

UK ARGO PROGRAMME

REPORT FOR ARGO STEERING TEAM 10TH MEETING, MARCH 2009

The UK Argo programme is undertaken by a partnership between the Met Office (who manage the programme), the National Oceanography Centre Southampton (NOCS), the British Oceanographic Data Centre (BODC) and the UK Hydrographic Office (UKHO).

The most important issue for the UK programme is in securing continuing and ongoing funding for UK Argo and ensuring the long-term delivery of data from the global 3,000 float Argo array.

Floats deployed and their performance

Floats deployed. The UK Argo programme was initiated in 2000, with our first Argo floats deployed in January 2001. Since then, 268 UK floats (including 5 donated to Mauritius) have been deployed as shown in Table 1 and Figure 1 below. (Argo equivalent floats are those that have been procured using research grants rather than from designated UK Argo funding.)

Year	UK Argo floats		Argo equivalent floats	Floats donated to Mauritius
	Apex	Provor		
2001	25	2	2	
2002	33	1	4	
2003	17	5	15	1
2004	33	12		2
2005	27	1		
2006	24			2
2007	27	4	2	
2008	28	1		
2009 (estimated)	40			

Table 1. Numbers of UK floats contributing to Argo deployed by year (including floats donated to and deployed by Mauritius).

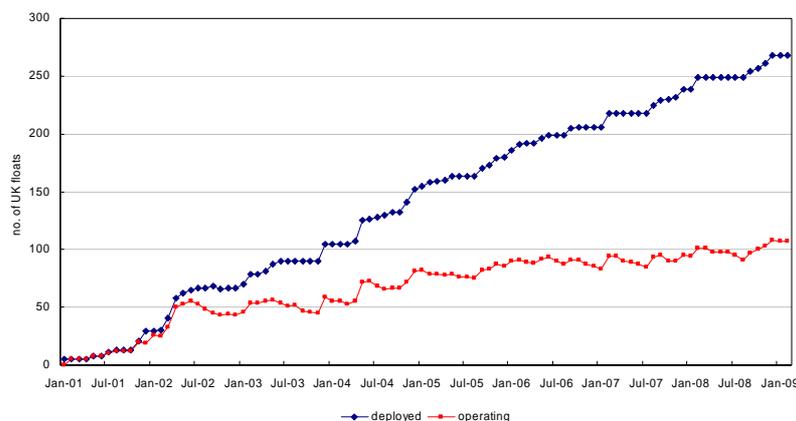


Figure 1. Number of UK floats deployed that contribute to Argo and the number operating by month.

The number of floats operating has increased steadily to over 100, with 107 floats operating at end February 2009. There has been a distinct improvement in the survival of our Apex floats deployed from 2004 to those deployed in earlier years in terms of cycles completed

(normalised to 2,000m for floats that make shallower profiles or only profile to 2,000m intermittently, with invalid cycles due to pressure transducer failure discounted and deployment failures omitted). Only 30-40% of floats deployed before 2004 made more than 100 cycles, although our longest-living float (from 2002) reached 185 cycles before expiring. However, for floats deployed in 2004 and 2005 around 70% and 75% exceeded the 100 cycle mark. For floats deployed in 2006 81% have exceeded 50 cycles, and in 2007 79% have exceeded 40 cycles.

Similarly for the Provor floats the survivability of the floats deployed after 2004 has been much better than those deployed in 2001 and 2002.

Hence despite the reduced number of floats deployed from 2005 the number of operating floats has continued to increase.

Float enhancements. In 2007 and 2008 a number of floats were fitted with lithium batteries, 14 in each year of which 23 are presently operating. One failed on deployment, one after 3 profiles and one after 29 cycles (suspected due to a slow water leak). The other 2 early failures were most likely due to damage from Antarctic ice. All Southern Ocean floats now considered at risk of ice are now specified with ice-avoidance capability. So far 8 floats with ice-avoidance have been deployed (in 2007 and 2008) and all are presently operating.

In 2008 two Apex floats with near surface temperature measurement capability (unpumped measurements) have been deployed and these have shown the ability to record near surface thermal structure (examples shown below) and are being evaluated by the Hadley Centre for climate application, these additional data are not as yet being distributed to GTS. (See poster for Argo Science Workshop.)

