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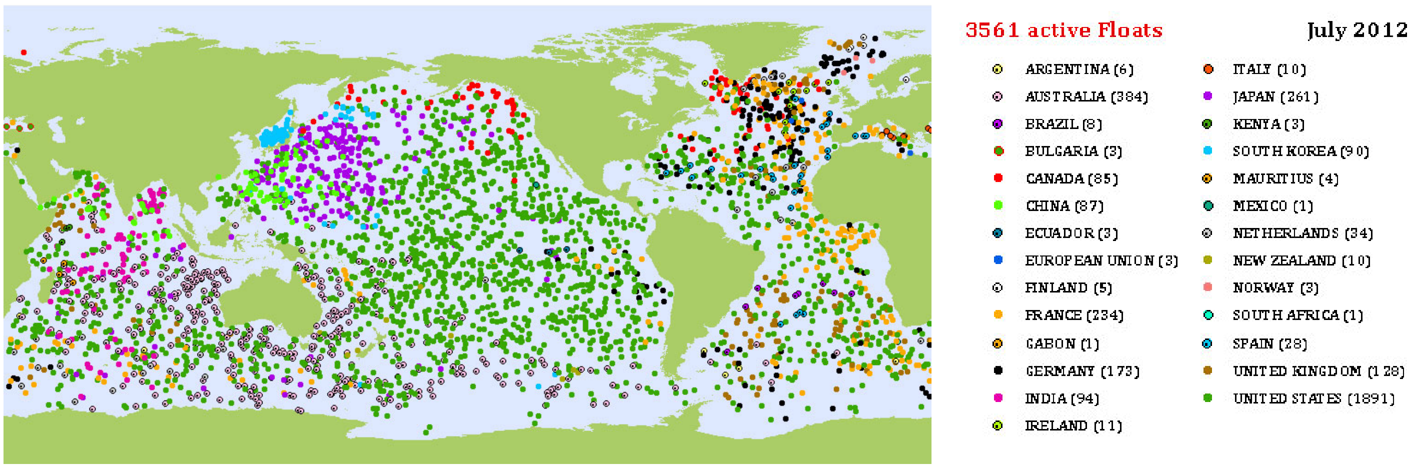
Newsletter of the international Argo project



Notes from the Editor

Since the last newsletter in July 2011, the Argo Program has spent time reviewing its current data and how the quality can be improved, and perhaps expanded through other sensors and deeper profiling floats. Work has continued to fix problems related to pressure bias within the Argo data set. Additionally, a new trajectory format has been introduced to better document the float's cycle timing and improve velocity estimates. The Argo Program would like to continue developing more education outreach activities. To this extent, the Google Earth Argo layer has been further developed and a new blog has been added to the educational use website with ideas on how to incorporate Argo data into the classroom. We are also exploring ways for students to "adopt a float" and follow the float as it reports data.

This past spring, the IOC and IFREMER welcomed back the Argo Steering Team to Paris for the thirteenth Argo Steering Team meeting. It was a chance for EuroArgo to offer hospitality after its formation and a chance to reconnect with the IOC through Albert Fischer. There is a summary of the AST-13 meeting in the Newsletter, but the focus of the meeting included reviewing Argo's status and its future evolution. As the push to expand to new areas suggested by OceanObs'09 continues, the AST took time to reflect on its first 15 years and if the current priorities are still appropriate.

The Argo co-chairs invited John Gould, Argo Director emeritus, to attend the AST-13 meeting and give a presentation evaluating Argo since its inception with an eye to Argo's possible future development. Gould's talk focused on Argo's progress, its impact, its reasons for success and its remaining challenges. For a review of the presentation, plus additional updates, see John Gould's article in this Newsletter.

There are two articles on new float technology. The first is on the development of float technology within the NAOS project in France. There are details on planned improvements to float reliability, lifetime and satellite communications as well as developmental work on deep floats and biogeochemcial floats. The second article discusses Argo Canada's experience deploying several of the new NOVA floats from MetOcean Data Systems. Specifications of the NOVA float are included as well as data from the first several profiles returned by one of the deployed floats.

As Argo continues to explore ways to complement the initial temperature and salinity parameters, the Bio-Argo project is becoming more and more mature. There is an article in this newsletter by Hervé Claustre, Ken Johnson and Emmanuel Boss that describes the progress of the Bio-Argo project. Details include how the project began, current plans for sensor packages to be included on Bio-Argo floats, and how to continue working with Argo to deliver high quality biogeochemical data in the Argo data stream. A two-day Bio-Argo session will be held just prior to the ADMT meeting this fall in Hyderabad, India.

The number of Argo-related papers published this year is close to 150, bringing the total number of papers published using Argo data since 1998 to over 1100. Due to the long list, it is not included in this newsletter, but it is always available online at http://www.argo.ucsd.edu/bibliography.html. Instead, I have included the three plots that are on the top of the Bibliography page. These plots show the number of papers published as a function of year, country of origin, and journal. I am investigating adding an additional bibliography comprised of Ph.D. theses using Argo data. If you know of any such theses, or databases containing theses, please send argo@ucsd.edu an e-mail.

Finding ways to deploy floats on dedicated ships is becoming more and more important as the array needs refilling in remote and varied locations. There are three short features on ships that have been recently helping Argo to deploy floats. One is familiar to Argo already, the *Lady Amber*, but the *Race for the Water* ship is new, as is the Voiles sans Frontières program.

Megan Scanderbeg

Argo – looking backwards and forwards

John Gould, National Oceanography Centre, Southampton, UK [wjg@noc.soton.ac.uk]

At the 13th meeting of the Argo Steering Team in Paris in March, Dean Roemmich asked me to comment on the progress that Argo had made and the challenges that the project faces. This is a summary of some of the thoughts I put forward in Paris and some more recent ones.

Getting to where we are today

Undoubtedly the story of Argo is one of success. The programme grew from the vision of those who, encouraged by the use of profiling floats during the 1990-1997 World Ocean Circulation Experiment (WOCE), first proposed an Argo programme at the OceanObs'99 conference. Progress towards realizing that plan of approximately 3000 floats that would fill the ice-free areas of the major ocean basins where depths were greater than 2000 m began with the first deployment of Argo-designated floats in late 1999. The target of 3000 floats providing data was reached in November 2007. That landmark has to be viewed with some caution, however, since not all of those floats were providing full temperature and salinity profiles, several of the floats were in marginal seas that had not been included in the original plan, and the spatial distribution of floats was far from uniform and had a northern hemisphere bias.

Since November 2007, the number of operating floats has, to my surprise, never dropped below the magic 3000. In large part this has resulted from the continuing improvement in float lifetimes that has been achieved despite Argo having to overcome technical difficulties with both floats and sensors (e.g. Druck Pressure sensor). Argo has also embraced new technological innovation (lithium batteries, two-way communication systems). This progress is documented in detail in the 2011 report from the AIC (http://w3.jcommops.org/FTPRoot/Argo/Doc/AIC_2011.pdf)

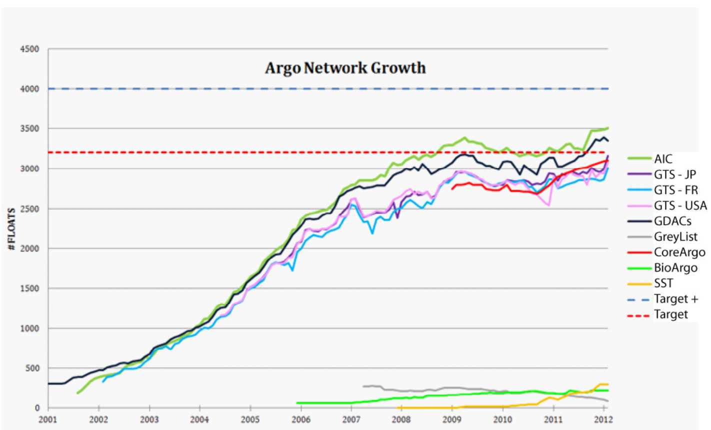


Figure 1. Various metrics of the growth of the Argo float array. The red line shows the "Core Argo" total that excludes floats in marginal seas. The lower curves show the number of biogeochemistry floats and floats making high resolution near surface temperature profiles. It also includes the number of "greylisted" floats that are delivering data of questionable quality. (Source AIC 2011 Annual report)

Data have, as planned, been made freely and rapidly available to all users and this has resulted in Argo data being widely used in scientific research and in "operational" ocean and climate analysis and forecasting applications. These applications are reflected by the Argo bibliography but, of course, this metric of Argo's progress typically shows Argo use around two years before the date of publication.

In one major respect the initial vision had been exceeded. The quality and stability of salinity measurements has, thanks to the hard work of Argo scientists focusing on delayed-mode quality control (DMQC), proved to be more stable than expected.

