UK Argo national data management report 2012

Justin Buck (BODC), Clare Davis (BODC)

Status

Staff changes

At the start of 2012 Sam Jones (UK Argo real time operator of 2 years) moved to SAMS in Oban to start a PhD. Sam had become competent on Argo matters so obviously left a void in is his wake. We rapidly recruited Clare Davis in his place. Clare has just come from a PhD in phosphate chemistry which seemed to compliment the move in Argo to measure new parameters. In addition to the real time processing eventually Clare will also share the UK delayed mode workload.

Funding

Data management work at BODC has been funded from a combination of core 'National Capability' and Oceans 2025 thematic programme by the Natural Environment Research Council. This is complimented with funding from the European Union (EU). The EU Euro Argo funding has several projects:

- Strengthening the International Dimension of the Euro Argo Research Infrastructure (SIDERI) which has been funding trajectory, near-surface temperature and will cover delayed mode processing cookbook activities in the coming year.
- Argo Improvements for the GMES Marine Service (E-AIMS) where funding will commence next year. This has an emphasis on biogeochemical sensors and new communications systems.

Acquisition and implementation of additional float technologies

Biogeochemical sensors and Iridium communications

In early 2012 an under-spend was identified by the Department for Energy and Climate Change which was allocated to funding floats to support the Natural Environment Research Council (NERC) Arctic programme. The money funded the purchase of 4 floats with additional oxygen optode, WetLabs FLBB combined fluorometer/backscatter sensors, and Iridium communications. In addition to these 9 further floats with standard core mission sensors and Iridium were purchased. These were deployed in the summer of 2012 in the Lofoten Basin, Norwegian Basin and Greenland Basin. Luckily, the first batch of these deployments were perfectly timed to coincide with the onset of the spring bloom.

The data processing for both of these new technologies has been the focus of much of the Argo resource at BODC this year. Real time data processing was operational within two months of the first Iridium deployment and once the latest format versions are cleared at USGODAE we are ready to send the full data from all of these floats to the GDACs in real time. We would like to take this opportunity to thank all the people that helped with information and advice when working on this; in particular but not exclusively Anne Thresher (CSIRO), Dana Swift (UW), Dave Stahlke (WetLabs) and Yann Bernard (CLS). It is hoped that delayed mode processing on these floats will begin next year.

E-AIMS project

The European Union funded Euro-Argo Improvements for the GMES Marine Service (E-AIMS) proposal was successful and funding will commence in early 2013. This project will part fund four floats: two with biogeochemical sensors and two with either Iridium or ARGOS-3 communications, all will be processed via BODC. Plymouth Marine Laboratory will be involved in the analysis/assessment of data from the floats with bio-optical sensors, which are planned to be deployed along the Atlantic Meridional Transect line.

Near surface temperature data

BODC have continued to collaborate with the UK Met Office on defining standards for the near surface un-pumped temperature data. Fiona Carse (Met Office) has also been working on assessing the measurements and the utility of the additional data.

The coverage of near-surface-temperature (NST) has continued to improve with contributions from APEX floats with un-pumped NST measurements, PROVOR floats with un-pumped NST measurements, and SOLO-II floats that stop pumped measurements at 1 dBar (rather than 5 dBar) all contributing to the dataset. In addition, STS sensor modules have been fitted to some of the newer APEX floats which record near surface salinity and temperature via a freely-flushing auxiliary module fixed to the float.

A map of near-surface-temperature data coverage coloured by the magnitude of near-surface temperature difference in the top 10 dBar of the water column is shown in Figure 1.

