

Argo Australia – 2013 Activities

Report to the Argo Steering Team

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1. Status of implementation

Floats deployed and their performance

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

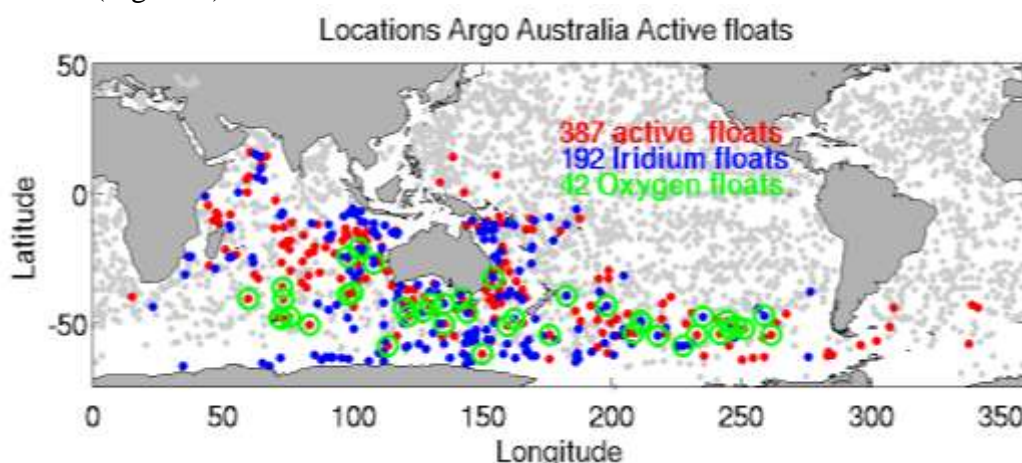


Figure 1. Locations of active Argo Australia floats (colours – defined as float reporting in the last 30 days north of 55°S, in the last year south of 55°S) as of February 2014 with active international floats in gray. Australian floats using Iridium Communications are in blue and those equipped with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

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

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

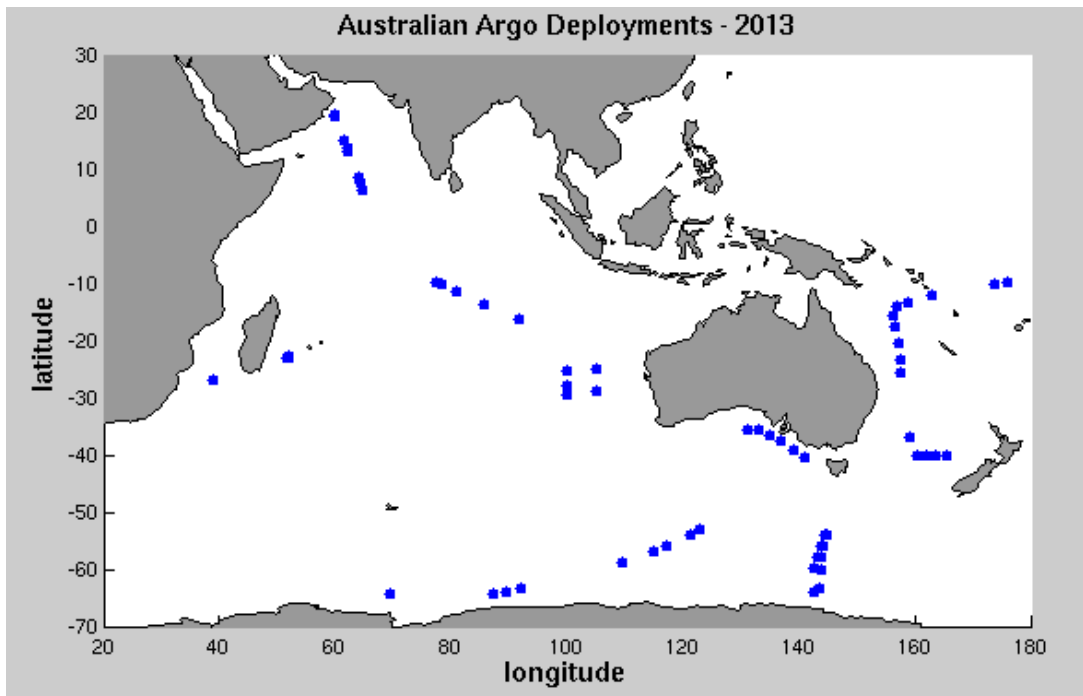


Figure 2. Locations of float deployments in 2013

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

Technical problems encountered and solved

Only 47 floats in our Iridium fleet have not been switched to RUDICS communications (they will be changed shortly – it was a provider issue and took us a long time to set up the RUDICS server with the local service). The changeover has decreased our costs significantly. Technical problems in the core fleet have been very few this year, aside from the Proof of Concept floats. Our fleet is also aging and we are now losing many of our floats as they reach operating ages of 7 or 8 years. Deployments have been able to fill the gaps caused by these losses.

