Argo Australia – 2009 Activities

Report to the Argo Steering Team

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1. Status of implementation

Floats deployed and their performance

Australia currently has 249 active floats distributed across the Indian and South Pacific Oceans (Figure 1)

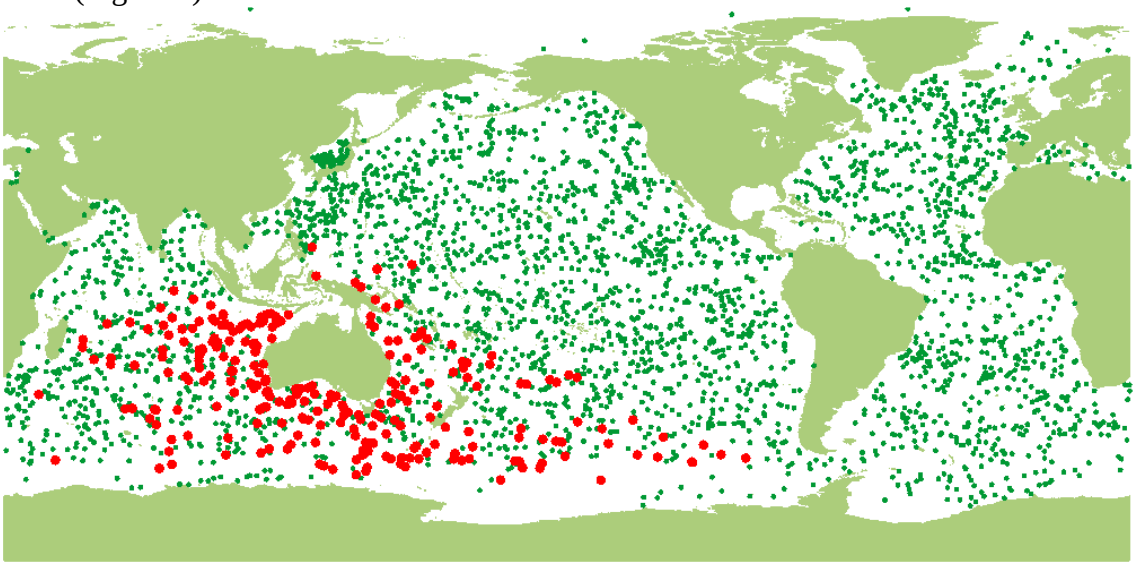

Figure 1: Locations of active Argo Australia floats (red) with active international floats in green (Argo Information Centre, March 2010).

Due to the deployment suspension associated with the Druck pressure sensor microleaks, Argo Australia deployed only 35 floats in 2009 (down from 81 the previous year). However, as floats became available again near the end of 2009, deployments are rapidly catching up, with 33 already deployed since January 2010.

Of the 35 deployed in 2009, 16 are equipped with Iridium transmitters and the rest had standard Argos transmitters, reflecting a move towards the increased use of Iridium communications to about 50% of new acquisitions. Ice-avoidance algorithms are active on 9 of these, with 4 deployed in the seasonal ice zone as a result of a one-off expansion in funding. Nine of this 2009 cohort are equipped with oxygen sensors (Optodes). Due to the lack of vetted Druck pressure sensors, we also took the opportunity to pilot the use of Kistler pressure sensors, deploying 7 floats off the repeat CLIVAR line along 32°S. So far, this cohort appears to be returning sensible data with little sign of surface pressure drift.

Argo Australia uses APEX floats manufactured by Teledyne Webb Research Corporation. When re-equipped with lithium batteries and carefully tested and inspected before deployment, APEX appear to be able to deliver well beyond the anticipated 3.5 years of useful life.

Securing deployment opportunities into array gaps in our region is becoming a key focus of the program. This year we partnered with the US and New Zealand programs to secure deployments of both US and Australian floats into the South Indian and Great Australian Bight (over 50 floats were deployed last month). We also took advantage of US repeat hydrographic activity in the South Pacific to deploy floats out of Brisbane with high-quality CTD data taken on deployment. These floats are equipped with a new pressure sensor (Kistler) which will be assessed for stability and accuracy, informing the global program in the face of difficulties with the current sensor (Druck).

Float Failure Analysis

As of the end of January 2010, Argo Australia had deployed a total of 293 floats. Of these, 49 are dead, 6 are suspect and 3 are returning bad data. Of these dead floats, only 9 ceased to operate due to 'natural causes' – that is, they ran down their battery packs. Most floats have died prematurely due to various environmental factors or failure modes.