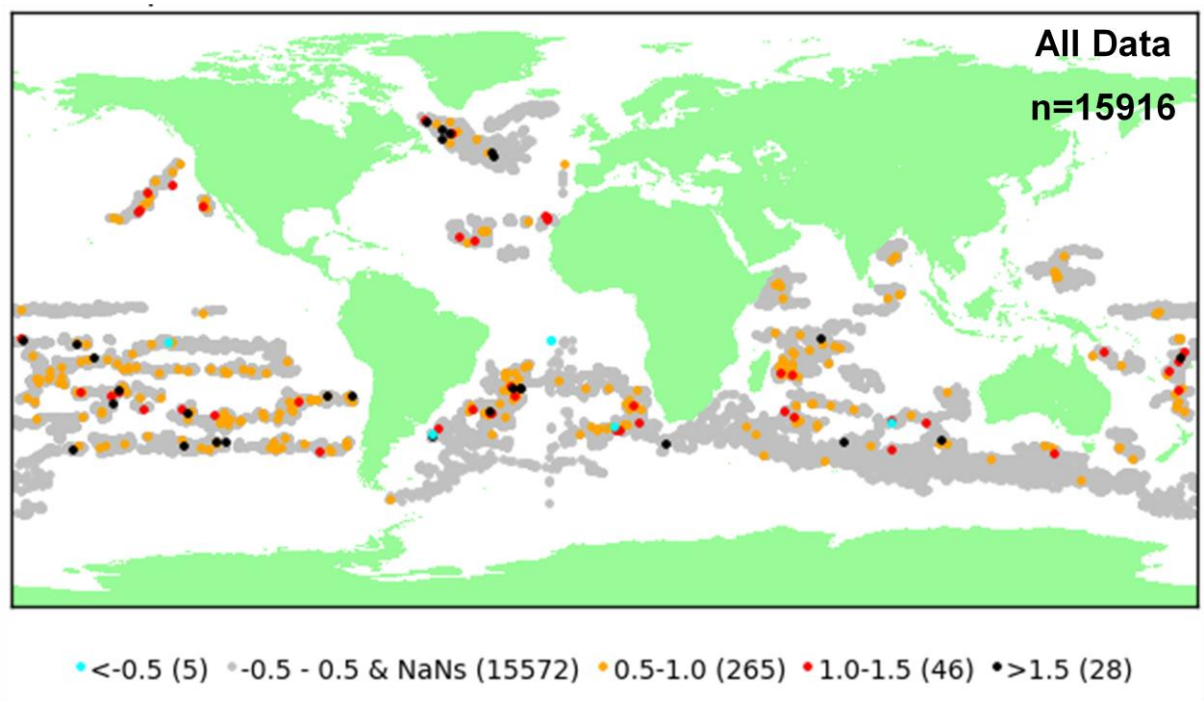

Figure 1: Locations of near surface temperature profiles with profiles showing significant surface temperature gradient shown in colour. This plot does not include data from STS floats.

The 345 Argo NST profiles with significant ΔT_{10} were compared to the Met Office OSTIA (Operational Sea Surface Temperature and Sea Ice Analysis) SST products (Donlon et al., 2012); OSTIA provides daily gridded SST_{fnd} values at 1/20° resolution. OSTIA is corrected for diurnal warming.

The 0-1 dbar Argo NST is consistently warmer than the OSTIA SST_{fnd}, whilst at 4-5 dbar the Argo NST are slightly cooler. Figure 2 suggests an 'equivalence depth' between Argo NST and OSTIA of approximately 4 dbar. This is close to the value of 3 metres, below which it is generally assumed there is no effect of diurnal warming (Takaya et al., 2010). This result further highlights the potential value of the NST data.

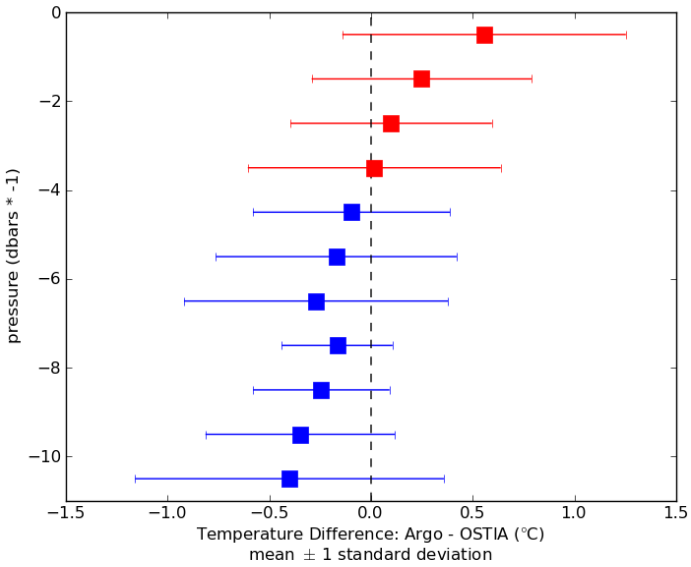

Figure 2: Mean temperature difference between Argo and OSTIA SST with standard deviations. This plot does not include data from STS floats.

