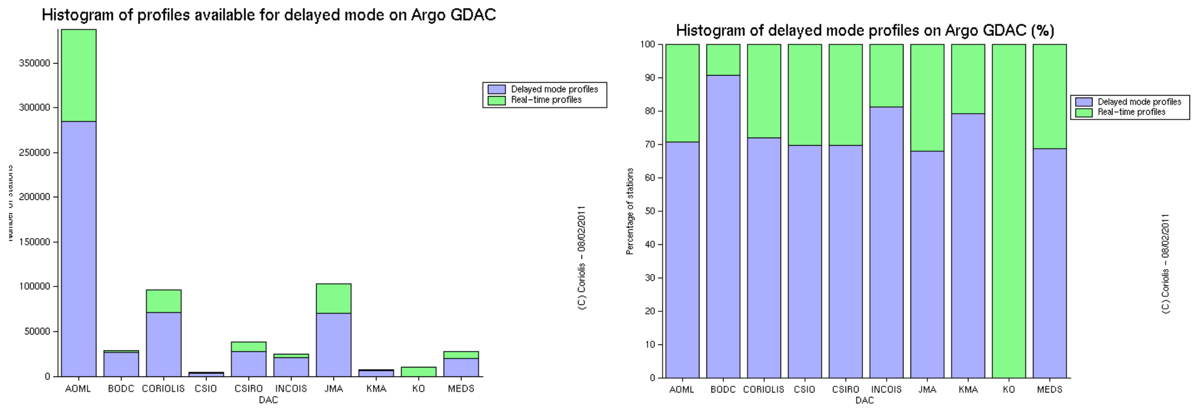



**Figure 2: Histogram of profiles available for delayed-mode on Argo GDAC. (Left) Number of pofiles; (Right) percentage.**

Figure 3 presents the status of the Coriolis floats. 72% of the floats have been processed, while less than 15% of the floats cannot be processed for various reasons (problem with floats which need to be review by decoding, floats too young, etc.). Among the remaining floats that must be controlled in delayed mode, 13% of the floats are currently under consideration by the PIs and should be processed in delayed mode very soon.

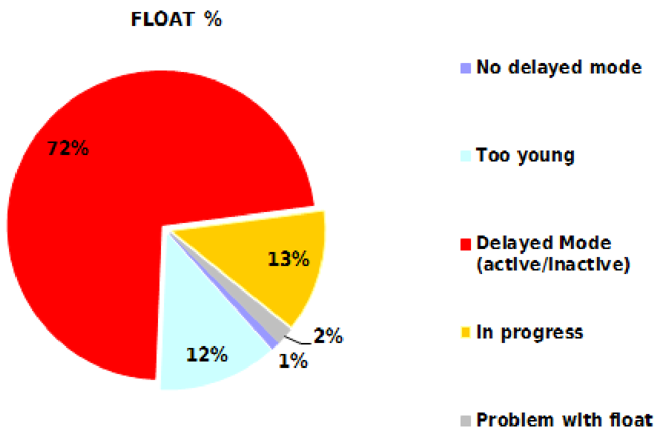


**Figure 3: Status of the delayed mode process at the Coriolis DAC.**

In terms of project, some of them are well updated and others have needed complementary studies (location studies of the various front) to provide delayed mode data, especially those that deployed floats in the southern ocean. Even if the OW's method has now an option to take into account the subarctic Front, sometimes we do not have enough data to provide significant results with the method.
The delayed mode profiles for some floats should be available in the next months. The method has been run on some of them and now we are waiting for the PI's answer.
In others projects (as that was done for the Ovide project), some reports are available and contain a complete overview of the behavior of the float, of the changes on real-time flags, as well as information about the correction applied to the data.
Those reports should be available on the new Argo web site. The reports for the OVIDE floats are available on the following Web page:
http://www.ifremer.fr/lpo/ovide/data/argo_profiling_floats.htm.

Some corrections have also been done by BSH for different countries, not only Germany. Those corrections correspond to a large account of DM profiles since they have some floats in the DAC Coriolis (Figure 6).

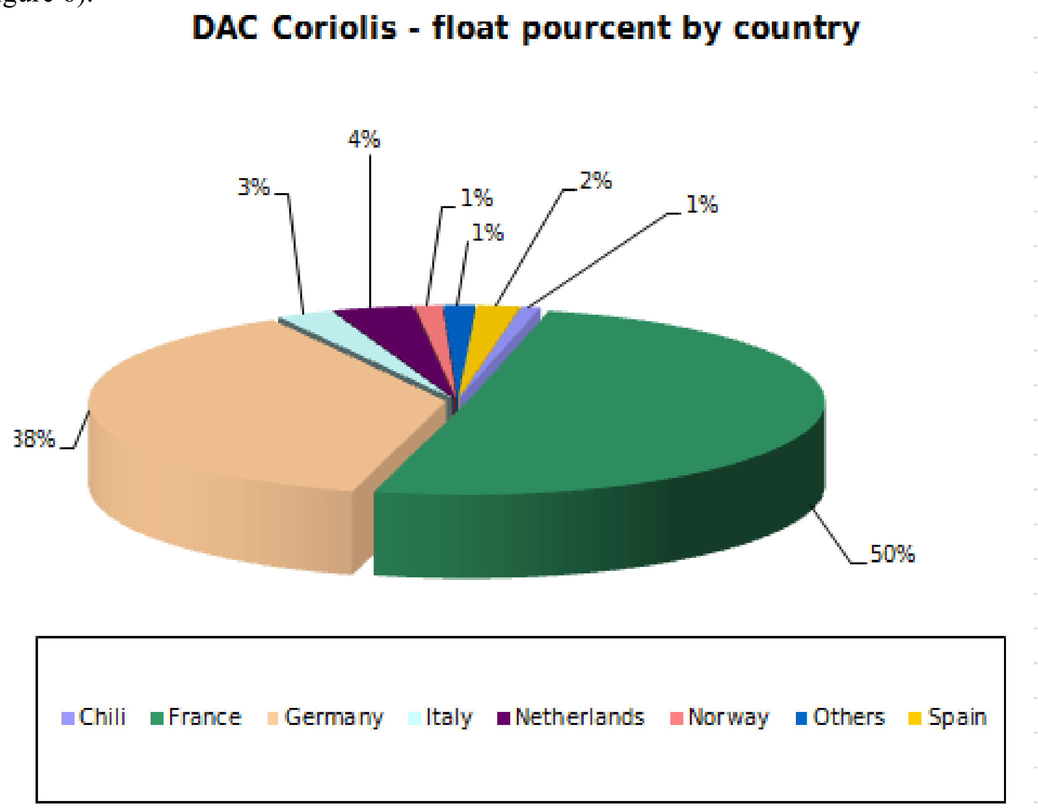



**Figure 4: Percentage of float by country.**

APEX Pressure correction:

Some corrections have been revisited and updated by BSH to take into account recommendations of the ADMT/AST. Others corrections have also been done by OGS for the Mediterranean floats.

Corrections of the French APEX floats deployed by SHOM are underway as well as those of the Spanish floats. Pressure of the Coriolis APEX fleet should be corrected before end of August 2011.

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

Since 2000, France has provided a significant contribution to the growing Argo array. 509 French floats and 68 floats co-funded by European Union have been deployed in different geographic areas. The deployments meet specific French requirements but they also contribute to the global array

| Year | Man/Year | French floats | Co-funded EU floats | Total |
|---|---|---|---|---|
| 2000 | | 11 | | 11 |
| 2001 | 3 | 12 | | 12 |
| 2002 | 6 | 7 | 4 | 11 |
| 2003 | 9 | 34 | 20 | 54 |
| 2004 | 15 | 85 | 18 | 103 |
| 2005 | 15 | 89 | 11 | 100 |
| 2006 | 12 | 51 | 14 | 65 |
| 2007 | 12 | 36 | | 36 |
| 2008 | 12 | 90 | | 90 |
| 2009 | 12 | 35 | | 35 |
| 2010 | 12 | 59 | | |
| ***Total(2000-2010)*** | | ***509*** | ***63*** | **572** |
| | | | | |
| **2010** | **12** | **60** | | |

**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 2010.**

The French Argo Project is funded by the ministry of Research and by local administrations (Britanny region, Finistère department, city of Brest) mostly through Ifremer but also through other french institutes involved in oceanography (CNES, IRD, INSU, Météo-France) and in a lesser proportion by the ministry of Defense through SHOM. Until now, the French contribution to the Argo global array was at the level of about 65 floats per year with funding from Ifremer (about 50 floats/year) and SHOM (about 15 floats/year). A new funding of 15 floats per year from 2011 to 2019 was recently accepted within the scope of the EQUIPEX call for proposal (NAOS proposal). This will allow Ifremer to increase its long term contribution to Argo from 50 to 65 floats/year.

As part of the Euro-Argo preparatory phase, Ifremer (for the Argo-France project) works with its funding ministry (mainly research ministry) to agree on a long-term funding level and commitment. Together with its European partners, Ifremer also works with the European commission to set up a long term EC funding to Argo.
In parallel to the Euro-Argo initiatives and to sustain the commitments of France in Argo, a proposal has been submitted to the French agencies to identify Argo-France project as a research observatory. The agreement has been obtained in January 2011. It is valid for 10 years.

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

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

According to the current deployment plan, 60 floats will be deployed in 2011. Deployments plans of few floats are already known and shown Figure 5.

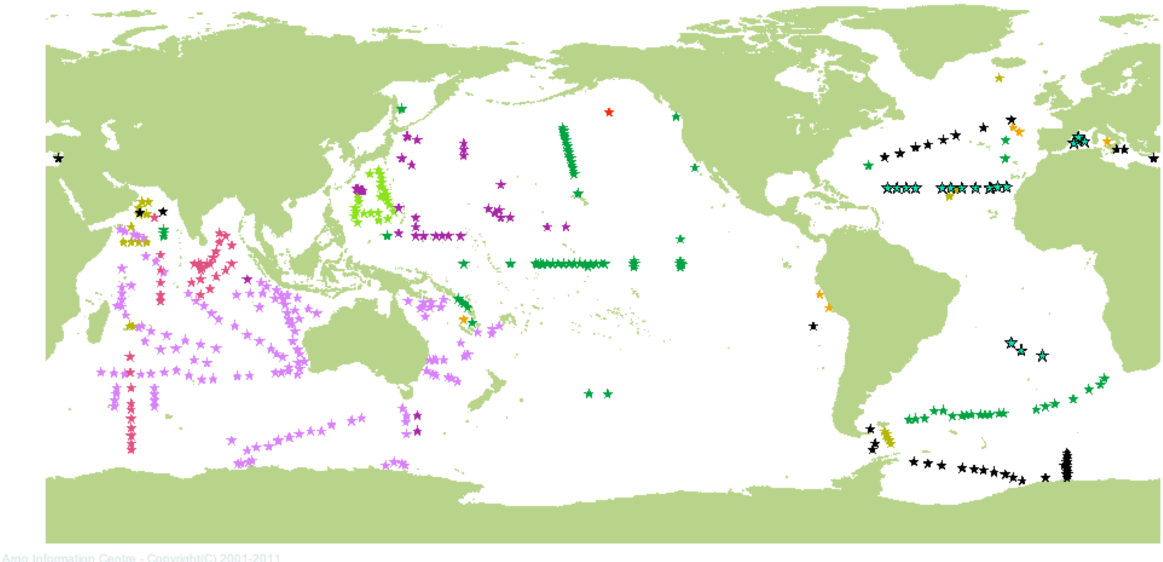



**Figure 5: Deployment plan. The orange stars represent the French deployment plan for 2010.**

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 behaviour of the European fleet and to improve data consistency check within NA-ARC.

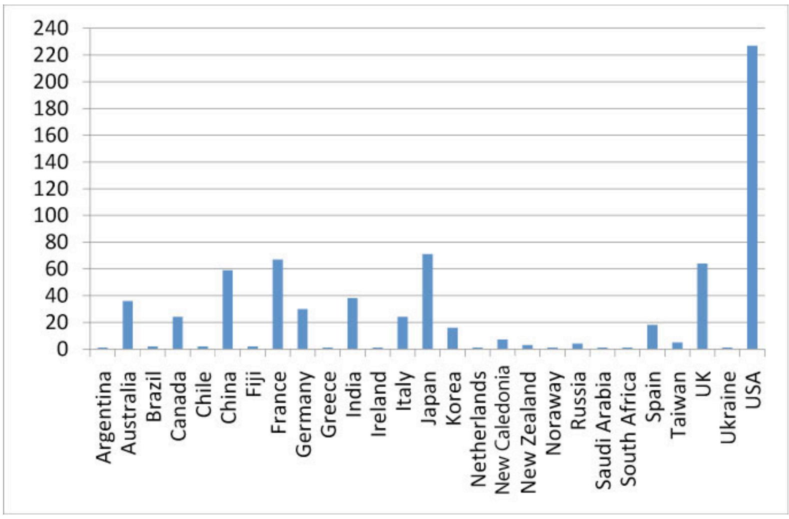
France also contributes to the funding of the AIC.

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

<u>Operational ocean forecasting</u>. All Argo data (alongside with other in-situ and remotely sensed ocean data) are routinely assimilated into the MERCATOR operational ocean forecasting system run by the MERCATOR-Ocean structure.

<u>Ocean science</u>. Argo data are being used by many researchers in France to improve the understanding of ocean properties (e.g. circulation, heat storage and budget, and mixing), climate monitoring and on how they are applied in ocean models (e.g. improved salinity assimilation, …). List of scientific publications is available trough the Argo web site (http://www-argo.ucsd.edu/FrBibliography.html)

The French Argo Users' Group provides a forum for engagement between these scientists and the French Argo program. More than 60 peer-reviewed papers using Argo-data have a leading author based in a French laboratory.




Argo France coordinates the North-Atlantic Argo Regional Center. Besides coordinating deployment in the North-Atlantic, Argo France is working on method to improve data consistency check in the North-Atlantic and to detect TNPD Apex floats with large negative pressure sensor drift.

## 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

One of the Argo project priority is data quality. Ensuring a good decoding is the first step to guarantee data quality but some decoding errors have already been discovered in profile, trajectory and technical files. One problem is that the decoding is not straightforward because of subtle encoding, because some floats manuals are not complete or up to date and because the number of float version keeps growing. We are particularly aware that decoding PROVOR floats is rather complex. What could be the solutions ?

- To keep raw Argos data in case of a new decoding is required (maybe such recommendation has already been done).
- To limit the number of float version and to stabilize the "regular" one.
- To keep somewhere a database on the floats functioning with manuals, decoders, etc.. This probably requires a float "referee" (a person or maybe a DAC). This referee could be the reference for decoding a float type and could be, for instance, the one who propose a name for the associated technical variables.

Ann Thresher has done a huge work on the issue of technical variables names but there is still no guarantee that there is consistency between DACs on the way names are attributed. I'm not sure we find the same name for the same parameter for the same float in two different DACS. Indeed, few months have been necessary to provide a simple table that summarizes the way each float managed the surface pressure data and to define a name of the surface pressure variable that corresponds to each different case. This work has been done for one technical parameter only and should be done for the 50 (or more) other technical parameters.

## 7. 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 2010 to the CCHDO website is not known.
No feedback from the CCHDO has been provided to Coriolis to update the reference database.

## 8. List of publications in which a french scientist is involved.

***<u>Peer reviewed publications in 2010 and 2011 (in bold publications that are not in the Argo Bibliography available on Argo web site)</u>***

**2011**

**Delcroix,T., G. Alory, S. Cravatte, T. Corrège, and M. McPhaden, 2011. A gridded sea surface salinity data set for the tropical Pacific with sample applications (1950-2008). Deep Sea Res., 58, 38-48 doi:10.1016/j.dsr.2010.11.002.**

**2010**

**Bindoff, N.L., D. Stammer, P.Y. Le Traon, K. Trenberth, C. Mauritzen, J.A. Church, N. Smith, T. Malone, T. Suga, J. Tintoré and S. Wilson, 2010. Capabilities of Global Ocean Programmes to Inform Climate Services, World Climate Conference-3, Procedia Environmental Sciences, Volume 1, 2010, Pages 342-353.**

Claustre, H. and co-authors, 2010: Bio-optical Profiling Floats as New Observational Tools for Biogeochemical and Ecosystem Studies. *Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society* J. Hall, D. E. Harrison, and D. Stammer, Eds., ESA Publication.

