22nd ADMT Meeting

Virtual Meeting

8th - 10th December, 2021

Table of contents

Welcome and introduction

The ADMT-22 meeting was a virtual meeting due to the COVID-19 pandemic. Despite the difficult time zone for many, there were over a hundred participants each day: 123 on day one, 116 on day two and 96 on day three. A Google Drive Folder was set up to share the presentations, documents and action items for the meeting.

The Agenda is in Annex I, the Action list status for ADMT-21 and new Action list for ADMT-22 are available in Annex II and III.

Session 1 - Wednesday 08/12/2021: Status,Real Time, & GDAC Data Management

1. Part 1 - Status

1.1 Feedback from AST

S. Wijffels presented feedback from the AST to the ADMT. She began by noting the overall downward trend in float deployments in the past few years (minus last year). When broken down by mission type, BGC-Argo and Deep Argo are deploying more floats as would be expected in the ramp up to the OneArgo design. However, since BGC and Deep float reliability is lower, and the overall number of floats deployed is lower, Argo may need to consider increasing core float deployments to address this. The good news is that overall coverage remains solid due to long float lifetimes based on work to improve float technology and survival.

Next, she presented immediate challenges facing Argo including impacts from COVID-19 such as greatly reduced RV operations and access to other vessels, supply chain issues which are likely to continue impacting Argo over the next 2 years, and float price increases. She also noted challenges due to the expansion including the need for better deployment planning acros missions, the need to develop appropriate temporal sampling strategies to reduce biases in upper ocean measurements, and the need to re-establish stronger connections with the operational community to ensure that quality controlled data are being properly used.

In terms of CTD development, she noted that a huge amount of progress has been made on the RBR Argo3 CTD and thanked the working group. She also noted that the SBE41 salty drifters are significantly impacting users as 25% of real time data is bad. She thanked the DACs and DMQC operators for identifying and flagging the data properly. She was hopeful that the drift would be engineered out in the factory in the future.

For BGC sensors, rapid progress has been made, but there is still work to be done including improving the dynamic error on chemical sensors and implementing DMQC processes on parameters besides oxygen. OCG has agreed to support cross-network sensor teams to work on these issues and the work is beginning with dissolved oxygen and members of the BGC Argo Mission, GOSHIP, Oceansites and the glider networks have been identified.

Finally, Argo was awarded the IEEE Corporate Innovation Award:
“For innovation in large-scale autonomous observations in oceanography with global impacts in marine and climate science and technology.”
https://corporate-awards.ieee.org/recipient/the-argo-program/

1.2 Feedback from BGC-ADMT

There were about a hundred participants for the two days of the meeting. 2021 is the first year for which the BGC network reached more than 400 floats at sea. 870 floats deployment are planned in the next 5 years, but there is still a lack of 400 floats to get 1000 floats at sea. Available tools and audits are advertised on the web page and are very helpful for DACS but correcting the data remains difficult (manpower, capacity building). A first BGC - DMQC Workshop is planned for fall 2022, with a scope of pushing more adjusted data to the GDAC and fostering the DAC collaboration. A FAQ page and a products page will be set up on the BGC-Argo website.
The BGC community would like to move forward with incorporation of a PSAL proxy (ARMOR3D as a first guess) for use in recovering BGC parameters with bad salinity. The recommendation would be to only apply this recovery method in delayed mode on a case-by-case basis, and the method must be tracked appropriately through the SCIENTIFIC_CALIB_* fields. A general consensus is reached to say that it should be done. The working group will work on the details, but the first guidance is summarized here :

- An agreed char string will be added to SCIENTIFIC_CALIB_COMMENT in the BD- files to denote this recovery process. In addition, the recovery process will be written in detail as a separate chapter in the BGC Argo QC manual, and then the DOI of the manual (http://dx.doi.org/10.13155/40879) will be cited in SCIENTIFIC_CALIB_COMMENT in the BD- files.
- The value of the salinity proxy used in the BGC recovery will be stored in a separate file in the /aux directory at the GDACs. The format of files in the /aux directory will follow the same format as the b-files. Hence for every BD- file with recovered data at the GDACs, there will be a supplemental file in the /aux directory. Suggest filename "suppBDxxx.nc" to mirror "BDxxx.nc". The variable name PSAL_PROXY seems to be agreed. No _QC variables for PSAL_PROXY.
- The BGC delayed-mode operator will make the final decision on what salinity proxy to use. ARMOR3D can be an initial suggestion. Details of PSAL_PROXY can be provided in the SCIENTIFIC_CALIB_COMMENT in the "suppBDxxx.nc" files.
- The BGC delayed-mode operator will make the final decision on when to switch to using PSAL_PROXY. (a lot of guidance should be given)
- PARAM_ADJUSTED_QC should be set to 1 or 2, as BGC sensing quality is not governed by PSAL, so even if PSAL is only approximate, the ordinary BGC QC flags should apply. With '5 value changed', we lose the granularity of our normal QC flags.

All details of the two days meeting will be stored in the BGC-Argo ADMT22 minutes.

Action item: ADMT supports using alternate source of PSAL to calculate BGC_ADJUSTED in 'D' mode when float salinity becomes too bad for use. These recovered BGC_ADJUSTED values should be accessible in the BD- and SD- profiles. The ADMT does not support including

PSAL_PROXY (or any alternate source of psal) in the main data files. The BGC PSAL recovery working group will finalize the details of how this can be implemented.

1.3 Action Item Status

21 completed, 32 in progress and we hope that they will be completed in next month and 8 didn't start. We need to understand the reason that prevent completion of all actions

M. Scanderbeg reported on the status of the Action items from ADMT-21. 21 were completed, 32 are in progress and 8 were not started. We understand that COVID has impacted our ability to achieve progress, but we would like to understand what are the other factors that are impeding the ADMT's ability to make progress on actions. Specifically the DACs are having trouble completing actions in a timely manner and we would like to know how to better support them.

She noted that putting a high priority on items seemed to help DACs determine what order to focus their work and S. Wijffels suggested working with the AST co-chairs to help set priority levels for DAC action items from ADMT-22.

Previous actions from ADMT-21 that were not completed will be carried over to ADMT-22 as needed. The link to the action items from ADMT-22 is here:
https://docs.google.com/spreadsheets/d/11OZ_H976jaKgw21L5ZT_vKzq3icLRjOyvq2h-ea0Olc/edit?usp=sharing

1.4 How to improve interactions with modeling community

At the European level, through the Copernicus Marine Service, two activities are undertaken: 1) the delivery of Argo-based products through two different Thematic Assembly Centers (i.e. the INSITU TAC and the MULTIOBS TAC) that deliver Argo and BGC-Argo in Near Real Time and Reprocessed products and qualified products based on observation and data fusion techniques; 2) Discussions through the Bio-Data Assimilation Working group on the access of BGC-Argo data, their quality and the uncertainties associated to the data. To improve interactions with modelers, there is the need for the BGC-Argo community to attend modeling meetings and specific working groups but also the need for modelers to attend our meetings in order to better understand our limitations and time frames. In this aim of initiating discussions, there was a dedicated session on the interactions with end-users during the Euro Sea meeting that took place in late September. For the next phase of the Copernicus Marine Service, a Memorandum of Understanding has been signed and it proposes the areas of collaboration between BGC-Argo and the operational community.

Feedback from the OceanPredict community on the use of Core, BGC, and Deep Argo data, and needed vertical sampling from Argo floats during ascent for operational systems and reanalysis was provided. A total of 21 operational systems and reanalysis were queried in this survey. Most operational systems use Core Argo data only or combined Core and Deep Argo data for assimilation. A small fraction uses Oxygen, Chlorophyl, and Nitrate for assimilation and validations. Other operational systems are planning to start using BGC variables in the next 3 years. While the Deep Arvor, Deep APEX, and Deep NINJA floats collect profiles during ascent only, Deep SOLO floats profile during descent and ascent. About half of the operational systems would be using profiles collected during both ascent and descent. Half of the operational systems

would require that the ascending profiles would be collected in the upper 2000-m, while the other half would be satisfied with either near-real time data in the upper 500-m or 1000-m. Needed vertical resolution during ascent would be either 1 or 2db in the upper 500-db, 10 or 20 db between 500-1000 db, and 20 db between 1000-2000 db. Out of the 21 reanalysis queried, about half of them use both Argo and Deep Argo data. A small fraction uses Chlorophyll for assimilation, and Chlorophyll, Nitrate, Oxygen, and particle backscattering for validations.

2. Part 2 - Real Time Data Management, DACs

2.1 DAC Real Time Status

2.1.1 Timeliness on GTS and DACs

Marine Environmental Data Section (MEDS) routinely collects and processes Argo data transmitted on the Global Telecommunication System (GTS) in BUFR format. Between October 2020 and November 2021, on average 13 426 BUFR messages were transmitted monthly on the GTS, of which 89% of the messages met Argo's timeliness target. There was no significant difference in timeliness between floats transmitting to Iridium or Argos satellites. Currently, 85% of the BUFR messages are from floats transmitting to the Iridium satellite. Since March 2021, the Japanese DAC has had difficulties in meeting the 12 hour target for floats transmitting to Iridium satellites due to network security issues. The problem will be fixed by March 2022. If Argo changes the timeliness target from 12 to 6 hours, only 81% of the current Argo data will meet the timeliness target.