BODC will continue to collaborate with other NST groups and make a proposal for real-time QC of NST data at ADMT13. A summary of our recommendations thus far is given in Table 1 which will be the basis for discussion at the meeting.

Table 1: Table describing modifications needed to real time quality control tests for near surface Argo data.

Test	Modification	Comment
Platform identification	None	Already applied in routine QC of the primary core mission profile
Impossible date	None	Already applied in routine QC of the primary core mission profile
Impossible location	None	Already applied in routine QC of the primary core mission profile
Position on land	None	Already applied in routine QC of the primary core mission profile
Impossible speed	None	Already applied in routine QC of the primary core mission profile
Global range	None	
Regional range	None	
Pressure increasing	None	
Spike	None	
Top and bottom spike	None	obsolete test anyway
Gradient	None	Figure 2 shows 9 °C threshold is unlikely to be triggered so no change needed to test
Digit rollover	None	
Stuck value	None	

Density inversion	drop test	Drop this test for near surface data (<5 dBar depth).
Grey list	None	No changes but, new parameters need to be communicated to operational centres so they understand the measurements.
Gross salinity or temperature sensor drift	drop test	Drop this test for un-pumped SST values, 1 °C threshold will be triggered in this data frequently because the un-pumped data is shallow and 1 °C is within the one standard deviation bar in Figure 2.
Visual QC	None	
Frozen profile	None	
Deepest pressure	None	

Trajectory data progress

Another focus for BODC efforts this year has been on the improvements to the quality of trajectory data. Our original database of cycle timings and non-spatial event times has been dropped and we are in the process of rebuilding this. This is leading to significant improvements to data hosted by BODC including:

- Derivation of non-spatial event times and transmission times in a manner that is internationally consistent
- Recalculation of all ascent end times to the current international standard
- Derivation of transmission end times (TET) using the method described by Park *et al*.(example shown in Figure 3)

