UK ARGO PROGRAMME

REPORT FOR 20TH ARGO STEERING TEAM MEETING, MARCH 2019

1. Status of Implementation

Floats deployed and operating

During the last year (2018) 34 floats were deployed: this includes 24 core (temperature and salinity only), 4 oxygen, 2 bio-geochemical (BGC) and 4 deep floats. These were deployed in the North and South Atlantic, western Indian and Southern oceans. As at the time of writing we have 146 operational floats (i.e. for which real-time data are presently being distributed), as shown in Figure 1.

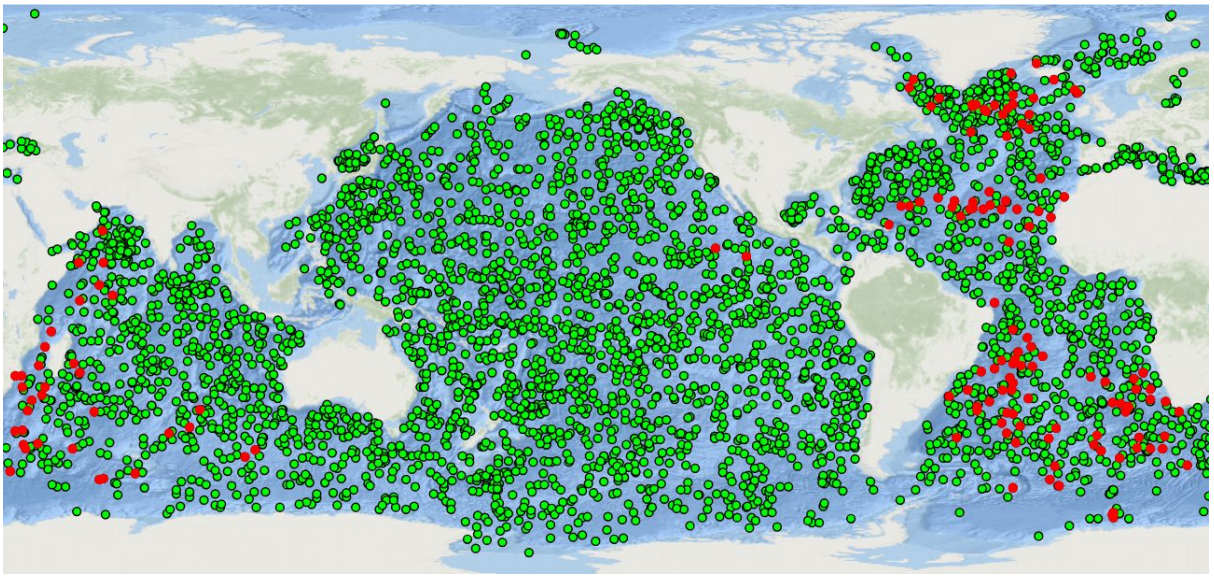

Figure 1. Showing the locations of reporting UK floats (in red) with the global network (in green), as at 14th February 2019.

Data processing

At present BODC are processing data from those 146 UK floats, 11 Irish floats and 74 Euro-Argo MOCCA floats. From 5th June 2018, all BUFR messages distributed on the WMO Global Telecommunications System (GTS) have been generated by the Met Office from the real-time netcdf files produced by BODC. In 2019 it is planned to include the capability for oxygen profiles into the BUFR files generated by the Met Office.

As of 19th February 2019 there were 40,722 real-time profiles and 31,921 delayed-mode profiles from core (standard CTD-only) UK floats available on the Coriolis GDAC, for the delayed-mode this represents 50% of the eligible profiles (i.e. all profiles from expired floats and profiles over one-year old from active floats).

However, at present there remains a significant number of floats deployed over the last three years for which the data are not yet being processed.

Deployed in 2016

- 2 Deep Arvor (both failed)
- 3 Apex RBR (1 failed on deployment)
- 4 Apex STS (1 failed)
- 3 Navis N1 with radiometer
- 2 Navis N1 (1 failed on deployment)
- 3 Apex Deep (all subsequently recovered)

Deployed in 2017

- 6 Navis N1 with oxygen
- 2 Apex RBR (both failed)
- 6 Apex with O2 & pH
- 4 Apex Deep with O2 (2 have failed)

Deployed in 2018

- 2 Navis N1 O2
- 2 Apex with O2
- 6 core Apex (APF11a)
- 4 Apex Deep
- 2 Navis N2 BGCi (1 has problems)

Despite the best efforts of BODC, little progress on handling these float types was made in 2018 and the backlog of floats needing to be processed has increased. As such, the highest priority for the coming year must be to ensure that the real-time data (even if only temperature and salinity) are processed and delivered to the GTS and GDACs from all the above float types apart from the Apex Deep.

Technical problems encountered and solved

Apex Deep. In December 2015 two Apex Deep floats were deployed in the North Atlantic. These performed 50 profiles and 127 profiles, lasting until June 2016 and April 2017 respectively. Three Apex Deep with O2, deployed and recovered during December 2016 after leaking, were shipped back to Teledyne Webb alongside one other for investigation and repair. Four other Apex Deep with oxygen were deployed in the Drake Passage during December 2017, of these one never transmitted, one transmitted one cycle, then went to sleep for 6 months and then reappeared. It is now cycling normally on a 3-day cycle. The other two are cycling normally on 3-day cycles, but one has been producing noisy salinity data since cycle 3. Three Apex Deep were deployed in the Atlantic in Nov 2018. One leaked on cycle 1 and is now drifting on the surface. The other two are cycling normally on 3-day cycles and are producing good data. The data from the working Apex Deep have allowed some evaluation of the SBE61 CTD.