Argo has also succeeded because of the dedication of individuals and small groups of scientists and technical support staff. One has only to consider the enormous contribution of the little ship *Kaharoa* in deploying floats in the remote South Pacific to see such an impact.

What difference has Argo made?

Quantity

The most obvious impact of Argo has been the enormous increase in the number of temperature and salinity profile data available from the open ocean. If one uses NOAA's World Ocean Database 2009 (WOD 09) (http://www.nodc.noaa.gov/OC5/SELECT/dbsearch/dbsearch.html) to define the number of ship-based profiles worldwide in which salinity has been measured to a depth of at least 1000 m the impact is very clear. Since the late 19th century there have been 543,000 profiles (CTD and water bottle stations plus XCTDs). That number drops to 320,000 profiles reaching 1500 m and 224,000 to 1900 m.

The number of profiles in WOD 09 from floats is 374,000. (There is an obvious delay in entering Argo data into WOD and so the total of float profiles is underestimated). A better measure is obtained by looking at the Argo profiles to 1000 m in the French GDAC and this presently stands at 944,320 up to June 30th and accumulating at a rate of 21,683 in the 61 days of May and June 2012.

So, whereas in pre-Argo decades there were less than 15,000 ship-based profiles per year now there are around 120,000 Argo profiles per year; an increase by a factor of eight.

Distribution

The quantity of data is not the whole story. Argo data are randomly and therefore quasi-uniformly distributed as the following two figures produced by Howard Freeland clearly show.

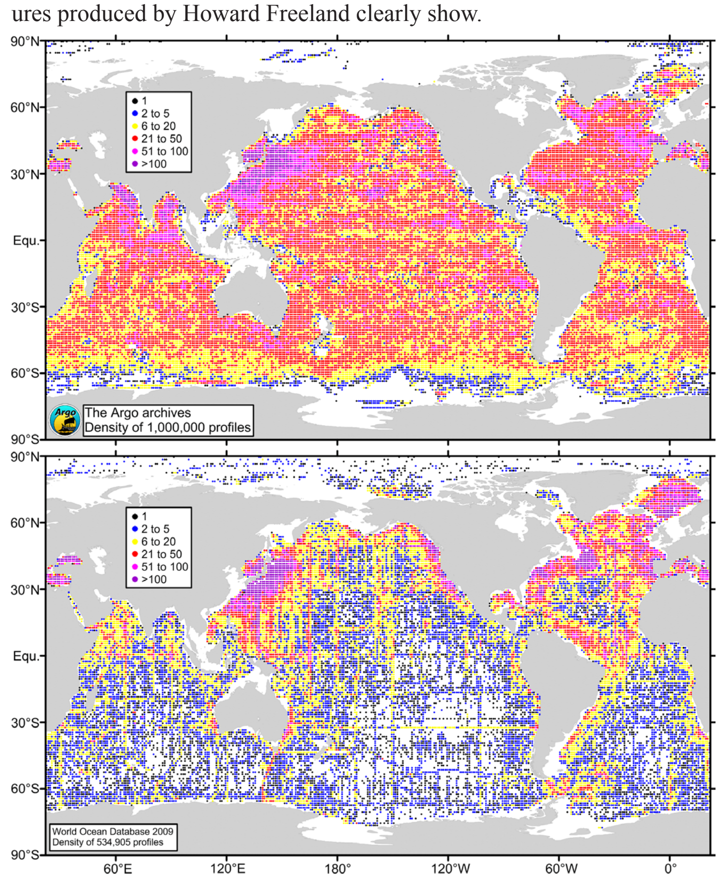


Figure 2. Lower panel Number of ship-based salinity profiles to at least 1000 m (WOD 09). Upper panel. Equivalent plot for Argo data (Source Howard Freeland)

Not only are they spatially more uniform than ship based measurements but they are also more uniform in their distribution throughout the year. This is most clearly demonstrated in the high latitude southern hemisphere.

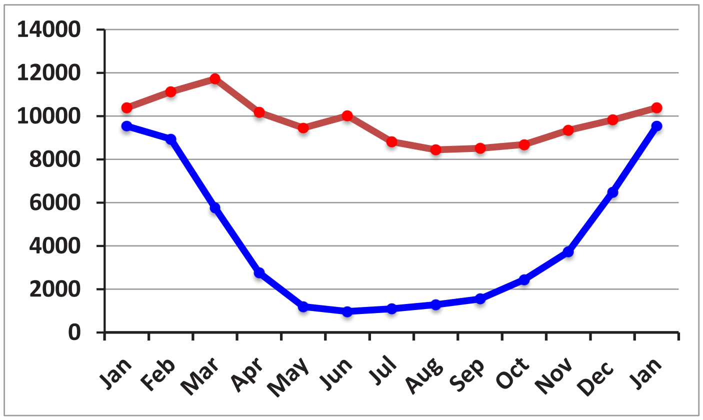


Figure 3. Monthly totals of ship-based and float profiles with salinity to at least 1000 m in WOD 2009.

This figure shows the extremely small number of ship-based profiles in that area in winter. For the float profiles, there is a small winter decrease probably due to the increase in ice cover preventing float data transmission.

These statistics clearly demonstrate the superiority of Argo over ship-based data for the generation of ocean climatologies and for documenting the oceans' state and, of course, for describing the previously unobserved subsurface circulation.

Reasons for Argo's success

A central cause of Argo's success has been that the initial vision of a core mission (a global array of around 3000 floats measuring temperature and salinity) has been pursued single-mindedly and has delivered data and products that are used by a large and diverse community that spreads far beyond the groups that deploy floats.

A second factor has been the "modularity" of Argo. Though Argo's objectives are global and ambitious, countries and research groups can participate by making a contribution in line with their national funding situation even if this is not lavish. This is illustrated by the fact that while the USA is operating more than half of the present array the remainder is made up of contributions from 27 countries. (Note during the lifetime of Argo, floats have been operated by a total of 33 countries plus the EU meaning that sadly six countries have "dropped out" of the programme). Some countries make contributions to Argo that are surprisingly large while others make smaller contributions than those that would one expect from their GDP and area of their EEZ.

Argo has been remarkably effective at rising to the technical challenges resulting from floats having to work autonomously for many years and with limited diagnostic data available. This means that if technical defects materialize several years after deployment there will be a large number of floats that will fail prematurely due to that defect. The continuing improvement of float lifetimes is testament to the close and successful collaboration between Argo float operators and the sensor and float manufactures.

Undoubtedly Argo's open sharing of data has been a major benefit and presents a model that is envied by many other programmes.

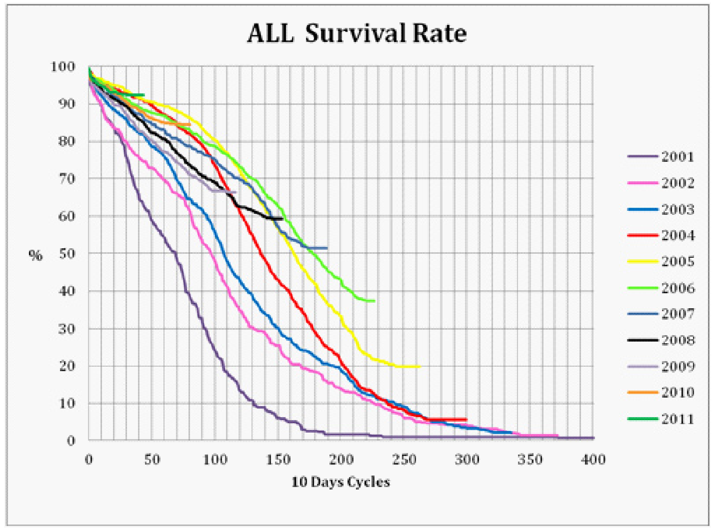


Figure 4. Survival rates of all models of Argo floats showing the year-on-year improvement. (Source AIC 2011 Annual report)

Challenges remaining

Despite these successes, Argo faces substantial challenges. Some of these are external and beyond the beyond the programme's influence. On other issues, decisions made by Argo may influence its future.

The major external factor is the state of the world economy and its impact on science budgets. Argo's development between 1999 and 2007 coincided with a period of economic growth and relatively healthy science budgets. The present global-scale economic uncertainty started around August 2007 and, as yet, no end is in sight. The pressure on science budgets resulting from the economic downturn increases competition for funding. In this respect Argo, having successfully reached its present status, may be seen as a "solved problem" and therefore somewhat routine when in competition with new, innovative but often more expensive projects. The difficulty of securing funding both from research agencies and from government departments with a remit to support sustained observations will continue but progress is being made. The successful use of the European Research Infrastructure Consortium (ERIC) to fund Euro-Argo is encouraging.