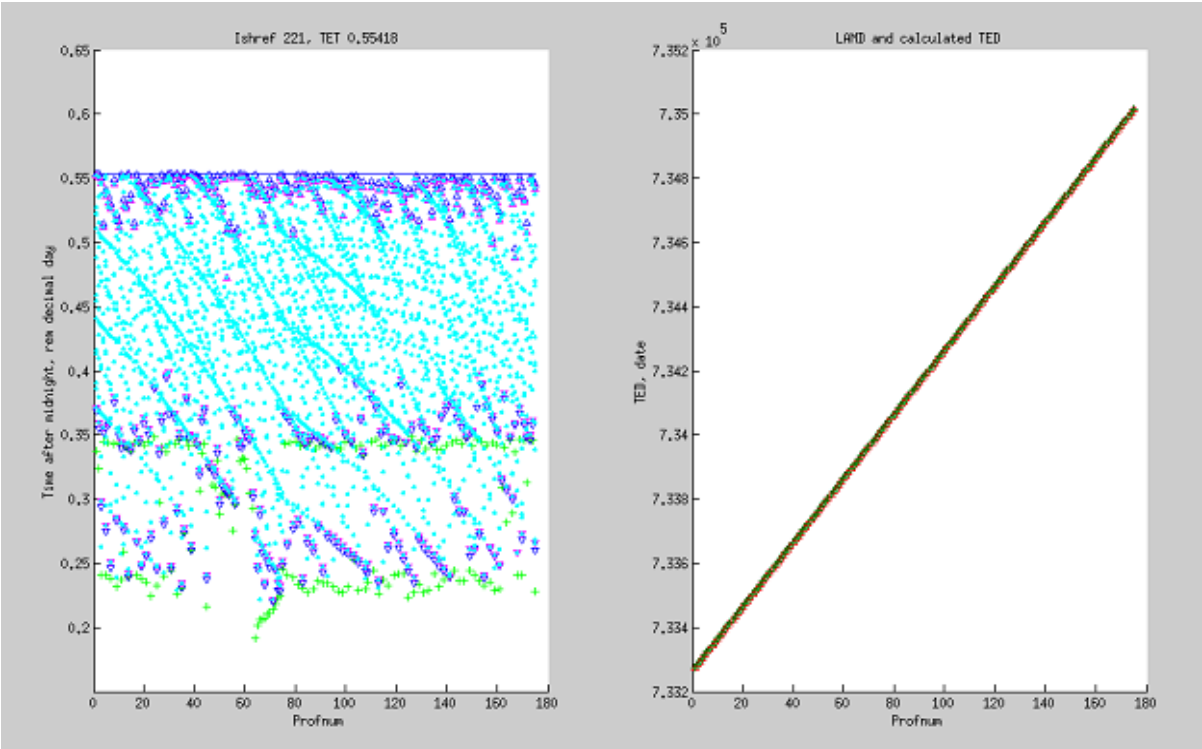

Figure 3: Example TET diagnostic plot for the float with WMO 6900604 showing TET derivation for the float with the date via the Last Argo Message Date (LAMD).

We have also contributed to the cookbook describing trajectory data processing and sourced answers to some of the unclear behaviours in the cycle timings and sub-surface trajectories in APEX floats. It has become clear that some aspects such as the end of park to start of profile for older APF7 and APF8 APEX floats may never be fully understood as the float source code does not exist anymore.

Data acquired from floats

Data from all UK floats are received at BODC by automatic download from the CLS database every 12 hours. Table 1 summarises the deployments and data received according to float form. BODC endeavours to set up floats for distribution of data to GTS and GDACS within a week of deployment. BODC also handles data from Irish, Mauritanian and Saudi Arabian floats.

Table 2: A summary of float deployments and data acquired from floats managed by BODC in the year preceding 1st October 2012 according to float type and Country.

Float Type	Deployment by country			Number of profiles
	UK	Mauritius	Ireland	
APEX APF9a				566
APEX APF9a - ice detection	9			245
APEX APF9a – near surface temperature	31	2		2071
APEX APF7a/APF8a				1738
APEX APF7a/APF8a – ice detection				148
APEX APF9i – ice detection	9			67
APEX APF9i – biogeochemical sensors	4			34
NKE ARVOR			2	80
Totals	53	2	2	4949

Data issued to GTS

Data from all UK floats are sent to the GTS every 12 hours. Almost 100% of TESACs messages are available within 24 hours. Occasional disruptions occurred due to email server failures and server problems.

In summer 2012 there was an initial delay of 1-2 months setting up our system to process data from Iridium floats. Processing of data from Iridium floats is now operational and we do not expect further delays. This delay did not impact of forwarding of data that use ARGOS communications.

Data issued to GDACs after real-time QC

All UK data received at BODC are passed through the agreed real-time quality control tests within one hour of the data arriving at BODC. All data that have been processed at BODC are queued for transfer to both GDACs which occurs twice a day. Any file that fails to be transferred is queued for the next transfer attempt.

Data issued for delayed QC

All delayed QC on BODC hosted floats is done within BODC.

Delayed mode QC with start at the end of 2012; the workload created by floats with new sensors/ Iridium communications and training of new staff moved the date we can start delayed mode QC this year.

The OW software is being used at BODC with latest reference data available from Coriolis (CTD climatology and Argo profile climatology for guidance). 94.4% of UK floats profiles eligible for delayed mode QC have been processed ad submitted to the GDACs in D-mode.

Web pages

BODC hosts the main data information and access pages for the UK. These pages include a list of the current status of all deployed UK floats, automatic request system for UK float data, links to both GDACs and other Argo related sites and an interactive map giving information on last known positions, deployment positions and direct links to profile plots of each float's most recent profile reported. There is also information on the history of Argo and how float technology has been and continues to be developed. There are also pages promoting knowledge transfer and the use of Argo-generated data for education, operational analysis and research.