Based on the sensor and technical data from the dead floats, we find that environmental factors are the biggest cause of float failures, including loss in the ice zone and groundings (see table below). We anticipate that as ice-avoidance algorithms are refined and with the broader adoption of Iridium communications reducing surface times drastically, the frequency of these failures will go down.

Summary of float failure mode (excluding those caused by natural causes i.e. end of battery life)	**Number of floats***	**% of dead floats***	**% of total floats***
Environmental factors (grounding/ice)	18	44	6
Hardware faults	7	17	2
Software issues	7	17	2
Human interference/error	4	10	1
Unknown	5	12	2
Total	41	100	14

*** only floats in the Australian array are included in this analysis**

Environmental category includes loss due to grounding and ice.
Hardware faults includes: motor backspin, leaking air bladder, failed potentiometer, transmissometer leak.
Software issues include: firmware bugs.
Human interference/error includes: floats turned on too early, picked up by fishermen.

Technical problems encountered and solved

The program was greatly impacted by the recall of the Druck pressure sensors. We also thank Dana Swift (University of Washington) for diagnosing this serious problem. We appreciated the prompt action of both the sensor and float manufacturers in alerting the community to this problem, working through its solution in a transparent manner. A pilot deployment of 7 floats with Kistler pressure sensors by Argo Australia in the South Pacific may help in assessing this alternative to the Druck sensor.

As our use of Iridium APEX floats is set to rise sharply we are closely tracking their performance. Of 36 deployed, 1 is leaking and 3 show incomplete or corrupt data.

2. Status of contributions to Argo data management

The program has been working with the Indian Argo program around adoption of the Australian realtime data processing software (http://www.marine.csiro.au/~gronell/ArgoRT/). This year, the Argo Australia delayed-mode system will also be tested and possibly implemented by India.

An analysis and correction of pressure drift errors in the global data set as available at the end of 2008 has been completed and submitted to the Journal of Atmospheric and Ocean Technology. This 'bias free' data set will be made available to the community once the paper has passed through peer-review (second-half of 2010).

3. Status of delayed mode quality control process

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

Of the eligible files, Australia has processed and submitted about 80% in delayed-mode. Full implementation of the global Argo reference data set and the Owens and Wong drift correction software is needed to complete the DMQC processing for the cohort of floats that display salinity drift.

Processing software was adapted to properly treat the Truncated Negative Drifting Pressure floats (APF8's are categorised into 3 types depending on the serial number and anomalous data checks). All Australian floats have been corrected for pressure drift (where possible), except the small number requiring salinity drift correction (these will be corrected over the coming months).

Of the 260 Argo floats assessed in DMQC, we find impressive salinity sensor performance – see Figure 2. Most float sensors do not show salinity drift (78% - Figure 2, top panel), 11% show drift after several years of profiles (Figure 2-middle) and 11% show drift from deployment onwards.