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

Float Failure Mode Analysis

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

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

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

Summary of Technical Issues

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

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

Status of contributions to Argo data management

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

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

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

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

Metadata Standardisation: Esmee van Wijk, Ann Thresher and Matthieu Belbeoch (with the help of the broader Argo community and manufacturers) have been working on making the content of the global metadata files consistent. A table of fixed configuration parameter names exists on the ADMT website so that file content is standardised. Any new names required for new floats etc. must be added to this table and vetted for consistency before being used in the files. Work on unifying the labelling of data formats is continuing. The

manufacturers have been asked to provide a unique data format label with all new floats and manuals. The task to identify old float formats is ongoing but will take some time.

Status of delayed mode quality control process

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

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

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

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

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

In total 480 floats have been assessed through the DMQC process for drift of the salinity sensor, many of these are now assessed in routine maintenance mode. Of these, 10 floats (2%) returned no data from deployment and 10 floats (2%) returned bad data for most of the record due to pressure sensor issues, cracked conductivity cells or other hardware problems. Of the remaining 460 assessable floats, 410 (85%) show no salinity drift for the life of the float. A further 40 floats (or 8%) show a positive salinity drift. Ten floats (2%) are affected by a fresh offset or biofouling. Most floats with either a salty or fresh drift were able to be corrected using the OW software. A further 16 floats (3%) suffered from TBTO fouling at the start of the record, generally only the first or second profiles but in some cases up to 7 profiles.

Detailed descriptions of the quality control process, including the data and plots for each float are available at the following CSIRO website:

<http://www.cmar.csiro.au/argo/dmqc/index.html>

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

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

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

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

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

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

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

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

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

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

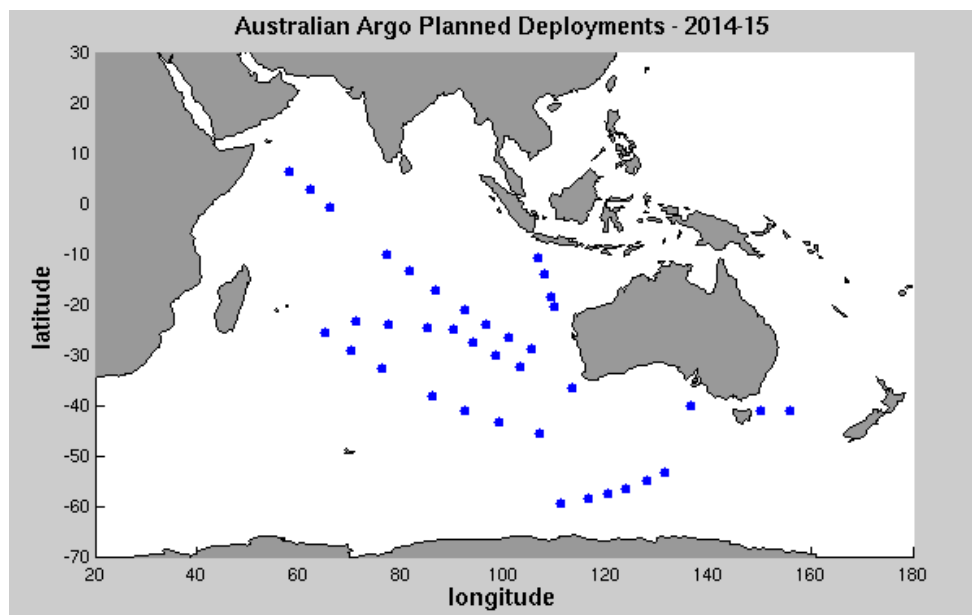


Figure 3. Proposed Locations of planned float deployments over the next year

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

- Argo data are routinely used in the operational upper ocean analyses Australian Bureau of Meteorology (<http://www.bom.gov.au/bmrc/ocean/results/climocan.htm>).
- The dynamical seasonal forecasting system POAMA heavily uses Argo data for forecast initialization, including assimilating salinity which greatly improves the analysis – Oscar Alves, Australian Bureau of Meteorology
- CSIRO Marine and Atmospheric Research, in collaboration with the Bureau of Meteorology Research Center, has developed an ocean model/data assimilation system for ocean forecasting and hindcasting. Argo data is the largest *in situ* data source for this system. The ocean reanalysis products can be found here: <http://wp.csiro.au/bluelink/global/bran/>.
- The OceanMap forecasts are now routinely published and are available via the Bureau of Meteorology website.
- Many students in the CSIRO/University of Tasmania graduate program and University of New South Wales are utilizing Argo data in their thesis studies.
- Jeff Dunn is refining a global ocean climatology based on Argo data - <http://www.marine.csiro.au/~dunn/cars2009/>

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

Real Time data documentation :

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

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

5. Issues to be raised with the Argo Steering Team

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

6. CTD cruise for Argo calibration purposes

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

7. Argo Publications

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