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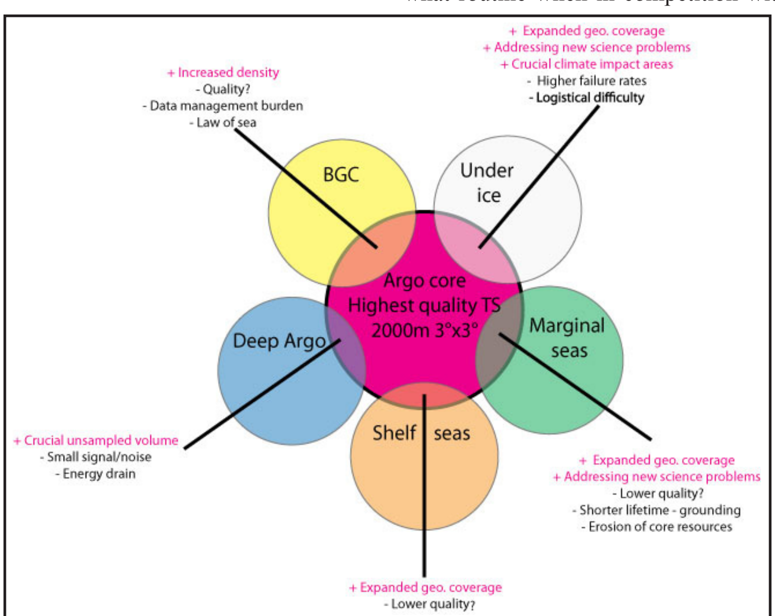

Figure 5. Interactions between the Argo core mission and other applications of profiling float technology.

Bio-Argo: from early meetings to the progressive structuration of a project and a community

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The recent emergence of a Bio-Argo project takes its roots in various workshops and conferences that started nearly a decade ago. The present note summarizes these various meetings and associated outcomes, and describes the current status of Bio-Argo along with some perspectives and associated issues for its near- and more long-term implementation.

The ALPS (Autonomous and Lagrangian Platforms and sensors) workshop, held at Scripps in 2003, can be considered as a stepping stone for the field of autonomous observation of biogeochemical cycles and ecosystems (Rudnick and Perry, 2003). This first workshop addressed the status of technological development in profiling floats, gliders and sensors as well as the new scientific topics that could be addressed with these remotely operated platforms.

Thanks to some level of maturity and readiness of oxygen sensors, oxygen was the first variable that was progressively added to the systematic measurements of temperature and salinity on profiling floats. In parallel, the "friends of oxygen on Argo" group, provided the first recommendations (Gruber et al., 2007) for developing an array of floats with oxygen sensors.

A few years later, the International Ocean Color Coordinating Group (IOCCG) launched the "Bio-optical sensors on Argo float" working group. Its general objective was to provide recommendations for the development of a cost-effective bio-optical float network. The recommendations (IOCCG, 2012) range from the identification of key bio-optical measurements to be implemented on floats to the real-time management of the data flux resulting from the deployment of a "fleet of floats". In addition to recommendations for a "Bio-Argo network", the report also discusses the development of a network of floats dedicated to specific activities (e.g. validation of ocean color products, process studies).

In line with the initial ALPS workshop, the Ocean Carbon and Biogeochemistry scoping workshop "Observing Biogeochemical Cycles at Global Scales with Profiling Floats and Gliders" (Monterrey, 2008) had several goals (Johnson et al., 2009). The first one was to provide carbon cycle scientists with a critical review of existing technologies and expected developments. The second was to identify scientific issues that could only be solved with these remote observations and to discuss possible future experiments. The third one was to outline the requirements for a long-term, global-scale integrated observing system of biogeochemical cycles based on in situ platforms as well as satellites and data-assimilating models.

Photo courtesy of http://www.oao.obs-vlfr.fr/robots-a-sensorssm/profiling-floatssm

OceanObs'09 was a very important conference for biogeochemical oceanographers using (or willing to use) autonomous platforms. One decade earlier, the OceanObs'99 conference had accompanied the launching of the Argo program. Ten years later, the biogeochemical cycle and ecosystems came into play. It was accompanied with the new ambition of developing an integrated observation system. Beside the maturation of autonomous platforms opening new scientific fields, many discussions arose on how these new technologies could be used in tight synergy with other observational platforms (ship, satellite) as well as (global) biogeochemical models. With respect to the specific use of profiling floats for a global observation of biogeochemical cycles, OceanObs'09 produced several key community consensus papers giving prospective guidelines for the implementation of oxygen (Gruber et al., 2010a) or bio-optical (Claustre et al., 2010a) sensors on profiling floats. Other papers also provide complementary views of the integration of floats into a global observational network (Claustre et al., 2010b; Gruber et al., 2010b; Roemmich et al., 2010; Send et al., 2010).

Taking advantage of the legacy of these meetings, conferences and reports, the Bio-Argo community is now reaching a level of maturity that makes it possible to switch from a cluster of individual or national projects to a global and internationally structured program. For example Euro-Argo is a new research infrastructure contributing to the Argo program, for which the extension of the core Argo mission towards biogeochemistry is an important objective.

Bio-Argo scientists also contribute to technological developments and enhanced capabilities of the profiling floats. They have accelerated the implementation of two-way iridium communication, which is essential for biogeochemistry. This technology allows for more data to be transferred as well as the modification of several float mission parameters in quasi-real time (e.g. vertical resolution, temporal resolution). A new generation of floats is on its way with more sophisticated electronics, one dedicated to the float mission, one to sensor management. The sensor boards allow selective powering and vertical resolution to be adapted for each sensor, eventually making the floats more cost-effective. A great capability for controlling the sensors remotely is an absolute requirement for scientific applications: the observation of biology and biogeochemistry indeed requires such flexibility.

Beside the new scientific questions that could be addressed thanks to Bio-Argo floats, there are some key a priori principles that have to guide the development of the future Bio-Argo array.

First, in addition to oxygen measurements, there are three more key variables that have been identified by the community as core variables for the first generation of Bio-Argo floats: nitrate concentration, chlorophyll a concentration, and backscattering coefficient which is an optical proxy for the concentration of Particulate Organic Carbon (POC). The community will first focus on these variables. It has to demonstrate that these core variables can be implemented and managed in an operational way, i.e. in a similar manner as for the Argo program. Obviously this strategy does not preclude testing novel emerging technologies, which, once a sufficient degree of maturity is established, could be progressively implemented into the Bio-Argo array. This will be the case, for example, for pH sensors, which are just beginning to be deployed on floats. An additional technological development is the creation of integrated biogeochemical packages to traditional floats (e.g. w/o specialized boards).

Secondly, the implementation of the four core variables into the Argo program and its success will be strongly linked to our capability to size and implement a data management system that fits the demands of operational oceanography as well as science requirements: delivering real time and delayed mode quality controlled data. Setting up such a management system is now the priority.

In order to step forward in this direction, a two-day Bio-Argo session will be organized at the next Argo Data Management Team meeting (Hyderabad, India; November 12-16, 2012). The objective of this meeting will be, in the context of discussions with the "historical" ADMT group, to set a roadmap for the coming years. The success of this meeting is essential to strengthen the relationship between Bio-Argo and the Argo program. Continued on page 5.

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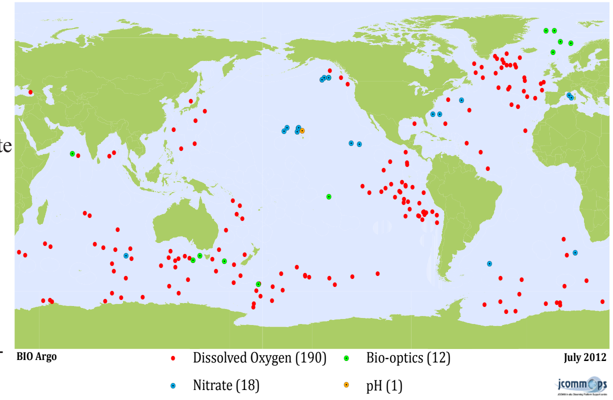

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John Gould's article continued from page 3:

There is also probably some scope to encourage new countries (and some whose contribution is now small) to make substantial contributions. One of the keys to sustaining funding for Argo lies in demonstrating the importance of Argo data to a wide range of research and operational activities and in showing the need to extend the Argo time series.

Another pressure on Argo is the diversion of "Argo" resources from the core mission into other scientifically valuable profiling float applications. I illustrated this in Paris with the diagram in figure 5.