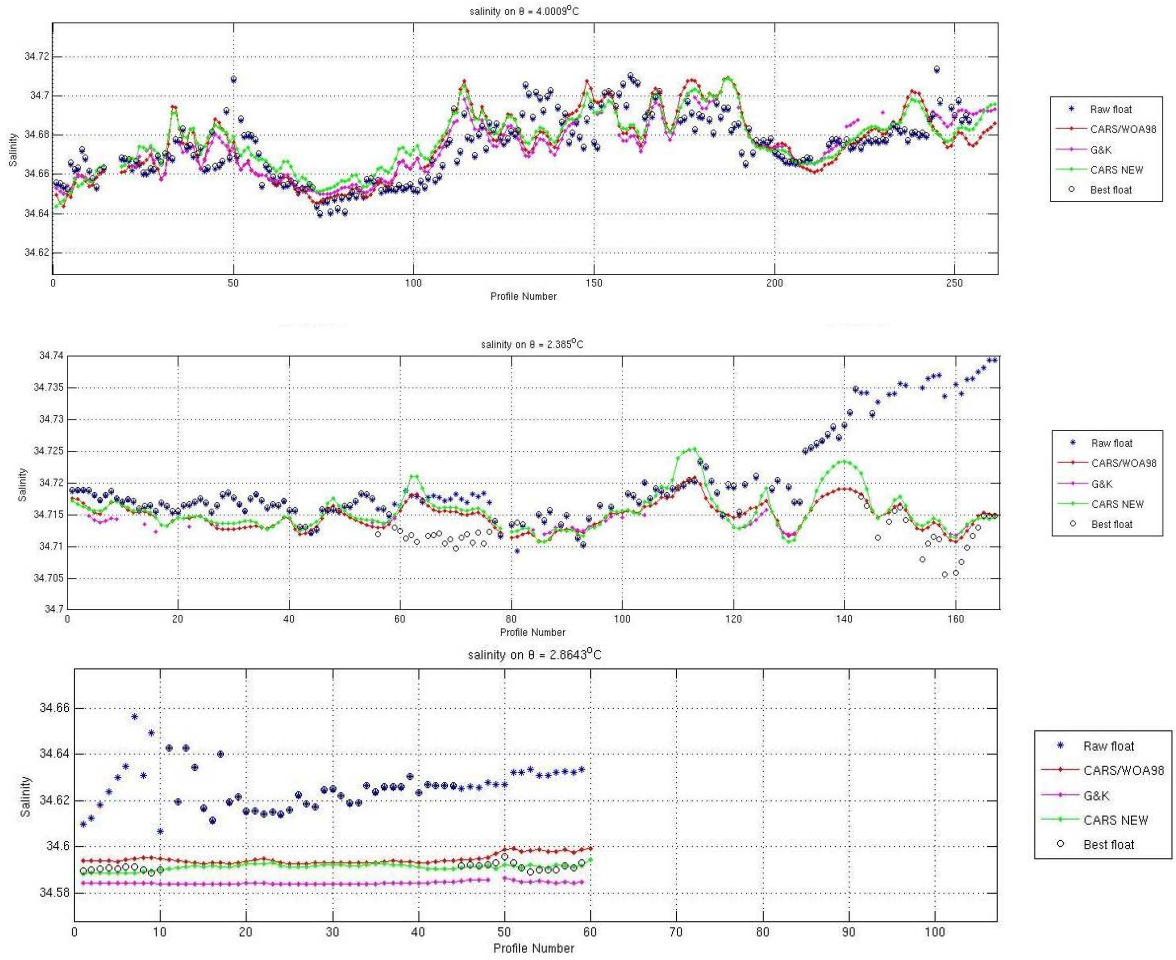

Figure 2: Salinity on a deep potential isotherm in 3 representative floats. Top – example of a float that does not drift after over 6 years of operation; Middle – typical example where drift arises after 100 profiles or so; Bottom – example where drift exists from deployment.

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

Argo Australia has been part of Australian Government initiative: an Australian Integrated Marine Observing System (IMOS; www.imos.org.au) for research infrastructure funded under the National Collaborative Research Infrastructure Initiative (NCRIS). Through IMOS, and if levels of support from our participating partners remains steady, Argo Australia will sustain deployments of 50-60 floats pre year and maintain an array of around 220-240 active floats. The NCRIS phase of IMOS was funded through June 2011. In early 2009, the Australian government announced an extension and slight expansion of IMOS via a new funding scheme, the Education Infrastructure Fund (EIF). This funding began in July 2009, and thus IMOS received a rapid injection of funds. Argo Australia was thus awarded funds to acquire and deploy an extra 40-50 floats in addition to its normal acquisition of ~50 floats before June 2010. Combined with the halt in float shipments due to the Druck pressure sensor recall, this presented a great challenge to the program. However, working with international partners and the manufacturers it appears the program will have acquired and deployed most of EIF-funding enhancement floats before June 2010 as required. EIF funding for Argo Australia is now secured through June 2013, and providing partner contributions remain

steady (CSIRO, Australian Bureau of Meteorology, Department of Climate Change), the program will remain funded at the level of 50-60 float deployments per year.

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

Argo Australia currently has over 95 floats either in the lab or on order. A further order for another 50 will go in shortly, completing our purchasing for 2009/10 and most of 2011. This map shows where deployments are planned for these floats.

