Argo National Data Management Report – Australia, October 2023

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1. Real Time Status

Deployments

Between September 2022 and September 2023, we deployed 47 floats. Of these floats, 4 were BGC floats with six BGC sensors, and 43 were core floats. We deployed 2 buddy pairs (Altos with RBR sensors, buddied up with floats with SBE41 sensors), and the other 6 Altos with RBR sensors deployed did not have buddy pairs. A map of deployment locations, showing float types, is presented in Figure 1. We have deployed more Arvors (NKE) this year than in the previous years. All recently deployed BGC-Argo floats are Provor floats.

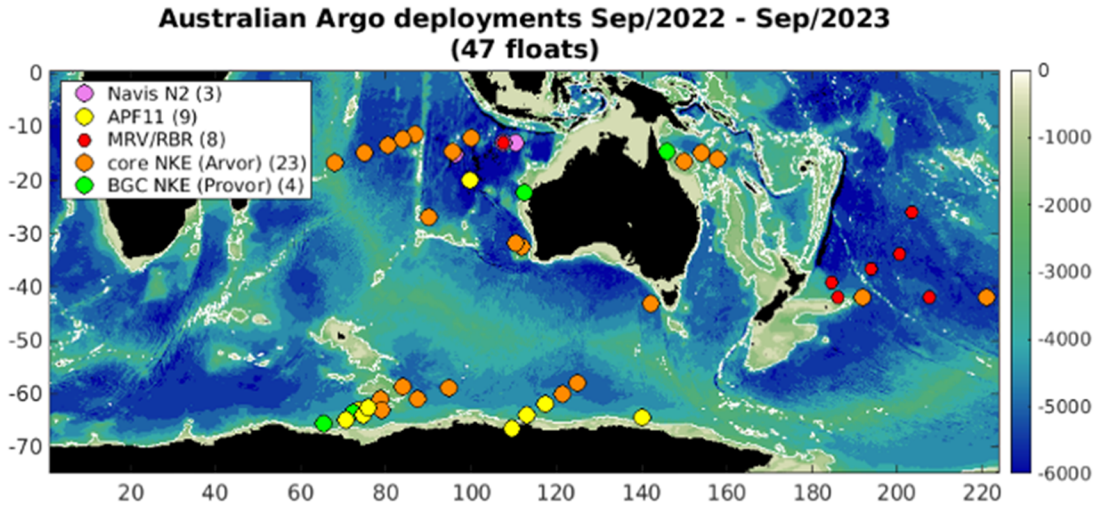


Figure 1: Map showing deployments between October 2022 and October 2023.

We have recovered two end-of-life BGC floats east of Tasmania; they're being refurbished and we plan to redeploy them within the next 12 months in the East Australian Current.

Overall, the biggest impediment to growing the Australian BGC-Argo fleet is cost. The nitrate sensor has become prohibitively expensive – to the point that we're refraining from purchasing any more of these sensors for our floats for the time being. We're also not buying any more pH sensors for the moment because we have seen such high failure rates (7 out of 12 on our live floats).

Real-Time (RT) system developments

We still maintain two RT systems: a Matlab-based RT system and a Python-based RT system. The Matlab-based system has been used for a long time to process data received from the RUDICS server and it requires regular manual intervention. Our Python-based system has more stability, is more portable, and does not require a paid user license. The Python-based system can process data from floats communicating through either the RUDICS server or via SBD. Both systems are run at CSIRO, and the Matlab system is also run at the BoM. In the coming year, we hope to port the Python-based system to BoM, and may be able to retire the Matlab-based system.

All of our operational floats are being processed by the Python-based RT system (including BGC and Deep floats). However, to maintain consistency through the life of a float, we continue to process some floats through the Matlab-based RT system. Currently, data from almost 50% of our operational floats are being exported to the GDACs from the Python-based RT system and this fraction will increase as the older floats end.

Both Matlab and Python RT systems perform real-time adjustment of salinity. We now routinely apply the PSAL offset value saved by the DMQC operator to data in the RT systems.