The interaction between Argo core and other activities is depicted as a series of intersecting circles with the positive and negative impacts on the core mission highlighted. For instance extending Argo to carry out deeper sampling will provide information on a crucial poorly-sampled volume of the ocean but will require technological advances to overcome the higher energy demand. It will also be challenging to produce data of high enough accuracy to be useful. Diversion of resources into marginal seas will allow a wider community to become involved and will allow new science problems to be addressed but may present challenges of maintaining data quality and floats will likely have shorter lifetimes due to grounding. The use of floats with biogeochemical sensors raises issues with regard to the Law of the Sea since they could be regarded as addressing some aspects of marine resource evaluation.

The relationship between the core activity and other applications of profiling floats will need to be handled carefully by the AST and ADMT and decisions need to be made about how those relationships are developed. Such collaboration has the potential to strengthen Argo's visibility and relevance to a wide range of problems.

We can safely assume that progress to improve float performance and reliability and to embrace new technology and materials will continue and that this will be used to improve Argo's "efficiency" and cost-effectiveness, particularly in respect of maintaining the array as floats reach their end and gaps appear. Array maintenance in remote areas will continue to require dedicated deployment platforms. We can also be sure that technological innovation will not be without teething problems.

Final thoughts

Part of the battle of securing funding must also lie in the manner in which Argo projects itself both nationally and internationally. Do we know what is the wider science community's view of Argo? What means, other than the peer-reviewed literature, can we use to project Argo's image? Could that view be enhanced through greater use of Argo in educational outreach?

Just as there are issues with the relationship between core Argo and other applications of float technology, Argo must be seen in the wider context of the ocean (and earth) observing system. Argo is now one of the most mature ocean observing elements and at some stage, (perhaps after the full array has been operational for a decade), a re-assessment will need to be made of the array design bearing in mind the contributions of other observing systems (such as gliders) that did not exist when Argo was first designed.

A strength of Argo is its very lean and effective management infrastructure – an Argo Information Centre within JCOMMOPS and dedicated Steering and Data Management Teams. That leanness is also a weakness since Argo has no full-time Programme Director to pursue and overcome the challenges to Argo. How can this situation be improved?

Another issue must be how effectively Argo's "fathers" and "mothers", those who made the original proposal to OceanObs'99, hand over the programme's leadership to a new generation of scientists?

Soon Argo will have collected its one millionth profile – a milestone worthy of celebration but one that perhaps only marks the end of the first phase of Argo's life. The challenges of the next phase are likely to be just as big as those Argo has already overcome.

The development of float technology within the NAOS project

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NAOS (Novel Argo Ocean observing System) (www.naos-equipex.fr) is one of the projects selected in the Equipex call for proposals of the French program Investissements d'avenir. The project has two main objectives:

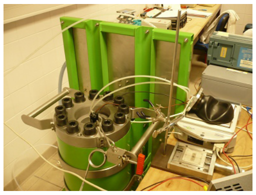


Photo 1: float sub-assembly tests on a high pressure tank

- To consolidate the French contribution to the Argo core mission (global temperature and salinity measurements down to 2000 m) by deploying 10 to 15 additional floats per year from 2012 to 2019 (total 110 floats). The French contribution to Argo and Euro-Argo should thus reach 70 to 80 floats per year.
- To develop and validate the next generation of Argo profiling floats. New float capabilities will include: improved performances, integration of biogeochemical sensors, deeper measurements (3500 m) and under ice operations in the polar seas. 60 to 70 new generation floats will be deployed in three pilot areas: the Mediterranean Sea, the Arctic and the North Atlantic.

NAOS is a strong partnership between IFREMER (coordinator), UPMC (co-coordinator), CNRS, UBO/IUEM, SHOM, and two private companies: CLS for satellite telecommunication aspects and the NKE SME which is in charge of the industrialization and commercialization of French Argo floats.

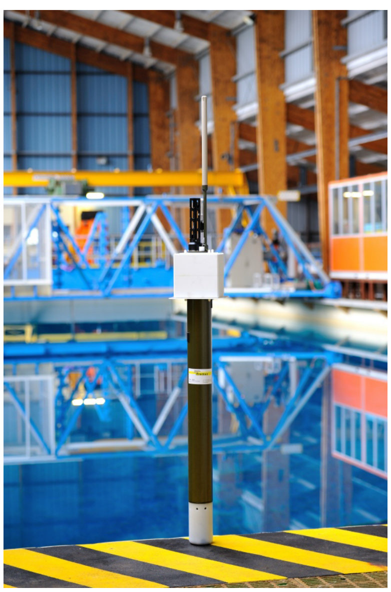


Photo 2: Arvor prototype with Argos3 transmission

During the 2011 to 2014 time period, project partners will work towards the development of the new generation of French Argo profiling floats including prototype developments and tests at sea. Five main tasks are planned:

1. Improving float reliability and lifetime. The manufacturing process, testing facilities and at sea monitoring facilities will be improved. The deployment protocol will be shortened. This task will also take into account new requirements from the Argo community. Today, vertical resolution near the surface has been enhanced on the Arvor float; in the near future, it will be possible to easily adapt the profiling scheme for specific studies.
2. Improving satellite communication. This will reduce the transmission time at the surface which is critical in marginal seas and will allow the transmission of more data and remote control of the float. The 3rd generation of Argos offers a downlink, allowing synchronization between the float and the satellite. The main objective is to transmit a whole profile during one pass. The low data rate mode has been assessed to define the best way to use it on a float, making a "rendez-vous" with the satellite using prediction pass. Tests at sea have demonstrated that a profile can be transmitted correctly and that the remote control of the float is possible. The work is now focused on the high data rate mode which offers 4800 bits/s data transfer rate. This feature should be used for high resolution profiles (~1000 pts) or multi-sensor platforms.
3. Development of a deep float. The design has been done by extending the different sub-assemblies of the Arvor to 3500 dbars depth while preserving the ease of the Arvor deployment (light weight) without any pre-ballasting. Two prototypes have been produced in early 2012; they embed a 3500m SBE41CP and the 4330 optode. Regarding the recommendations of the Argo oxygen community, the raw data (phase and temperature measurements) are transmitted. The Arvor3500 will be able to perform a minimum of 150 cycles at max depth, acquiring T, S, O2 every meter. A greater number of cycles will be reached if the user programs 3500dbar profiles alternatively with current 2000 dbar profiles (eg 1 cycle at 3500 dbar every 10 cycles). The transmission uses an Iridium modem and remote control of all the parameters will be possible.
4. Development of biogeochemical floats for operation in the Arctic ocean. These floats will differ from standard floats in several aspects: multi-sensors, large amounts of data, influence of measurement on the float behavior. For these reasons, new hardware will be used, based on the use of two separate electronic units, giving more flexibility: one for the float motion and satellite transmission, the other one for sensor acquisition and data computing. This powerful architecture associated with a new software will offer us a new capability: the float will detect events and will react by modifying its mission scheme itself. The first test will be ice sensing for Arctic application during the ascent to the surface. In parallel, work has started to assess improved means of ice detection (acoustics, optics).
5. Assessment of a density sensor on a Provor float. The "NOSS" sensor (NKE Optical Salinity Sensor) is dedicated to acquiring density and salinity of sea water, by measuring the refractive index (from a position sensing detector) of a laser beam passing through the water sample. The refractive index allows us to compute absolute salinity. Improvements of the first version of the sensor were done by the end of 2011 and early 2012. This should improve long term withstanding in sea water, light influence, accuracy. In 2013, the sensor will be embedded on a Provor already equipped with the SBE41CP.

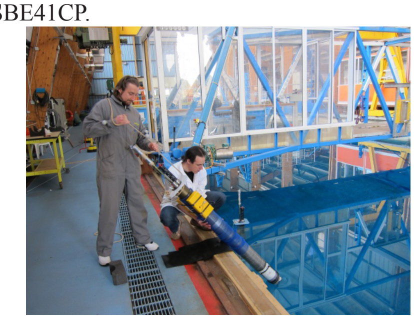


Photo 3: Prototype of deep Arvor during tests at Ifremer pool

Photo 4: Float endcaps at NKE (photo courtesy of www.naos-equipex.fr)

Early results from NOVA floats deployed by Argo Canada

Denis Gilbert, Department of Fisheries and Oceans Canada, [Denis.Gilbert@dfo-mpo.gc.ca]

The Argo Canada program recently purchased 27 NOVA floats from MetOcean Data Systems (www.metocean.com). The NOVA float weighs 22.8 kg, with a diameter of 16.5 cm, a hull height of 114 cm and a full height of 134 cm including the Iridium/GPS antenna (Figure 1). It uses a continuously pumping SBE 41CP CTD and field trials with 1-day cycles in the Caribbean Sea demonstrated a lifetime capability of more than 300 profiles from 2000 db to the surface.