**Church, J.A., D. Roemmich, C. M. Domingues, J. K. Willis, N. J. White, J. E. Gilson, D. Stammer, A. Köhl, D. P. Chambers, F. W. Landerer, J. Marotzke, J. Gregory, T. Suzuki, A. Cazenave, and P.Y. Le Traon, 2010. Ocean Temperature and Salinity Contributions to Global and Regional Sea-Level Change, 143-168, in Understanding sea level rise and variability, Editors J.A. Church, P.L. Woodworth, T. Aarup and W.S. Wilson.**

de Boisseson, E., V. Thierry, H. Mercier, and G. Caniaux, 2010: Mixed layer heat budget in the Iceland Basin from Argo. *J. Geophys. Res.*, **115,** C10055.

Dobricic, S., N. Pinardi, P. Testor, and U. Send, 2010: Impact of data assimilation of glider observations in the Ionian Sea (Eastern Mediterranean). *Dynamics of Atmospheres and Oceans*, **50,** 78-92.

Foltz, G. R., J. Vialard, B. Praveen Kumar, and M. J. McPhaden, 2010: Seasonal Mixed Layer Heat Balance of the Southwestern Tropical Indian Ocean. *Journal of Climate*, **23,** 947-965.

Freeland, H. J. and co-authors, 2010: Argo - A Decade of Progress. *Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society*, J. Hall, D. E. Harrison, and D. Stammer, Eds., ESA Publications.

Ganachaud, A., A. Vega, M. Rodier, C. Dupouy, C. Maes, P. Marchesiello, G. Eldin, K. Ridgway, and R. Le Borgne, 2010: Observed impact of upwelling events on water properties and biological activity off the southwest coast of New Caledonia. *Marine Pollution Bulletin*, **61,** 449-464.

Henocq, C., J. Boutin, F. Petitcolin, G. Reverdin, S. Arnault, and P. Lattes, 2010: Vertical Variability of Near-Surface Salinity in the Tropics: Consequences for L-Band Radiometer Calibration and Validation. *Journal of Atmospheric and Oceanic Technology*, **27,** 192-209.

Koch-Larrouy, A., R. Morrow, T. Penduff, and M. Juza, 2010: Origin and mechanism of Subantarctic Mode Water formation and transformation in the Southern Indian Ocean. *Ocean Dynamics*.

Le Traon, P. Y. and co-authors, 2010: GODAE OceanView: From an Experiment Towards a Long-term Ocean Analysis and Forecasting International Program. *Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society*, J. Hall, D. E. Harrison, and D. Stammer, Eds., ESA Publication.

Lee, T., T. Awaji, M. Balmaseda, N. Ferry, Y. Fujii, I. Fukumori, B. Giese, P. Heimbach, A. Kohl, S. Masina, E. Remy, A. Rosati, M. Schodlok, D. Stammer, and A. Weaver, 2010: Consistency and fidelity of Indonesian-throughflow total volume transport estimated by 14 ocean data assimilation products. *Dynamics of Atmospheres and Oceans*, **50,** 201-223.

Llovel, W., S. Guinehut, and A. Cazenave, 2010: Regional and interannual variability in sea level over 2002Ð2009 based on satellite altimetry, Argo float data and GRACE ocean mass. *Ocean Dynamics***,** 1-12.

**Morel, A., Claustre, H., and B. Gentili (2010) The most oligotrophic subtropical zones of the global ocean: similarities and differences in terms of chlorophyll and yellow substance. *Biogeosciences, 7, 3139–3151,*doi:10.5194/bg-7-3139-2010**

Pouliquen, S. and co-authors, 2010: Argo Data Management. *Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society*, J. Hall, D. E. Harrison, and D. Stammer, Eds., ESA Publication.

Roemmich, D., L. Boehme, H. Claustre, H. J. Freeland, G. Fukasawa, G. J. Goni, J. Gould, N. Gruber, M. Hood, E. Kent, R. Lumpkin, S. Smith, and P. Testor, 2010: Integrating the ocean observing system: Mobile platforms.

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

Taillandier, V., S. Dobricic, P. Testor, N. Pinardi, A. Griffa, L. Mortier, and G. P. Gasparini, 2010: Integration of Argo trajectories in the Mediterranean Forecasting System and impact on the regional analysis of the western Mediterranean circulation. *Journal of Geophysical Research-Oceans*, **115,** 17.

Tanguy, Y., S. Arnault, and P. Lattes, 2010: Isothermal, mixed, and barrier layers in the subtropical and tropical Atlantic Ocean during the ARAMIS experiment. *Deep-Sea Research Part I-Oceanographic Research Papers*, **57,** 501-517.

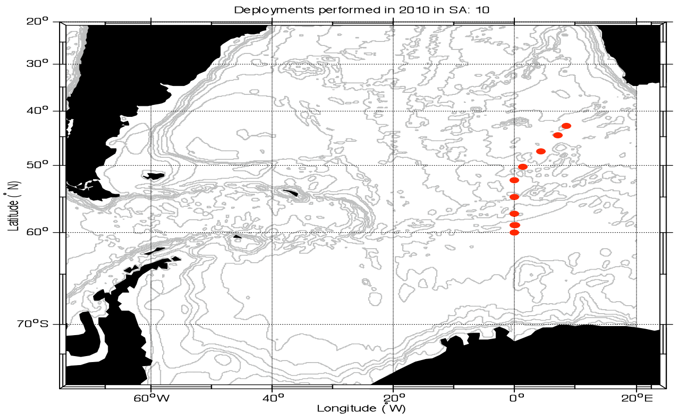
Vivier, F., D. Iudicone, F. Busdraghi, and Y.-H. Park, 2010: Dynamics of sea-surface temperature anomalies in the Southern Ocean diagnosed from a 2D mixed-layer model. *Climate Dynamics*, **34,** 153-184.

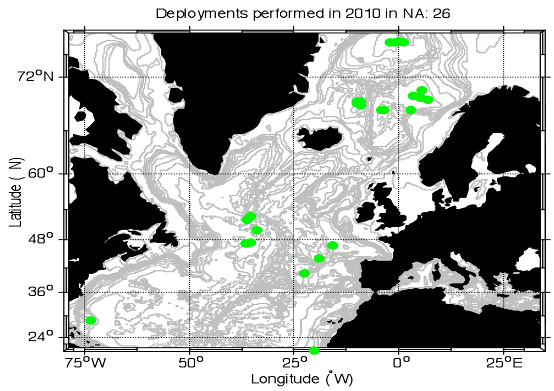
German national report for 2010/2011:

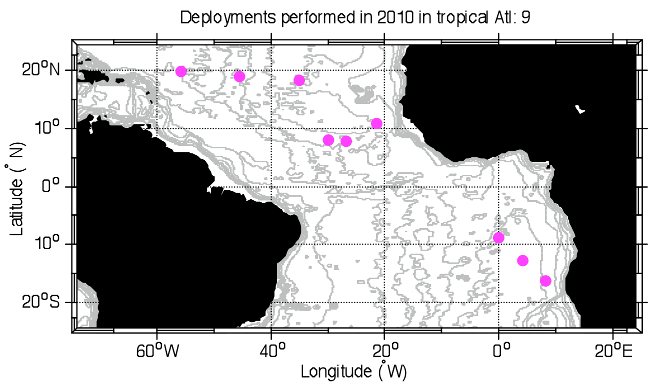
## 1. The status of implementation (major achievements and problems in 2010)

- floats deployed and their performance

Most of the floats deployed by Germany will be operated by BSH but additional funding has been acquired by various research institutes. Deployments in 2010 lagged behind the original plans due to time delays in float procurement. 21 floats purchased in 2010 by BSH which could not be sent to cruises in 2010 will be deployed early 2011. Since the price of floats increased due to the dollar exchange rate a slightly smaller amount of floats could be purchased. The float deployment from the science community is also lagging behind the original plans for 2010. The deployments in the Southern Ocean have started in 2010 and are continuing in 2011. Until the end of 2010 the deployments have reached 45 floats in the Northern, tropical and Southern Atlantic.



- technical problems encountered and solved

No major technical problems were encountered in 2010. Software problems associated with new firmware in NEMO floats encountered in 2009 seem to be solved.

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

The majority of pressure corrections for German floats have been finished with the exception of floats operating in the Southern Ocean. DMQC for these floats will be performed by the Alfred-Wegner Institute after the field cruises in the Southern Ocean are finished in February 2011. BSH has adopted most orphaned floats in the Nordic Seas belonging to the national programmes from Denmark, Norway, Finland and Poland. The pressure corrections for these floats have also been performed. BSH has also adopted floats from the German research community from research projects for which funding has ceased. DMQC for these floats has been performed.

- status of delayed mode quality control process

The delayed quality control process is well underway and no major delays have been encountered.

## 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 German Argo Project has been receiving its operational funding by the Ministry of Transportation from 2008 onwards. Overall the level of support is indicated in the table below. It is anticipated to contribute 40-50 floats per year to the global array by Germany, but the exact amount will depend on the actual purchase conditions. The research community has also secured funding for floats in the order of 20 floats per year for the next 3 years which will mostly be used for regional enhancements.

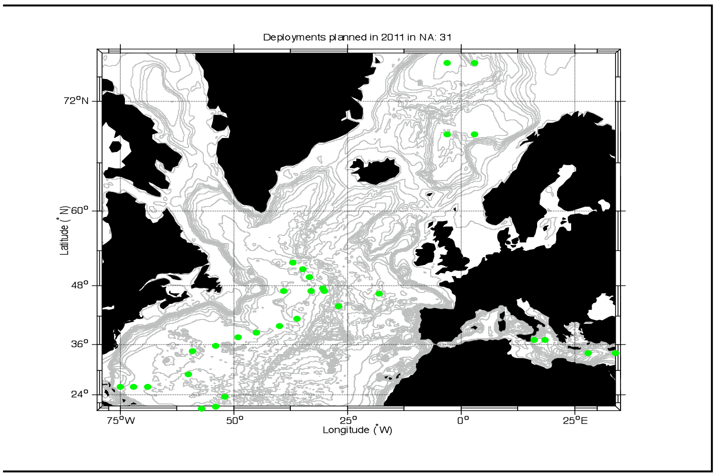
Float purchases in 2010 were marked by an increase in prices which can only be adjusted in the operational budgets after 2012. Funding from the Ministry of Transportation covers only costs related to float procurement and transmission costs, personnel will be provided by BSH. This will consist of 1 scientist and 1 technician.

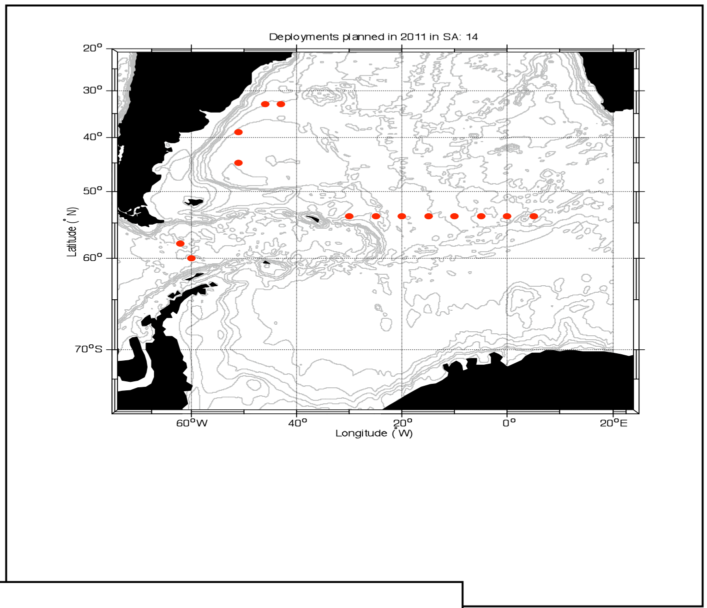
| Year | Float related costs | Manmonth/Year |
|---|---|---|
| 2008 | 550k€ | 24 |
| 2009 | 600k€ | 24 |
| 2010 | 600k€ | 24 |
| 2011 | 600k€ | 24 |
| 2012 | 600k€ | 24 |
| 2013 | 650k€ | 24 |

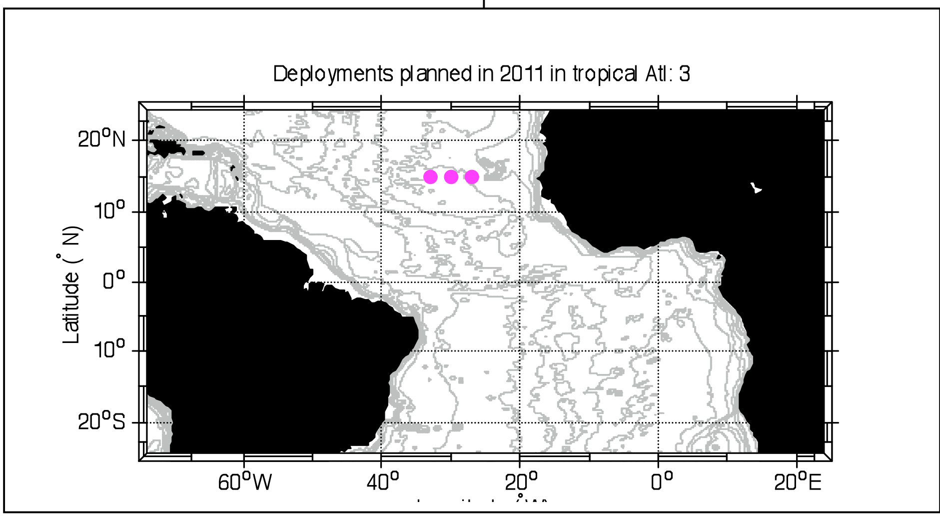
*Table 1. Previous and future operational funding for German Argo.*

## 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.

Together with the remaining floats out of the 2010 budget the deployment plans for 2011 will comprise 48 floats. 8 additional floats will be purchased from research grants and will be deployed in the tropical Pacific. The main goal is to support the global array in the Atlantic Ocean and will focus on data sparse regions, specifically in the southern Atlantic. A map of the expected deployment positions is given below. 15 more floats will be purchased in 2011, but will remain in the storage facility for deployment in early 2012.




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

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 (assimilations, boundary conditions).

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

**5. Issues to be considered:**

The data transmission for almost all German floats is still using ARGOS. The few tests with Iridium floats showed mixed results probably due to antenna problems. It would be useful to receive continued updates about the technical progress with Iridium transmission from other programmes. A detailed cost analysis showing costs for the different Iridium transmission options (SBM, Rudics server) would be welcome.

**6. Improve the CTD data base**

A request has been send to the research community to list the recent CTD data uploaded to CCHDO.

**7. Keeping the Argo bibliography**

A request has been send out to the our national mailing list to update the Argo bibliography.