In total, we manage 332 operational floats, including 317 core floats, 3 deep floats, and 12 BGC floats. Our effort to support the BGC floats is disproportional to the float numbers. The complexity of BGC floats means that about half the time supporting our RT system (i.e., code support) is dedicated to BGC.

Data issued to the GTS

Currently, the Australian Fleet has 332 operational floats, including 317 Core, 12 BGC, and 3 Deep floats. Of the 12 operational BGC floats, all have six BGC sensors – however the pH sensor failed on 7 of our BGC floats. Parameters pushed to the GTS are P, T, S and DOXY.

We run our Matlab-based system every 3 hours, four times a day at CSIRO and four times a day at the BoM – with execution at the two locations offset by 3 hours; and we run our Python-based system every 3 hours at CSIRO. Real-time data delivery, after real-time QC is applied, is summarised in Figure 2 and 3. Of all Iridium BUFR bulletins reported during October 2022-October 2023, 99.43% were submitted within 12 hours of observation time; and 97.40% were submitted within 6 hours. We no longer have any operational floats that communicate using Argos.

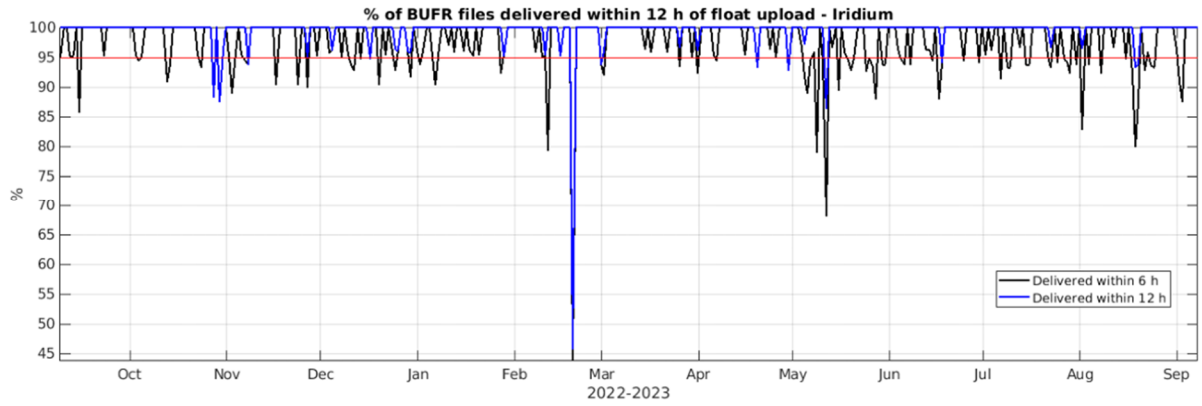


Figure 2: Percentage of BUFR files delivered within 12 (blue) and 6 (black) hours after data being received by the float, for floats with RUDICS communications between September 2022 and September 2023. Floats with SBD comms are not included in this measurement, but BUFR files from floats with SBD are also transmitted.

