Australian Contribution to Argo

Report to the 9th Argo Science Team meeting, March 2008
Submitted by Susan Wijffels, CSIRO Marine and Atmospheric Research and the Australian Center for Atmosphere, Weather and Climate Research.

1. Status of implementation

Floats deployed and their performance

In 2007 45 WRC APEX SBE-41 floats were deployed and Australia has currently 158 operating Argo floats in the South Indian, Pacific and Southern Oceans. Australia has also deployed more floats with oxygen sensors.

APEX performance in the Australian array has generally been good – of APEX floats deployed in 2002 with mixed battery lithium/alkaline battery packs, 14 continue to operate past 5 years, with many achieving > 200 profiles to 2000db in the tropics and subtropics.

Of the 45 floats deployed in 2007, most continue to operate. Several floats were affected by software errors which were diagnosed with the help of the manufacturer and fixed. Some floats were replaced by the manufacturer.

Technical problems encountered and solved

Operational Changes: All floats are now fitted with a full complement of lithium batteries, rather than mixed lithium/alkaline battery packs. The switch was made to:
1) avoid any premature float failures associated with alkaline cell reliability; and
2) to extend the life of the floats.

Argo Australia, among others, has proved that APEX floats can profile usefully to 2000db (including the tropics) for 5 years +.

Problems solved in the last year:
1) the manufacturer discovered a programming bug in the oxygen-equipped float software. Deployments were delayed until the bug fix is tested and sent to us. However 4 floats were deployed with the bug.
2) we observed erratic reports by some recently deployed floats – deployments were halted, the manufacturer was alerted and subsequently identified a software bug. The remaining floats were reprogrammed and we have received replacements for the deployed floats from the manufacturer.
3) lab. tests found faults in buoyancy bladder manufacture that required some floats to be returned to the manufacturer for repair. The manufacturer has changed their QA/QC procedures.
4) lab. testing found faulty batteries from one of our suppliers and this, along with observed unexpected early voltage drops in a particular float batch halted deployments

while all batteries were re-tested. This has now been completed and we are satisfied our installed packs are all good. Deployments will recommence. Further lab tests will be carried out to identify the reason for the fast discharge of some floats in the field. All battery packs will now be load-tested before future installations. We continue to dialogue with the battery manufacturers on the causes of these failures. The cause of rapid voltage drop in some floats remains a mystery and we have not been able to diagnose its cause clearly in the laboratory yet.

Status of contributions to Argo data management:

Ann Thresher and the Argo Australia team hosted the International Argo Data Management Team (ADMT) in Hobart in November, 2007. The meeting was very successful and worked through many issues around improvements to the Argo data stream. Surrounding the meeting was good media coverage of the Argo 3000 float milestone and the awarding of the Sverdrup Medal to Dean Roemmich, who has provided excellent international leadership for Argo since its inception.

Real time: Last year's upgrade of our real-time processing software has resulted in a more stable and timely data stream. Real-time plots and monitoring of float data can be found at:

http://www.marine.csiro.au/~gronell/ArgoRT/select_floats_WMO.html

Status of delayed mode quality control process

About 70% of eligible Australian data are delivered in D-mode and we continue to make progress. We aim to begin including 'good' Argo data profiles in our drift assessments soon, as adjustments in certain data sparse regions remain difficult to judge.

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

Argo Australia is now part of the Australian Government initiative: an Australian Integrated Marine Observing System (IMOS) for research infrastructure funded under the National Collaborative Research Infrastructure Initiative. Through IMOS, and if levels of support from our participating partners remains steady, Argo Australia will be funded at a 50-60 float/year level for 4 years to maintain an array of around 220-240 Argo floats. The ongoing support through the Australian Climate Change program, however, may be in doubt as this program ends in July 2009, and its replacement is not yet scoped out.

Human resources: Australian Argo requires approximately 100% of a engineer and 75% of a technician for float checkout and preparation, test development; 50% of a fulltime operations officer for float shipping coordination and deployment training; delayed – mode data processing requires 150% fulltime data experts but we have been working on a large back-log and hope this level can be reduced as the processing becomes more routine.

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

Argo Australia has ~83 floats prepared for deployment. The map below shows where deployment plans have been made for some of these. We are seeking assistance in filling the gaps opening up in the SW Indian Ocean and South Pacific Oceans.