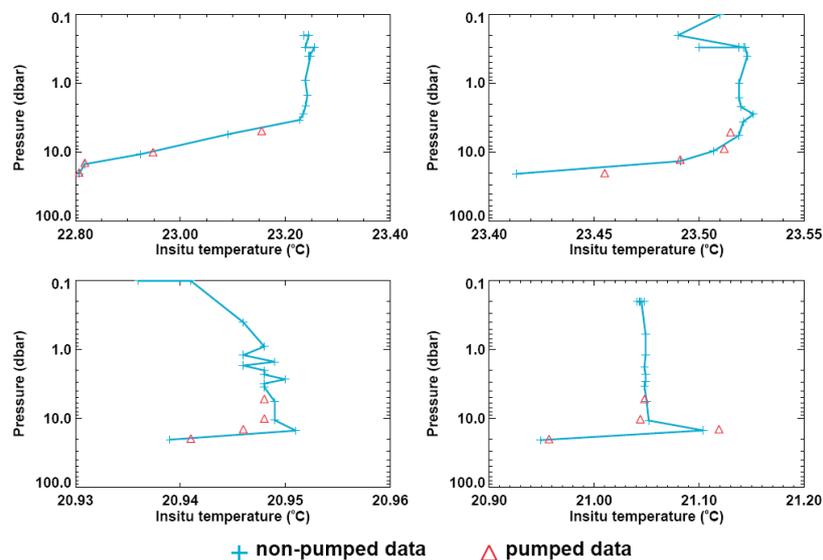


Figure 2. Examples of near surface data collected from Apex floats with near surface temperature recording, from the first 2 profiles from floats 1901072 (top) and 1901073 (bottom).

Technical/engineering web-site. We have established a partnership with CSIRO, Australia to develop an engineering web-site for UK and Australian Apex floats (see <http://www.cmar.csiro.au/argo/tech/>) enabling the performance of deployed UK (and Australian) Apex floats to be monitored and assisting failure cause diagnosis.

Deployment plans for 2009

As at early February 2009, we have 16 deployments scheduled and hope to make around 40 deployments during the year, as shown in Table 2 (below).

<i>Floats scheduled for deployment (16)</i>	
<i>South Atlantic</i>	<i>16 Apex along 26S section to be deployed from RRA James Cook during March/April (4 with near surface temperature capability)</i>
<i>Floats planned for deployment (13)</i>	
<i>4 Apex for south-east Atlantic (plan to deploy from SA Agulhas in September)</i>	
<i>3 Apex for South Atlantic (~15S, 25W) during Atlantic Meridional Transect (Oct/Nov)</i>	
<i>6 Apex for Southern Ocean (Drake Passage section, Nov/Dec) (2 with ice-avoidance)</i>	
<i>Floats with deployments still to be planned (20)</i>	
<i>9 Apex for north-east Atlantic (Iceland Basin/Rockall Trough)</i>	
<i>2 Apex for north-east Atlantic (26N) (with near surface temperature capability)</i>	
<i>1 Apex for Arabian Sea</i>	
<i>4 Apex for Somali Basin</i>	
<i>4 Apex for South Indian Ocean (~30S)</i>	

Table 2. Floats deployed and available for deployment in 2009.

Data management

Real-time. The UK Argo Data Centre, established at BODC, processes all our float data. An automatic system processes the data in real-time and generates the profile data in WMO TESAC and BUFR and Argo netCDF formats. The TESAC/BUFR messages are relayed to GTS via the Met Office (EGRR). Almost 100% of GTS messages are available within 24h. Occasional disruptions happen due to email server failures and server problems. Data in netCDF format are also sent (by FTP) to the two GDACs. The real-time processing system operates every 12 hours and delivers data twice daily. The data are also available from the UK Argo Data Centre web-site via an interactive map interface. In addition the technical files are updated once a week and these files are used by CSIRO Marine to populate the technical web-site.

Delayed-mode. Delayed-mode processing is carried out by BODC with support from the UKHO. A new member of staff began work on delayed mode QC (25% of his time) at the start of the year. Much of the work in 2008 has been working on identifying and correcting pressure sensor issues with our Argo floats. A total of 5,688 delayed-mode profiles have now been submitted, this is about 27% of all our profiles eligible for delayed mode qc (i.e. excluding floats that have been operating for less than 18 months). The UKHO are taking the lead on processing the Arabian Sea floats (~2,000 profiles).

Southern Ocean. We work with 3 other organizations to operate a Southern Ocean Argo Regional Centre (SOARC), and to cover the entire Southern Ocean - BODC (Atlantic Ocean Sector), CSIRO ('Australian' sector), JAMSTEC (Pacific Ocean Sector) and the University of Washington (Indian Ocean Sector). BODC hosts the main SOARC data and information web pages. These pages contain an animation of the Met Office Forecast Ocean Assimilation Model (FOAM) outputs (potential temperature, salinity and velocity at 5m and around 1,000m depth) and an interactive map giving information on last known positions, deployment positions and direct links to both GDACs ftp sites.