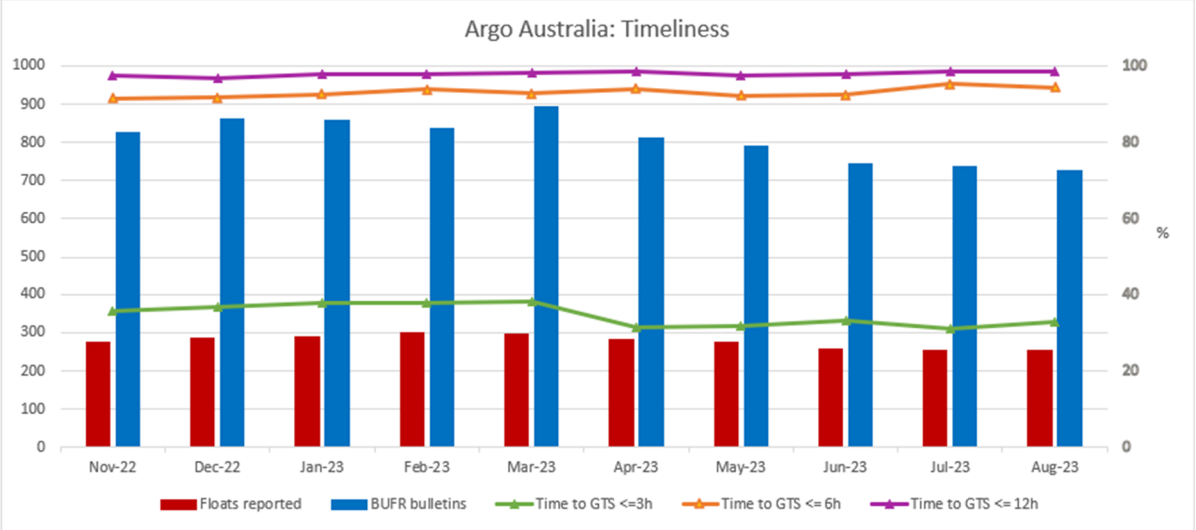


Figure 3: Timeliness of Argo Australia BUFR files reaching the GTS

Real Time QC status

For core floats, real-time QC is applied (P, T, S) and real-time adjustment is made to S based on DMQC offset values. For BGC floats, real-time QC and adjustments are performed on DOXY, NITRATE, PH and CHLA. We hope to soon apply real-time QC to BBP data. We are also working on improved nitrate calculations (from the UV spectra) with the recently updated calibration coefficients. Our DOXY adjustments are still calculated using % surface saturation (with SAGE, using WOA 2018) but we hope to have traj files operational soon so that we can switch to in-air oxygen calibrations.

We have recently accomplished QC of CHLA on most of our “legacy” floats (processed 24 floats out of 27), following the most recent RTQC recommendations. Almost all our

raw DOXY, NITRATE, PH and CHLA data now has QC set to 3 (as per recommendations). We will continue to work our way through the backlog over the next 12 months.

2. Delayed Mode QC status

Delayed Mode data sent to the GDACs

As of 8 September 2023, in the preceding year, the number of R-files (NR) submitted to the GDACs is 13,604; the number of R-files older than 365 days (NN) is 4,021; and the number of D-files (ND) is 201,000. The raw percentage of D-files processed (100*ND/[NR+ND]) is 93.66%. Considering only data from the eligible floats, we calculate that the percentage of D-files (100-100*NN/[NN+ND]) is 98.04%. Over the last year, the number of D-files submitted to the GDACs is 44974, from a total of 363 different floats.

We have submitted D-files for 18 floats with RBR CTD sensors. These include both pre-April 2021 (batch calibration) sensors with post-deployment compressibility coefficients determined by RBR and post-April 2021 (individually calibrated) sensors.

We have implemented a significant update to our DMQC matlab code to accommodate QC of core parameters on multi-profile (N_PROF>1) floats. This was previously limited to N_PROF=2, but is now more flexible and has been used successfully with both APF-11 and Provor floats with N_PROF=6.

The DMQC group has been active in participation in the bi-monthly working group lead by Tatiana Rykova. In particular, we have contributed to the recent discussion of TBTO effects.

We are up to date with feedback on Objective Analysis and Altimetry alerts and have regularly updated the ASD spreadsheet. We have submitted our response to the 2023 Audit and updated profile files on the GDACs.

Delayed Mode BGC data sent to the GDACs

We are currently not producing any new D-mode BGC data. A lot of our A-mode data is technically D-mode (only lacking spike detection/visual inspection of individual profiles) but is not currently reported as such. We hope to change this in the next 6 months and start producing D-mode data for NITRATE, PH and DOXY. This will be done for both active and legacy floats.

Support for Argo, India

We performed core (P, T, S) DMQC on 40 Argo-India floats with CTD sensors in the SBR recall serial number range. The R-files were obtained from the GDAC and we delivered the D-files and DMQC documentation to Uday Bhaskar at INCOIS. The Dfiles were then submitted to the GDAC by INCOIS. Of the 40 floats, 10 had severe PSAL drift with some uncorrectable cycles. The documentation provided to INCOIS will enable them to approach SBR with evidence to discuss warranty claims on some of these sensors. Some updates to our matlab DMQC software were required to accommodate the Argo-India Arvor floats (which deliver profile data on cycle 0). We have offered to provide the updated matlab code to INCOIS so that they can continue to assess their floats when they have the capacity.