<u>**Argo Steering Team Meeting (AST-12)**</u>

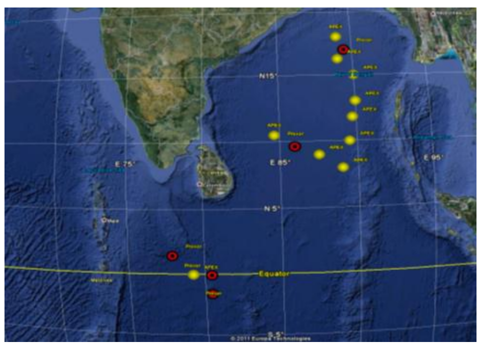
National Report – India

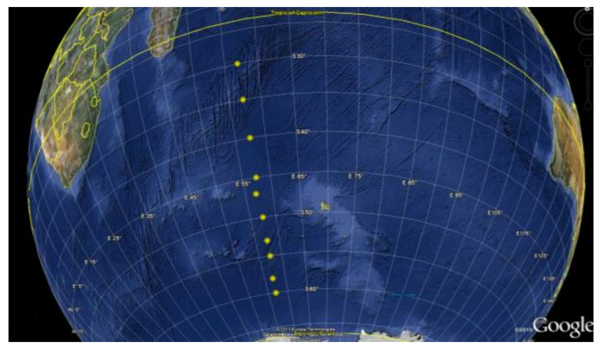
*(Submitted by M Ravichandran – ravi@incois.gov.in)*

## 1. The status of implementation

### 1.1a Floats deployment

During the year 2010–11, India deployed 26 floats in the Indian Ocean taking the total to 206. The deployment location in the North Indian Ocean and Southern ocean are shown below.





### 1.1b performance Analysis of Floats deployed

Out of 206 floats deployed so far, 83 floats are active. Out of these 83 active floats, 39 floats are less than 3 years old.

### 1.1c Software support of CSIRO for DMQC

CSIRO extended whole hearted support by providing the Delayed Mode Quality Control processing software to INCOIS. One scientist from INCOIS visited CSIRO and had hands on experience with the DMQC s/w. Subsequently all the eligible floats were DMQCed and uploaded to GDAC. We take this opportunity to thanks the CSIRO team for sharing the software and support.

### 1.2 Technical problems encountered and solved

None

### 1.3 Status of contributions to Argo data management

- **Data acquired from floats**
  India had deployed 206 floats so far. Out of these 83 floats are active. All the active floats data are processed and sent to GDAC.
- **Data issued to GTS**
  Presently we do not have GTS access. Up on our request CLS ARGOS is continuing to send Indian floats data in TESAC format to GTS.
- **Data issued to GDACs after real-time QC**
  All the active floats (83) data are subject to real time quality control and are being sent to GDAC.

- **Web pages**
  INCOIS is maintaining Web-GIS based site for Indian Argo Program. It contains entire Indian Ocean floats data along with trajectories. Further details can be obtained by following the link:
  http://www.incois.gov.in/incois/argo/argo_home.jsp.
- **Statistics of Argo data usage**
  Argo data is widely put to use by various Organisations/ Universities/Departments. INCOIS Argo web page statistics (for the past one year) are as shown below

| **Page** | **Views** | **Visitor** |
|---|---|---|
| Argo Web-Gis | 827 | 395 |
| Data downloads | 784 | 1092 |
| Live Access Server | 1,62,034 | 74,091 |
| Argo products | 1169 | 444 |

### 1.4 Status of Delayed Mode Quality Control process

With the support from CSIRO, DMQC s/w developed at CSIRO is installed at INCOIS and majority of the problems are resolved.

- Using this s/w reprocessing of all the eligible floats data is done. Around 140 floats were passed through the DMQC s/w and the following problems are tackled
  - Pressure Sensor offsets.
  - Salinity drift.
  - Salinity Hooks.
  - TBTO problems.
  - TNPD problems. etc
- Around 81 % of FLOATS are DMQCied for INCOIS DAC.
  - Lack of CTD profiles in some of the region in North Indian Ocean is still a critical problem when decision is to be taken for the complicated cases.

### 1.5 Trajectory files status:

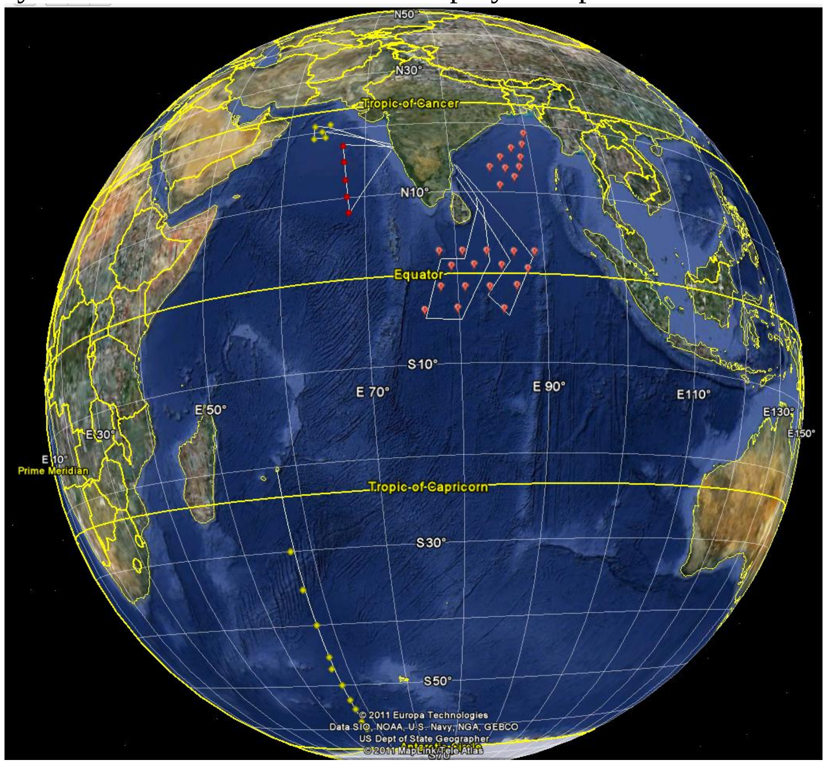
A total of 2**06 trajectory** netcdf files were processed and uploaded to the GDAC. The process of generation of trajectory netcdf files undergoes quality checks like position, time, cycle number, etc., and corresponding quality status is assigned to each parameter.

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

Indian Argo Project is a 5 year Program started from April 2007 to March 2012 and it is fully funded by Ministry of Earth Sciences, Govt. of India. Funding is secured upto 2012 for deployment of 45 Argo floats, Data management activities, Data analysis, etc. Efforts are underway to secure funds for 200 floats during the years 2012-17.

## 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 committed to deploy floats in North Indian Ocean wherever gap exists. Also plans to deploy few tens of floats in the Southern Indian Ocean. During the year 2011-12, India plans to deploy 45 floats and the locations of deployment plan are shown below:




For the above 45 floats to be deployed, 25 floats are in hand and order has been placed for the remaining 20 floats. All these floats will be deployed using Indian research vessels.

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

- Argo data has been widely utilized to understand the Indian Ocean dynamics, especially Dipole event, understanding the monsoon system in relation to heat content, buoyancy flux of the Indian Ocean and for validation of OGCM.
- In a major initiative, INCOIS started providing global ocean analysis products with assimilation of all *in situ* data (Argo, XBT and Moorings). These products are generated using OGCM (MOM) with GODAS assimilation system. These products are being made available at INCOIS Live Access Server (las.incois.gov.in).
- INCOIS is hosting Indian Ocean ARC, wherein all floats data from Indian Ocean region are archived and distributed apart from many products

**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.**

Nil

## 6. Bibliography


Subrahmanyam, B., V. S. N. Murty, and D. M. Heffner, 2011: Sea surface salinity variability in the tropical Indian Ocean. *Remote Sensing of Environment*, 115, 944-956.

Bhaskar, T. V. S. U., D. Swain, and M. Ravichandran, 2010: Sonic Layer Depth variability in the Arabian Sea. *International Journal of Oceans and Oceanography*, 4, 17-28.

Bhaskaran, P. K., R. R. Kumar, R. Barman, and R. Muthalagu, 2010: A new approach for deriving temperature and salinity fields in the Indian Ocean using artificial neural networks. *Journal of Marine Science and Technology*, 15, 160-175.

Sharma, R., N. Agarwal, I. M. Momin, and V. K. Agarwal, 2010: Mixed Layer Depth and its Variability in the Eastern Equatorial Indian Ocean as Revealed by Observations and Model Simulations. *Marine Geodesy*, 33, 154-163.

Sharma, R., N. Agarwal, I. M. Momin, S. Basu, and V. K. Agarwal, 2010: Simulated Sea Surface Salinity Variability in the Tropical Indian Ocean. *Journal of Climate*, 23, 6542-6554.


## 7. CTD data base

Efforts are underway to archive all CTD acquired by different PIs.

## 1. The status of implementation (major achievements and problems in 2010)

- **floats deployed and their performance**

During February 2010 three Argo floats were deployed during the standard section ICES cruise on the R.V. Celtic Explorer in the Rockall Trough. The JCOMMMOPs float density map was consulted prior to choosing the deployment locations. Three more floats will be deployed on a transect to Newfoundland in February 2011.

- **technical problems encountered and solved**

None that I am aware of.

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

N/A

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

The first of the Argo Ireland floats (ARGOS 79616, WMO 6900649) went through the BODC DMQC in 2010.

The results from the OW software are in:
ftp://ftp.pol.ac.uk/pub/bodc/argo/argo_ireland_dmqc/

and the initial decision is that OW indicates offsets of up to 0.05 in salinity but error bars on the mapped salinity are large and at theta level 7.9C the raw data is within the error bars of the mapped salinity. Conclusion, no correction, PSAL error = 0.01.

There are two runs of the OW software; the run including Argo profile climatology is for guidance only. The plot on page 5 seems to indicate large offsets (0.05 salinity) but the plots on page 8 indicate the raw salinity is within the error bars on the mapped salinity (indicating a high natural variability).

The remainder of the Argo Ireland floats deployed to date were processed in 2010.

## 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 Irish Marine Institute has indicated to the Euro Argo co-ordinator that we intend becoming Observer Members of the Euro-Argo ERIC (legal consortium). This requires an annual contribution of €8k per annum with an intention to deploy some floats also.

At this point in time, there is no national "pot" of funding available for Ireland's participation in any of the large Research Infrastructures on the ESFRI Roadmap[1]. Indications from the science funding agencies are that any commitments to Euro-Argo will have to be met from the annual budgets of the Marine Institute. While we cannot make a long-term commitment to the deployment of floats on an annual basis, we intend to make every effort to deploy three floats per annum over the short-medium term as an indication of our commitment to the project and the Euro-Argo ERIC.

[1] http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri

One section manager (Glenn Nolan), one team leader (Fiona Grant) and two Science and Technical Officers (Kieran Lyons and Sheena Fennell) are responsible for the delivery of the Euro Argo programme in Ireland. The programme is overseen by the Director of Ocean Science Services, Michael Gillooly.

**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.**

As before, we do not have a long term commitment to the deployment of floats as yet. It is our intention to deploy 3 floats per annum over the short-medium term. These are generally deployed on cruises aboard the national research vessel, the Celtic Explorer. The cruises tend to be focussed in the North Atlantic but every effort is made to deploy in areas with less than 100% coverage.

Ireland will pay an annual subscription to the Euro-Argo ERIC and the Marine Institute has an arrangement with BODC for a contribution to the DMQC processing.

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

We monitor the performance of our Northeast Atlantic Operational Model by performing routine validation against real-world measurements. Validation allows us to quickly identify problems in the model as well as increasing our understanding of the model's abilities and limitations. It also helps us to fine-tune the model for optimal performance. We calculate quantitative model skill metrics such as the correlation coefficient (r) between measured and modelled parameters, and the rms error. We are currently using data from the following sources for validation: Argo floats; Microwave sea surface temperature; Irish National Tide Gauge Network; and Irish Marine Weather Buoy Network.

Some additional research has been conducted jointly between the Oceanographic Services team in the Marine Institute and collaborators at the NUI, Galway. Over 10,000 ARGO profiles are available for the Atlantic Ocean adjacent to Ireland since float deployments began a decade ago. Querying and interpreting this amount of data presents challenges in itself. A suite of tools were developed in Matlab to allow rapid sub-setting of the data, calculation of key parameters including stratification and mixed layer depth and the subsequent plotting of this data. The research findings will be detailed in a peer-reviewed journal paper currently in preparation.

**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.**

N/A – all issues are dealt with through the Euro-Argo coordinator.

**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.**

Annually, the Marine Institute uploads all CTD cruise data to the ICES database (http://www.ices.dk/ocean/data.asp).

**7. Keeping the Argo bibliography (http://www.argo.ucsd.edu/FrBibliography.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. Please include a list of all papers published by scientists within your country in the past year using Argo data, including non-English publications**.
N/A for 2010.

**8. I am also attaching a spreadsheet of the commitments table which I updated on January 5, 2011 using the AIC website. It is clear that more deployments were possible this year, but not as many as had been estimated. Please correct any errors on float totals in the past year and send me an estimate of the expected number of deployments for 2011**.
Attached as requested.

It would be helpful to receive these national reports by *1 March 2011*.

# Japan National Report

(Submitted by Toshio Suga)

## 1. The Status of implementation (major achievements and problems in 2010)

### 1.1 Floats deployed and their performance

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

Japan Agency for Marine-Earth Science and Technology (JAMSTEC) deployed 63 floats from January 2010 to December 2010: 46 APEXs, 5 PROVORs, 11 NEMOs and 1 POPS (Polar Ocean Profiling System). All the floats except POPS were deployed with the aid of R/Vs of 7 domestic organizations.

POPS is an ice-based drifting buoy with a PROVOR float moving up and down along a 1000m cable. The observed data (temperature-salinity profiles of every day, hourly GPS position, atmospheric temperature and pressure) are transmitted to Iridium Satellites and distributed to GTS via JMA. One POPS was deployed in the Arctic Sea in April 2010. Unfortunately, this POPS terminated the mission in October 2010. Another POPS is planned to be deployed near the North Pole in April 2011.

Eight NEMO floats were deployed in the western tropical Pacific in April and May 2010 in order to investigate oceanic mixed layer structure and tropical air-sea interaction. The floats use the Iridium transmitter, measuring temperature and salinity from 500 dbar depth to the sea surface every day. Six floats among these floats operated for 8 months. Another NEMO float is planned to deployed in the tropical Indian Ocean in 2011 as part of Cooperative Indian Ocean Experiment on intraseasonal variability in the year 2011 (CINDY2011).

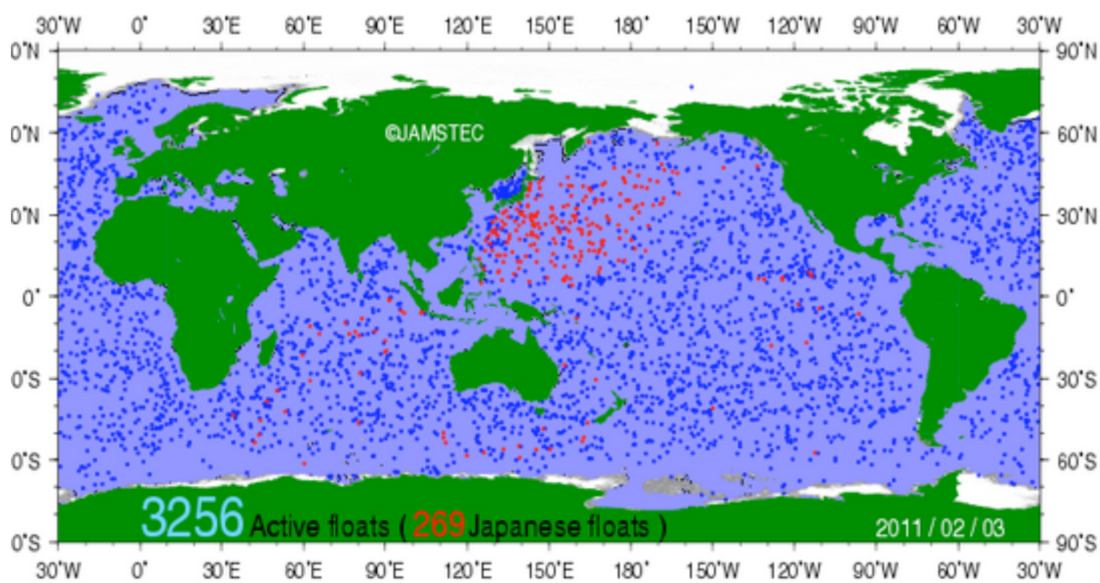



Figure 1: The distribution of active Argo floats. The red dots represent active Japanese floats.