2.1.2 Anomalies (Action item 11)

Christine explained the process to detect anomalies using OA, MinMax or Altimetry. All these warnings are now loaded in OceanOPS where their status can be monitored and alerts are sent to responsible PIs. PIs can also give feedback through this interface. They are also available as csv files for DAC usage (daily basis for all corrections, monthly basis for new-previous-greylisted sections) . A new column will be added to the monthly-basis files with more information to help the DAC operators know when a float needs to be put on the Grey list.
Christine showed data that have detected using these tests and that are still circulating with a qc flag of 1 on the GDAC and GTS. In the case of slow drift, it is detected after a few cycles and action is needed to go back and correct to when the drift started.

Comparison with Altimetry : New synthetic climatology from altimetry (2003-2019) was computed and is now used. All the cycles detected are visualized and only the confirmed ones are sent to DACs and loaded in the OceanOPS system. Anomalies seem to be corrected more rapidly in 2021, however there are really bad floats that have been on the list for a long time, or floats that drift significantly, and should be on the greylist. They have been corrected in DM and should be put with a qc flag of 3 for RT data. For these floats, bad profiles (last cycle) are still circulating with a qc flag of 1 on GDAC and GTS.

Action item: Ask DMQC operators to prioritize DMQC of floats identified by Coriolis monthly anomalies report sent by C. Coatanoan and available here: https://data-

argo.ifremer.fr/etc/Report_ObjectiveAnalysisWarning/ CSV versions are available in the csv_drift folder. OceanOPS is also sending out emails to PIs/DM operators.

2.1.3 Real time qc tests and flagging of data

Claudia Shmidt presented the different refined tests for" Deepest pressure test for shallow profiles" and made a recommendation that will be documented in the QC manual. She pointed out that deep pressure metadata information should be carefully checked before implementing the procedure.
Multiple ways to check for anomalus profile pressures based on the CONFIG_ProfilePressure_dbar were applied and the outcome compared. The test that performed best is:
The tolerance is derived based on a percentage that evolves linearly between
150% for CONFIG_ProfilePressure_dbar=10 dbar to 10% for
CONFIG_ProfilePressure_dbar=1000 dbar.
For CONFIG_ProfilePressure_dbar>1000 dbar the tolerance is 100 dbar.
The pressure threshold is CONFIG_ProfilePressure_dbar+tolerance.

It was agreed that: Pressures that fail this test get a qc flag of 3, unless they are already flagged as 4.

It was agreed that: Because CONFIG_ProfilePressure_dbar can be erroneous DACs will need to have a way to check the CONFIG_ProfilePressure_dbar if a profile fails this test.

Claudia sent the details for this test to Annie for updating of the qc manual.

Action item: DACs to implement refined deepest pressure test for shallow profiles. If profiles fail this test, they will be assigned a qc flag of '3' unless they are already flagged as '4'.

Action item: Update QC manual with refined deepest pressure test

2.1.4 Combined Trajectory Files (v3.2): implementation status & when to stop accepting v3.1 Btraj files (Action items 13, 20)

Annie reported that the V3.2 traj format was finalized in 2021 and published in the Argo Users Manual, Section 2.3. The ADMT was reminded that the V3.2 traj files were for floats that collected park/surface BGC data, which were previously stored in the V3.1 Btraj files. For other floats, DACs can continue to use the V3.1 core traj files, although they can be upgraded to V3.2 if the DACs wish to do so. Mark Ignaszewski has been working to upgrade the GDAC file checker, and reported that it should be ready to accept V3.2 traj files in June 2022. Annie has produced some sample V3.2 DM traj files and Coriolis is producing V3.2 RT traj files on a dedicated FTP (ftp.ifremer.fr/ifremer/coriolis/argo/etc/decoder_output/trajectory/nc) to help test the GDAC file checker. As soon as the GDAC file checker is ready, DACs can submit V3.2 traj files. A timeline for the GDACs to stop accepting V3.1 Btraj files will be discussed at the next ADMT meeting in late 2022. Megan mentioned that instructions on how to store these BGC park/surface data should be added to the Argo Trajectory Cookbook.

Action item: Update DAC Trajectory Cookbook with instructions on how to fill BGC parameters & grounded flag
Action item: Decide on end of transition period for BGC floats, during which both v3.1 Btraj and v3.2 traj files can exist, at ADMT-23.

2.1.5 DAC status discussion (Action items 9, 14, 15, 16, 17, 18)

There was agreement during the discussion that a second DAC workshop would be useful. In order to plan the topics effectively, the results of the survey from the previous workshop will be reviewed by BODC and AOML in early 2022 and then shared with the ADMT.
Tanya suggested that a DAC workshop could be a side event of the proposed BGC-DMQC workshop if it makes sense.
S. Diggs suggested a hack-a-thon type approach similar to the Data viz workshop in Villefranche.

Action item: Consider holding a virtual second DAC workshop. Ask C. Bellingham and C. Schmid to compile survery results from DACs about where they needed the most help and use that to begin planning the content of the workshop. Could consider having a day for DACs in conjunction with the planned BGC DMQC workshop. Need to identify a planning committee for this workshop.

There already are a lot of tools shared on GitHub (both BGC and Core) and this should be made more visible and may be useful to some DACS. Some good links currently exist here and will be updated after the meeting:
https://argo.ucsd.edu/data/argo-software-tools/
https://biogeochemical-argo.org/data-tools.php
https://github.com/ArgoDMQC
https://github.com/ArgoRTQC

Action item: Consider using the GitHub repository for real time tools for DACs: https://github.com/ArgoRTQC

Action item: Ask DACs to put floats that fail MinMax test for drift on the greylist. Information for this is found in the first table in the monthly report from Coriolis and OceanOPS has begun sending emails to float PIs/DM operators. Additionally, starting in Jan 2022, a column will be added with greylist recommendations. DACs should automatically put these floats onto the greylist without contacting the PI. The PI can then review the floats in dmode and can use this indication to put a higher priority on these floats in dmode.

Older actions that were not completed by all DACs:

Action item: DACs to apply real time adjustment to all R files when a D mode adjustment becomes available. This means going back and re-processing R files after last D mode file and current R files coming in.

Action item: Start to implement the v3.2 traj file format for BGC floats.

Action item: Replace RTQC gradient test T&S with the new MEDD test. Refer to QC Manual for instructions on MEDD test

Action item: Ask DACs to implement new global range test

Action item: DACs to include TEMP_CNDC and NB_SAMPLE_CTD in the core-files as intermediate parameters, ie. no _ADJUSTED, no _ADJUSTED_QC, no _ADJUSTED_ERROR.

Action item: Ask DACs to apply the greylist test to trajectory files

3. Part 3 - GDAC Data Management

3.1 Update on NVS reference tables: roadmap on how to implement unconstrained fields and whether all ref tables can be entered (Action items 27 - 28, 60)

Guillaume Alviset (Ifremer) has created the Argo ontology to enhance the FAIRness ('Findable, Accessible, Interoperable, Reusable') of the Argo metadata. The Argo ontology is linked directly to the NVS concept URIs of some of the Argo vocabularies, and describes floats and their cycles semantically using the Resource Description Framework (RDF) standard. Through the ontology, the Argo metadata has become machine-readable and accessible through a SPARQL endpoint. The ontology itself does not hold any data, though it provides the links to the netCDFs containing the observations that match a user's search criteria. This is possible because the ontology uses the DCAT description (a standard way of describing catalogues of datasets) for each Argo float. Because the ontology reuses numerous existing standards, it makes it easier to discover the Argo datasets as well their links to other observational programs. More information on the Argo ontology can be found in the Argo data management website, by following Documentation - Argo vocabulary server - Argo linked data and SPARQL endpoint.

Over the past year, progress was made in the Argo manual to NVS transfer of metadata tables. The following collections are now available on the NVS: R15 (trajectory file Measurement Codes), RMC (trajectory file Measurement Codes categories), RTV (trajectory file cycle timing variables), R25 (SENSOR), R26 (SENSOR_MAKER) and R27 (SENSOR_MODEL). The outstanding tables include: technical and configuration parameter names tables, CONTROLLER_BOARD_TYPE (currently being constructed), BATTERY_TYPE and BATTERY_PACKS. The recent kick-off of periodic link with industry meetings between the Euro-Argo community and the main Argo sensor/float manufacturers has set in motion a direct collaboration in sharing and improving manufacturer-related metadata needed by DACs. Moreover, there has been progress in our effort to constrain currently free-text netCDF metadata fields, including PI_NAME, PROJECT_NAME, DEPLOYMENT_PLATFORM, DEPLOYMENT_CRUISE_ID and DEPLOYMENT_REFERENCE_STATION_ID. Details of the status on each can be found on the Argo Vocabulary Task Team (AVTT) GitHub repository Argo Vocabs: https://github.com/nvs-vocabs/ArgoVocabs. A new vocabulary has been collated to constrain the Floats Ending Causes, and feedback from the ADMT community was requested to finalize this vocabulary and its use in the Argo data system.