Operational and scientific use of Argo data

Operational ocean forecasting. All Argo data (alongside other in-situ and remotely sensed ocean data) are routinely assimilated into the FOAM operational ocean forecasting system run by the National Centre for Ocean Forecasting (NCOF). The FOAM predictions are used by the Royal Navy and also provide forcing for high resolution models of the north-west European shelf-seas. Experiments have shown that Argo data has a significant positive impact; without Argo data temperature errors are up to 40% larger and salinity errors near the surface are over twice as large, even when all other in situ data sources are assimilated. During 2008 a new version FOAM-NEMO, based on the European NEMO (Nucleus for European Modelling of the Ocean) has been developed and will be used for further assessments of the impact of Argo (and altimeter) data. This work is being carried out as part of our input to GODAE.

Seasonal to decadal prediction. Seasonal forecasts provide long-range warning of weather conditions, both for the UK and for developing countries (e.g. forecasts for drought conditions in the Sahel, East African rainfall). They are based on both statistical techniques and coupled ocean-atmosphere models. Argo data are used in the GloSea (Global Seasonal) coupled model run for seasonal forecasting. Although initialising the model with Argo data improves the accuracy of its predictions of surface temperature, the models are not presently any more accurate than the statistical techniques as they are still experimental and this is an area of continuing research and development.

The Hadley Centre DePreSys (Decadal Prediction System) is being developed for climate predictions on decadal timescales. Idealised model experiments have demonstrated that observations of temperature and salinity in the upper 2,000m, as potentially provided by Argo, are sufficient to enable skilful predictions of the Atlantic Meridional Ocean Circulation on decadal timescales. Furthermore, additional observations below 2,000m increase the overall skill, especially at longer lead times. Model experiments have also shown that predictions of upper ocean temperatures from March 2007 to August 2008 are more accurate when the model is initialised with the full Argo array than when it is initialised with sub-sampled observations typical of historical periods.

Climate monitoring and prediction. The Hadley Centre HadGOA dataset is a new ocean analysis of historical temperature and salinity. Variables are on a 2-degree grid and computed on number of fixed isotherms and fixed depths at monthly resolution. The data is available for scientific research at <http://hadobs.org>. The HadGOA analyses will soon include near real-time updates using Argo data.

Ocean science. Argo data are also being used for various scientific studies within the NERC and University community. This includes many scientists from beyond the UK Argo community. The UK Argo Users' Group has provided a forum for engagement between these scientists and the UK Argo programme, and this activity is now being taken forward in the context of a European Argo Users Group under the Euro-Argo project.

Funding

UK Argo is funded by the Department for Energy and Climate Change (DECC) (previously from the Department for Environment Food and Rural Affairs – Defra), the Ministry of Defence (MoD) and the Natural Environment Research Council (NERC).

NERC funding is agreed to March 2012 through the Oceans2025 programme, with the expectation that it will continue after this time. This covers effort at NOCS and BODC on data processing and science leadership (but is not presently at a level sufficient to cover all

our data processing requirements and commitments). Funding through the Met Office is from MoD and DECC. The MoD funding is part through the Integrated Climate Programme and part through the Defence Oceanography Programme. The MoD Argo funding is not ring-fenced within either of these programmes. In addition MoD also funds UKHO support for data processing. The DECC (ex-Defra) funding has, for the last few years, been agreed on an annual basis although the principle of a multi-year agreement (2 or possibly 3 years) has been accepted.

These various arrangements fall short of the longer-term commitments that would be needed to provide secure and sustained funding for the UK contribution to Argo (and Euro-Argo). Our aspiration for UK Argo is to contribute to the global programme to at least a GNP level based share (~5%), i.e. to deploy 40 – 50 floats each year.

Considerable time and effort has been (and continues to be) expended in trying to secure longer-term funding for UK ocean observations that have been committed to international programmes such as the GOOS, GCOS and the GEOSS; with Argo as a pressing example for the need for a solution. This has so far been unsuccessful as there is currently no mechanism within UK Government to transition funding from research to operational funding lines. The problem is exasperated by the fact that the priority for government is (regulatory) monitoring that is mandated to meet European directives; Argo (and other climate observing) is accepted as important but regarded as optional. Hence it is likely that funding for Argo for the next few years will continue to be requested from existing research budgets, at least until the next government (Comprehensive Spending Review) funding cycle.

Euro-Argo

Both the Met Office and NERC are involved in the Euro-Argo project (January 2008 to June 2010) to develop and recommend a European infrastructure to enhance the collective ability of the European nations to contribute to Argo, to the level where 'Europe' has the capacity to deploy ~250 floats per year, and to process the resulting data. Such a European contribution would support approximately 25% of the global array and provide an additional 50 floats per year for enhanced coverage in the European and marginal seas. This will require long-term funding commitments from the European partners (~150 floats per year) and from the EU (via GMES, ~100 floats per year). The Met Office and NERC are leading on several Euro-Argo work packages (3. Financial Work and 6. Strengthening the User Community respectively) and the Met Office also lead on the Impact Studies and Demonstration Cases task.