Five floats (2 APEXs and 3 NEMOs) equipped with dissolved-oxygen sensors (Aanderaa Optode3830) were deployed in September and October 2010 around a biogeochemical observing mooring site S1 (30N, 145E) maintained by JAMSTEC (Fig. 2). The purposes of the deployments are to investigate changes in biogeochemical parameters associated with mesoscale physical variability as a preliminary experiment for developing an integrated physical and biogeochemical ocean observation system, in collaboration with other observation systems such as moorings and research vessels. The floats measure temperature, salinity and dissolved oxygen from surface to 2000 dbar every 3 days, transmitting a large amount of data using the Iridium interactive telecommunication system. The time series data from these floats already detected biogeochemical responses to mesoscale disturbances. To enhance the measurement of biogeochemical variability associated with mesoscale and sub-mesoscale physical variability, another 25 oxygen floats are planned to be deployed around the S1 site in July 2011.

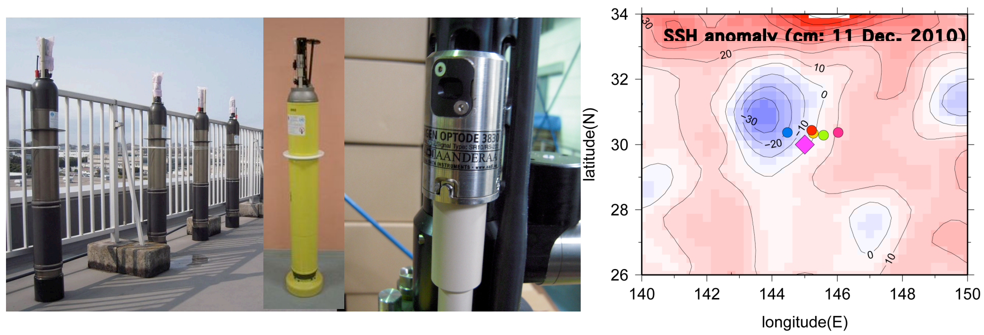



Figure 2. NEMO and APEX floats with dissolved oxygen sensor (left), Optode3830 oxygen sensor (middle) and the positions (circles) of the 5 floats around S1 (diamond) plotted on the of sea surface height anomaly map from a merged altimeter satellite product distributed by AVISO (http://www.aviso.oceanobs.com) (right).

Two APEXs equipped with two different oxygen sensors (Optode3830 and SBE43) were deployed in the Yamato Basin, Japan Sea late January 2009. The main purpose of this deployment was to evaluate sensor biases, drifts, etc. The layer below 300-500 m in this basin is occupied by Japan Sea Proper Water, which is vertically and horizontally homogeneous deep water with small temporal variability. One of them was recovered after drifted close to the Japanese coast in 2009 as reported last year. The other float was also recovered on October 11, 2010 with the aid of Akita branch of Japan Coast Guard after drifted close to the northern coast of Honshu (the main island of Japan). The two types of sensors on these floats have been sent back to the manufacturers for calibration. We expect the calibration results for the recovered floats will provide useful information about performance of the sensors.

Among JAMSTEC's 812 floats (708 APEXs, 77 PROVORs, 11 NEMOs, 11 NINJAs, and 5 POPSs) deployed in the Pacific, Indian and Southern Oceans, from 1999 to the end of January 2011, 249 floats (240 APEXs and 9 NEMOs) are now in normal operation. The other 563 floats (468 APEXs, 77 PROVORs, 2 NEMO, 11 NINJAs, and 5 POPSs) terminated their mission, including 6 floats (all of them are APEXs) transmitting on the beaches after stranding, two floats drifting at the sea surface (1 APEX and 1 NEMO) and 11 floats (8 APEXs, 2 PROVORs, 1 NINJA) recovered. The Japan Meteorological Agency (JMA) deployed 30 Argo equivalent floats (14 APEXs and 16 ARVORs) in the seas around Japan from January 2010 to December 2010. The floats get 2,000m T/S profiles every 5-day for operational ocean analysis and forecast. Among 89 floats (14 PROVORs, 59 APEXs and 16 ARVORs) which JMA deployed from 2005 to 2010, 38 floats (22 APEXs and 16 ARVORs) are active as of the end of December 2010, while 15 floats (all of them are APEXs) terminated the transmission in 2010. JMA deployed 3 ARVORs in January 2011.

Four isopycnal-APEX floats among 9 floats deployed by the Fisheries Research Agency

(FRA) in 2005 and 2008 are active at the end of January 2011. One of them has been operating for longer than 2000 days. FRA developed lithium buttery for a Slocum glider (1-km model; manufactured by Webb Research) to extend its life time to 3 months. They conducted observation using this glider in the Kuroshio-Oyashio mixed water region in the North Pacific for 5days in July and 8 days in September 2010.

Among Tohoku University's 8 floats deployed during 2008 as Argo equivalent floats (3 NINJAs having a ECO FLNTU (Fluorometer and Turbidity Sensor) manufactured by WET Labs and an anti-biofouling shutter with the parking depth of 40 dbar and 5-day cycle, 4 APEXs having a Sea-Bird oxygen sensor and an ECO FLNTU with 3-day cycle, and an APEX with an AANDERAA oxygen sensor with 3-day cycle), one APEX float is active at the end of January 2011. All the FLNTUs except one on the NINJA failed after 3-26 profiles as reported last year. Two APEXs recovered in 2008 have been repaired, equipped with a new sensor, ECO FLbb-AP (Combination Fluorometer-Scattering Sensor) and ready for redeployment in 2011.

### 1.2 Technical problems encountered and solved

Last year JAMSTEC purchased 73 PROVOR floats, which was planned to be deployed in 2010. However, several problems were found in almost all the floats, namely, unsatisfied accuracy of conductivity sensor, deep scratch on a float body, oil bladder trouble, and data acquisition trouble. In June, all the floats except for 5 already deployed were recalled by the manufacturer. Because of a lack of deployable JAMSTEC floats until the end of summer in 2010, when the floats purchased this year were delivered, the number of active Japanese float has been decreased. Regarding the recalled floats, the causes of most of the problems were identified by late 2010 and all the floats will be fixed and sent back to JAMSTEC by the end of March 2011, after large effort in discussion among and investigation by NKE, SBE and JAMSTEC.

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, 3 floats have the extreme negative surface pressure drift, exceeding -10 dbar. The floats repaired and sent back or those purchased after the problem was fixed have either a Kistler pressure or a Druck pressure sensor. The Kistler sensors show slight positive drift smaller than 1dbar; the Druck sensors show no drift.

Tsurumi Seiki Co. and JAMSTEC are developing a new profiling float for deep ocean, Deep NINJA, which has an ability to measure PTS profiles at the depth of up to 4000 dbar. We are planning the first field test in the southeast of Japan this year.

### 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 275 active floats as of January 17, 2011. Nine Japanese PIs agree to provide data to the international Argo. All profiles from those floats are transmitted to GDACs in netCDF format and issued to GTS using TESAC and BUFR code 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 71,089 profiles to GDACs as of January 2011. Among these data, 20,277 profiles were provided within a year. JAMSTEC has continued the operation of delayed-mode QC for the floats of Japanese PIs other than JAMSTEC. The remaining backlog of about 24,000 profiles will be cleared by this operation.

At the 11$^{th}$ Argo Data Management Meeting, the definition of APEX Truncated Negative Pressure Drift (TNPD) was decided. In according to the new definition of APEX TNPD, JAMSTEC updated processing program and is now re-creating D files of target 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 continued the operation until FY2008 nearly in the same scale (about 80 floats to be deployed every year) under its mid-term program. While new mid-term program for FY2009-2013 started in April 2009, JAMSTEC has been trying to continue the operation nearly in the same scale as part of its research activity. 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 FY2011, it has been proposed that JAMSTEC will deploy about 70 floats in total in the Pacific, Indian, and Southern Oceans for the Argo core mission. Twenty five Argo equivalent floats with dissolved oxygen sensor Optode3830 will be deployed near 30N 145E in June 2011 as part of Western North Pacific Integrated Physical-Biogeochemical Ocean Observation Experiment (INBOX). One POPS is planned to be deployed as an Argo equivalent float near the North Pole in April 2011. One NEMO float is planned to be deployed also as an Argo Equivalent float in the tropical Indian Ocean in 2011 as part of CINDY2011. JMA will deploy 27 Argo equivalent floats around Japan in FY2011 and in the coming years. All the JMA floats are same with Core Argo floats but in 5day cycle, which is identical with real time model cycle. Tohoku University will deploy 3 Argo equivalent floats equipped in or near the Kuroshio Extension region.

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 forecasts 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) and 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). 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. JAMSTEC is now upgrading the site which provides the float monitoring information and the upgraded site will be open soon. New Google Earth application has been created by Argo Information Center (AIC) and JAMSTEC. The application can show the recent location of Argo floats and various information of each float. JAMSTEC has created contents which show profile plot for not only Japanese floats but also all the Argo floats (Fig. 3).

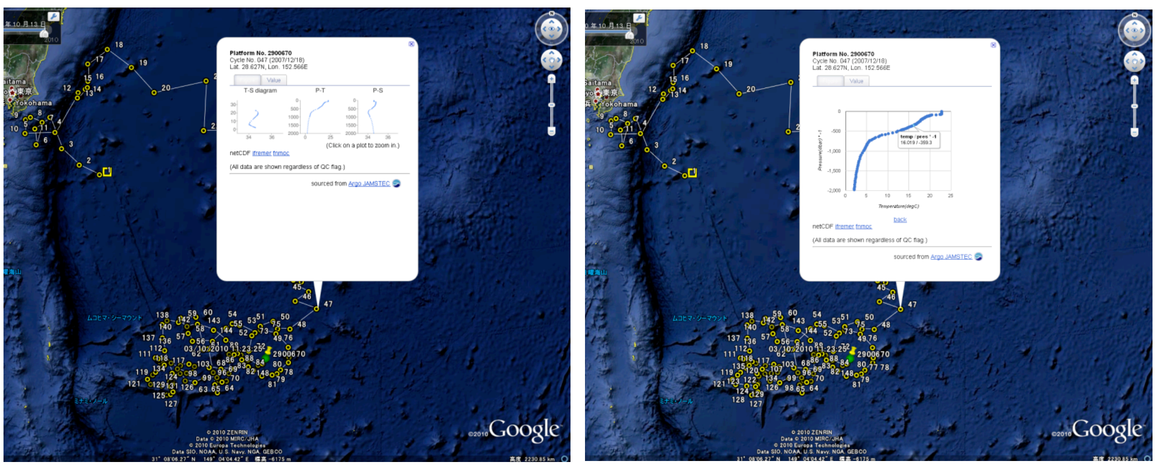


Figure 3. Display of trajectory and profile of Argo float on the Google Earth.

Based upon the accomplishment of the JAMSTEC research project "Japan Coastal Ocean Predictability Experiment (JCOPE)", Forecast Ocean Plus, INC (FOP) was established as a JAMSTEC venture in March 2009. FOP has been providing the ocean current forecast information over the global ocean based on the state of the art ocean models, including real time forecasts for the shipping companies, offshore industries, coastal engineering works, and the weather information company. Argo is one of important sources of in-situ data for the FOP data assimilation system.

Following the accomplishment of the FRA-JAMSTEC joint research project "A new operational ocean prediction system with hydrographic data of coastal repeated observation lines and its linkage for ecosystem problems", FRA has been operating the ocean prediction system FRA-JCOPE since 2007. FRA-JCOPE has been providing the hydrographic forecast information around Japan both to the fisheries research/management community and the general public. Argo is one of important sources of in-situ data for the FRA-JCOPE data assimilation system.

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

Data of 631 CTD casts conducted by JMA in the western North Pacific from autumn 2009 to winter 2010 were uploaded to the CCHDO website.

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# National Report on Argo-2010

**by Republic of Korea**

## Deployment in 2010 and Future Plan

National Institute of Meteorological Research of Korea Meteorological Administration (METRI/KMA) and Korea Ocean Research and Development Institute (KORDI) are involved in the International Argo Program since 2001. In 2010, METRI/KMA deployed total of 12 floats in the East/Japan Sea (8 floats) and southwestern region of Kamchatka peninsula (4 floats).

Total 14 floats will be deployed in the Northwestern Pacific Ocean (6 floats) and the East/Japan Sea (8 floats) in 2011. METRI/KMA has also a plan to deploy 15 floats (one float with DO sensor) in 2012. It is expected that METRI is able to secure funding to maintain the current level of float launch for the next several years. KORDI's strategy regarding the Argo program is under revised in terms of contribution toward the global ocean observation.

## Status of Argo data management

METRI's RTQC Argo data with TESAC and NetCDF format are transmitted thru GTS network and GDAC, respectively. Currently, we distribute the pressure-corrected profile data, and SP is given in the technical file. We also have a plan to transmit Bufr-formatted message this year using the perl program developed by Japan.

National Fisheries Research and Development Institute (NFRDI)/Korea Oceanographic Data Center (KODC) is responsible for Delayed Mode QC (DMQC). KODC has been preparing algorithms for the renewal of Korean DMQC data including KORDI's data in line with new version of Argo QC manual. This work will be finished by the end of this March, and thereafter Korean DMQC data will be provided normally.

## Research and operational uses of Argo data

METRI/KMA has a three-year plan to develop the operational ocean forecasting system for the global ocean. We will develop an OI-based ocean data assimilation system using NEMO ocean model in 2011. Also, we have started to generate reanalysis fields for the East/Japan Sea since 2010, and we will perform observing system experiments to investigate the impact of Argo data for the reanalysis fields in the East/Japan Sea, where Argo observation is the most dense region in the world ocean. We confirm that the Argo data are very effective to improve modeled ocean fields, based on the comparison with the surface velocity from drifter buoy (see Figure 1 and 2).

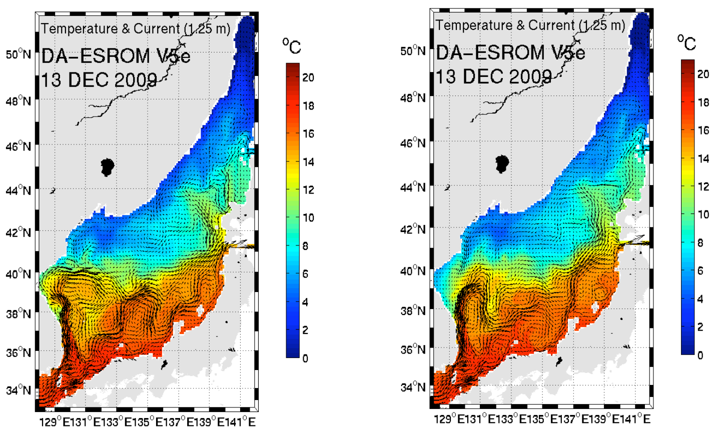


**Figure 1** Comparison of surface temperature and velocity distributions between model results assimilated with SST, SSH, temperature profiles including Argo (left panel) and No-Argo data (right panel).

