

Argo Australia – 2014 Activities

Report to the Argo Steering Team

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Australian Bureau of Meteorology and CSIRO
CSIRO Oceans and Atmosphere Flagship

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1. Status of implementation

Floats deployed and their performance

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

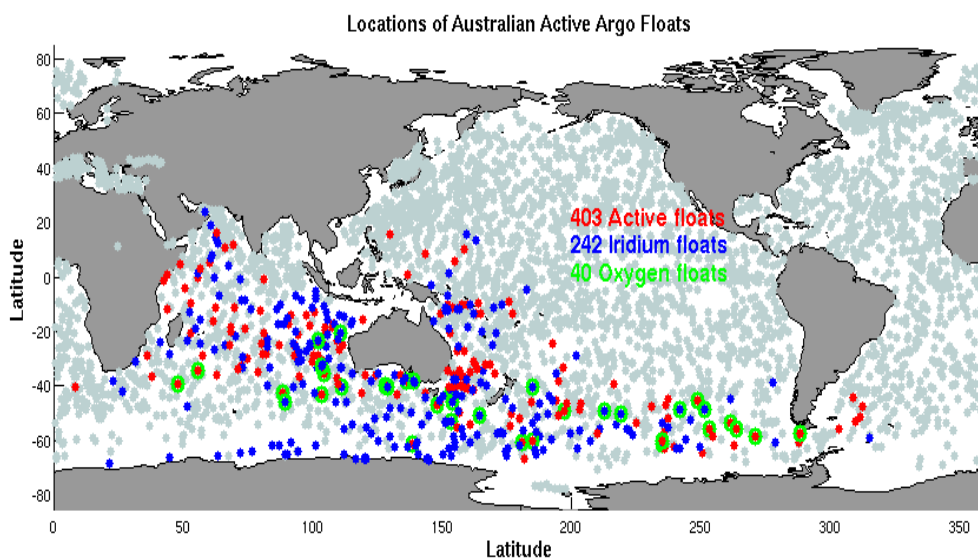


Figure 1. Locations of active Argo Australia floats (colours – defined as float reporting in the last 30 days north of 55°S, in the last year south of 55°S) as of March 2014 with active international floats in gray. Australian floats using Iridium Communications are in blue and those equipped with oxygen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

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

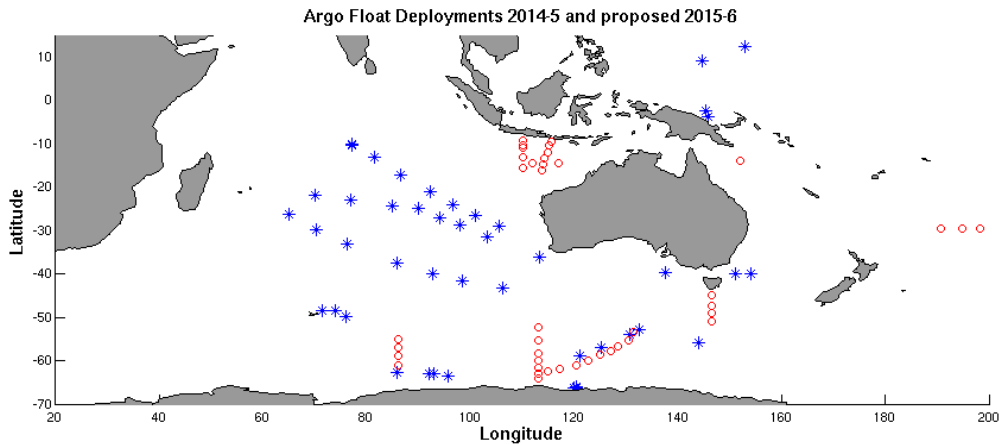


Figure 2. Locations of float deployments in 2014 (*), with proposed deployments for 2015-6 (o)

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

Technical problems encountered and solved

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

Float Failure Mode Analysis

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

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

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

Summary of Technical Issues

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

Status of contributions to Argo data management

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

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

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

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

Status of delayed mode quality control process

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

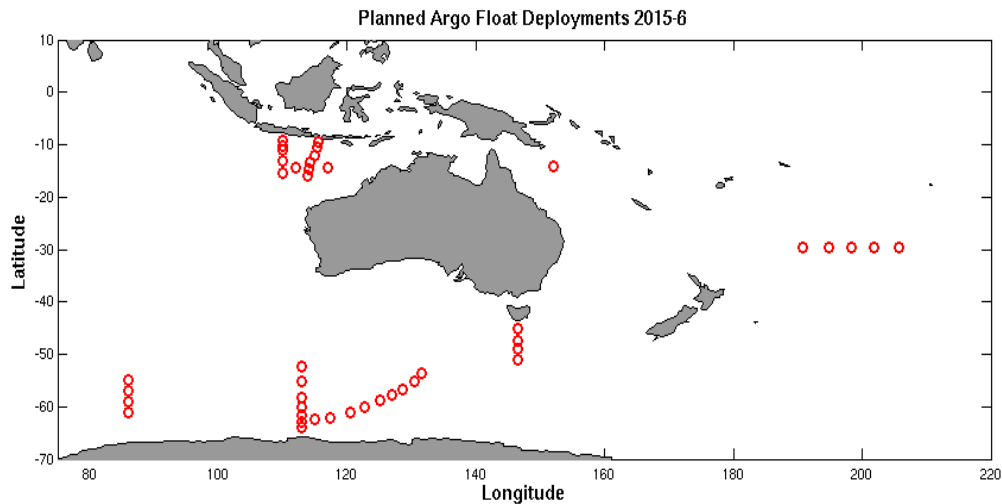


Figure 3. Proposed Locations of planned float deployments over the next year

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

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

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

Real Time data documentation:

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

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

5. Issues to be raised with the Argo Steering Team

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

6. CTD cruise for Argo calibration purposes

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

7. Argo Publications

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