As of July 5, 2012, we have deployed 11 of our 27 NOVA floats and 13 others will have been deployed by the end of July 2012. Among these 11 deployed floats, one failed to report any data and the other 10 floats are functioning properly. Problems encountered with the GPS unit on the first NOVA float that we deployed have disappeared after the 4th profile. All floats subsequently launched returned good GPS data.

Preliminary comparisons made by Igor Yashayaev between NOVA float CTD descent data collected immediately upon launch in the Labrador Sea and nearby ship CTD data (SBE9) are excellent, well within the SBE 41 CP technical specifications for both temperature and salinity. Time-depth contours of salinity and temperature from the first 14 profiles collected by NOVA serial number 17 are displayed on Figure 2. This float was launched from the Canadian Coast Guard Ship Tully by Marie Robert on February 15, 2012, in the vicinity of station Papa (50°N, 145°W).

Several decoding and data management tasks accompany the introduction of a new float model. Mathieu Ouellet has worked with Ann Thresher (CSIRO) to introduce GDAC-approved technical parameter names for the NOVA float. This is still a work in progress.

Admittedly, our experience as end users of NOVA floats is still very limited. We will be reporting on a larger set of NOVA float deployments and longer time series of their CTD data at the AST-14 meeting.

In response to our requests, future NOVA float software improvements by MetOcean will permit the float to perform a first ascent profile within a few hours of being launched and take measurements at variable depth spacing intervals. In addition, MetOcean has short-term plans to introduce the Iridium 9523 transceiver and RUDICS communications instead of the short-burst data (SBD) communications currently being used.

Figure 1. Picture of 10 NOVA floats (www.metocean.com).

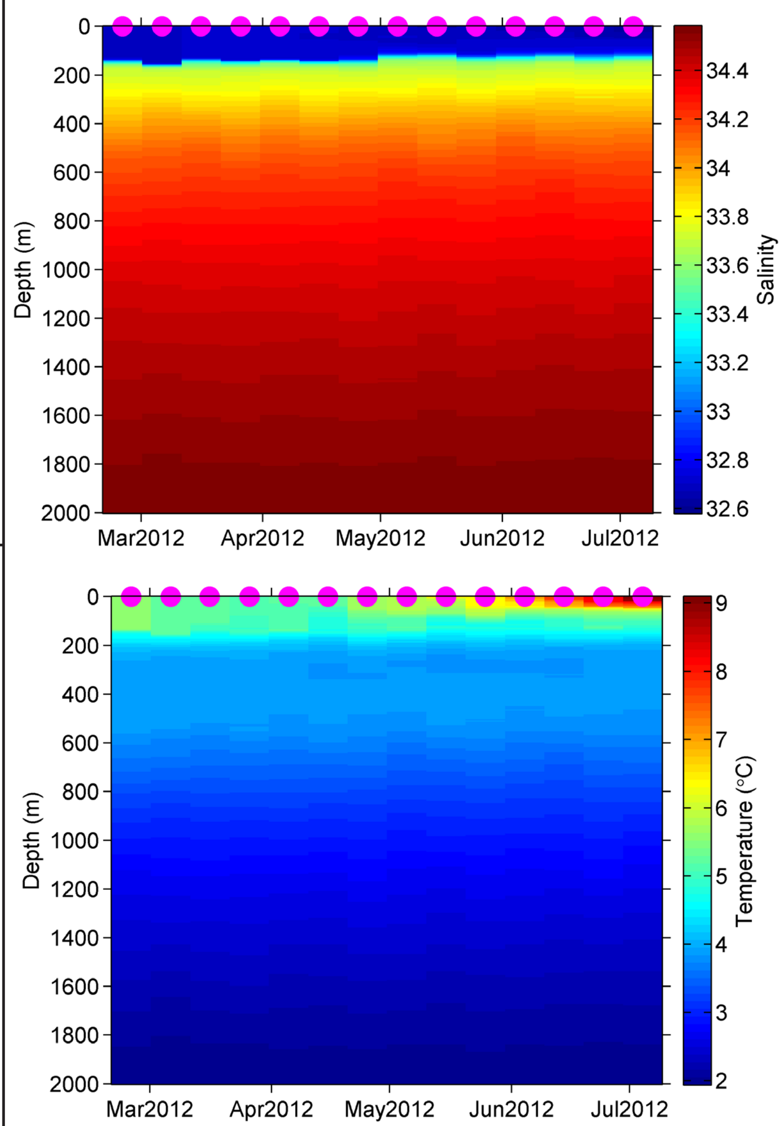


Figure 2. Salinity (upper) and temperature (lower) contours from the first 14 profiles of NOVA float serial number 17 in the vicinity of station Papa in the NE Pacific.

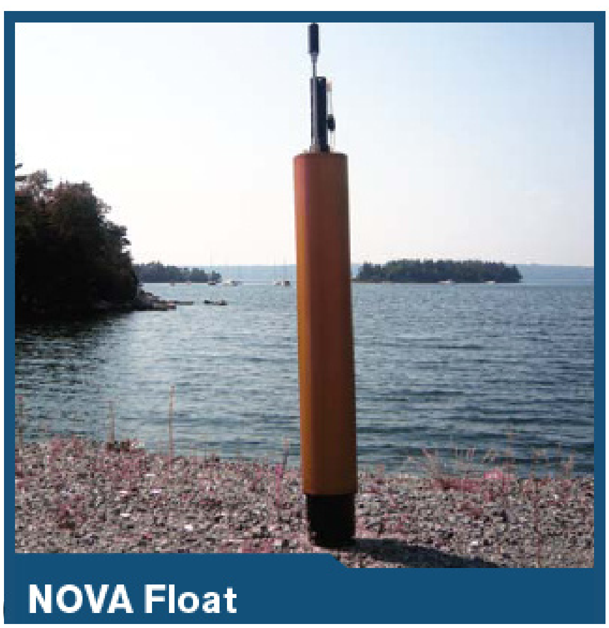


Figure 3. Picture of a NOVA float (www.metocean.com).

Report on the Thirteenth Argo Steering Team Meeting

Megan Scanderbeg [mscanderbeg@ucsd.edu]

Meeting Summary

The 13th meeting of the international Argo Steering Team was held in Paris, France on March 20-22, 2012. Both the IOC and IFREMER acted as hosts for the meeting. AST-13 focused on looking back over the first 15 years of Argo and evaluating if the current priorities are still appropriate. Additionally, the AST looked at whether the Argo core is being maintained while also extending into areas endorsed by OceanObs'09.

Implementation issues

D. Roemmich gave a presentation focused on what contributed to successfully taking Argo from an idea to a functioning program. In light of Argo looking to potential major enhancements, Roemmich presented, and then led a discussion, on the key ingredients that helped form Argo:

- A cost effective and transforming technology
- A well-justified but basic statement of requirements (program design)
- Consensus among user groups on value (science, operational applications, policy, education)
- Entrainment of agency sponsors/collaborators
- International scientific collaboration
- Intergovernmental coordination
- Commercial partnerships
- The final ingredient: determination

In 2012, Euro-Argo will set up its new European legal structure (Euro-Argo ERIC) that 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. A new proposal (E-AIMS: Euro-Argo Improvements for the GMES Marine Service) was also recently accepted and will allow European partners to test new generations of Argo floats (e.g. oxygen, biogeochemical, Arctic and deep floats) and to analyze the impact on ocean analysis and forecasting centers, climate centers and satellite validation. Euro-Argo plans to deploy 216 floats in 2012 and this number will increase in 2013 with the first EU floats (E-AIMS). Part of the Euro-Argo floats are in regional or marginal seas (> 50 floats/year).

S. Riser reported on a proposal to create a Science and Technology Center dedicated to examining Southern Ocean Biogeochemical Observations and Models that has been submitted to the US National Science Foundation, with a decision expected late in 2012 or early in 2013. The plan for this Center is to fabricate and deploy 50-60 profiling floats per year in the Southern Ocean (i.e., in the Southern Hemisphere south of 30°S), with each float equipped with oxygen, nitrate, pH, fluorometer, and particulate backscatter sensors. The deployments would be carried out from research vessels, with ancillary shipboard carbon and biogeochemical data collected during deployments.

Two talks were given on different sampling schemes used in marginal seas - one focused on the Mediterranean Sea and another on the Sea of Japan. In both cases, the seas are sampled more densely than the 3° x 3° degree open ocean plan. The float lifetime is shorter in both seas, but there is hope this will be improved with Iridium and with setting the drift depth to shallower than 1000 db. In both seas, the floats are being used to monitor temperature and salinity and are being used in models. There have been some issues with where floats can be deployed in the Sea of Japan due to EEZ issues and there is some difficulty with Argo DMQC due to the lack of CTD data.