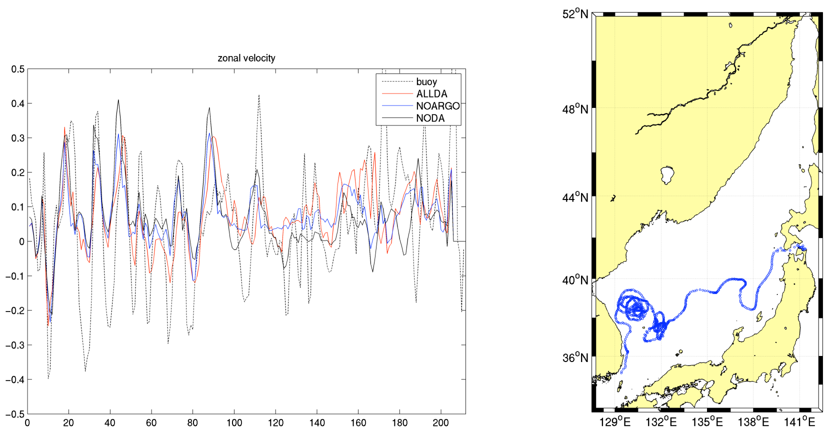


**Figure 2** Time variation of surface velocity at 15 m depth (zonal component). Black dot line indicates velocity of surface drifter (see its

trajectory at right panel). Red and blue solid lines show the model results assimilated with all data (including Argo) and withheld Argo data along the trajectory, respectively.

Also, KORDI uses Argo data for scientific research and a data assimilating-model to understand circulation in East/Japan Sea. Researches on the variability of heat content in the mixed layer, data assimilation and other application for ocean modeling are actively carried out by several universities in Korea.

The float of WMO_Id 3900197 made its first profile at the Drake Passage on 4th December 2003, and it is working for more than 7 years following the ACC somehow, which covers about 60 % of a whole ACC system (Figure 3). We have its last profile on 16 January 2011 with heading as below.

02096 042558 73 31 K 3 2011-01-16 08:10:04 -38.560 147.479 ….

It looks like it is already ashore or dead. Its last position is (-38.560 N, 147.479 E), of very shallow profile about 40m.

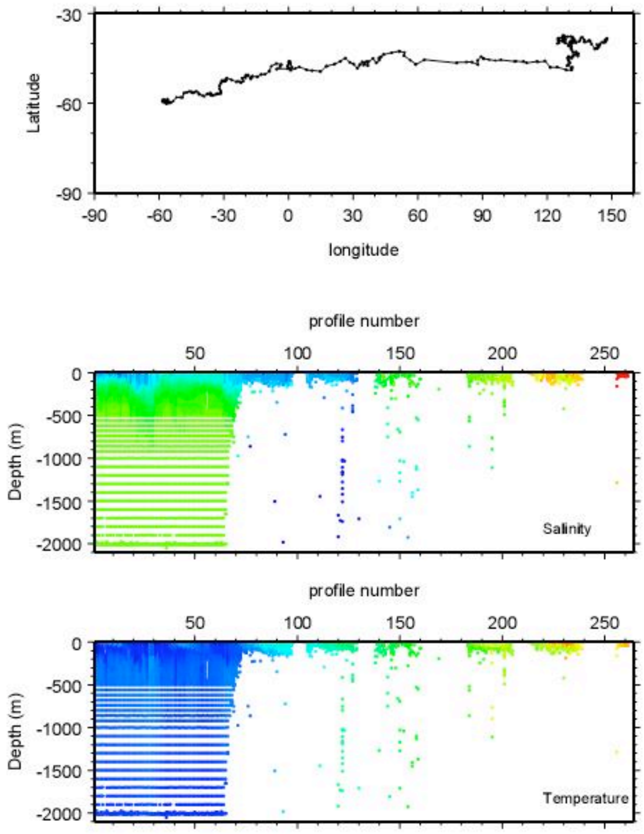


**Figure 3** Trajectory (upper panel) and time-plots of salinity (middle) and temperature (lower) obtained from the float deployed at Drake Passage (WMO ID 3900197).

# New Zealand National Report March 2011

NIWA is the New Zealand participant in Argo. NIWA has purchased 2 floats per year since 2001, with no floats being purchased in 2003 because of float availability. We have also deployed floats for other providers and are collaborating on large deployments by contributing towards vessel costs.

**New Zealand's floats**

NIWA has purchased 20 floats and deployed 18 floats to date. Purchases and deployments are likely to continue at the 2 floats/year level.

Information on the New Zealand floats, designated (WMO#) 2039 (5900106), 2042 (5900109), 2137 (5900205), 2138 (5900206), 2331 (5900631), 2332 (5900632), 2463 (5901028), 2547 (5901227), 2555 (5901239), 2585 (5901271), 2693 (5901763), 2659 (5901804), 2739 (5901843), 2750 (5901853), 2859 (5902224), 2860 (5902225), 2872 (5903332) and 2873 (5903333) can be found at: http://sio-argo.ucsd.edu/weqpac_web.html.

The data from the NZ floats are administered by Scripps Institution of Oceanography and are available on the Argo Global Data Assembly Centers (GDACS).

**Providing deployment opportunities**

NIWA has provided deployment opportunities for other nation's floats in the southwest Pacific and Southern Ocean. This is a very important contribution to Argo, given that these regions had poor float coverage and limited deployment opportunities from commercial vessels.

In an ongoing collaboration, NIWA is funding 15% of the vessel costs of R/V Kaharoa deploying floats for University of Washington and Scripps Institution of Oceanography. CSIRO (Australia) has now joined this collaboration.

NIWA's larger research vessel, R/V Tangaroa has also deployed floats in the southern ocean, both as part of the same collaboration and opportunistically when other research takes place in the southern ocean.

These voyages, dating back to 2004 have deployed around 850 floats, primarily in the South Pacific but also in the eastern Tropical Pacific and Indian oceans.

Additional R/V Kaharoa deployment voyages are in planning stages.

Finally, NIWA is also available to facilitate float deployments being mobilized out of New Zealand ports.

# Status of Argo Norway, Feb-2011

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

## 1. The status of implementation

At present we have in total purchased and deployed 15 floats, all in the Norwegian Sea. Three floats were deployed in 2002, six floats in 2003, two floats in 2006 that included oxygen and fluorescence sensors, and four floats in 2010 that also included oxygen and fluorescence sensors. All floats are APEX floats and the latest four deployed floats have Iridium telemetry. The floats with additional sensors have so far performed well.

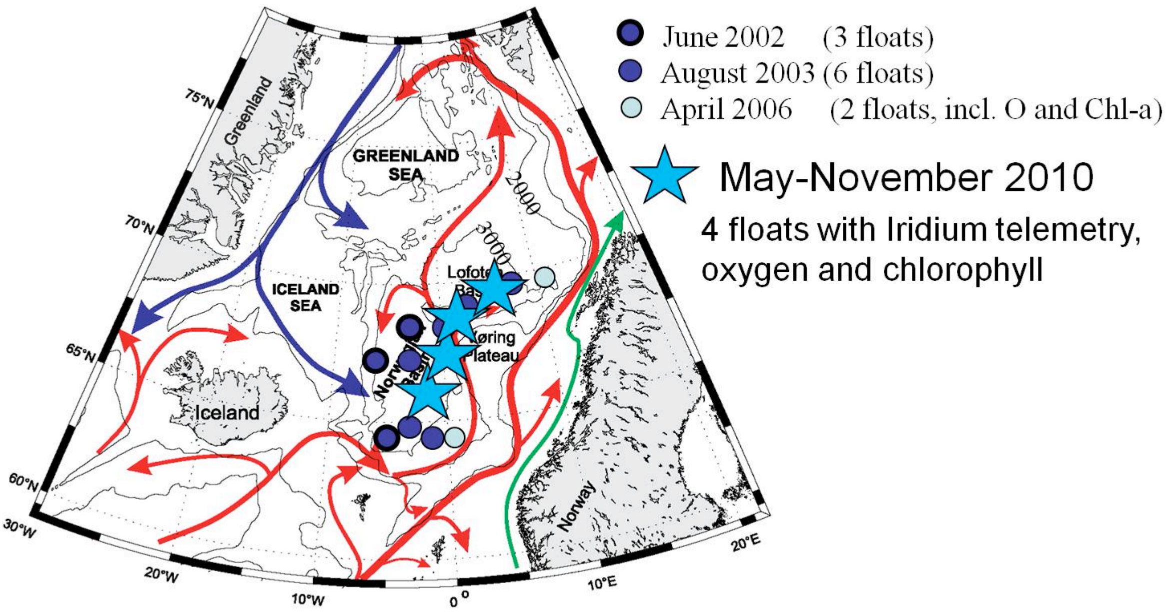


Figure. Locations of all Argo deployments from Argo Norway.

### Delayed mode

Regarding the "Delayed mode" the Argo German do delayed mode quality control for all floats in the Nordic Seas including our floats.

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

The funding has so far been self-financed (i.e. funded by our institute). The total float purchase has cost about 260kEURO. There are not devoted any funding for scientific analysis, but some persons are partly working with the Argo floats regarding data collection and management. The scientific analysis is done in other external financed projects.

In 2010, IMR received funding from the IMR's annual budget for purchasing of four floats with oxygen and fluorescence sensors. These floats were all deployed in the Norwegian Sea during 2010.

In October 2010, IMR submitted a proposal to the Norwegian Research Council (NRC, Ministry of Education and Research) for long-term funding of Argo floats and to be a full member of the Euro-Argo European Research Infrastructure Consortium (ERIC). The proposal has a target of purchasing and deploying eight floats per year over five years. An answer from the NRC is expected during the spring 2011.

## 3. Summary of deployment plans

At present we have no deployment plans due to lack of funding.

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

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

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

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

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

At the moment we have no suggestion.

# South African Argo Report

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South Africa has not purchased any further Argo floats but remains active and committed to the Argo program through deployment of floats and also outreach programs. There is a certain amount of commitment to become more actively involved in the next 5 years. Argo floats remain a line item on the budget, but as yet funding has not been approved. Thus instead of the national report template requested, please find below a detail of current marine activities of relevance to Argo.

**SAEON – South African Environmental Observation Network,**
**Juliet@saeon.ac.za**

Initiated the purchase of the first South African owned Argo floats in 2009, along with funding from the South African National Antarctic Program. SAEON provided all logistics and maintained support for the two floats. Additional floats remain on the budget each year but have not been given priority.

The Argo float program and data remains the key focus of the education program.

**DEA OC – Department of Environmental Affairs, Oceans and Coasts,**
**ajohnson@dea.gov.za, cc oceangeoff@iafrica.com**

DEA Oceans and Coasts has a mandate involving ocean research, with one focus on operational oceanography. As a new government department, funding for Argo will be seriously assessed and it is anticipated that within the next 5 years DEA_O&C will contemplate investing in Argo floats. Numerous Argo floats have already been deployed by DEA staff on South African vessels as part of international efforts, and this support for Argo will continue where possible.

**SAWS – South African Weather Service,**
**johan.stander@weathersa.co.za**

SAWS is the official mandated Government organisation with regards to Argo. SA focus on marine meteorology and oceanography has changed significantly to such an extent that one of the Government Department's sole mandate involves ocean research, with one focus on operational oceanography. For this reason Johan works closely with key oceanographers (in particular Juliet Hermes, SAEON, Isabelle Ansorge, UCT and Mike Roberts, DEA_OC) to support Argo and other operational oceanography. As such, Juliet was nominated by Johan to attend the Argo meeting.

**UCT - University of Cape Town,**
**Chris.Reason@uct.ac.za, Isabelle.Ansorge@uct.ac.za**

Remains the key oceanographic research and teaching organisation in SubSaharan Africa and continues to do research in the science underpinning operational activities, collaborating with operational organisations like SAWS and DEA_OC in helping SA to contribute towards operational global efforts like Argo.

UCT also hosts the Nansen-Tutu centre where we are working towards ocean state estimation in the ocean regions neighbouring SA in collaboration with NERSC in Bergen and other local and international institutions (see OceanSAfrica).

Students and postdocs often go on cruises and help with the deployment of Argo and surface drifters for operational purposes

**OceanSAfrica,**
**Bjorn.backeberg@uct.ac.za, jennifer.veitch@uct.ac.za,**
**Mike Roberts squid@metroweb.co.za**
Predominantly a network driven from the bottom-up to grow and support operational oceanography in South Africa. Members of all marine organisations sit on the technical task group. At present Argo is not being used, however it is recognised as being necessary for model validation and assimilation as we require more information about the ocean interior to properly assess and "tune" our models. The data is integral in the development of ocean model simulations that will eventually be run in nowcast and forecast mode. There is also the aspect of ground truthing satellite observations and developing 3-d ocean monitoring aspects combining proxies derived from vertical profiles and relating these to surface expressions observed from satellite platforms.

**ACEP and ASCLME - African Coelacanth Ecosystems Program and Agulhas Somali Current Large Marine Ecosystem, tommy.bornman@asclme.org**
Support the Argo program, primarily from deployment of Argo floats through NOAA, ongoing cruises in the SW Indian Ocean.

**CSIR, SOCO - Centre for Scientific and Industrial Research and Southern Ocean Carbon Observations, sbernard@csir.co.za, PMonteir@csir.co.za**
Input to the IOCCG Bio-Argo WG, *http://www.ioccg.org/groups/argo.html* of which the last draft report is currently being edited and the final report should be produced within the next few months.
Currently concentrating on gliders (6 - 8) starting this year and only go for design-specific (eg; bioArgo) floats in the context of seasonal and multi-year experiments in about 2013 or 2014. Our gliders will concentrate on regular missions in the upper water column 0-1000m between 40 - 50oS & 40W - 40E for a period of 3 - 5 years over the spring - autumn period. There will be periodic adhoc missions around experiments and process observations.

**ACCESS – Applied Centre for Climate and Earth System Science,**
**nsweijd@access.ac.za**
Newly formed Centre of Excellence (funded by the Department of Science and Technology) to support the Governments Global Change Grand Challenge and focus on capacity building of graduates as well as acting as a platform for Earth System Science Research. There is no involvement in Argo yet, but potentially in future.

**SADCO – Southern African Data Centre for Oceanography,**
**mgrundli@csir.co.za, cc RvBalleg@csir.co.za**
From here there is access to all validated CTD data collected in the southern African region. When Argo floats pass through SADCO target area, delayed mode data is loaded and available through SADCO.

# South African Environmental Observation Network (SAEON) report on Argo floats from 2010

## 1 Description of Research Work

### 1. Introduction

The importance of the Southern Ocean with regards to our weather and climate, as well as global change, has recently been identified, yet observations in this region (especially south of South Africa) are sparse. The Southern Annular Mode is becoming increasingly topical and measurements from programs such as Argo will prove invaluable to its understanding. Argo plays a crucial role in monitoring climate change signals in the oceans and also in long range climate prediction (30 days to 2 years). Argo is capable of monitoring signals on intraseasonal and longer scales.

Argo floats allow continuous monitoring of the temperature, salinity, and velocity of the upper ocean, with all data being relayed and made publicly available within hours after collection. Unlike satellites, Agro floats are able to measure subsurface ocean variables. These measurements are essential because the ocean's upper layers can store 1,000 times more heat than the atmosphere does. Changes in subsurface currents, temperature, and salinity eventually change conditions at the surface, where the ocean interfaces with the atmosphere. Such data is necessary to improve our understanding of both long term anthropogenic climate change and natural modes of variability in the oceans. This will benefit not just researchers but also governments, policy makers and industries. Argo data provides a vital input for ocean models which will lead to a more accurate prediction of the ocean state and how it will change over time and with different forcing. Recent work has shown the importance of Argo float data for realistic model assimilations (Oke and Schiller[*]).

### 2. SAEON involvement

Obtaining South African owned Argo floats is of importance primarily because the oceans surrounding South Africa are sparse of observations and floats. Another important reason behind funding an Argo float is to enable South Africa (SAEON and SANAP) to be more involved in the Argo project by being recognized on the Argo website, increasing South Africa's scientific capabilities internationally.

SAEON has led this project from the beginning, instigating the initial funding and motivation to SANAP. SAEON also provided all of the support to purchase and import the floats and then worked closely with UCT and SANAP to deploy them.

A final, minor yet important, aspect to deploying South African owned Argo floats, is the possible use of the program in education. For example, school children would be able to track the South African float, download the data and manipulate it.

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[*] P. R. Oke and A Schiller, 2007: Impact of Argo, SST, and altimeter data on an eddy-resolving ocean reanalysis. Geophysical Research Letters, 34, L19601, doi:10.1029/2007GL031549.