Action item: NVS task team to finalize the Argo Vocab and identify cleary what is managed at NVS/BODC, what is managed at OceanOPS and what are the tables where another solution needs to be found

Action item: Clearly identify which sensors are accepted and which are pilot or experimental in ref table 27. This needs to be in User Manual and NVS tables

3.2 GDAC status

Thierry Carval presented the status of the GDAC and the increase in terms of new data made available for Core, Deep and BGC missions. He presented the new tools made available at the GDAC (Fleet Monitoring and data selection).

In November 2021, 11 DACs submitted data to GDACs. The Argo GDAC dataset consists of 17.000 floats having 2,5 million profiles files. The number of floats increased by 11% compared to last year, the number of profiles increased by 17%.

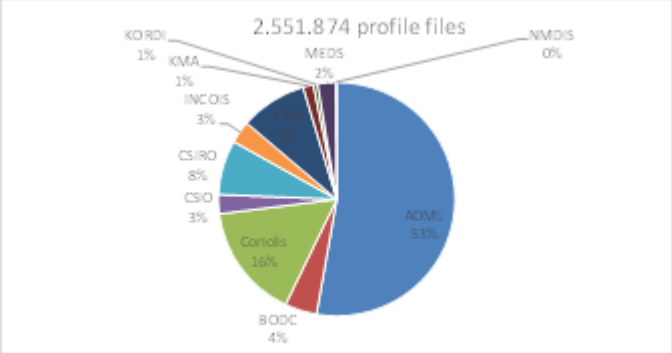
The total number of NetCDF files on the GDAC/dac directory was 3.124.121 (+9% in one year).
The size of the GDAC/dac directory was 316 Gb (+11%).
The size of the GDAC directory was 661 Gb (+16%).
The GDAC/aux directory contains “unregulated” files, at 2.9 Gb, its size remains reasonable.

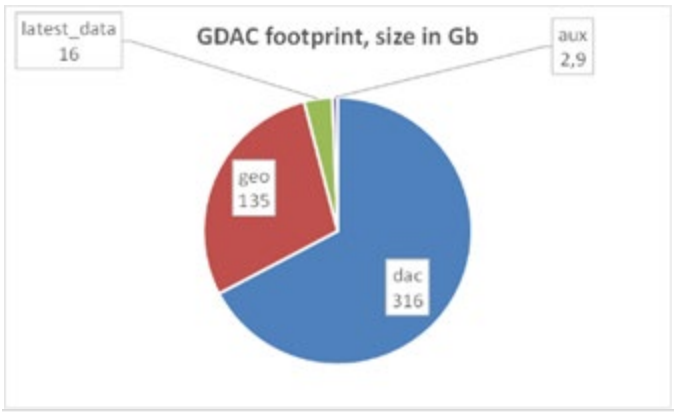
In November 2021, 250.000 BGC-Argo profiles from 1664 floats were available on Argo GDAC. This is a fair increase compared to 2020: +35% more floats and +33% more profiles.

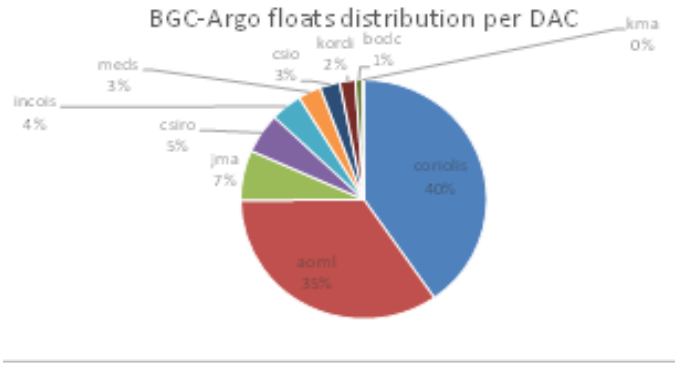
The GDAC detailed status is interactively available from:

- Interactive floats and data discovery on Argo fleet monitoring & Argo data selection https://fleetmonitoring.euro-argo.eu
- https://dataselection.euro-argo.eu

DAC	metadata files 2021	Increase	profile files	Increase2	delayed mode profile files	Increase3	trajectory files	Increase4
AOML	7941	4%	1 345 968	7%	1 131 308	9%	9 854	4%
BODC	798	6%	112 039	11%	87 276	16%	519	1%
Coriolis	3 298	7%	404 850	11%	323 813	19%	3 219	8%
CSIO	509	13%	67 509	13%	50 954	19%	507	14%
CSIRO	1 035	8%	192 827	8%	178 313	9%	967	9%
INCOIS	491	0%	78 729	4%	33 950	1%	412	0%
JMA	1 854	4%	232 674	6%	175 111	9%	1 596	2%
KMA	253	2%	36 325	3%	32 590	41%	244	3%
KORDI	110	1%	15 350	0%	14 505	0%	107	0%
MEDS	603	4%	63 143	7%	44 832	14%	585	4%
NMDIS	19	0%	2 460	0%	45	-	19	0%
Total	16 911	11%	2 551 874	17%	2 072 697	32%	18 029	10%







3.3 File Checker updates: plan for using NVS tables to update File Checker, roadmap on how to implement changes in File Checker (Action items 1-7)

M. Ignaszewski presented the FileChecker updates during the past year:

- User Manual 3.4 revisions (March 2021):
- POSITION_ERROR_ESTIMATED
- PLATFORM_WIGOS_ID (including new dimension STRING17)
- NB_SAMPLE_CTD, _SFET
- Updates to the reference tables (several updates through the year)
- Enhanced checks on CONFIGURATION_PARAMETER_NAME / TECHNICAL_PARAMETER_NAME as discussed in ADMT-21 (March 2021)

Ongoing updates:

- Reference Table 28, 29, 30. Propose making these tests WARNINGS in March 2022.
- CONTROLLER_BOARD_TYPE_PRIMARY, BATTERY_TYPE, BATTERY_PACKS
- The FileChecker updates are complete. There are many non-conforming files. The list of on-conforming values will be created and put on the US GDAC in January 2022.
- Trajectory v3.2. Propose making these tests WARNINGS in June 2022.

- Initial development is complete. Testing and refinement is ongoing using available Coriolis datasets. (Annie has provided test files too.)
- Tech files with time-series. No estimate of availability.
- This is a “work in progress”. Development is in a very early stage. No estimated date for completion.

The following priorities were agreed :

1. Use of the NVS server for reference tables.
2. This work has not yet been started but has the potential to greatly improve the FileChecker.
3. Traj v3.2.
4. Tech time-series

There has not been significant progress towards sharing the FileChecker code yet, but the goal is to move it to a GitHub type environment. As it stands currently, anyone can download the file checker and run it locally.

In the discussion following the File Checker presentation, several things were contemplated and then agreed to. Priorities were established for File Checker improvements as follows:

- Highest priority is linking the File Checker to the controlled Argo vocabularies on theNVS
- Next is updating the File Checker to accept v3.2 trajectory files
- Final is to update the File Checker to accept technical time series data.

Action item: Ifremer to set up a GitHub repository for the GDAC FileChecker to allow for co-development and as a place to issue requests for updates to the FileChecker.

Action item: Transition the File Checker to reading NVS versions of the Argo ref tables to allow for automatic updates to the FileChecker when NVS tables are updated and to help in constraining the fields appropriately.

Action item: Update the File Checker to accept v3.2 trajectory files.

Action item: Update the File Checker to accept time series data in the technical files.

Action item: Run all existing v3.1 files through the current FileChecker and export results to ADMT

Susan agreed that we should move forward with the new controlled vocabularies and suggested that the ADMT put together a list of what DACs are being asked to do and the AST can help set priorities.

There was some discussion surrounding the use of controlled vocabularies, which tables to work on next and when they should be implemented in the File Checker. Mathieu offered to help improve the metadata on ships that they collect at OceanOPS. More discussion on this topic occurred on the third day of the meeting under the Format Updates topic.

In order for DACs and users to take advantage of the controlled vocabularies on the NVS, V. Paba was asked to clearly advertise them in the User Manual and on the ADMT website.

Action item: Update Users manual with NVS version of the Argo ref tables (when available) and include instructions for DACs & users on how to apply the tables.

Please think carefully about how to accept new sensors. People sitting on these panels for acceptance understand what is approved, pilot and experimental. A reminder on this would be helpful. We implement what the AST has decided and we can work with NVS to ensure it is working properly.

Action item: Improve guidelines on ADMT website for DACs/PIs who wish to add something to the Argo ref tables on the NVS. This process will take place on GitHub and each submission will be reviewed by the appropriate team. When accepted, the NVS table will be updated and so will the FileChecker when it is able to read in the NVS tables.