Data Management related issues

S. Pouliquen presented an overview of the ADMT status and activities in the past year. Changes include a new co-chair, A Gronell-Tresher, who is replacing M. Ignaszewski after he stepped down. Two phone meetings are now held each year to encourage more action on items earlier in the year and the first meeting went well. Both real time and delayed mode activities are working well and the action on standardization (Technical and metadata files) is progressing according to schedule. S. Pouliquen also mentioned that a "DAC Instruction/cookbook" which aims at gathering procedures to be applied by DACs that do not fit into the User manual or the QC manual is under construction with M. Scanderbeg acting as the book coordinator. S. Pouliquen reiterated that, as many BGC Argo floats are, and will be deployed in near future, it is important to discuss how to manage and QC these sooner rather than later. It was agreed to hold a BGC data management workshop prior to ADMT-13 on the 13th November in India. S. Wijffels presented audit work done by J. Dunn based on the GDAC contents on 4 March 2012. In general, progress has been made in technical file surface pressure parameter name compliance, with three non-compliant names still in use. For the TNPD floats, there was a small increase in the rate of correctly identified and flagged cases, and significant progress in repairing almost-correct SCIENTIFIC_CALIB_COMMENT strings. In terms of the surface pressure correction, there was a strong increase in agreement on pressure correction in recently processed (RT and DM) profiles. There are around 15,000 less missing or bad RT PRES_ADJUSTED data profiles, which might be largely due to changing Surface Pressure Parameter names to now indicate that the floats are of types that do not require adjustment. However there are still apparently > 70,000 such profiles, mostly at AOML. Some DACs, especially JMA, have made substantial progress here, but the situation appears worse at BODC and KORDI.

M. Scanderbeg reported on the Argo Trajectory Workshop held the day before ADMT-12 last fall in Seoul, Korea. The objectives of the workshop included improving the quality and consistency of data that is currently in trajectory files and how to improve and migrate to a new trajectory file format. A two step process was developed to try and improve the trajectory files. First, the new trajectory file format suggested by a small working group was agreed upon with the caveat that a DAC cookbook is needed to help DACs understand how to correctly fill all the cycle timing variables included in the format. Secondly, the workshop addressed the problem of how to improve older float data. The idea is to build on work done by the ANDRO team to fill velocity product files called "TRAJ2" files. The TRAJ2 files will be similar in format to the new trajectory file format, but with increased flexibility for additional variables that might include extrapolated positions, velocity estimates, etc. Brian King and the ANDRO team have agreed to work towards producing these product files which will likely be served on the GDACs.

Technical issues

A series of talks were given updating the status of several different float types. See the articles on the NOVA float and the ARVOR/PROVOR developments in this newsletter.

S. Riser discussed issues related to Apex floats and stated that the APF9 controller used in APEX floats since 2003 will soon be obsolete due to the end of production of one of the main electronic components on the controller board. Replacing this component requires hardware redesign and new firmware which often takes 1-2 years to complete. Engineers at Teledyne/Webb are working on this project, with the new controller called the APF11. Only a limited number of APF9 boards remain in stock at Teledyne/Webb, but it is essential that the work on the new APF11 be completed rapidly so that the new board can be fully tested and debugged before the stock of APF9 boards is exhausted.

B. Owens reported on the SOLO-II design that has been commercialized to MRV, LLC. MRV delivered 20 floats to Scripps which were deployed in October 2011. 60 SOLO-II floats manufactured by the Scripps Instrument Development Laboratory have also been deployed. There have been minor problems that have been corrected through a redesign of the external bladder and GPS board and manufacturing technique of the antenna and minor changes in the float software.

G. Johnson supplied a report on PMEL's recent experience with Seabird Navis floats. The Navis float is an Iridium/GPS float using RUDICS for data transmission with firmware based on the APF-9 (UW – Swift & Riser). As of 7 March 2012, 17 floats had been delivered to PMEL and five of those floats had been deployed. Those five floats had reported between 1-5 profiles and appeared to be functioning normally.

T. Suga reported on work done at Tsurumi Seiki Co. and JAMSTEC to develop the "Deep NINJA", which has an ability to measure

PTS profiles at the depth of up to 4000 dbar. The first prototype was tested in Sagami Bay in 2011. Further deep ocean testing will be carried out in summer 2012, and then a (small) fleet of Deep NINJAs will be deployed in the Southern Ocean during R/V Mirai cruise in 2012/13 austral summer. Deep NINJA is planned to be available for public in 2 – 3 years.

D. Roemmich briefly updated the AST on the Deep SOLO float. The target depth is 6000 db, with an expected lifetime of more than 100 cycles. Prototypes will likely available at the end of calendar year. There is not a specific plan yet for a pilot deployment. Initially the Deep Solo will go into not so deep water near San Diego.

Two reports were given on oxygen measurements and quality control. The first was done by S. Riser and it summarized results from the dissolved oxygen data workshop held in Brest, France in May of 2011. A number of important issues relevant to float oxygen data were discussed and several important conclusions were made. It was noted that floats should transmit all the raw data collected by the float oxygen sensor rather than computing oxygen on board the float and transmitting only the computed value. Using all the transmitted data, an initial estimate of dissolved oxygen on the float can be made. Additionally, the factory calibration of the most commonly used variety of sensors is known to be relatively poor, so this initial estimate must be adjusted to either the local oxygen climatology or to shipboard data collected at the time of float deployment. Since the most commonly used sensors do not show appreciable drift over time, acquiring calibration data at the time of deployment is very valuable and should be done whenever possible.

D. Gilbert reported on the possibility of developing oxygen quality control procedures. The SOLAS/IMBER subgroup 2 on ocean interior biogeochemistry changes, headed by Niki Gruber (ETH-Zurich), expressed the desire to play a role in the quality control of Argo-O2 data, so that Argo-O2 float profile files may have useful quality flags and error estimates on the GDACs. Virginie Thierry and others suggested that the Argo-O2 quality control group should meet immediately before or after the annual ADMT meeting in Hyderabad, so as to facilitate the two-way exchange of technical information between the oxygen experts and the Argo data management team. Finally, Steve Diggs pointed out that CCHDO can assist in building a high quality reference database for oxygen in a manner similar to what it currently does for regularly updating the high quality reference database that Argo uses for delayed mode quality control of salinity.

J. Turton reported on work done evaluating near-surface temperatures (NST) and interacting with the GHRSST community. Argo provides an independent data set for GHRSST to validate their product. As such, GHRSST would prefer the highest possible vertical resolution, without stringent accuracy requirements. During 2011, an analysis of 3,007 profiles (recorded between October 2008 and May 2011) from 54 NST-capable floats was made. On the NST-capable floats, the deeper cross-calibration measurements suggest the agreement of pumped and non-pumped measurements is sufficiently good and the various results suggest that the accuracy of the un-pumped temperatures is sufficient for GHRSST's requirements. A key question was how close to the surface can we safely go with the pump on to ensure delivering the most accurate data, before turning the pump off to avoid contaminating the salinity sensor. Scripps's SOLO-II (Iridium) floats provide continuous profiles at 2 dbar resolution with higher (1 dbar) resolution above 10 dbar until the pump is switched off at 1 dbar (but where the surface pressure is reset for every profile to remove drift). This sampling should resolve all but the most shallow of features. Other operators are more cautious, switching the pump off between 2 and 5 dbar and there is a need to investigate whether leaving the pump on for longer has any effect on the quality of the salinity measurements.

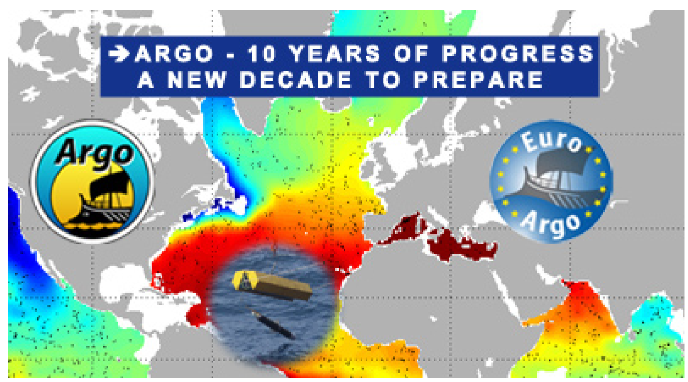
Demonstrating Argo's value

The 4th Argo Science Workshop (http://www.ifremer.fr/forms/?p=558) will be part of the large symposium "20 Years of Progress in Radar Altimetry" organized by ESA&CNES from September 24 to September 29 2012 in Venice, Italy. The theme of the workshop will include 1) a review of Argo achievements in ocean and climate research and 2) float technology and science discussions on the development on the new phase of Argo (sustaining Argo, developing extension towards biogeochemistry, deep ocean and polar regions). The program (http://www-argo.ucsd.edu/Argo-Venice-Agenda-June-2012-V2.pdf) has recently been published and includes two and a half days of talks as well as a morning poster session. AST members are strongly encouraged to participate to this major event and should relay this information to their national Argo teams.