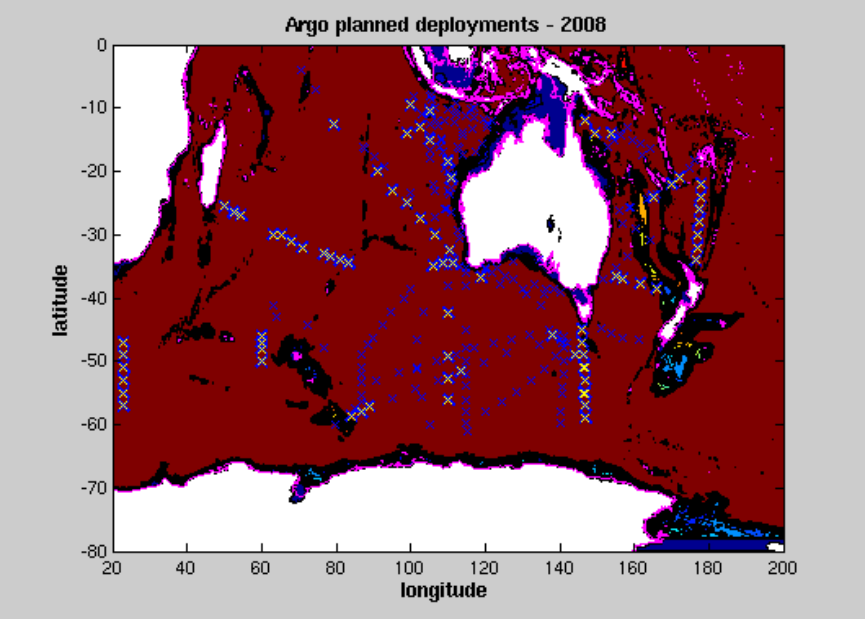

Figure caption: Yellow-white 'x' - planned deployment locations of fy 07/08 floats either on ships, in the laboratory or shortly to be delivered; blue 'x' – past deployments. Most Southern Ocean deployments can only be done in the Austral summer. Most deployments north of 40°S will take place in the next 3 months.

4. 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 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. Work on subsurface profile assimilation is underway. PI: Andreas.Schiller@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 (Sloyan, Rintoul), generation of modern era climatologies (Ridgway and Dunn), ocean warming and its role in

sea level rise (Church, Domingues, Wijffels), 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, Tchen, Wijffels)

5. Issues that your country wishes to be considered and resolved by the Argo Steering Team

Gaps opening up in the Southern Hemisphere: While Argo has made tremendous progress internationally, the array density remains biased towards the Northern Hemisphere - coverage in the SW Indian and central Pacific is inadequate. We would like to see basin coordinators target these regions.

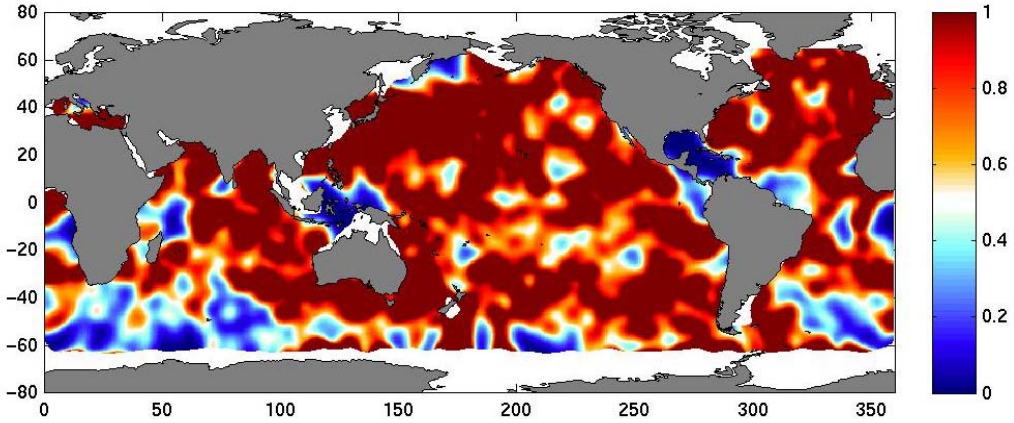

Figure caption: Argo density as a fraction of optimal design coverage in January 2008. Blue regions indicate where coverage is half or less of optimal.