Session 2 - Thursday 09/12/2021: Pilot Data Management & Delayed Mode Data Management

Chair: Sylvie POULIQUEN

1. Part 1 - Pilot Data Management - real time and delayed mode

1.1 Deep Argo

1.1.1 Real time data/CPcor correction & Report on status of DMQC process for Deep Argo floats

C Cabannes presented the work done on deep Argo processing. As of November 2021, 307 Deep floats have been processed by 6 DACs. Salinity profiles should be corrected using new Cpcor values (Cpcor correct from compressibility of the cell). 45% profiles have been corrected with the new Cpcor value either in 'A' or 'D' mode but some DACs have not yet started. Some DM operators have found new Cpcor values larger than the ones recommended by the working group (WG), which is wondering if Cpcor could be different for each batch. WG requested more feedback from DM operators to eventually provide a new recommended value for RT adjustments. The WG still has to provide guidance on how to evaluate the static accuracy of pressure at depth. Additional guidance has been given to the DM operators: the evaluation of salinity sensor drift should be done at the 0.004 level and not 0.01PSU as for core mission. For now, DM operators must use the latest version of the CTD reference database (including GO-SHIP easy product), and not the 2K Argo_for_DMQC reference database.

In the discussion, Kim Martini from SeaBird offered to implement a new cpcor value in the factory. Argo does not feel ready for this yet and would like to track the optimized cpcpor values by CTD serial number to see if there is batch dependence.

Susan asked where the tools are available to calculate the optimized cpcor and Cecile has made them available on GitHub :https://github.com/ArgoDMQC/DM_CPcor.

Action item: Ask Cecile Cabanes to set up a Google sheet/database for dmqc operators to record the optimized cpcor values along with CTD serial number. This can help track cpcor values to see if there is any batch dependence. Tools for making cpcor estimates can be found here: https://github.com/ArgoDMQC/DM_CPcor

1.1.2 Matlab tool for selecting deep reference CTD in OWC

J. Lyman presented a new tool to be plugged to OWC tor better selection of deep reference CTD to take into account the topography.
Available on github https://github.com/ArgoDMQC/Deep_CTD_selection#deep_ctd_selection

1.2 RBR data

Mat Dever presented work done by the RBR Argo data task team (DTT) towards validating and correcting RBR*argo*^{3}CTD data. Pressure and temperature were found to be accurate to within manufacturer quoted accuracy. Salinity was found to require two types of correction: compressibility correction for pre-April2021 RBR*argo*^{3}CTDs, and thermal inertia correction for all RBR*argo*^{3}CTDs. The need for a compressibility correction was eliminated in post-April2021 RBR*argo*^{3}CTDs because RBR switched to unit-based compressibility calibration. In addition, RBR is pursuing the route of implementing thermal inertia correction onboard the CTD in future.

Mat and Annie reported that the procedures for real-time and delayed-mode adjustment for RBRargo^3's salinity had been prepared for the QC Manual. Mat also made codes for salinity adjustment available on github.com/ArgoDMQC/RBRargo_DMQC. A table with WMO IDs of deployed Argo floats equipped with pre-April2021 RBRargo^{3}CTDs, and a new set of compressibility coefficients for them, would be made available via the QC Manual and github. Argo groups with floats with pre-April2021 RBRargo^{3}CTDs that were still to be deployed were reminded to deploy them in areas with good reference data, so that a new set of compressibility coefficients could be derived for them by RBR post-deployment. Jenny Lovell asked about the 6 very early RBRargo^{3}CTDs at CSIRO that had a different manufacturer calibration. Mat and Annie will work with CSIRO on a special set of delayed-mode adjustment procedures for these 6. Virginie Thierry asked about the compressibility error in the RBRargo^3 6k CTDs. Mat explained that their correction would be different, and that work was ongoing to characterize their errors.

Annie and Mat then described that the thermal inertia error in RBR CTDs had two timescales: short timescale (~8s) and long timescale (~120-150s). The short timescale error is similar to that in SBE41CP CTDs, but the long timescale error persists longer and therefore can result in a salinity bias over a larger portion of the vertical profile. Analysis by Clark Richards and Mat Dever shows that this long timescale-related bias is small in most regions of the global ocean, but is more pronounced in the tropics, where dT/dz is larger. Broad estimates show that about 10% of RBR*argo*^{3}'s salinity in the upper 200m in the tropics will have a bias > 0.01.

Annie recounted that previously, when the RBR pilot first began, DACs were instructed to flag RBR*argo*^{3}'s data in real-time with PRES_QC='3', TEMP_QC='3', PSAL_QC='3', and that data should not be distributed on the GTS. Based on work done by the DTT, DACs are now instructed to flag RBR*argo*^{3} data in real-time with PRES_QC='1', TEMP_QC='1', but PSAL_QC='3' for pre-April2021 CTDs. Discussions were held as to whether PSAL_QC should be '1' or '2' for post-April2021 CTDs, because of the long timescale thermal inertia error. Susan Wijffels and Brian King reminded the ADMT that the raw flags were more an indicator of whether the sensor was working as designed, and therefore PSAL_QC should be set to '1' if all RTQC tests were passed. The ADMT community consequently agreed unanimously to set PSAL_QC='1' for raw salinity data from post-April2021 RBR CTDs from hereon.

The meeting further agreed that DACs should begin implementing real-time and delayed-mode salinity adjustment for RBR*argo*^{3} CTDs. Annie and Mat will finalize these procedures in the QC Manual and on github. All real-time adjusted RBR data can be distributed on the GTS from hereon.

DACs are reminded that the intermediate parameter TEMP_CNDC is needed to do RBR real-time salinity adjustment. For delayed-mode, both TEMP_CNDC and NB_SAMPLE_CTD are needed. Please implement their inclusion in the core profile files. See action item on TEMP_CNDC and NB_SAMPLE_CTD.

Action item: Ask DACs with RBR floats to implement real-time salinity adjustment as per the QC manual and flag PSAL_ADJUSTED with QC '1' in 'A' mode. Real-time adjusted data can be distributed on the GTS.

Action item: Ask DACs with pre-April2021 RBR floats to keep psal qc flag of 3. Please go back and flag pres, temp qc flags as 1. All data can be distributed on the GTS.

Action item: Ask DACs with RBR floats to flag real time temp, pres with qc of 1. Raw salinity from post-April2021 RBR CTDs can now be flagged with PSAL_QC='1'. All data can now be distributed on the GTS.

Action item: QC manual to be updated with RBR 2K procedures.

Action item: Advertise on Argo websites and through email/communication channels that RBR ctd data will be marked with improved quality flags moving forward and that users should be sure to use the adjusted parameters.

2. Part 2 - Delayed Mode Quality Control

2.1 DMQC code updates

◆ **Python version of OWC toolbox**

Kamila Walicka (BODC) presented progress in development works related to the Python OWC toolbox used for DMQC analysis of core Argo floats. The pyowc toolbox is fully functional and can be used by DMQC operators for DMQC analysis. The development version of the package is currently available on the EuroArgo GitHub argodmqc_owc. The output generated by pyowc toolbox is in very good agreement to those obtained from the Matlab version, matlab_owc of the code. The small differences could be due to rounding of data by both programs and also due to improvements in the interpolation method.The pyowc toolbox tested for 60 randomly selected floats from ocean regions and using only CTD reference data, showed about 25% of improvement in speed compared to Matlab version.

The progress made in 2021 includes: completed conversion of all remaining parts of the code, fixed all known bugs in the pyowc package, improved readability and reduced complexity of pyowc code, completed works to deploy code documentation to the ReadTheDocs, included detailed description of installation and software usage, improved the Pangea Binder in Jupyter notebooks, fixed CI pipelines, unit tests and Pylint issues, improved ease of installation for users. The major limitation was limited involvement of Python developers and feedback from DMQC operators from the broader international Argo community in developing and testing the code. Kamila highlighted a few useful steps for DMQC operators on how to test the code and also called for other DMQC operators to test and use the pyowc package. There are potential plans to organise a workshop or training for DMQC operators regarding the use of the pyowc package.

The next steps in developing the pyowc package will be focused on continuing to improve the maintainability of the functions and to improve calibration and other software options and parameters. Moreover, some future enhancements could cover deploying the code as a package to PyPi/Conda, deploying a standardized user interface, integration with other python packages of codes related with DMQC processing and publishing pyowc code at https://github.com/ArgoDMQC.

Action item: DMQC operators are asked to consider testing the OWC python tool available here: https://github.com/euroargodev/argodmqc_owc Feedback is requested to be sent to Kamila Walicka (kamwal@noc.ac.uk) or argo@bodc.ac.uk.

2.2 SBE CTDs

SeaBird CDT Report from salty drift working group (Action items 38, 39, 40)
John Gilson presented an update on the SBE salty drift issue on behalf of the "salty drift" working group (WG). There has been salty drift in SBE CTDs since the beginning of Argo. But the recent increase in un-adjustable salty drifters has meant an increase of data loss in Argo. The WG agreed on a definition for "abrupt salty drift" (ASD). The definition aims to characterize the behavior of the drift in order to delineate adjustable and un-adjustable salinity data. A new chapter on best practices for dealing with salinity drift in delayed-mode, including ASD, has been prepared for the QC Manual.
Monitoring of SBE salty drifts in general continues via the google spreadsheet maintained by Euro-Argo. Delayed-mode operators are requested to fill the spreadsheet at least once a year. In particular, if ASD is observed in floats with SBE41Cp SN > 11252, or SBE61 SN > 5724, please report these serial numbers to Susan Wijffels. So far, 7 floats in SN > 11252 have been identified with ASD.