M. Scanderbeg presented work done in the last year on the bibliography pages on the AST web site. Argo has over 1100 papers published since the start in 1998. There were over 200 papers published in both 2010 and 2011. This jump by about 50 papers over 2009 probably reflects the improved visibility after OceanObs'09. A few plots are maintained on the web site including the number of papers published per year and per country. A new plot was added showing the number of papers published in the top journals. Based on citations submitted through national reports, searches for Argo papers are successful. All of these plots and the current bibliography for 2012 are included in this newsletter.

John Gould presented a mid-term review of the Argo program, looking back to the start of Argo around 2000 and towards a future horizon at 2020. See his article in this newsletter to learn more.

Timetable of Argo meetings		
2012-2013		
September 27 - 29 2012	Venice, Italy	4th Argo Science Workshop
November 12-16, 2012	Hyderabad, India	ADMT-13 and Bio-Argo Workshop
March 2013	Wellington, New Zealand	AST-14



The theme of the Argo workshop is to celebrate 10 years of progress for Argo and to prepare the next decade and new challenges for Argo. The 2.5 day workshop will include both oral and poster presentations. It will include a review of Argo achievements in ocean and climate research (e.g. heat and salt budget, large scale seasonal and interannual variability and ocean circulation, mesoscale variability, marginal seas, ocean analysis and forecasting) and float technology and science discussions on the development on the new phase of Argo for the next decade (sustaining Argo and developing extension towards biogeochemistry, deep ocean and polar regions).

The general objectives of the Workshop are (i) to stimulate more research using Argo data, especially in combination with altimetry, (ii) to entrain young scientists into the Argo community (iii) to strengthen communications between the Argo and altimetry groups (iv) to further increase the visibility of the Argo Program (v) to broaden the discussion of Argo's future evolution.

Meeting registration will be via the altimetry symposium WWW site (http://www.altimetry2012.org).

The Sailing World and Argo

compiled by Megan Scanderbeg [mscanderbeg@ucsd.edu] and co-authors

Skipper Stève Ravussin deploys Argo float in the Atlantic

Sourced from: http://www.unesco.org/new/en/natural-sciences/ioc-oceans/single-view-oceans/news/navigator_steve_ravussin_deploys_argo_float_in_the_atlantic/

© Yvan Zedda / Sea & Co / MOD S.A *Race for Water*, the trimaran flagship vessel of the Multi One Attitude Foundation

While delivering the MOD70 boat *Race for Water* to New York, skipper Stève Ravussin took action in favor of ocean preservation: he deployed an Argo float. The boat *Race for Water* is the ambassador of the Multi One Attitude Foundation, which has chosen to use sailing as a means to raise awareness on two essential issues: the preservation of oceans and the reduction of the water footprint. *Race for Water*, skippered by swiss navigator Stève Ravussin and his crew, took part in the Krys Ocean Race, a transatlantic race starting in New York (United States) on 7 July and arriving in Brest (France) around 14 July, carrying the Foundation's message across the ocean.

The *Race for Water* crew proudly deployed an Argo float (WMO#6900910) on 20 June 2012, for the Coriolis Argo team in Brest, as part of the partnership between the Foundation and UNESCO's Intergovernmental Oceanographic Commission (UNESCO-IOC). Watch a video of the deployment here: http://www.youtube.com/watch?v=uCZtdcyg1i0&feature=youtu.be. Another MOD70 competitor, *Foncia* skippered by Michel Desjoyeaux, also deployed an Argo float (WMO#6901407).

Both crews took Argo profiling floats on their journey to New York to evaluate the feasibility of deploying such instruments to fill gaps identified in the global array that are difficult to reach. The ocean changes continuously and must, as a result, be observed constantly. A better understanding of the ocean is needed to improve climate projections, reduce the risks stemming from storms and floods, steer international actions and optimize governmental climate change mitigation policies.

"The Argo community thanks these great sailors for their contribution and the Multi One Foundation for developing such a partnership with UNESCO" said Mathieu Belbeoch, technical coordinator of the Argo programme for UNESCO. "The ambassador boat *Race for Water* gives us a wonderful opportunity to promote our global observing system further. I hope such first successful deployments will introduce a longer cooperation. We need to deploy 1,000 of these units every year!"

You can follow the floats' progress on Google Earth (http://argo.jcommops.org/argo.kml). The crew of the *Race for Water* deployed float 6900910, while the *Foncia* crew deployed float 6901407. So far both floats have completed four cycles.

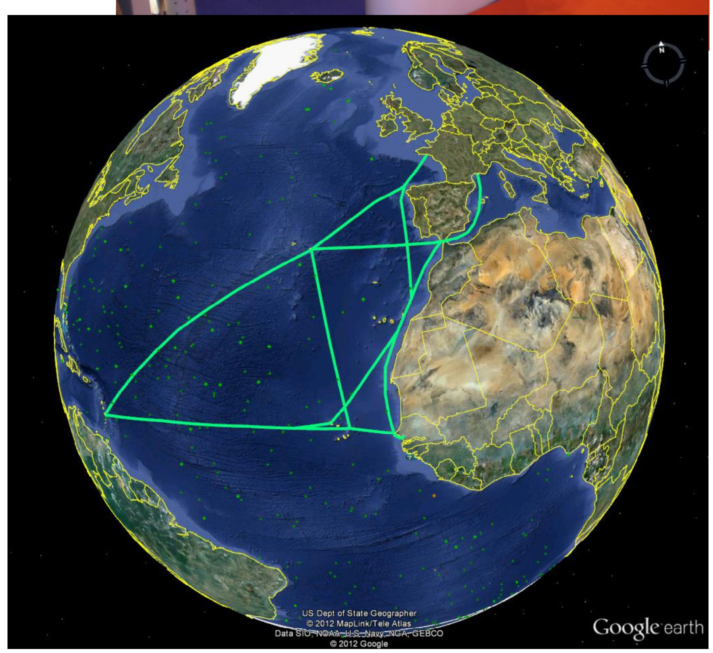
Voiles sans frontières

Mathieu Belbeoch [belbeoch@jcommops.org]

Voiles sans frontières is a unique French NGO that recruits 20 ships every year to reach remote areas and deliver medical care and education. This year, 16 ships agreed to load and deploy floats for Argo. Similar to other ships with two missions, there is a potential for large spatial coverage, but it is dependent upon the routes chosen for that year. Oftentimes the ships move between West Africa and the West Indies.

There is a great chance for outreach on these trips as the ships travel to different places in Africa and Europe.

The current cost is 500 euros/float deployed.



Photos and Google Earth track courtesy of Argo Technical Coordinator

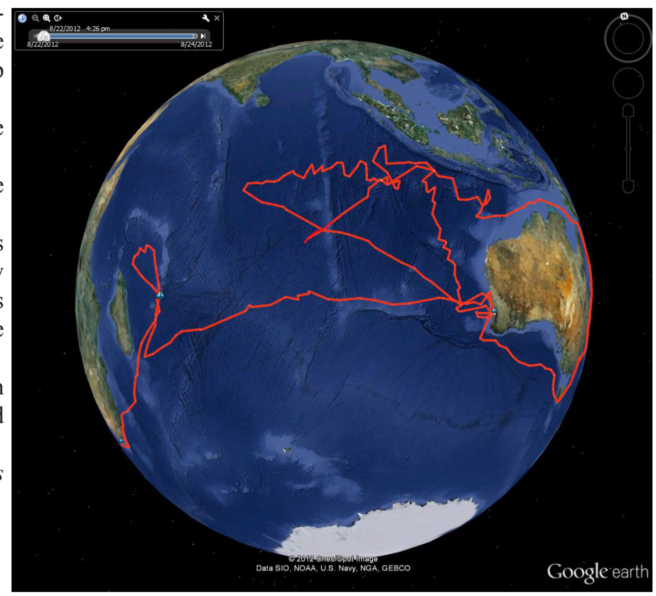
Update on the *Lady Amber*

sourced from: http://www.unesco.org/new/en/media-services/single-view/news/enlisting_sailing_vessels_to_help_build_a_global_ocean_observing_system/

Recently a South African education sailing ship, *Lady Amber*, has been enlisted to deploy Argo floats in parts of the Southern Indian Ocean which are otherwise seldom visited by research or cargo vessels. After a year of operations in the Indian Ocean for Argo Australia, under UNESCO, and JCOMM, the *Lady Amber* arrived in Perth Australia, where she was greeted by the IOC Perth Regional Programme Office and Australia's CSIRO. The crew deployed about 57 floats in 2011 for CSIRO and have taken some risks at sea for Argo, crossing storms, tropical cyclones. After celebrations in Perth the *Lady Amber* will continue its journey to Hobart to meet with the Argo officials from CSIRO.