Statistics on Argo data usage

In addition to the GDACs, BODC data are also made available through the UK Argo Data Centre website via an interactive map interface. During the last year, UK Argo metadata, trajectory and profile files have been provided to users through the BODC website. BODC has handled 24 requests made by 21 users from 9 countries.

Operational and scientific use of Argo data at the Met Office

Operational ocean forecasting

All Argo data (alongside other in-situ and remotely sensed ocean data) are routinely assimilated into the Forecasting Ocean Assimilation Model (FOAM) operational ocean forecasting system run by the Met Office National Centre for Ocean Forecasting (NCOF).

Seasonal to decadal prediction

Argo data are also in the GloSea (Global Seasonal) coupled model run to make seasonal forecasts for several months ahead. On longer timescales, the Hadley Centre DePreSys (Decadal Prediction System) is being developed for climate predictions on decadal timescales. Idealised model experiments have shown that sub-surface data, such as Argo data, are necessary to provide plausible predictions.

Climate monitoring and prediction

The Hadley Centre maintains the HadGOA (sub-surface global analysis) dataset of historical temperature and salinity. Variables are on a 2-degree grid and computed on a number of fixed isotherms and fixed depths at monthly resolution. The dataset includes available Argo data and will include near real-time updates using Argo data. The dataset is used for global ocean heat content analysis.

Products generated from Argo data

None specifically generated from only Argo data.

Scientific use of the data within NERC and the academic community

A basic citation search indicated that 13 research papers that directly used Argo data were published in 6 different journals in 2011-2012 with UK authors.

Turbulent nutrient fluxes in the Iceland Basin Original Research Article

Deep Sea Research Part I: Oceanographic Research Papers, Volume 63, May 2012, Pages 20-35

A. Forryan, A.P. Martin, M.A. Srokosz, E.E. Popova, S.C. Painter, M.C. Stinchcombe

Fronts and habitat zones in the Scotia Sea Original Research Article

Deep Sea Research Part II: Topical Studies in Oceanography, Volumes 59–60, January 2012, Pages 14-24

Hugh Venables, Michael P. Meredith, Angus Atkinson, Peter Ward

Mechanisms of subantarctic mode water upwelling in a hybrid-coordinate global GCM Original Research Article

Ocean Modelling, Volumes 45–46, 2012, Pages 59-80

Hao Zuo, Alberto C. Naveira Garabato, Adrian L. New, Andreas Oschlies

Terrestrial waters and sea level variations on interannual time scale Original Research Article

Global and Planetary Change, Volume 75, Issues 1–2, January 2011, Pages 76-82

W. Llovel, M. Becker, A. Cazenave, S. Jevrejeva, R. Alkama, B. Decharme, H. Douville, M. Ablain, B. Beckley

Seasonal to interannual phytoplankton response to physical processes in the Mediterranean Sea from satellite observations Original Research Article

Remote Sensing of Environment, Volume 117, 15 February 2012, Pages 223-235

Gianluca Volpe, Bruno Buongiorno Nardelli, Paolo Cipollini, Rosalia Santoleri, Ian S. Robinson

Seasonal evolution of the upper-ocean adjacent to the South Orkney Islands, Southern Ocean: Results from a "lazy biological mooring" Original Research Article

Deep Sea Research Part II: Topical Studies in Oceanography, Volume 58, Issues 13–16, July–August 2011, Pages 1569-1579

Michael P. Meredith, Keith W. Nicholls, Ian A. Renfrew, Lars Boehme, Martin Biuw, Mike Fedak

The observed signature of mesoscale eddies in sea surface temperature and the associated heat transport Original Research Article

Deep Sea Research Part I: Oceanographic Research Papers, In Press, Accepted Manuscript, Available online 30 August 2012

Ute Hausmann, Arnaud Czaja

2.16 - Measurement Technologies: Measure What, Where, Why, and How?