Action item: Annie to include best practices chapter in QC Manual on how to deal with salinity drift in delayed-mode, including ASD.

◆ Updates from manufacturer Seabird

K Martini presented the status on FSD from the Seabird manufacturer
April 2018 production stopped. Oct 2018 had a manufacturing change. Feb 2020: abrupt salty drift detected in water. April 2021: recall for SBE 41cp CTDs. Dec2021: continued monitoring of fleet.
SBE has also found a small number of floats with issues after 11252. They all came from the same batch.
SBE verified the delamination in the recovered float. Thanks JAMSTEC for helping with this.
We do not need to recover anymore CTDs. We understand the mechanism now.
We will continue honoring the recall and will replace the CTD cell.
Birgit: Kim, any thoughts on recent salty drifters? I do think they are related to manufacturing change. Still following up on this.

Action item: Ask DMQC operators to continue filling in the spreadsheet for salty drifters at least once per year.
https://docs.google.com/spreadsheets/d/1TA7SAnTiUvCK7AyGtSTUq3gu9QFbVdONj9M9zAq8CJU/edit#gid=0

Action item: Ask DMQC operators to inform Susan Wijffels if floats with SBE41cp CTD serial number > 11252 or SBE61 CTD serial number > 5724 exhibit signs of abrupt salty drift.

Action item: Ask DMQC operators to respond to A. Wong's audit of delayed mode salinity data. Email was sent on 16 Aug 2021 with pdf of audit.

Sea-Bird Scientific continues to make progress on resolving the abrupt salty drift issue. Continued monitoring of the Argo fleet makes us cautiously optimistic that the manufacturing change implemented in October 2018 has substantially decreased the occurrence of abrupt salty drifters. Since the change, six abrupt salty drifters have been identified by the Abrupt Salty Drift Team, but these have been tied to a single batch of conductivity cells. Production is following up to determine the cause. We would also like to acknowledge JAMSTEC for retrieving a deployed abrupt salty drifter. Calibration verified the magnitude of drift and we were able to verify the cause of abrupt salty drift, delamination of the urethane. We are continuing with the recall of affected SBE 41cp CTDs, replacing cells on undeployed floats and following up on data from deployed floats. Finally, monitoring the status of the fleet and the production process is ongoing.

2.3 Under-ice position estimation (P. Oke)

40% of southern ocean profiles are under ice. Linear interpolation is not necessarily the trajectory path. Kaihe Tamazaki suggested a terrain following trajectory instead of linear interpolation. It's similar to the Chamberlain method, but works on any trajectory.
Python code is available on the EURO-Argo GitHub repository and provides a csv file with interpolated coordinates. (https://github.com/euroargodev/terrain-following)

Questions remain for applying it in dmode (e.g., spatial variation of the interpolation error, choice of the topographic data).

Publication reference

- Yamazaki, K., Aoki, S., Shimada, K., Kobayashi, T., & Kitade, Y. (2020). Structure of the subpolar gyre in the Australian-Antarctic Basin derived from Argo floats. Journal of Geophysical Research: Oceans, 125(8), e2019JC015406.
- Chamberlain et al. (2018): https://doi.org/10.1029/2017JC012990

Utilization of grounded pressure also needs to be considered;
E.g., Wallace et al. (2020): https://doi.org/10.1029/2020GL087019

Action item: ADMT encourages work done to improve position estimates for profiles under-ice and to applying such methods in delayed mode work. A python toolbox for estimating under-ice positions is available here: https://github.com/euroargodev/terrain-following People are encouraged to test it and provide feedback.

Action item: Ask. K. Yamazaki to continue investigating how under-ice position estimates could be applied in delayed mode. This may involve coordination with others interested in this such as E. van Wijk, U. Bhaskar, P. Oke, others. Please report back at ADMT-23.

2.4 Trajectory files

M. Scanderbeg presented on work done by the delayed mode trajectory working group over the past year. Draft guidelines were sent around for review by ADMT DM operators prior to the meeting and covered the 7 main tasks needed to create a delayed mode trajectory file. The five mandatory tasks include:

1. Check cycle number & fill various cycle number variables in N_MEASUREMENT and N_CYCLE array
2. QC surface times and positions
3. QC PARAMS and apply PARAM adjustments from corresponding profile files. Exact details on suggested guidelines will be forthcoming.
4. Fill JULD_ADJUSTED* variables. Includes instructions on how to fill float clock times, satellite times and estimated times.
5. Copy best times from N_MEASUREMENT array into N_CYCLE array.

The two strongly encouraged tasks are:

1. Fill MC301/Representative Park Pressure variables to facilitate subsurface velocity calculations
2. Determine GROUNDED flag

She requested feedback on whether the two strongly encouraged tasks should be moved to mandatory, but the group agreed that they should not be moved to mandatory.
She suggested that delayed mode quality control of trajectory files should first be done on dead floats as they are usually core floats and methods have already been developed to estimate missing timing information. She also noted that the v3.2 trajectory file format allows for recording of JULD_DATA_MODE, PARAMETER_DATA_MODE and the SCIENTIFIC_CALIB* section which all add value to delayed mode trajectory work. She encouraged DACs and DM operators to think about how it might be possible to create v3.2 trajectory files for all floats.

Finally, she presented a list of tasks for the working group for the next year including:

- Adding the dmode instructions to the Argo QC Manual
- Finalizing guidelines on exactly how to QC and to apply PARAM adjustments to trajectory files
- Consider endorsing peer review methods for estimating missing positions as linear interpolation clearly could be improved upon for under-ice profiles where several months of positions are missing.
- Updating the DAC Trajectory Cookbook with GROUNDED flags, new float types and how to include surface and near-surface oxygen & other BGC measurements.
- Consider developing tools for parts of trajectory DMQC that are non-float specific.

The last point about tools was well received. There were also suggestions of holding workshops or seminars to help DM operators and DACs begin creating dmode trajectory files.

Action item: Update QC manual with instructions on how to create dmode trajectory files.

Action item: Ask DMQC Trajectory working group to finalize guidelines on applying PARAM corrections from profile files to trajectory files.

Action item: Ask DMQC Trajectory working group to consider developing tools for non-float specific tasks.

Action item: Consider holding a DMQC Trajectory Workshop or a series of seminars to begin familiarizing DM operators with tasks necessary for DMQC of trajectory files.

3. Part 3 - DMQC monitoring and reference databases

3.1 Delayed mode monitoring at OceanOPS (Action items 49 - 52)

Victor Turpin is taking over as Argo technical coordinator as Mathieu Belbeoch changes his position at OceanOPS. Magali Kreiger has been hired as a metadata expert and will be working with the Argo Data Management team on the NVS activities. This reshaping of the OceanOPS responsibilities regarding the Argo program should not impact the operational work.

Monitoring DM operators:
The role of “BGC delayed mode operator” will be created. OceanOPS will capture this information for each Argo BGC program and update the OceanOPS database. We will share a document with ADMT in the coming weeks for that purpose. DMQC warning for BGC parameter will then be addressed to BGC DM operator directly.

Action : DM operator for BGC will be added to the OceanOPS system in the next year at the float level as is done for temperature and salinity.

Monitoring delayed mode floats:
87% is the percentage of floats that have been delayed mode and are the delayed mode data files are available in less than 12 month. This is a great percentage, reflecting the hard work done by the DMQC operator to identify salty drifters.It is also the best score since OceanOPS is monitoring the DM files availability. This percentage is constantly growing since 2016 due to high priority lists (Itimetry warning, Objective Analysis warnings and FSD CTD serial numbers).

Orphan floats:
Orphan floats are the floats with no Delayed mode operator identified. This situation makes the mandatory delayed mode management of the argo fleet. OceanOPS will review and report about Orphan floats to encourage the delayed mode management of the associated data.

Action Item : Review orphan floats (no DM operator) and report about it at the next ADMT.

Argo Vocabulary:
A working group formed by NVS, EuroArgo and OceanOPS experts has started to work in 2022 to improve and harmonize the following metadata vocabularies : “PI”, “controller board”, “ships”, “programs”, “networks”, “deployment_reference_station_id”, “deployment_cruise_id”.

Action item : OceanOPS work with NVS to import ships, networks and program vocabularies into NVS system.

BGC metadata issues:
OceanOPS is taking advantages of the work on the metadata of the BGC floats metadata done by Henry Bitig (https://biogeochemical-argo.org/cloud/document/implementation-status/) to improve the quality of the BGC metadata related to sensors.

Action Item : Validate an operational procedure to improve general BGC sensor metadata based on operational comparison done by Heny Bitig.

Data flow monitoring at the variable level:
Quality and timeliness assessment at the variable level has been set up by OceanOPS this year. These new indicators need to be tracked along the year for validation.

Action Item : Track and validate Quality and timeliness KPI at the variable level

Ingesting QC lists in the OceanOPS system:
Audit from the Objective Analysis and MinMax tests are now in the system as it was done for the Altimetry check. OceanOPS could add other QC lists (FSD) to relay warnings to the DMQC operators and provide QC statistics. This can be done on demande.