The Argo floats deployed off the *Lady Amber* constitute a major contribution to the Indian Ocean Observing System and will assist scientists better understand and be able to predict the Indian Ocean's dynamics, and thereby lead to societal benefit as that understanding and associated products transfer to Indian Ocean communities through the Indian Ocean Global Ocean Observing System (IOGOOS) framework.

Mathieu Belbeoch, the Argo technical coordinator, points out that "After a decade of implementation using mainly research vessels and merchants ships, the global programmes are now investigating green, flexible, free or non-profit based, and dedicated deployment platforms. The JCOMMOPS office is currently setting up partnerships with diverse sailing communities, including NGOs (such as Voiles Sans Frontières in the Atlantic Ocean), sailing races or individual explorers, scholarships, etc. In a context of constant pressure on economy, including on ship time budgets, we need to be inventive and set up win-win cooperations.



Finally we need to humanize GOOS and tell the public stories of people involved in its day to day implementation.

The Lady Amber then stopped in Hobart, to celebrate a successful cruise with its main sponsor (Argo Australia, CSIRO), before going back to CapeTown.

In Cape Town (around October) the *Lady Amber* will load about 50 floats from the US Argo program (WHOI) to be deployed in the South Atlantic, and a few drifters (AOML). Final routes are currently being set up (see map). The ship is right now in the middle of the Indian Ocean and will stop in Mauritius to do some outreach on Argo.

The establishment of a dedicated coordinator for ship logistics within JCOMMOPS in 2012 will permit us to continue to explore these opportunities, and better assist float/buoy programmes in their operations."

A Google Earth application tracks the progress of the *Lady Amber's* cruise: ftp://ftp.jcommops.org/JCOMMOPS/Cruises/JCOMMOPS_ZR2335.kml

Photos and Google Earth track courtesy of Argo Technical Coordinator

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Ships Logistics Coordinator Position Open

The JCOMM in-situ Observations Programme Support Centre is seeking international candidates for a new Technical Coordinator position, to act as focal point for all ship based activities related to the implementation of global ocean observing systems supported by JCOMMOPS.

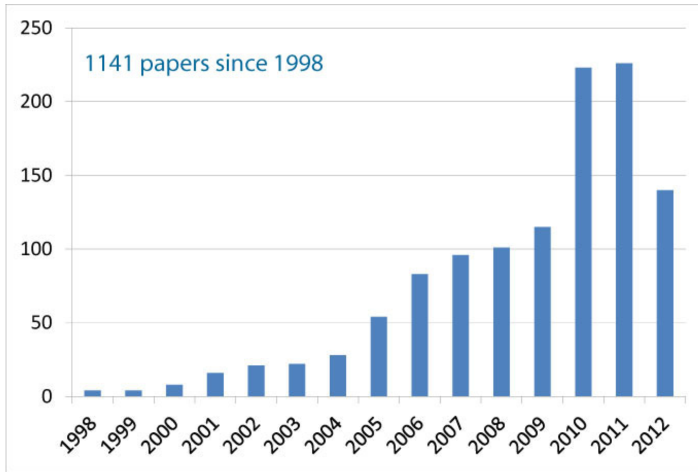
The position is full time in Toulouse, France at CLS. For more information see: http://www.jcommops.org/FTPRoot/JCOMMOPS/Jobs/Ship%20Logistics%20Coordinator-10052012.pdf

Closing date is August 31, 2012.

How to apply
Candidates should send a curriculum vitae and cover letter via regular mail or Internet to JCOMMOPS:
Mathieu Belbeoch 8-10 Rue Hermes Parc Technologique du Canal 31526 Ramonville
France
belbeoch@jcommops.org +33 5 61 39 47 30

Bibliography

Number of papers including Argo data by year



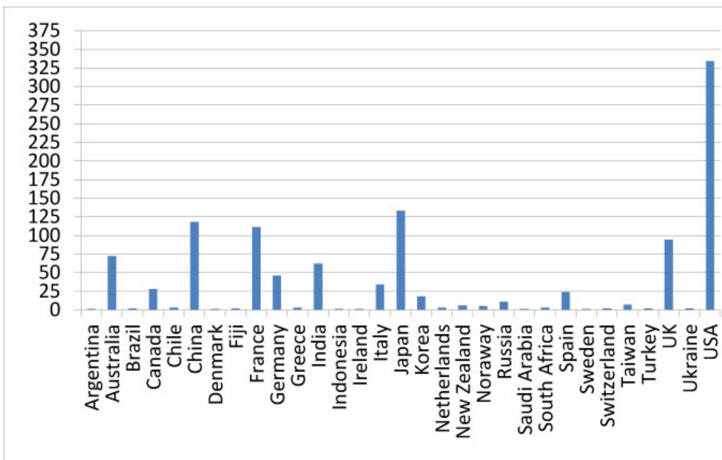
Unlike in past Argonautics newsletters, the list of papers published using Argo data in 2012 will not be listed because the number is close to 150. This brings the total number of papers published using Argo data since 1998 to over 1100. The complete list is always available online at http://www.argo.ucsd.edu/bibliography.html.

Instead, I have included the three plots that are displayed at the top of the Bibliography page. These plots show the number of papers published as a function of year, first author's country of origin, and journal.

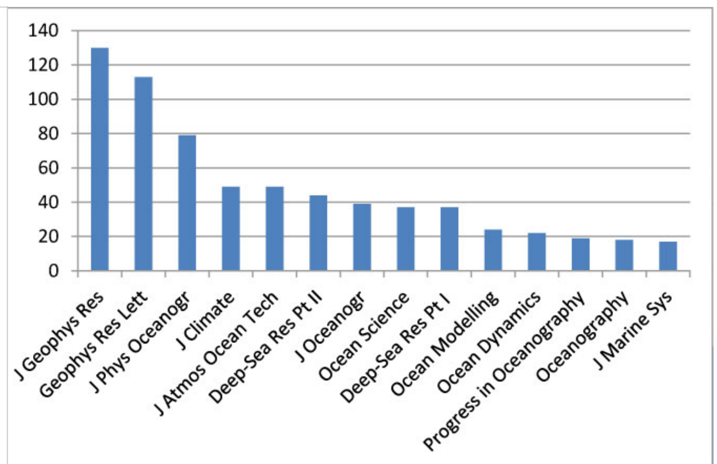
There is also a lengthy list of papers in press which can be viewed at http://www.argo.ucsd.edu/Argo_research_in_press.html. As usual, I always like to receive any citations related to Argo data - either in press or already published. Please send argo@ucsd.edu an e-mail.

I am investigating adding an additional bibliography comprised of Ph.D. theses using Argo data. If you know of any such theses, or databases containing theses, please send argo@ucsd.edu an e-mail.

Number of papers including Argo data by first author's country



Number of papers including Argo data by journal



Update the Argo bibliographies

Please send argo@ucsd.edu citations for Argo articles submitted, in press, or published to keep the bibliographies updated.

New Argo Thesis Bibliography

A new bibliography containing Ph.D. theses using Argo data is being compiled. This new feature will be added to the Argo website in early 2013. If you know of any theses that have been written using Argo data, please email the citation to argo@ucsd.edu. This list will help showcase the impact Argo is having on education and the training of new scientists.

How to Acknowledge Argo Data

The Argo Steering Team encourages the use of a standard acknowledgement in publications that use Argo data: "These data were collected and made freely available by the International Argo Program and the national programs that contribute to it. (www.argo.ucsd.edu, argo.jcommops.org). The Argo Program is part of the Global Ocean Observing System". People using Argo float data should, as a courtesy, contact the person responsible for the floats used and outline the type of research or analysis that they intend to carry out.

Argonautics is the Newsletter of the International Argo Project
Please send articles for *Argonautics* to argo@ucsd.edu or to Mathieu Belbéoch, Argo Technical Coordinator (belbeoch@jcommops.org)
Permission to quote an article from *Argonautics* should be obtained from the author.

Information about Argo can be found at www.argo.ucsd.edu and from the Argo Information Centre at argo.jcommops.org. The AIC site includes information about the present and past distribution of Argo floats. Argo data may be downloaded from the Global Data Centers www.usgodae.org/argo/argo.html and www.ifremer.fr/coriolis/cdc/argo.htm