## 3. Progress to date

The logistics of setting up the South African Argo programme were varied and proved challenging at times but with the help of the French and South African teams, these challenges were overcome. The South African science and support vessel, the *SA Agulhas*, was the platform from which the floats were deployed. Scientists from SAEON and UCT decided that the floats would be deployed at specific locations, along the ship's course, coinciding with interesting ocean features. The deployment of the two floats occurred at 41°S, 10°E, within an ocean eddy and ~60°S, at the Antarctic Polar Front, as planned. Young researchers and students were trained, by Dr Isabelle Ansorge of UCT, in the techniques of deployment of the floats and they successfully completed the launching of the two floats from the SA Agulhas.

Since purchasing and deploying the floats, South Africa has been welcomed into the Argo community, invited to sit on the Argo steering Committee and a representative from the South African Weather Services will be attending the steering committee meeting in Scripts, California at the end of March.

SAEON Egagasini's education officer, Thomas Mtontsi, has been actively engaging with educators to develop the scope of how the Argo floats are able to aid and expand science education. He organized an educators' workshop, where he invited Dr Isabelle Ansorge to present information about Argo floats and their impact on the understanding of the world's oceans and climate. He has also made strong links with the Argo education community, specifically with Lisa Beal from the Rosenstiel School of Marine and Atmospheric science, and these will be taken forward in the upcoming weeks. Furthermore, a move to design an educational poster for learners is underway and will be created to stimulate science learning and education.

The data that has been collected by the South African floats can be viewed online. Data from the floats (identity numbers 1901470 and 1901469) can be viewed and downloaded at the following website http://www.coriolis.eu.org/cdc/ and the ftp site ftp://ftp.ifremer.fr/ifremer/argo/dac/coriolis/.

## 2 Expected Impacts

The data collected by these Argo floats will feed into a network of floats around the world and add to the data being used to research the world's ocean systems. Dr Sebastian Swart is one of the South African scientists who used Argo data in his PhD research. Dr Swart's focus was on the Southern Ocean heat and salt fluxes, an area which has many unanswered questions. With the help of Argo data he was able to add new understanding to this topic. South African and international research being conducted south of South Africa and in the Southern Ocean region will benefit from the deployment of these floats as they provide more observations in a data poor area. Scientists, Oke & Schiller (2007), from the Commonwealth Scientific and Industrial Research Organization of Australia (CSIRO) have shown that Argo drifter paths play a vital role in the re-analysis and forecasting of meso-scale ocean systems. The addition of the Argo drifter paths to the model creates a significantly more accurate representation of the ocean system.

Argo floats will assist in the development of the understanding of the importance of long term monitoring of the oceans, specifically with the public and learners. Argo floats generate excitement and curiosity and thus aid bringing the public and learners closer to scientific research. Furthermore, the involvement of South Africa in the Argo programme also brings exposure and recognition for our local scientists to the international scientific community.

## 3 Research team

SAEON, SANAP and UCT.

## 4 Additional Information

This project has been endorsed and received feedback from a number of scientific stakeholders and organizations: South African Weather Services, (SAWS) University of Cape Town (UCT), the South African Weather Service and Climate Variability Africa (CLIVAR Africa).

Photo 1 Argo float being held just before it is deployed off a ship

Photo 2 Students aboard a research vessel learn about the marine environment from a marine scientist.

# ARGO National Report 2011 – Spain

## *1.- Status of implementation*

The Argo-Spain program is coordinated by the *Instituto Español de Oceanografía* (Spanish Oceanographic Institute, IEO).
It started with the deployment of 7 floats in the Iberian Basin in 2003. Since then, 43 have been deployed, 14 of which are still working correctly.

Additionally, the Argo-Spain program gives support to research groups in Spain that purchase Argo profilers as part of the observational strategy of their research projects.

During 2010, eight profilers were deployed in in the Iberian Basin, Tropical Atlantic and South Atlantic. Three of the profilers had oxygen sensors.

Delayed mode calibration is underway.

IEO is involved in EuroArgo and Spain has decided to join a European Argo consortium that will establish in 2012.

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

When the Spanish participating in the Euro-Argo consortium was evaluated, and observational strategy consisting in a fleet of approximate 20 floats was established. Given a lifetime of about 4 years for a float this means purchase of about five floats per year. This level of funding is actually renewed on a yearly basic, however since Spain will join the Euro-Argo contribution it is planned that the funding will be semi-permanent in the budget of the IEO.

One person (Pedro Vélez) is working on Argo-España.

## ***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).

**2011.**
- 10 floats will be deployed in the subtropical Atlantic along the parallel 24.5ºN.
- 7 floats will be deployed in the western Mediterranean.

**2012**
- 5/6 floats will be deployed in the tropical Atlantic.

The deployment plans are properly uploaded to the Argo information Centre, at least, 6 month in advance.

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

Argo data is used in several research projects in Spain. published results are update in the Argo Bibliography web page of the AST.

Regarding the operational uses, the Argo data is not yet used.

### *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*

At most of the Argo-Spain deployments, a CTD profile is carried out. The upload o the CCHDO is underway.

# UK ARGO PROGRAMME

## REPORT FOR ARGO STEERING TEAM 12TH MEETING, MARCH 2011

The UK Argo programme is undertaken by a partnership between the Met Office (who manage the programme), the National Oceanography Centre Southampton (NOCS) and the British Oceanographic Data Centre (BODC).

The most pressing issue for the UK programme remains on securing continuing and ongoing funding for UK Argo and internationally on ensuring the long-term delivery of data from the global 3,000 float Argo array.

### Floats deployed and their performance

Floats deployed. Since 2001, over 315 floats have been deployed (including 5 floats donated to Mauritius) in support of the Argo array since January 2001. Of these 23 floats have been Argo-equivalent floats as they have been procured using research grants rather than from designated UK Argo funding. As can be seen from the figures below the number of floats purchased each year has been very variable, often due to funding being supplemented by end-of-year under-spend monies. As a result, the number of deployments each year has also been rather variable. In 2010 we had hoped to deploy around 40 floats but actually only deployed 25 floats, this being due to funding issues that were not resolved until end 2010. As can be seen funding for floats (as opposed to personnel effort) has not been a problem and we presently have over 100 floats available for deployment.

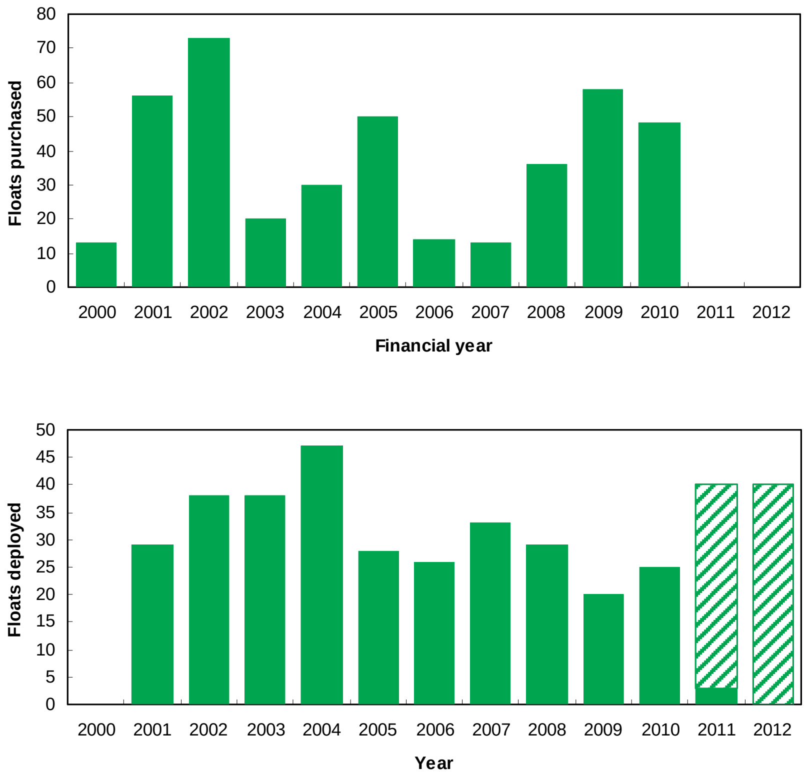


*Figure 1. Showing (top) the number of floats procured each financial year (Apr-Mar) and (bottom) deployed in each calendar year.*

At the end of February 2011 the Argo Information Centre listed 109 active UK floats (as shown below in red) contributing to the global Argo array, plus 2 active floats (shown in blue) that were provided to Mauritius and deployed by them in 2006.

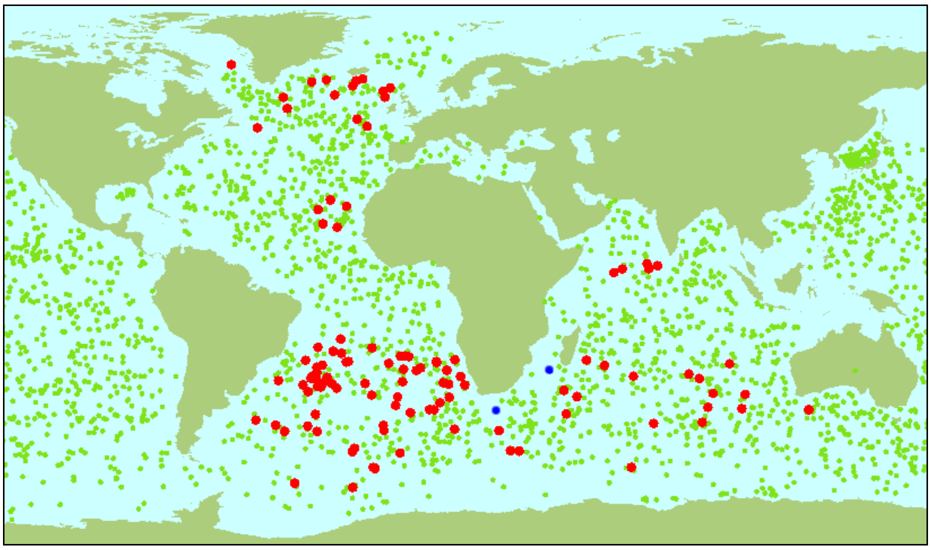

*Figure 2. Showing the locations of operating UK floats (in red) and the two surviving Mauritian floats (in blue) at end February 2011.*

Float performance. However, despite the lower number of floats deployed in the last 6 years, the number of operating floats still appears to be on an upward trajectory due to improved reliability and lifetime, as shown in Figure 3 below.

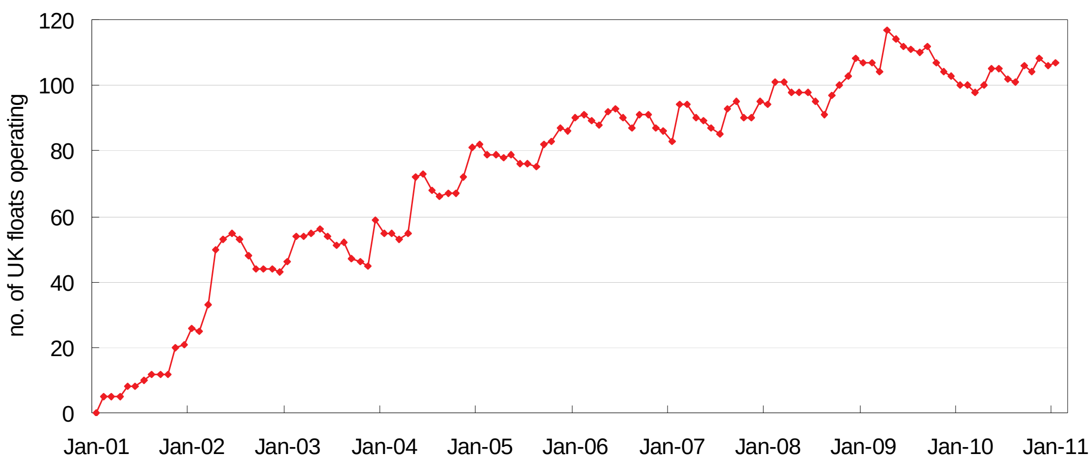


*Figure 3. Number of active UK floats contributing to Argo by month.*

There has been a distinct improvement in the survival of our Apex floats deployed since 2004 compared to those deployed in the earlier years in terms of cycles completed (normalised to 2,000m for floats that make shallower profiles or only profile to 2,000m intermittently, with invalid cycles due to pressure transducer failure discounted and deployment failures omitted), as shown in Figure 4.

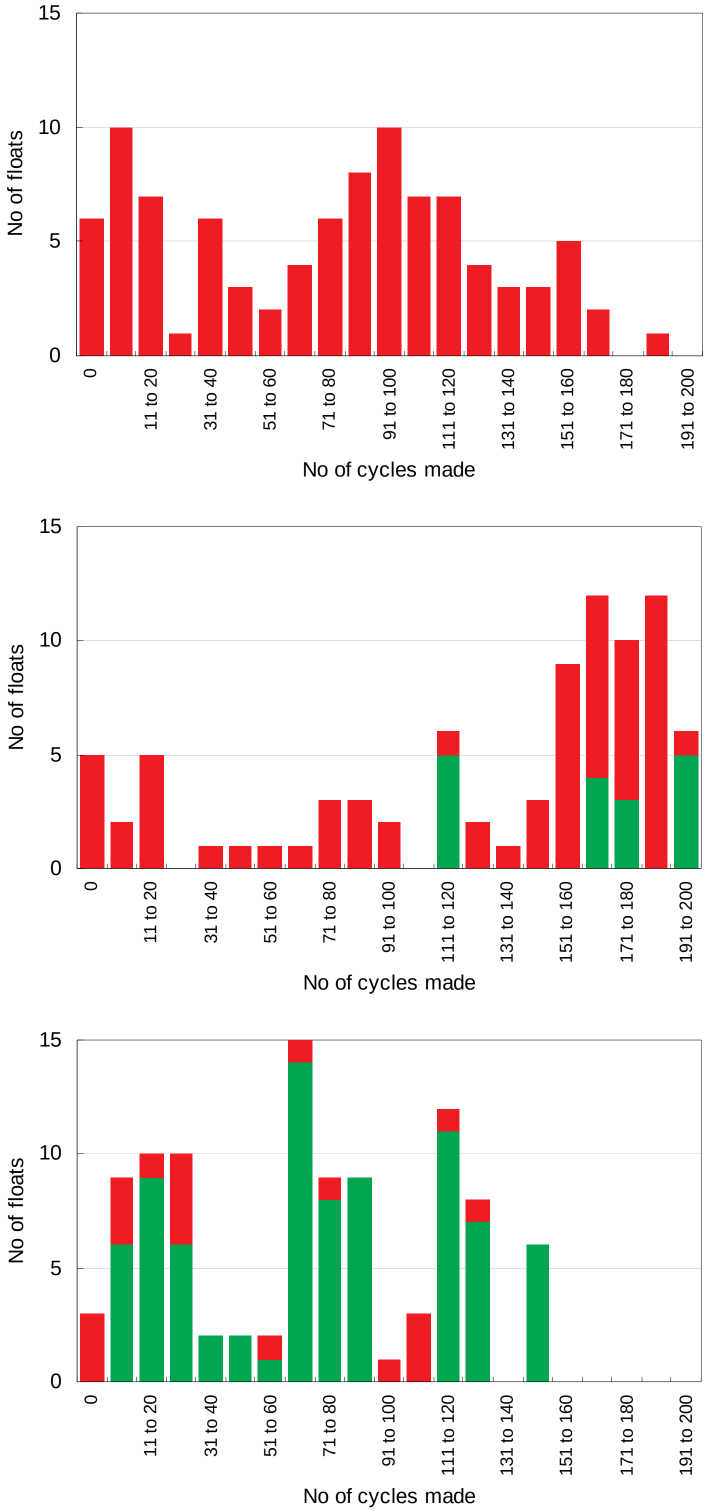


*Figure 4. Number of (normalised) cycles made by UK Apex floats deployed in 2001-2003 (top), 2004-2006 (centre) and 2007-2010 (bottom). Operating floats are shown in green, with dead/failed floats in red.*

Only 30-40% of floats deployed before 2004 made more than 100 cycles. However, for floats deployed between 2004 and 2006 around 72% of floats exceeded the 110 cycle mark. This performance is also likely to be achieved for those floats deployed since 2007.