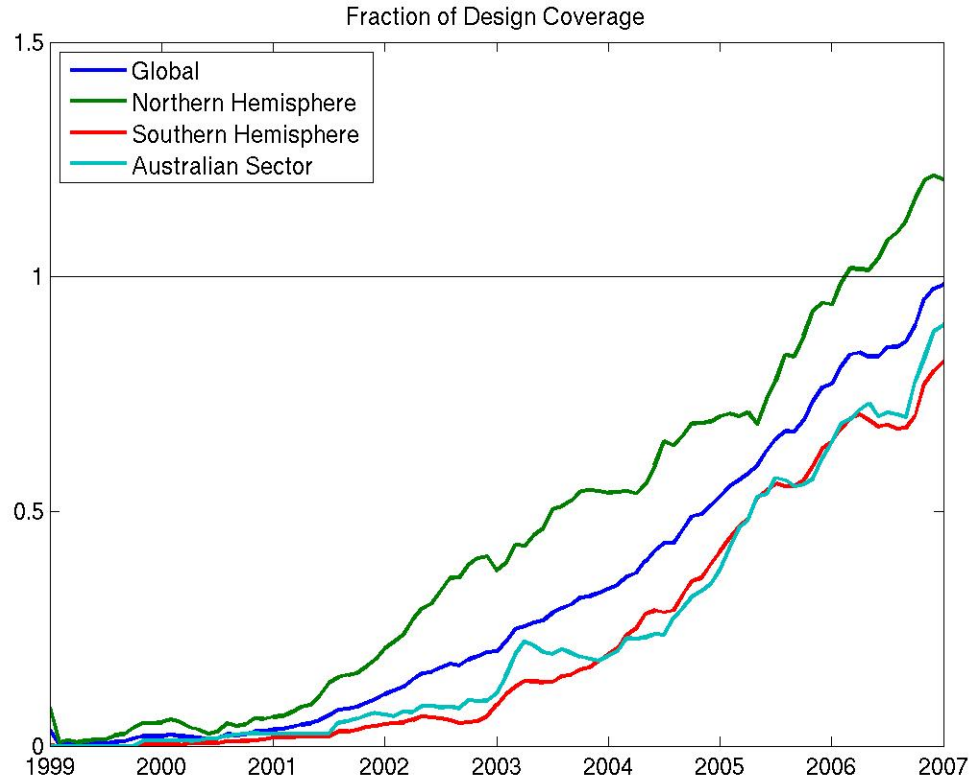

Figure caption: Time history of the fraction of design density reached by Argo averaged over various areas. A fraction of 1 means design density has been achieved. Globally averaged, Argo achieved design coverage at the end of 2007. Note, however, that the northern hemisphere is over-sampled and the southern hemisphere is under-sampled.

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Probe phones home

Missing sea robot turns up in fisherman's van

Glenis Green

ONLY the sheer determination of a CSIRO scientist has prevented a $30,000 ocean robot from being turned into one of the Sunshine Coast's most unusual and expensive letterboxes.

The robotic profiler — which monitors ocean temperature and salinity — went missing late last year when it grounded on the sea floor off southeast Queensland and failed to surface as part of its routine cycle.

Scientists had almost given up hope of recovering the expensive device until January 20 when it unexpectedly resumed transmitting.

Surprised at the probe's reappearance, scientists were even more surprised when they pinpointed the source of the transmission — a fisherman's work van at Mooloolaba.

Mooloolaba prawn fisherman Robert Wilson, 45, had hauled the robot up in the turtle excluder in his nets from about 40m deep on January 20.

Heavily barnacled, scraped and filthy, the robot immediately resumed its normal 10-day transmission to the CSIRO and the Bureau of Meteorology.

But by that time it was in the back of Mr Wilson's blue work van. Thinking it was just a piece of abandoned flotsam, he had salvaged it for conversion into a nice, new letterbox using his angle-grinder.

That is where the story might have ended — if not for the self-confessed "sheer stubbornness" of Ann Thresher, based at CSIRO's Hobart headquarters.

Knowing only that the probe had suddenly popped up within a 1km radius of Mooloolaba, she joined scientists from Brisbane in the hunt.

"I took a radio direction finder and when it gets close you can hear it," she said. "The trouble is it only transmits for five hours every 10-day cycle."

Dr Thresher's search was frustrated by the fact the probe was still in Mr Wilson's van and was constantly on the move.

By Tuesday, Dr Thresher said she was getting "a bit frantic" at not being able to home in on her prize.

"I was going to give up on it, but I just couldn't leave it alone. I couldn't leave unless I turned over every rock," she said.

Postponing her return flight to Hobart, Dr Thresher returned alone to Mooloolaba and decided to foot-slog the wharves and marinas with a photograph in the hope that a sailor or fisherman had seen the machine.

"Believe it or not, on the last vessel I got to, the crew recognised it and got in touch with Robert who brought it around," she said.

Dr Thresher said while data gathered in the past 18 months had been transmitted, finding the float meant its condition could be evaluated by CSIRO engineers.

"Rarely do we have the opportunity to recover the profilers because they are mostly drifting with the remote currents in the ocean basin anywhere between the Arctic and Antarctica," she said.

Usually about 2800 of the robots are floating at any one time around the world.

As for Mr Wilson — he's philosophical about losing his potential letterbox.

"I didn't know what it was, no one seemed to know."

But unusual as it was, Mr Wilson said he had seen more interesting objects hauled up in the nets since he began working on trawlers at the age of 16.

"I've had pieces of aeroplanes, torpedoes, all sorts of things," he said.

Dr Dean Roemmich, from Scripps Institute of Oceanography, said the east coast of Australia was a place that the floats would occasionally travel thousands of kilometres to visit.

GONE fishing ... Brian Logan from CSIRO with the robotic profiler, *above*, fisherman Robert Wilson who snared the device in his nets, *right*. Pictures: Glenn Barnes/Graeme Parkes