3. Value Added items

Argo Technician Community of Practice

The Argo Technical Community of Practice, initiated in 2021 and endorsed by AST in 2022, has continued. The forum aims to promote collaboration, knowledge sharing and coordinated action to establish, review and refine best practice procedures for pre-deployment testing of floats to eliminate premature loss of function.

This group meet quarterly over Zoom, and rotate the chair and responsibility for each meeting. The group has not been open to vendors, and is targeted at technical staff working directly with floats. The group welcome topics for investigation from PI's and will capture and report key findings to AST. For more details, contact Pat McMahon (Pat.McMahon@csiro.au). A website has been maintained to communicate with participants and to provide a record of past meetings and topics covered. The website is at: www.cmar.csiro.au/argo/dmqc/html/ArgoCop.html.

DMQC Discussion Series

A series of virtual meetings on ***Argo DMQC Discussions***, initiated in 2022, has continued. This discussion series is intended to promote collaboration between Argo DMQC Operators and interested members of the Argo Community. The forum is an opportunity for newer Operators to learn from more experienced Operators, to build a greater sense of community, and to promote consistent DMQC practices. The meeting is open to anyone interested. Discussions have been held every two months, with 6 discussions held this calendar year. Topics covered include:

- TBTO Issues (identifying characteristics of TBTO contamination);
- OWC best practice (how to);
- Demonstrations of DMQC systems; and
- Many discussions on Difficult floats.

Discussions have been led by 9 different members of the Argo DMQC community, and have been attended by 9-20 people at each gathering. Meetings run for 2 hours, and are scheduled with start times that are offset by 8 hours for each consecutive meeting, to allow people in all different time-zones to attend without necessarily having to endure meetings at night. For more details, contact Tatiana Rykova (tatiana.rykova@csiro.au). A basic website has been maintained to communicate with participants and to provide a record of past meetings and topics covered. The website is at: www.marine.csiro.au/argo/dmqc/html/ArgoDM-Disc.html.

Deployment Planning

Gabriela Pilo leads our deployment planning and has joined the international community in meetings focused on the Indian Ocean and on the Pacific Ocean deployments. Esmee Van Wijk plans the deployments of floats in the Southern Ocean, Esmee, Steve Rintoul and Annie Foppert plan Deep float deployments and Christina Schallenberg and Peter Strutton plan the deployments of BGC floats.

We are making an effort to populate the Indian Ocean – this year we have deployed 13 floats in the central and western part of the Indian Ocean, and 3 floats off Australia's west coast that are likely to be advected towards the Indian Ocean's inner gyre. We have 4 more deployments planned between Australia and Réunion for early 2024.

For the upcoming year, we have deployments planned in the tropical western Pacific (in the new Kaharoa delivery voyage), in the East Australian Current (western boundary current of the South Pacific), in the Indian sector of the Southern Ocean, and on the Antarctic Shelf.

This Austral summer, we will deploy 10-12 deep floats in the Indian Sector of the Southern Ocean, off the RV Investigator. We are very grateful to our German colleagues from AWI who have offered to deploy 10 floats (5 with oxygen optodes) for us from RV Polarstern this summer in the East Australian Antarctic sector, in an area that we would otherwise not be able to access.

We are continuously looking for opportunities to deploy near the Kerguelen Plateau and in the central part of the Indian Ocean. A limitation for us is the departure port of the vessels. We give preference to voyages in which we can load the floats in Australian or New Zealand ports – to reduce shipping costs.

Over the past years, our deployments were supported by the RV Investigator, the Kaharoa, the vessels from the Australian Antarctic Division during their resupply voyages, the L'Astrolabe, the RV Sonne, Laura Bassi, Japanese research vessels, NZ Navy vessels, and a vessel from the Minderoo Foundation.