Float enhancements. In 2007 we deployed our first 14 Apex floats with lithium batteries and have now deployed 39 such floats with lithiums. 4 of the first 14 floats failed early: 1 on deployment and 1 after 29 cycles (suspected failure due to a slow water leak), the 2 other early failures were after 21 cycles and almost certainly due to damage from Antarctic ice. Since then another 2 have stopped after 101 cycles (nearly 3 years operation) again almost certainly due to Antarctic ice damage. In 2008 we deployed another 14 floats with lithiums, 1 failed early after 3 cycles and 1 stopped after 2 years (77 cycles), the other 12 are all working normally. In 2009 and 2010 we deployed 11 floats with lithiums, with 10 working normally, the other failed on deployment. At this stage it is too early to demonstrate extended longevity from fitting lithium batteries (although data from University of Washington floats does show an extended average lifetime should be expected).

Following the early float losses to ice damage in 2007, from 2008 all new Southern Ocean floats considered at risk of ice have been specified with ice-avoidance capability. So far 11 floats with ice-avoidance have been deployed and none have failed due to ice damage.

From 2008 all our new Apex floats have been with the newer apf9 controller, although we still have 4 older apf8 floats awaiting deployment.

In 2008 our first 2 Apex floats with near surface temperature measurement capability (un-pumped measurements) were deployed, with another 4 deployed in 2009 and 12 in 2010 (plus another 2 in Jan 2011). All are working normally at present. All those floats (apart from those with ice-avoidance) ordered in 2009 and 2010 have this capability as standard. As yet only an initial evaluation (June 2010) of the data has been made, with 2 of the floats clearly measuring marked near surface warm layers that would otherwise be unobserved.

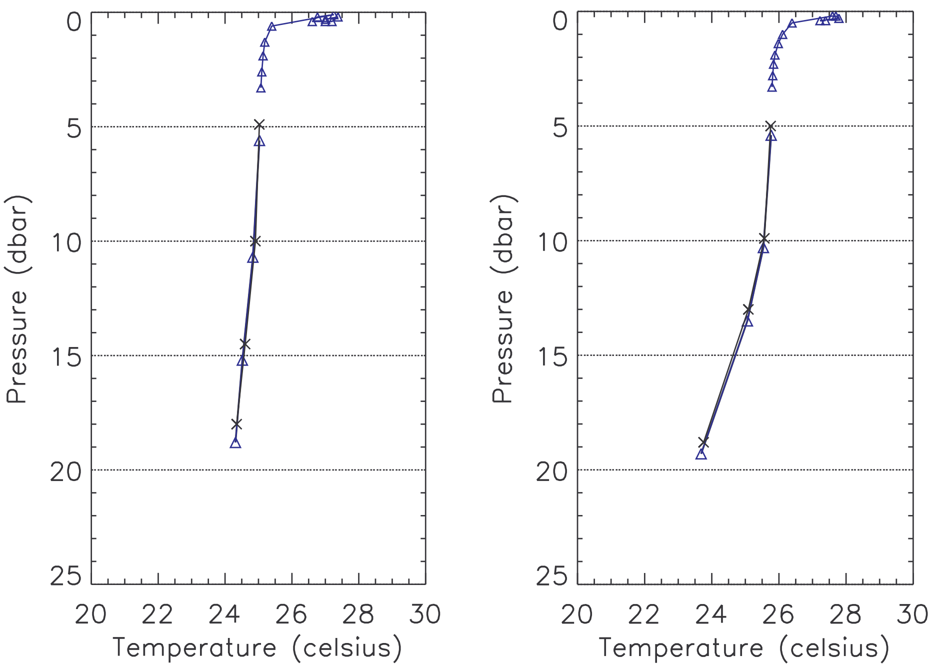


*Figure 5. Temperature profiles showing the corresponding pumped and non-pumped measurements and the non-pumped near-surface measurements (pumped measurements in black with crosses and non-pumped measurements in blue with triangles) for (left) float 1901072 on 20/12/2008 15:51 GMT and (right) float 1901073 on 10/1/2009 15:31 GMT.*

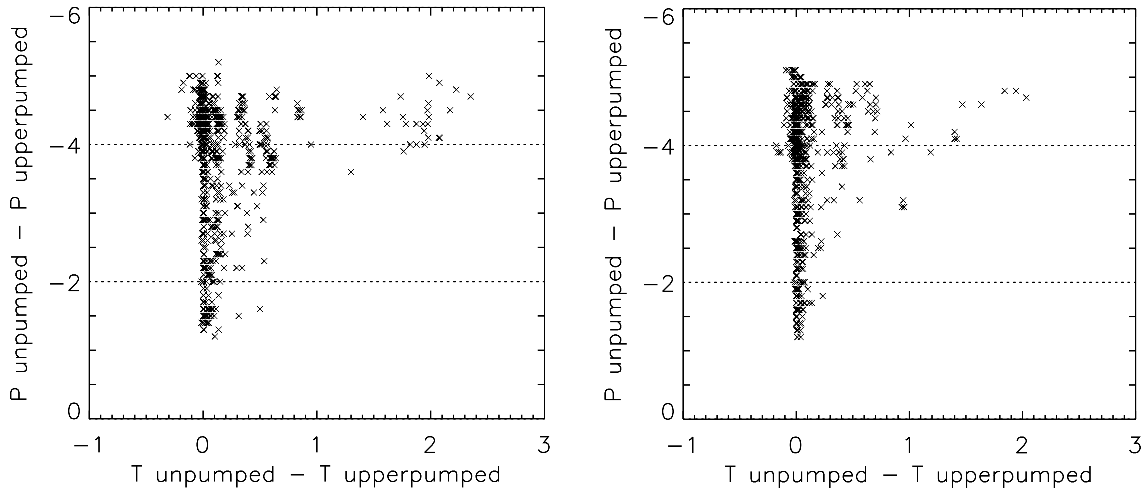


*Figure 6. For float 1901072 (left) and 1901073 (right) non-pumped minus the uppermost pumped temperature differences showing the existence of temperatures up to 2.5 ℃ warmer than the uppermost pumped temperature (at nominally 4 or 5m depth).*

Examination of these data has revealed one float (1901243) where the un-pumped temperatures were consistently warmer than the pumped temperatures (at the same depths). These data were referred to Dana Swift at the University of Washington who has suggested it is a problem with the electronics and the same cause as "pressure divergence" errors in SBE41s where reported pressures can differ depending on whether they are P-only sample-requests or STP-sample requests.

Technical/engineering web-site. We have established a partnership with CSIRO, Australia to develop an engineering web-site for UK and Australian Apex floats (see http://www.cmar.csiro.au/argo/) enabling the performance of deployed UK (and Australian) Apex floats to be monitored and assisting failure cause diagnosis. However the web-site is presently inoperable and this needs to be discussed with CSIRO.

BODC are currently developing a UK Argo website which will bring together much of the Argo information spread across multiple UK sites. The need for the site came out of the UK Argo user group meeting in spring 2010. This will likely include a technical monitoring section so additional detailed technical information is more accessible.

**Deployment plans for 2011 and 2012**

As at the end of Feb 2011 we have over 100 Apex floats available for deployment for the coming years. Proposed deployments for 2011 are shown in Table 1, with further deployments in 2011 still to be arranged.

Our aspiration is to make between 35 to 45 deployments in 2011 and maintain this level into 2012 and 2013, however achieving this will be subject to adequate funding to cover the personnel time involved in planning and arranging deployments.

| Proposed deployments | |
|---|---|
| 2 Apex for Mauritius | March 2011 |
| 4 Apex for north-east Atlantic (Iceland Basin/Rockall Trough) | May 2011 (RRS Discovery) |
| 6 Apex for south-east Atlantic (~36S) | Sept 2011 (SA Agulhas) |
| 6 Apex for South Atlantic(~15S) | AMT cruise autumn 2011 |
| 2 Apex for Mauritius | Autumn 2011 |
| 6 Apex for Drake Passage | Autumn/Winter 2011 |
| Other floats available for deployment | |
| 6 Apex for Mauritius | |
| 5 Apex for north-east Atlantic (Iceland Basin/Rockall Trough) | |
| 15 Apex for Arabian Sea | |
| 12 Apex for Somali Basin | |
| 6 Apex for South Indian Ocean (~40S) | |
| 13 Apex for North Atlantic (~26N) | |
| 11 Apex for Southern Ocean | |
| 5 Apex for the south-east Atlantic | |
| 5 Apex for the South Atlantic (~15S) | |

*Table 1. Floats available for deployment.*

**Data management**

The UK Argo Data Centre, established at BODC, processes all our float data (including the floats donated to Mauritius and also floats for the Irish Argo programme).

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. 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 and these files are provided to CSIRO Marine to populate the technical web-site.

Delayed-mode. Delayed-mode processing is carried out by BODC using the OW software and the CTD_for_DMQC_V1 and ARGO_for_DMQC_V02 reference datasets. Reference data are updated when new versions are available. During the summer of 2010 the backlog in DMQC of BODC hosted (Argo UK, Ireland, Mauritius, Saudi Arabia) Argo profiles was cleared. As of February 2011, 99.8% of eligible BODC profiles (profiles older than one year) had been submitted to the GDACs in delayed mode. This equates to 90.0% of BODC hosted profiles.

Work in 2010 included the following improvements to the BODC data system and delayed-mode data files:

- The resolution of existing format errors identified by John Gilson's format checker. A format checker has not currently been implemented at the DAC level meaning a few profiles that fail the checks get to the GDACs. It is hoped that that this check can be introduced operationally at GDAC level in the near future.
- Resolution of issues in BODC technical files identified by Jeff Dunn's (CSIRO) audit of pressure corrections applied to Argo profiles.
- The flagging of data for APEX TNPD issues is complete.

- Jointly reviewing the definition of TNPD with other members of the ADMT (primarily CSIRO and UW) and (re)adjustment of floats according to the new definition.
- Production of notes for the historic “sharing of regional DMQC expertise” ADMT action item.
- The cell thermal lag corrections are not applied by BODC yet.

Southern Ocean. BODC works with three other organizations to operate a 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. These pages contain an animation of the Met Office Forecast Ocean Assimilation Model (FOAM) outputs (potential temperature, salinity and velocity at 5m and around 1,000m depth) and an interactive map giving information on last known positions, deployment positions and direct links to both GDACs ftp sites.

Under the EC-funded MyOcean project the level of SOARC activities at BODC is increasing. So far, the following activities have been initiated at BODC:

- Working up and submission of relevant CTD profiles to the CCHDO and US NODC which will then filter through to the Argo delayed-mode QC reference data.
- An increase in support for the Partnership for Observation of the Global Oceans (POGO) research cruise programme information system with the goal of improving knowledge of potential Argo deployment opportunities within the Argo community.
- Collaborative work with the Environmental Systems Science Centre (ESSC) at Reading is beginning that will compare the results of Argo QC to several Met Office operational assimilation QC tests. It is hoped to identify potential improvements for both the Argo QC and operational data assimilation QC systems.

**Operational and scientific use of Argo data**

Argo has an open data policy which means that all Argo data are freely available without any restrictions, for both scientific research and operational applications. The data are used extensively in a wide range of research projects in UK Universities and research laboratories and is a central component of several PhD and MSc projects covering a broad range of topics including water mass properties and formation, air-sea interaction, ocean circulation, mesoscale eddies, ocean dynamics and seasonal-to-decadal variability. In recent years there have been between 100 and 120 Argo based papers per year, of which between 10 and 15% have a UK lead author or co-author.

**Operational and scientific use of Argo data at the Met Office**

Operational ocean forecasting. FOAM is the “Forecasting Ocean Assimilation Model” 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. A recent description of the system can be found in Storkey et al. 2010.

*(Storkey, D., Barciela, R.M., Blockley, E.W., Furner, R., Guiavarc’h, C., Hines, A., Lea, D., Martin, M.J., Siddorn, J.R. 2010. Forecasting the ocean state using NEMO: The new FOAM system. J. Operational Oceanography, 3(1), pp. 3-15.)*

The system is run operationally at around 0500 UTC every day. The system assimilates in-situ profile temperature and salinity data (e.g. Argo data obtained over the WMO GTS), sea surface temperature (in-situ and satellite), sea level anomaly data, and sea-ice concentration data. The system was recently developed to improve its use of Argo data by going back an extra day in order to assimilate Argo observations which would otherwise be missed (because of the receipt time delay which can be up to 24 hours between the float surfacing and transmitting its data and it being available for use), as shown in the table and figures below.

| Delay | % of Argo floats received |
|---|---|
| 0 to 6 hours: | 9% |
| 6 to 12 hours: | 39% |
| 12 to 18 hours: | 31% |

*Table 2. Receipt time delays for Argo data on GTS.*

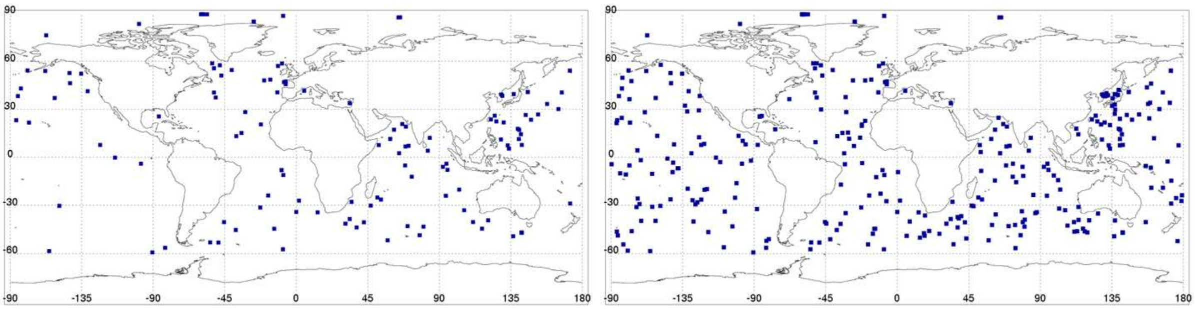


*Figure 7. Left, Argo profiles received from the previous day (6 July 2010) at 05:00UTC 7 July 2011; right, Argo profiles received over previous 2 days (6 and 7 July 2010) at 05:00UTC 8 July 2010.*

This change results in a significant (5-10% RMS) reduction in the model forecast errors in temperature and salinity.

For further details on ocean forecasting research at the Met Office see http://www.metoffice.gov.uk/research/weather/ocean-forecasting.

Seasonal to decadal prediction. 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. Such forecasts are more reliable for tropical regions (such as the Sahel, East Africa and north-east Brazil) than for temperate climates and seasonal forecasting is still an area in which the science is being developed.

A recent paper by Nick Dunstone, Doug Smith and Rosemary Eade (Hadley Centre) describes some idealised experiments which demonstrate predictability of the tropical Atlantic atmosphere in the hurricane development region on inter-annual timescales. Data denial experiments highlight the importance of knowing the sub-surface conditions (temperature and salinity – as is currently delivered by Argo) of the high latitude north Atlantic for making such predictions.

*Dunstone, N.J., Smith, D.M. and Eade, R. 2011: Multi-year predictability of the tropical Atlantic atmosphere driven by the high latitude north Atlantic Ocean. Submitted to Geophysical Research Letters.*

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 assessed in idealised experiments (Dunstone and Smith, 2010).

*Dunstone, N.J. and Smith, D.M. 2010: Impact of atmosphere and sub-surface ocean data on decadal climate prediction. Geophysical Research Letters. Vol. 37, No 2.*

For further information and experimental forecasts see
http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal.