Treatise on Estuarine and Coastal Science, Volume 2, 2011, Pages 361-394

A.J. Souza, R. Bolaños, J. Wolf, D. Prandle

Food web structure and bioregions in the Scotia Sea: A seasonal synthesis Original Research Article

Deep Sea Research Part II: Topical Studies in Oceanography, Volumes 59–60, January 2012, Pages 253-266

Peter Ward, Angus Atkinson, Hugh J. Venables, Geraint A. Tarling, Mick J. Whitehouse, Sophie Fielding, Martin A. Collins, Rebecca Korb, Andrew Black, Gabriele Stowasser, Katrin Schmidt, Sally E. Thorpe, Peter Enderlein

Closing the loop – Approaches to monitoring the state of the Arctic Mediterranean during the International Polar Year 2007–2008 Original Research Article

Progress in Oceanography, Volume 90, Issues 1–4, July–September 2011, Pages 62-89

C. Mauritzen, E. Hansen, M. Andersson, B. Berx, A. Beszczynska-Möller, I. Burud, K.H. Christensen, J. Debernard, L. de Steur, P. Dodd, S. Gerland, Ø. Godøy, B. Hansen, S. Hudson, F. Høydalsvik, R. Ingvaldsen, P.E. Isachsen, Y. Kasajima, I. Koszalka, K.M. Kovacs, et al.

Assimilation impacts on Arctic Ocean circulation, heat and freshwater budgets Original Research Article

Ocean Modelling, Volume 40, Issue 2, 2011, Pages 147-163

Hao Zuo, Ruth I. Mugford, Keith Haines, Gregory C. Smith

Group for High Resolution Sea SurfaceTtemperature (GHRSST) analysis fields inter-comparisons: Part 1. A GHRSST multi-product ensemble (GMPE)

Deep-Sea Research II, Volumes 77–80, 15 November 2012, Pages 21–30

Matthew Martin, Prasanjit Dash, Alexander Ignatov, Viva Banzon,Helen Beggs, Bruce Brasnett, Jean-Francois Cayula, James Cummings, Craig Donlon, Chelle Gentemann, Robert Grumbine, Shiro Ishizaki, Eileen Maturi, Richard W. Reynolds and Jonah Roberts-Jones,

Group for High Resolution Sea Surface Temperature (GHRSST) analysis fields inter-comparisons—Part 2: Near real time web-based level 4 SST Quality Monitor (L4-SQUAM) Original Research Article

Deep Sea Research Part II: Topical Studies in Oceanography, Volumes 77–80, 15 November 2012, Pages 31-43

Prasanjit Dash, Alexander Ignatov, Matthew Martin, Craig Donlon, Bruce Brasnett, Richard W. Reynolds, Viva Banzon, Helen Beggs, Jean-Francois Cayula, Yi Chao, Robert Grumbine, Eileen Maturi, Andy Harris, Jonathan Mittaz, John Sapper, Toshio M. Chin, Jorge Vazquez-Cuervo, Edward M. Armstrong, Chelle Gentemann, James Cummings, et al.

Regional centre activity

Four organizations participate in the Southern Ocean Argo Regional Centre - BODC (Atlantic Ocean Sector), CSIRO (“Australian sector”), JAMSTEC (Pacific Ocean Sector) and the University of Washington (Indian Ocean Sector).

BODC hosts the main data and information web pages. These pages contain an animation of the Forecast Ocean Assimilation Model (FOAM) outputs (potential temperature, salinity and velocity at

five metres and 995.5 m) and an interactive map giving information on last known positions, deployment positions and direct links to both GDACs ftp sites.

Re-establishing a link to submit profiles to CCDHO is on-going and the aim at BODC is to automate delivery. The goal is for these to filter through to the Argo delayed-mode QC reference data. It is still hoped ease this restriction in due course. The routine submission of CTD profiles to CCHDO when they are banked at BODC is the eventual goal, negotiations are complete and just the technical development is required to make this operational.

Partnership for Observation of the Global Oceans (POGO) work has continued with development of routines to automate the collection and submission of cruise plans to POGO. This effort has been enhanced in Europe due to the EU-funded EUROFLEETS project. The SIDERI project is also looking to use POGO to collect research vessel itineraries for the purpose of cruise planning. This is semi-automatic for the US University-National Oceanographic Laboratory System (UNOLS) managed ships whilst the data are publicly accessible. It is hoped to extend this method of collection of data to UK and German research vessels next.