A tourism vessel, from Heritage Expeditions, has recently agreed to support Argo float deployments. Their vessel is large and has recurrent voyages that leave Auckland (NZ) towards the Ross Sea, the Antarctic Islands, the South Pacific Islands, and Japan.

Web pages

We maintain several technical web pages that we use to monitor the status of our fleet, and the performance of each component of our operation. Details can be provided if anyone from the Argo community wishes to examine these, but they are intended for internal use.

IMOS-OceanCurrent (https://oceancurrent.aodn.org.au/product.php) shows the location of Argo floats within oceanographic context, by overlaying them into maps of Sea Surface Temperature and satellite-derived surface geostrophic velocity. The maps cover regions around Australia, NZ, and the South Pacific Islands. The user can then click on the float to look at the cycle's profile sampled on the date of the surface map (e.g., https://oceancurrent.aodn.org.au/profiles/cycle.php?wmoid=5905515&cycle=124&depth=0)

Statistics of Argo data usage

Australian operational systems that use Argo data include:

- OceanMAPS: www.bom.gov.au/oceanography/forecasts/;
- POAMA/ACCESS-S: poama.bom.gov.au;
- OceanCurrent: oceancurrent.imos.org.au; and
- BoM's SST Analysis: www.bom.gov.au/marine/sst.shtml.

Scientific applications include:

- BRAN2020: research.csiro.au/bluelink/global/reanalysis/
- Blue Maps: research.csiro.au/bluelink/blue-maps-a-new-ocean-analysis/;
- Argo Trajectories under ice: zenodo.org/record/6571146#.Y3thKS0Rptw.

A record of what data types are used by OceanPredict systems for initializing forecasts and reanalyses is at: oceanpredict.org/observations-use/#section-argo-profiling-floats. This is not a product produced, or maintained by Argo Australia, but we include it here in case it interests members of the ADMT.

4. GDAC Functions

N/A

5. Regional Centre Functions

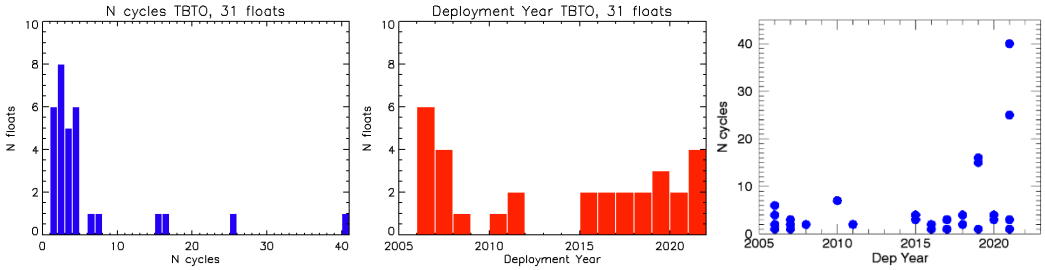
N/A

6. Other Issues

As part of the DMQC Discussion series, an emerging issue with TBTO contamination been identified which was illustrated by an extensive study of floats in the Weddell Gyre (Birgit Klein). Following this discussion, we made a preliminary study of the prevalence of TBTO contamination in Australian Argo floats. We note that our current deployment practice does not include any flushing of the CTD. The criteria for inclusion in this study were:

1. Floats deployed after 2000
2. Floats with Seabird CTD
3. PSAL fresh offset initially and later returning to climatologically consistent values (consistent over all depths)

Of 1017 floats fitting the first 2 criteria, we found 31 floats that fit the third. Most of these floats exhibit fresh offset for a small number of cycles (< 8 cycles), but in four floats the offset persisted for more than 15 cycles.



These four floats (5905432, 5905441, 5906654, 5906655) were deployed in 2019 and 2021, two are Seabird Navis hulls and two are TWR APEX hulls. One (5905441) was initially profiling with a daily mission, reverting to a 10-day mission after 14 cycles. The other three were on a 10-day cycle throughout. One float (5905441) has since been recovered and is undergoing refurbishment of the BGC sensors. This may provide an opportunity for examination of the CTD and the TBTO tablets. We are following this up with Seabird.