BGC profile quality monitoring issues :
It was noted that less than 1% of BGC profiles are quality 'A'. Is this because of the index file or is this due to a problem in how we assess this? It was agreed that more discussion was needed as the current quality indicators at OceanOPS are based on real time data for which BGC sensors regularly need to be adjusted prior to good flag being assigned. The metric should be updated for BGC data.

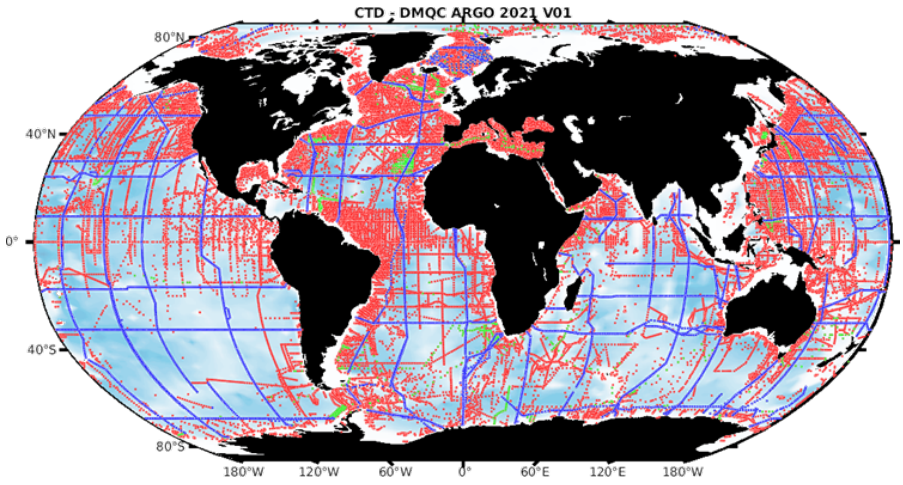
Action item: Ask OceanOPS to work with BGC-ADMT co-chairs to develop useful metrics on data quality of BGC parameters

Action item: Ask OceanOPS to read in the 'SPECIAL_FEATURES' string in meta files to look for additional experimental sensors that need to be included in float notifications to comply with IOC rules.

3.2 DMQC reference databases

A new version was issued in March 2021 including Easy-Ocean GO-SHIP data as well as new CTD from PIs. This version also takes into account important cleaning work according to certain criteria as well as a more in-depth work on the Nordic seas.

A new version will be delivered in 12/2021 taking into account corrections on a few box profiles as well as new CTDs from float deployment and new scientist CTDs.



Tools are available on the Euro-ArgoDev GitHub to check ref DB of boxes in your area of expertise: https://github.com/euroargodev/check_CTD-RDB
Don't forget to provide feedback to Christine.

One map from Tim Boyer showed data loaded to WOD in the last year. CTDs 2000-2021 deeper than 2000m and corresponding to 1,535 deep casts total from 135 cruises, 751 through CCHDO (78 cruises).

CCHDO transitioning to CF compliant Netcdf files. During pandemic, we've focused on historical data and other data that haven't been addressed yet. Concerned about overall drop in profiles from the past two years. Jenny wonders if you get data from CSIRO marine facility or IMOS. These are publicly available, but should we make an effort to push these towards you? Steve: We don't usually get data this way, but we need to look for this type of data in each country.

John: he is releasing a new version of the Argo ref db by the end of 2021.

Left over action items for DMQC operators from ADMT-21:

Action item: Ask DMQC operators to obtain an ORCID for recording in D and BD prof files. Add this ORCID to AIC system

Action item: Ask DMQC operators to add their name to the global attributes section of the D- and BD- files, as per the agreed format described in Section 3.7 of the QC Manual.

Session 3 - Friday 10/12/2021: Format, Value added tools, Upcoming meetings 4h

1. Part 1 -Format updates

1.1 Review list of proposed meta file changes & improvements

Thierry Carval explained the new process for format change request managed on a GoogleDOC (https://docs.google.com/document/d/1DSFcJa1LCuZQxPJorX_Z00GQkF1OIEdXdVWlH1NexN0/edit#heading=h.yreuupfowlg2) where each request has a status. Each request may be discussed in a dedicated GitHub issue

- https://github.com/euroargodev/ArgoNetCDF
- https://github.com/nvs-vocabs/ArgoVocabs

The need to clearly specify a non-ambiguous vocabulary to define the level of changes around modification of file format or addition in file content. Format change implies a change to the structure of the file and impacts the DACs and the users. In case of content 'enhancement', there is the addition of attributes or new variables that can be mandatory (checked by file checker) or optional (with no impact on a user that doesn't want to use it).

Also there is a transition period for DACs when the File Checker moves from unconstrained to constrained variables. Mark noted it is much easier to start with constrained vocabularies.

Action item: Find agreement on vocabulary around format changes and content changes. Within Argo, we need a clear way of talking about format changes and content changes.

Action item: Finalize float ending cause content after consultation with manufacturers and possibly the new technical group. Suggest either filling the 'anomaly' field, adding a new variable, or update existing field END_MISSION_STATUS in the netCDF files. In the meantime, it is suggested to use the OceanOPS system to populate this metadata field.

Action item: For SENSOR_MODEL, move towards using the manufacturer's model name in this variable. For sensors that are identical, but the company changed, include a comment about this in the NVS Argo ref table for SENSOR_MODEL

Action Item: Ask NVS team to find a machine to machine solution to find identical sensors, even if name is changed in Argo vocabulary.

Action item: Ask T. Carval to open a discussion ticket on how to directly link the Argo netCDF files to the NVS tables. Right now the 'conventions' point to 'Argo reference table 2', but it would be nice to have this point directly to the NVS tables.

Action item: DACs to change BGC 'count' parameters to integer data type. Store RAW_DOWNWELLING_IRRADIANCE* , RAW_DOWNWELLING_PAR, NB_SAMPLE_CTD,

NB_SAMPLE_<parameter sensor name> as 16 or 32-bit integers in NC_USHORT with NC_FILL_USHORT as fillvalue.

Action item: Remove <PARAM>_MED and <PARAM>_STD from § 2.3.5 of the Users Manual: because these statistical variables are intermediate parameters which will be added in the Ref Table 3.

1.2 Review list of proposed changes that affect multiple file types T. Carval

- **CF compliance to salinity and uncertainty**
- **Adding DOI to files**

The meeting ran out of time to discuss these proposed changes.

1.3 Discussion: develop timeline for possible format updates which must also coincide with NVS, User Manual, and FileChecker updates (Discussion Lead:)

The discussion that took place is recorded under the review of metafile updates above.

2. Part 2 - Value added section

2.1 GADR status and updates (Action item 45)

The system moved to North Carolina over the past year. The services mostly moved forward smoothly, but it is not possible to get usage statistics on the new server yet.

Archival of Argo data:

Reproducibility of data for any specific instance of Argo is difficult given that the Argo GDACs are updated multiple times per day but the archival of the Argo data is executed monthly and saved as one single aggregated tar file and compressed. The same Argo cycle can have multiple files with multiple updates, with some files updated more than once within a month. Downloading the full tar file, uncompressing and locating the exact files is a difficult and time consuming operation. The GADR is proposing a new archival system whereby each Argo cycle is archived separately with all instances of each file preserved and available. For reproducibility a user would then simply need to access the files as of a given specified date. This archival can really only be feasibly done in a cloud environment, facilitated by cloud ready objects such as Parquet.

Marine Climate Data System:

To facilitate a more international delivery system for Argo in tandem with other ocean observing system data, a cloud system through the IODE InfoHub has been proposed and accepted as a contribution to the U. N. Decade of the Ocean.
To further facilitate access to Argo data by more communities of use, Tim is also working with the NOAA Big Data Program to explore the possibility of loading and updating Argo data into the Google Big Query.

Action item: Ask T. Boyer to continue exploring the ability to archive Argo data in the cloud on a profile basis. Argo supports this and would be happy to provide a letter of support if needed.

2.2 ARCs combined quick status update from all

Kanako presented the PARC activity operated by JAMSTEC and IPRC. APDRD actively provides the various products on their website. Unfortunately, the PARC web site has been unavailable, due to a network security incident that occurred at JAMSTEC in mid-March this year. Even under this situation, we continue to build the new PARC web sites. It will have a few new functions as well as providing information on Argo data of core, bgc and deep floats in the Pacific Ocean; (1) to share information of technical problems and quality control of data including core, bgc, and deep Argo floats among PIs, DMQC operators and users, and (2) to coordinate float development opportunities. We will release the new version of the PARC website in 2022, after JAMSTEC's internet connection is fully restored.