Climate monitoring and prediction. The Hadley Centre maintains the HadGOA (sub-surface global analysis) dataset of historical temperature and salinity. Variables are on a 2-degree grid and computed on number of fixed isotherms and fixed depths at monthly resolution. 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.

**Research using Argo data at NOC**

Research using Argo data at NOC is carried forward mainly, though not exclusively, through graduate students. Current projects include:

Upper ocean circulation and variability in the North Atlantic. Alex Brearley, a PhD student at the National Oceanography Centre, Southampton, has been using Argo data to investigate processes that control the variability at 36°N. Can everything be explained by variations in local winds, or are other processes at work ? Brearley's work has shown that on time scales up to the annual cycle, the ocean responds mainly to local wind forcing. On longer time scales, the ocean responds to basin-scale changes in the winds, including changes due to the North Atlantic Oscillation (NAO). Brearley's work has also shown the power of combining data from Argo, which provides good coverage away from ocean boundaries, with data from 'Line W', a set of moorings maintained on the western boundary at that latitude by the Woods Hole Oceanographic Institution. Further addition of satellite altimeter data provides a more complete picture of mid-latitude Gulf Stream variability than could be achieved form any of the three techniques alone.

*Brearley, J.A. 2010, Upper Ocean Transport Variability in the subtropical North Alantic. University of Southampton, PhD thesis, 242pp.*

Ocean correlation scales in the Pacific and Atlantic oceans. Assimilation of observations is a critical element in either present state estimation or forecasting using atmosphere or ocean numerical models. A model representation of the ocean at some location in space and time should be improved by adjusting it to be in closer agreement with nearby observations. But what does 'nearby' mean in practice? A data assimilation procedure must have a way of assigning importance (or 'weight') to an observation. Nearby observations are highly correlated with the point of interest and are given a high weight. Distant observations are uncorrelated and are given a low weight. The rate at which the weight should be reduced with distance is the correlation length scale. Previous studies disagree about whether the scales are the same in all directions, or whether for example variability is more correlated in an east-west direction than north-south, and whether the scales are the same at all ocean depths. The most comprehensive study of this question to date has been undertaken by Lorna Mclean, a PhD student at the National Oceanography Centre, Southampton. Using the best-quality Argo temperature and salinity data, McLean has described the difference in correlation scales between east-west and north-south, (east-west scales are generally longer, as expected from ocean dynamics), and the variation of scales in the vertical. The majority of previous studies have used just temperature data from the historical databases. McLean's work exploits the availability of Argo salinity data to show that the most effective way to assimilate salinity observations is to do so at ocean depths defined by temperature rather than by pressure.

*McLean, L.M. 2010 The Determination of Ocean Correlation Scales Using Argo Float Data. University of Southampton, PhD thesis, 185pp.*

Sally Close is studying seasonal to decadal variations in water mass properties (SAMW, AAIW, NADW, UCDW) in the SE Pacific/Drake Passage/Atlantic sector of the Southern Ocean. All available data are being used, including repeat hydrography, Argo profiles and animal-borne sensors.

Gerard McCarthy is studying decadal changes in intermediate and thermocline water properties in the subtropical South Atlantic, from CLIVAR/GO-SHIP repeat hydrography lines. Argo profile data are being used in support of this study to determine the magnitude of interannual variability and hence to clarify the timescale of observed changes.

The NOC satellite oceanography group is involved in ground truth for SMOS and is evaluating ways in which Argo near-surface data can be used for SMOS evaluation.

## Funding

It was initially agreed in 1999 that MoD and DETR (then Defra, Dept of Environment, Fisheries and Rural Affairs and now DECC, Dept of Energy and Climate Change) would provide matching funding (through the Met Office) for UK Argo, and that NERC would also provide funding and support through NOCS and BODC. Figure 8 shows the funding for UK Argo on an annual basis since 2000.

As can be seen the funding from MoD has declined from 2005 and ceased after March 2010. Regular funding from DECC (ex Defra) has also reduced since then, although it has been supplemented in some years with year-end under-spend funding for floats. Hence the funding through the Met Office has exhibited large year-to-year variations. The MoD support for Argo data processing at the UK Hydrographic Office has also now ceased.

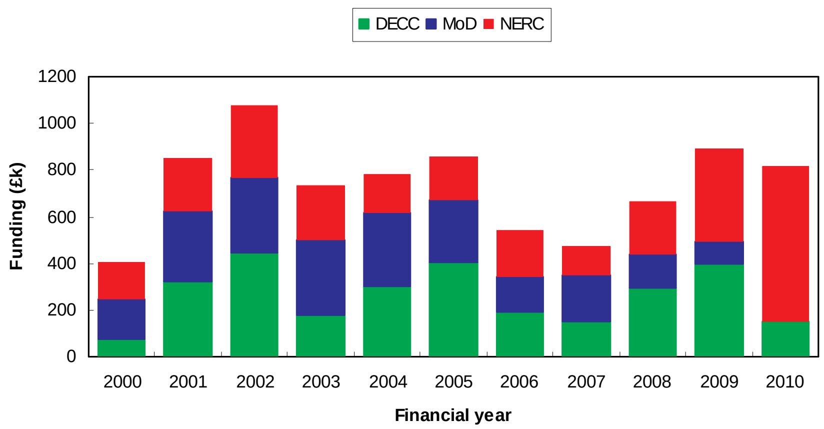


*Figure 8. Showing the variability in annual funding for UK Argo from DECC, MoD and NERC.*

Securing an adequate level of regular funding for UK Argo activities at the Met Office continues to be an issue, particularly with the cessation of the MoD funding line in 2010. In the last few years, funding for personnel (programme management, coordination and technical support) has been at a minimum level (hence the relatively low number of float deployments in recent years) and has not kept up with the funding for floats; hence the backlog of floats to be deployed. At this time (March 2011) the level of DECC funding for UK Argo for FY2011 and subsequent years is not known.

NERC funding has also been variable due to funding for floats relying largely on bids to thematic programmes and end-of-year under-spends, although the regular funding for support activities (e.g. data processing, science leadership) has been relatively stable. In 2010 additional staff resource was provided at BODC such that there are now two people involved in Argo data processing and this has been instrumental in enabling them to clear in 2010 the backlog of UK floats that needed to be subjected to delayed-mode QC. NERC funding for these support activities has been allocated to March 2012 through the Oceans2025 settlement, with the expectation it will continue after the 5-year Oceans2025 period. Significant capital funding was provided by NERC for floats in FYs 2009 and 2010 and there are reasonable prospects of ongoing capital from NERC for floats.

With the variable funding the number of floats procured each year has also been variable, as shown in Figure 1 earlier.

Considerable time and effort has been (and continues to be) expended in trying to secure longer-term funding for UK ocean observations that have been committed to international programmes such as the GOOS, GCOS and the GEOSS; with Argo as a pressing example for the need for a solution. This has so far been unsuccessful as there is no mechanism within UK Government to transition funding from research to operational funding lines. In 2009 a new high-level cross departmental Marine Science Coordination Committee (MSCC) was established, reporting to a Ministerial Marine Science Group. One of the priority tasks of the MSCC is to "*develop a transparent prioritisation tool to help inform decisions on the funding of observation systems (for both starting and stopping observation systems)*" and to "*also develop practical proposals to provide cross-cutting, longer-term funding for priority long term monitoring systems*" to help address this problem. This is being carried out by a Long Term Monitoring Working Group which is due to report to MSCC in 2011. However, securing adequate long-term funding for Argo is likely to remain a challenge particularly given the significant reductions in UK government spending (an average 19% cut in departmental budgets) outlined for the coming four-year period.

## Euro-Argo

Both the Met Office and NERC are involved in the Euro-Argo project (January 2008 to end June 2011) to develop and establish a longer-term European infrastructure for Argo with longer-term commitments from both the member countries and the EU (e.g. through GMES). It has been agreed by DECC (and supported by NERC) that UK should become full members of Euro-Argo and expected that the Met Office will lead on representing UK in Euro-Argo, with the support of NERC (NOCS). The expected timescale for formal UK agreement to sign-up to the Euro-Argo ERIC (European Research Infrastructure Consortium) is likely to be mid-summer 2011.

**USA Report to AST-12, March 2011. (Submitted by D. Roemmich)**

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

U.S. Argo is supported through the multi-agency National Ocean Partnership Program (NOPP), with major funding provided by the National Oceanic and Atmospheric Administration (NOAA). 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 Fleet Numerical Meteorology and Oceanography Center FNMOC). Float production, deployment 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.

The present 5-year cycle of U.S. Argo implementation will end in mid-2011, to be followed by a 4-year cycle having the same multi-institutional structure.

***Objectives:***

*Primary objectives identified in the 4-year Work Plan (2011-2015) for U.S. Argo are:*

i. In float technology, an evolution of the Argo array to 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 be extended beyond 4 years[1] by deployment of next generation floats (SOLO-II) and through improvements to existing (APEX) float models. 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 (through repeated audits of the data system, and by automated checking at global data centers) 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. OceanObs'09 recommendations for temperature/salinity profile measurements from Argo include extension of coverage to include the seasonally ice-covered oceans, increased density of observations in western boundary regions, enhanced vertical resolution of profiles, profiling to the ocean floor (as deep as 6000 m) with a subset of floats, and taking measurements nearer to the sea

[1] The 515 U.S. floats deployed in 2005 have completed an average of 174 cycles (= 4.8 years mean lifetime), with 42% still active as of 03/2011. Source: Argo Information Center

surface. Enhancements will only be undertaken if they do not compromise the present core Argo sampling of 3° resolution every 10 days between 60°N and 60°S

***Support level:***

The support level for U.S. Argo is aimed at providing half of the global Argo array. The target level is 1600 active floats, based on a deployment rate of about 410 floats per year. Due to level funding, the number of floats decreased to about 360 in FY2010. For FY2011, the budget is not yet known and a substantial decrease in the number of US floats provided, perhaps to as few as 240, is possible.

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. All of these activities would be impacted by the possible budget reduction.

***Status:***

As of March, 2011, there are 1799 active U.S. Floats (source AIC) and these have completed an average of 122 cycles. Of the active floats (Fig 1), 1729 are provided by U.S. Argo and 70 by partnering programs. Following the 2009 hiatus in deployment (240 U.S. floats deployed), the number of US floats increased to 379 in 2010 (Fig 2). There remains a backlog of approximately 100 floats, to be deployed in addition to those funded in FY11. A concern for the international array is that the number of U.S. floats may decrease in the future below the 1600 float target number.

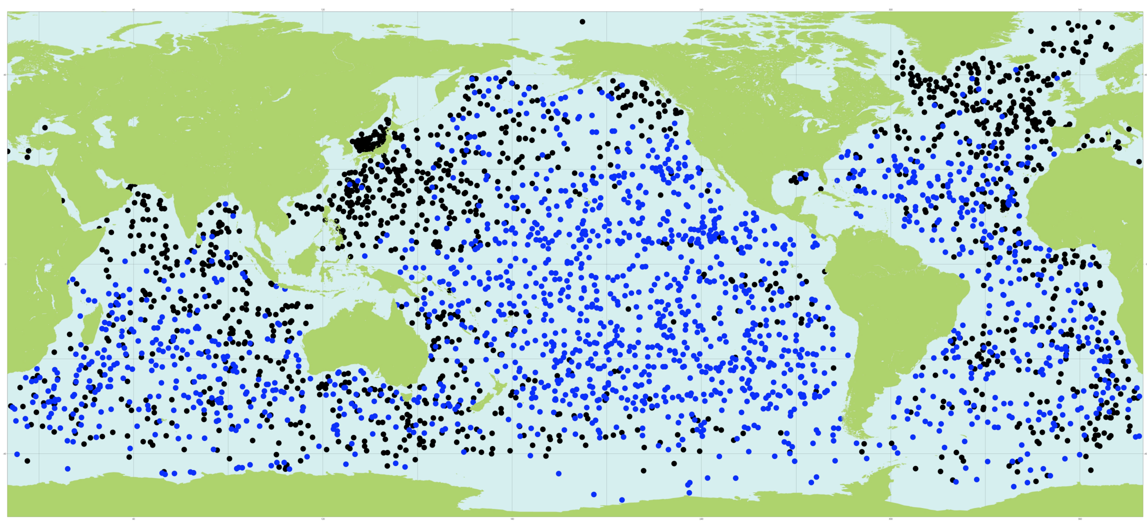

*Fig 1 Positions of 1799 active U.S. floats (blue dots) as of March 2011.*

The highest priority for U.S. Argo is to sustain a global Argo array. Specific plans for 2011 float deployments, as they evolve, are posted on the AIC deployment planning links. A major U.S./New Zealand/Australia deployment cruise in the South Pacific Ocean was carried out in late 2010 on R/V Kaharoa, and another is planned beginning in August 2011. RV Kaharoa has deployed 850 Argo floats since 2004.

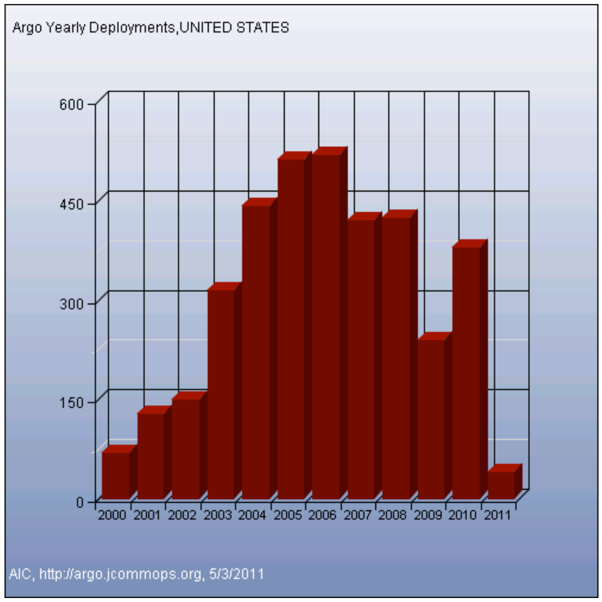


*Fig 2. Yearly deployment of U.S. floats. (Source: AIC)*

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 2010 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 FNMOC/Monterey. The two GDACs at FNMOC/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.

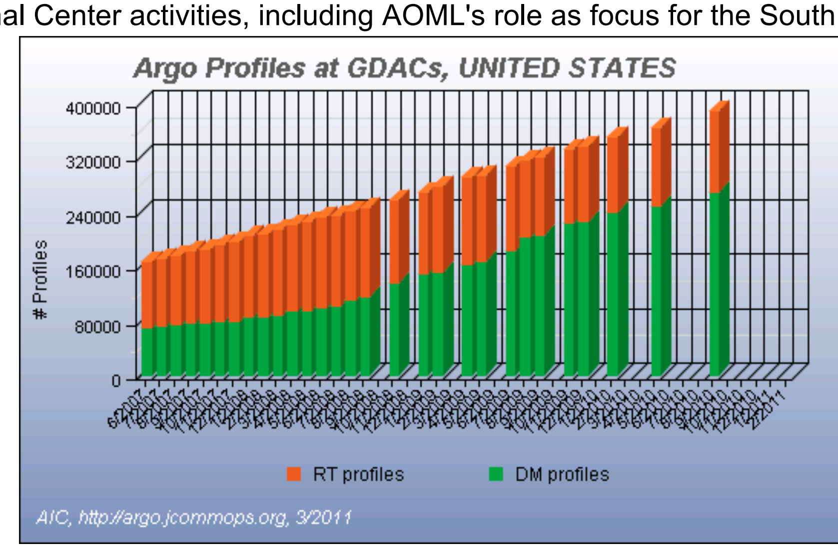


*Fig 3. Number of profiles held at GDACs for U.S. floats (source: AIC), including those with delayed-mode and real-time levels of quality control. Roughly 65,000 of the RT profiles are less than one year old and not yet eligible for DM processing.*