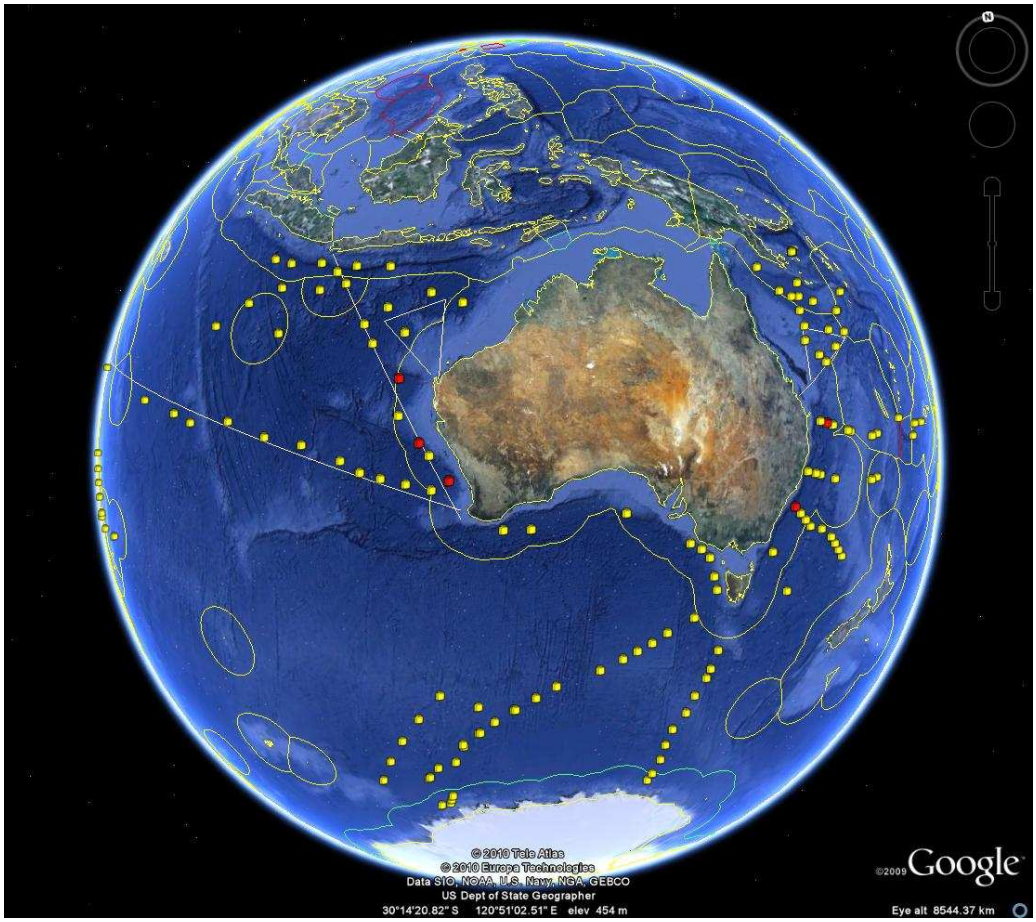

Figure 3. Locations of planned float deployments over the next year – red dots are IMOS2 oxygen floats still on order.

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

- Argo data are routinely used in the operational upper ocean analyses of Neville Smith at the Australian Bureau of Meteorology (http://www.bom.gov.au/bmrc/ocean/results/climocan.htm). These analyses are also used to initialize an experimental seasonal rain forecasting system.
- The dynamical seasonal forecasting system POAMMA heavily uses Argo data – Oscar Alves, Australian Bureau of Meteorology
- CSIRO Marine and Atmospheric Research, in collaboration with the Bureau of Meteorology Research Center, has developed an ocean model/data assimilation system for ocean forecasting and hindcasting. Argo data is the largest *in situ* data source for this system. Ocean forecasts and reanalysis products are now routinely published and are available via the Bureau of Meteorology website or the PI (www.marine.csiro.au\~griffin): David.Griffin@csiro.au

- Many students in the CSIRO/University of Tasmania graduate program are utilizing Argo data in their thesis studies. It's use is becoming widespread for studies of subduction in the Southern Ocean (Sallee, Sloyan, Rintoul), generation of modern era climatologies (Ridgway and Dunn), ocean warming and its role in sea level rise (Church, Domingues, Wijffels, Barker), in ocean observing system studies (Oke and Schiller), Ocean salinity changes (Durack/Wijffels)
- Developing model-based gridding techniques to produce an Argo-gridded data set (Dunn, Oke, Wijffels) and a new global Argo climatology

6. Issues to be raised with the Argo Steering Team

Pressure Bias Corrections: We congratulate the DACs in making progress in removing the pressure errors in float data where possible and report floats with unknown pressure errors to the GDACs so that a list of these are available to users. We urge them to complete this task as soon as possible so that Argo may be confidently be used to track the evolution of the global ocean heat content.