Giulio Notarstefano from OGS presented the status and activities carried on in the MedArgo Regional Center for the Mediterranean and Black Seas. More than 79000 Argo profiles were acquired in the Mediterranean and in Black Seas in the last 20 years and more than 5500 since January 2021. In 2021, 72% of profiles were collected by Core-Argo, 17% by floats equipped with Oxygen sensor, 9% by Bio-Argo platforms, and a small part by Deep and BGC Argo. A total of 23 new floats have been deployed; 13 out of 23 platforms are core-Argo, 7 are core-Argo with DO, 1 is a Bio-Argo, 1 is a BGC-Argo and 1 is Deep-Argo. Regional partners are working to strengthen the collaboration with the riparian countries through the H2020 Euro-Argo RISE project in order to promote and expand the Argo activities. In the framework of the same project, the extension of the Argo operations in shallow/coastal waters is initiated. The DMQC method was applied to approximately 65% of eligible floats in the Mediterranean and Black Seas and the respective D-files were gradually sent to the GDAC. DMQC was also applied to another 6.7% of the fleet but the analysis has to be repeated due to problems related to the reference dataset or in the data itself. Salinity was checked to identify floats that could be affected by fast salinity drift. The results and comments have been reported in the shared spreadsheet. The DMQC analysis of deep floats recently started and they worked on two deep floats deployed close to the Hellenic Trench in the Mediterranean Sea. CPcor corrections have been applied and compared and CPcor correction that provides the best result was selected. The high-quality ship-based CTD reference data for QC of core variables was reviewed and improved. Data was collected from several research institutes at regional level and the main European Marine Services. A quality control was applied such as an additional visual check to avoid spike or duplication. The updated reference dataset consists of about 67000 CTD profiles, about 10000 CTD profiles more as compared to the

previous one. The spatial distribution has improved a lot especially in the Aegean and Levantine sub-basins. The policy free data will be soon integrated in the Coriolis dataset.

Cecile presented the Atlantic Arc activity: Consistency check was run and the analysis is underway . 2 new products were released: ISAS 20 for T&S (2002-2020 - 0-5500m). First version of ISAS-O2 (2010-2020) will soon be issued. The Andro Argo drift data are update annually.

Kamila presented the SO-ARC activities . Work on a proposal for regional coordination of the Southern Ocean (SO) deployments has been started. 10 RAFOS/HAFOS sound sources have been deployed by AWI in the Weddell Sea to support analysis of the Argo floats. A group is going to compile a document with known float issues with an initial focus on the SO, under-ice floats. CSIRO has begun drafting a review technical paper to improve awareness of Argo's under-ice capabilities. There are some potential plans to organise an under-ice workshop to share technical knowledge and stimulate interest in the SO deployments across the Argo community. The works related with updating the CTD reference database for the regions in the SO are continued, these include adding data from the Pangea database. The work related to establishing a method of regional data quality assessment in the SO is in progress. This includes exploring the profile characterisation methods to classify Argo profiles into specific zones in the SO based on their P, T and S properties, with further plans to classify also the reference data for the OWC analysis. Review of the available QC assessment methods used in Atlantic ARC and available reference data is in progress. There are also investigations of potential implementation of the classification of reference data involving machine learning techniques, developed in ifremer.

Uday presented the Indian-Arc summary including deployment coordination, setting up BGC QC, DMQC of all eligible floats, improvement of the reference DB as well as improving gridded product and services to users including Capacity building. Activity is also ongoing into alternative QC methods.

2.3 Core Argo Best Practices document status and pathway to official endorsement (Action item 58)

T. Morris presented the progress on the Core Argo Best Practices document development. The Core Argo best practice document has been drafted in terms of layout, and follows a similar structure to what BGC Argo have done for their best practice. Ideally, this document will be in a full first draft and discussed as a side meeting prior to AST-23 by the team and those members of AST keen to contribute. The document will be presented at AST-23, but also presented to the Argo community for their endorsement, possibly at the 7th Argo Science Workshop, before being published in the Frontiers Journal. Thereafter, with the Argo community endorsement, the document will go through GOOS endorsement. There are a fair number of documents from various user groups, float manufacturers and operators, and the idea is to bring these together for use by all communities - established and emerging. Once endorsed, the Best Practices documents will be advertised on the AST website.

Action item: If anyone is interested in joining the core Argo Best Practices Working group, please email Tammy Morris.

2.4 Data visualizations, APIs, and access tools: report on which tools are advertised, where to find them, and how to keep this updated (Action item 59)

M. Scanderbeg presented ways to access the data products, visualizations, and tools on the AST website. She noted that these can be accessed from various places including some from the homepage, by clicking on the 'data' menu link and from sub menus under the 'data' menu link. The data visualization tools and data products are fairly static, but many tools are being created now, especially to access BGC data, and it is important to keep these up to date. To facilitate that, she suggested adding a new question to the National Reports asking countries to review the tools, products and visualizations to make sure they are complete for their country.

She also asked for feedback on whether to repeat all BGC tools on the AST website or simply make a link to them clear. There was some discussion on this as Argo is moving towards OneArgo and it should be easy to find all types of data and tools on the AST website. For now, there was agreement that tools targeted at the general user and beginner level should be duplicated on both the AST and the BGC Argo website.

Action item: Add question to National Reports asking countries to review the Argo visualizations, products and tools on the AST website and to include any new ones in the report. If there is a peer-reviewed paper that goes along with the viz/product/tool, please include that citation as well.

Action item: M. Scanderbeg to work with C. Schmectig & T. Maurer to identify BGC tools that are appropriate for all to use and be listed on AST website.

2.5 ArgoOnlineSchool developed within Euro-Argo-Rise project

A Gonzales present the Argo Online school has been developed within the Euro-Argo-Rise project and will be available on the Euro-Argo site https://www.euro-argo.eu/Outreach/Educational-material/Argo-Online-School in the next weeks of December. Alberto highlighted the potential of the Argo Online School to learn the basics of the Argo program and extract information from Argo data through a basic programming environment based on Jupyter Notebooks. The AOS is similar to classic e-learning platforms. Alberto also highlighted that, since the AOS is hosted on GitHub, it is modifiable and fully configurable by the Argo community, without depending on third parties. ADMT participants welcome the availability that will allow them to reach Argo from the most novice (lessons 1 and 2), to the most experienced users (lesson 3); with the possibility of self-evaluation through different quizzes.

2.6 Feedback from the 2nd Ocean Observers workshop

C. Gourcuff presented the Ocean Observers initiative with M. Bollard and E. Rusciano. The Ocean Observers workshop was organized at the end of November and was attended by around 100 persons (up to 70 persons in each session) from 22 countries, most of them engaged in educational activities. The educational resources will be put to the Ocean Observers website and available for more people. The simultaneous translation was great and the virtual way, although not favorable for networking, allowed participation from people who don't have funding to travel. All presentations and recording will be available on https://www.oceanobservers.org/.

3. Upcoming meetings 30min

3.1 AST-23: 21 - 25 March 2022, Monaco with Monaco Ocean Week

Argo Steering Team will organize during Monaco Ocean Week , probably as an Hybrid type option will be studied due to Pandemic situation.

3.2 Argo Forum with invited UN Ocean Decade Programs

To increase collaborations with end users and other components of the UN Decade activities, the AST is proposing to have the 1st annual Forum associated with AST-23 in Monaco. The AST executive committee has started to develop connections with UN Decade Programs through AST members contacting them. A list of potential UN Decade programs were identified with potential contact points in the Argo community.

Breck mentioned that the questions that are expected to be addressed include:

1. Explore how the Program will rely on OneArgo's data stream and the parameters that are crucial for this Program.
2. Discuss the appropriate necessary accuracy and sampling strategies for these parameters as well as timely delivery.
3. Find short-term joint projects, such as task teams, to address issues for these parameters.
4. Ensure the Program is aware of the status of OneArgo, and discuss how to promote the support of these measurements and the necessary steps to provide this data to their community.

It was suggested to add an interface with Ocean Literacy for UN Decade.

3.3 7th Argo Science Workshop: October 2022 in Europe

It was decided at ADMT 22 that the dates of the 7th Argo Science Workshop will be 10-14 October 2022 and it will likely be a hybrid meeting. A call for volunteers was made to form an organising/scientific committee.

3.4 ADMT-23: late fall 2022 at AOML

Based on feedback, hybrid meetings should become the standard for future ADMT and AST meetings, but thought needs to be put into the exact format in order to make these successful. Input from experts on this is welcome to both ADMT and AST co-chairs.

4. Conclusions

The virtual ADMT-22 meeting ended with the hope that ADMT-23 could meet in person next year at AOML in Miami. The ADMT co-chairs did receive feedback from several participants that keeping a virtual component at future meetings would be beneficial as many countries cannot send as many people as they would like to the meeting.

At the end of the meeting Sylvie Pouliquen informed ADMT members that ADMT22 was her last ADMT as she will be retiring before the next ADMT. Megan and Susan had organized a nice virtual farewell to thank Sylvie for her involvement in Argo Data Management activities in the past 23 years and the ADMT community sent her very nice messages that led to a very emotional end of meeting !