Apex floats with RBR CTD: Six of these were procured in 2015. Two were planned to be deployed during the BoBBLE (Bay of Bengal Boundary Layer Experiment) cruise in June 2016. The first failed immediately after deployment so the second was returned to India for a firmware upgrade. This was done under TWR supervision and subsequently deployed in February 2017, but still failed in spite of passing all pre-deployment checks. Two other RBR CTD floats were deployed in the North Atlantic in June 2016 and both are transmitting data. These were all with early RBR heads that had less favourable flow geometry. The other two RBR-CTD floats were returned to TWR for upgrade of the heads, one of which was later deployed in the North Atlantic in October 2017 and failed, the other failed pre-deployment tests and has been returned to TWR for repair.

Bio-geochemical floats. We have deployed Apex, Navis and Provor biogeochemical floats with a mix of radiometers, fluorometers, backscattering meters, pH sensors, Aanderaa and SeaBird oxygen sensors. We have seen creep on SBE ODO sensors when deployed on long-term moorings and kept at pressure. This has promoted further examination of ‘park’ oxygen data, and a similar effect can be seen in NAVIS floats parked at 1000m for 10 days. This will be further investigated. We have also deployed 6 Apex with O2 and pH sensors with the first batch of SBE pH sensors, and are examining the stability and performance.One of the two Navis BGCi floats deployed in December 2018 has

exhibited problems (unable to go into continuous profiling mode due to the SBE41 being unresponsive). Currently, the root cause of this issue is unknown.

2. Funding and human resources

The UK Argo programme is undertaken by a partnership between the Met Office, the National Oceanography Centre Southampton (NOC), the British Oceanographic Data Centre (BODC) and Plymouth Marine Laboratory (PML). The Met Office are responsible for programme management and coordination, procurement of floats, organizing float deployments, preparation of floats for deployment, telecommunications (costs) and international contributions. NOC and BODC have responsibility for Argo science and data management respectively. PML play a leading role in the recent expansion of the UK programme into BGC-Argo.

UK Argo funding to the Met Office is presently provided by BEIS (Department for Business, Energy and Industrial Strategy) mainly through the Hadley Centre Climate Change Programme (HCCCP), but with an additional contribution through the Public Weather Service Programme. The HCCCP funding is agreed for a 3-year period to end March 2021 and provides ongoing funding for around 20 core floats per year. With this Argo funding now part of the HCCCP it should be less vulnerable to being cut.

NERC funding is primarily directed through NOC (which includes BODC) through its National Capability (NC) funding line. NOC is expected to become independent from NERC in 2019 subject to Ministerial approval. Post-independence, NOC will continue to be eligible to receive NC funds from NERC. Its NC funding, which is expected to remain level in cash terms for a few years, covers Argo data management at BODC and Argo science at NOC. In addition, it is expected that up to ten floats per year for the Argo extensions (deep and bio-geochemical) could be provided through bids to NERC for funding.

3. Summary of deployment plans

At the time of writing we have 54 core Apex floats available for deployment. Over the coming year it is expected that UK Argo will deploy 25 core floats (North and South Atlantic, Southern Ocean and Indian Ocean) and two bio-geochemical floats. Full deployment plans have not yet been prepared, but the following deployments are tentatively anticipated.

1 Apex (Iridium), 1 Apex-RBR: North Atlantic Gyre (AMT-29 Oct 2019)
2 Apex: Subtropical South Atlantic (AMT-29 Oct 2019)
4 Apex: South Atlantic (Argentine Basin) (AMT-29 Oct 2019)
4 Apex: Drake Passage (DY113 Feb 2020)
2 Apex (Iridium): West Antarctic Peninsula
4 Apex: South Indian Ocean (SA Agulhas II April/May 2019 - these four floats have still be located)
4 Apex: South-east Atlantic/Southern Ocean (SA Agulhas II Sept/Oct/Nov 2019)

The above is not a complete list and other deployment opportunities, primarily in the western Indian Ocean will be investigated.

We will also shortly take delivery of two Navis BGCi floats for which deployment will be arranged once the continuous profiling mode problem has been corrected.

At this stage we have six Deep APEX floats under refurbishment/repair at TWR. These will be deployed in the North and South Atlantic in late 2019/early 2020 depending on deployment opportunities as the floats become available.

4. Uses of Argo data in the UK

Argo data are used widely within NOC, where the science applications include:

- Measurement of evolution and drivers of mixed layer processes in the (Indian Ocean);
- Inventory and evolution of heat and freshwater establishing controls on budgets (both regional and global);
- Deep heat content (N Atlantic).

PML have the lead for BGC Argo in the UK, where the data are used for:

- investigating the seasonal dynamics of the biological carbon pump;
- developing techniques to generate 3D fields of biogeochemical variables by merging ocean-colour and in-situ data;
- investigating mesoscale structures by combining altimetry and in-situ profiles with a special focus on Agulhas rings;
- investigating particle dynamics in oxygen minimum zones.

At the Met Office Argo data are used operationally:

- they are routinely assimilated into its FOAM (Forecasting Ocean Assimilation Model) suite which is run daily and produces 2 analysis days and a 7-day forecast;
- fields from global FOAM are also used to initialise the ocean component of coupled monthly-to-seasonal forecasts
- Argo data are also used in the initialization of ocean conditions in climate models run to make decadal predictions;
- a coupled ocean/atmosphere prediction system has been developed for weather forecasting timescales, and is now being run operationally, delivering ocean forecast information to the Copernicus Marine Environment Monitoring Service (CMEMS);
- near-surface Argo data are used to validate the output from the Met Office's OSTIA (Operational Sea Surface Temperature and Sea Ice Analysis), where the OSTIA fields are used as a lower boundary condition in numerical weather prediction models run by both the Met Office and ECMWF.