5. Annex 1 – Agenda

22nd Argo Data Management Team Meeting

8 - 10 December 2021 (13:00 to 17:00 UTC)

Virtual meeting

Agenda – Draft version

Welcome and introduction '5 Sylvie Pouliquen & Megan Scanderbeg

Session 1 - Wednesday 08/12/2021: Status & Real Time Data Management 4hr

Chair: Megan Scanderbeg

Part 1 Status (Moderator: B. Owens) 1hr

- ➔Feedback from AST S. Wijffels, T. Suga 10'
- ➔Feedback from BGC-ADMT C. Schmechtig 10'
- ➔Action Item Status **M. Scanderbeg** 10'
- ➔How to improve interactions with modeling community **P. Oke** 10'
- ➔Discussion 20'

Part 2 Real Time Data Management, DACs (Moderator:) 1.5hr

- ➔DAC Real Time Status
  - ◆ timeliness on GTS and DACs **A. Tran, M. Belbeoch** 10'
  - ◆ anomalies (Action item 11) **C. Coatanoan, N. Verbrugge** 10'
- ➔Real time qc tests and flagging of data
  - ◆ Deepest pressure test for shallow profiles (Action item 12) **C. Schmid & JP Rannou** 10'
- ➔DAC collaboration or plans for 2nd DAC workshop??
- ➔Combined Trajectory Files (v3.2): implementation status & when to stop accepting v3.1 Btraj files for floats with BGC traj data (Action items 13, 20) **TBD/BGC-ADMT** 10'
- ➔DAC status discussion (Action items 9, 14, 15, 16, 17, 18) 20'

➔**Break** 10'

Part 3 GDAC Data Management (Moderator: A. Wong) 1hr

- ➔Update on NVS reference tables: roadmap on how to implement unconstrained fields and whether all ref tables can be entered (Action items 27 - 28, 60) V. Paba 20'
- ➔GDAC status T. Carval 10'

➔File Checker updates: plan for using NVS tables to update File Checker, roadmap on how to implement changes in File Checker (Action items 1-7) M. Ignaszewski 10'
➔GDAC status discussion 20'

Session 2 - Thursday 09/12/2021: Pilot Data Management & Delayed Mode Data Management 4h

Chair: Sylvie POULIQUEN

Part 1 Pilot Data Management - real time and delayed mode (Moderator: A. Wong) 1hr

➔Deep Argo
- ◆ Real time data/CPcor correction & Report on status of DMQC process for Deep Argo floats 15 ' C. Cabanes/Deep Argo working group
- ◆ Matlab tool for selecting deep reference CTD in OWC 5 ' J. Lyman

➔RBR data 20' M. Dever & A. Wong/RBR working group
➔Pilot data discussion 15'

Part 2 Delayed Mode Quality Control 1.5hr (Moderator: B. Owens)

➔SBE CTDs
- ◆ Report from salty drift working group (Action items 38, 39, 40) 20' J. Gilson, B. Klein
- ◆ Updates from manufacturer Seabird 10' K. Martini

➔Under-ice position estimation 10' P. Oke
➔Under-ice position estimation 10' Kaihe Yamazaki
➔Trajectory files 10' M. Scanderbeg
➔DMQC code updates
- ◆ Python version of OWC toolbox 10' K. Walicka

➔Discussion 20'

➔**Break 10'**

Part 3 DMQC monitoring and reference databases 1hr (Moderator:)

➔Delayed mode monitoring at OceanOPS (Action items 49 - 52) 20' ◆ Monitoring percentage of floats that have been dmoded based on high priority float lists such as altimetry warning, MinMax warnings, OA warnings and FSD CTD serial numbers
- ◆ Monitoring DM operators
- ◆ Orphan floats

➔Discussion 10'

➔DMQC reference databases 30
- ◆ CTD_for_DMQC - joint update from (Action item 43) C. Coatanoan, S. Diggs, T. Boyer 10'

➔Discussion 10'

Session 3 - Friday 10/12/2021: Format, Value added tools, Upcoming meetings 4h

Chair: Megan Scanderbeg

Part 1 Format updates 1 hr (Moderator:)

➔Review list of proposed meta file changes & improvements **20'** T. Carval

Proposed Additions:

- ◆ Proposed Additions
- ◆ Proposed Consistency Improvements (Action item 29)

➔Review list of proposed changes that affect multiple file types **10'** T. Carval

- ◆ CF compliance to salinity and uncertainty
- ◆ Adding DOI to files

- ◆ Discussion: develop timeline for possible format updates which must also coincide with NVS, User Manual, and FileChecker updates **30'** **(Discussion Lead:)**

➔**Break 10'**

Part 2 Value added section 1.5 hr (Moderator:)

➔GADR status and updates (Action item 45) **15' T. Boyer**

➔ARCs combined quick status update from all **10'**

Full ARC reports available with National Reports

➔Core Argo Best Practices document status and pathway to official endorsement (Action item 58) **10' T. Morris**

➔Data visualizations, APIs, and access tools: report on which tools are advertised, where to find them, and how to keep this updated (Action item 59) **15' M. Scanderbeg**

➔ ArgoOnlineSchool developed within Euro-Argo-Rise project **10' P. Velez/A Gonzales**

➔ Feedback from OceanObserver workshop **10' C Gourcuff E Rusciano**

➔Discussion **15' (Discussion Lead:)**

Part 3: Upcoming meetings 30min

➔AST-23: 21 - 25 March 2022, Monaco with Monaco Ocean Week **5'** H. Claustre

➔Argo Forum with invited UN Ocean Decade Programs **5'** B. Owens

➔7th Argo Science Workshop: October 2022 in Europe **5' C. Gourcuff**

➔ADMT-23: late fall 2022 at AOML **5'**

Conclusions: M. Scanderbeg

6. Annex II - ADMT21 Action List Status

	Action	Who	When	Priority	Status
	GDACs				
1	Ask M. Ignaszewski to consider ways to transition the File Checker to a more sustainable format to prepare for his retirement in late 2021.	M. Ignaszewski	ADMT-22	H	
2	Update GDAC file checker to accommodate changes to Ref Table 3 in Users Manual.	M. Ignaszewski	ADMT-22	H	
3	Ask DACs to review warnings on configuration and technical parameters from the File Checker, work with M. Iganszewski and take actions to fix the problems.	DACs, M. Ignaszewski	AST-22	R	CORIOLIS done (see action 9) CSIRO reviewed meta and tech files, and issues with Rtraj files will be fixed when we migrate to new Python-based RT system (2022) BODC done
4	Add new reference table checks (ref table 28, 29, 30) to the File Checker.	M. Ignaszewski	AST-22	R	
5	Transition the File Checker to using the NERC vocabulary server version of the Argo reference tables.	M. Ignaszewski, M. Donnelly, NVS	ADMT-22	R	BODC- in progress
6	Update the GDAC FileChecker with the v3.2 traj format	M. Ignaszewski	ADMT-22	R	
7	Run all existing v3.1 files through the current FileChecker and export results to ADMT	M. Ignaszewski	AST-22	R	
	DACS				
8	ADMT co-chairs will continue to try and prioritize DAC actions from meetings to provide clear guidance on which ones to accomplish first. Co-chairs will consider mid-year virtual meeting with DACs to check on progress.	ADMT co-chairs	juin 2021	H	
9	Ask DACs to review warnings on configuration and technical parameters from the File Checker, work with M. Ignasewski and take actions to fix the problems.	DACs, M. Ignaszewski	ADMT-22	H	CORIOLIS done CSIO-not done CSIRO reviewed meta and tech files, and issues with Rtraj files will be fixed when we migrate to new Python-based RT system (2022), INCOIS fixed notified tech and meta files, not much progress on trajectory files. JMA - no progress, BODC updated meta and tech files, issues with Rtraj not yet addressed
10	Ask US Argo to work with NAVO on finding a way to prevent bad data from going onto the GTS.	C. Schmid, M. Scanderbeg, US Argo	AST-22	H	Only one active NAVO Argo float sending data onto GTS. NAVO stopped notifying floats a few years ago and it looks like there are just a few active floats left.
11	Ask DACs to put floats that fail MinMax test for drift on the greylist. Information for this is found in monthly report from Coriolis in first chart. Start cycle and QC flag suggestion are included in the report. DACs should do this automatically without contacting the PI.	AOML, JMA, CSIO, CSIRO, KMA, KORDI	monthly	H	aoml - we do what the DM operator asks us to do. CSIRO - we check the monthly reports and give feedback, floats that fail MinMax are put on the greylist. JMA - in progress, INCOIS - Have put all possible floats under Greylist. KMA - we check the monthly reports and there are no floats that fail MinMax test.
12	Finalize refinement of deepest pressure test for shallow profiles.	C. Schmid, DACs	ADMT-22	R	JMA - no progress, CSIO-not done, CSIRO - no progress, BODC not done
13	Start to implement the v3.2 traj file format at the DACs.	DACs	ADMT-22	R	aoml - target AST-23, CORIOLIS : ready to provide traj in format 3.2 wait for checker (action 6), CSIO-not done, CSIRO - not done INCOIS - no progress JMA - no progress MEDS- target AST 23 BODC no progress,

14	Replace RTQC gradient test T&S with the new MEDD test. Refer to Action in User Manual update on this topic	All DACs but Coriolis	ADMT-22	R	aoml - target AST-23, CSIO-done, BODC no progress CSIRO - done for Matlab-based code, but not for Python-based code JMA - in progress MEDS - in progress, complete by AST 23, INCOIS - in progress. KMA - in progress
15	Ask DACs to implement new global range test	AOML, BODC, JMA, CSIO, CSIRO, KMA, KORDI,	ADMT-22	R	aoml - done, CSIO-done, CSIRO - done, BODC not done JMA - in progress, INCOIS - done KMA - not done
16	DACs to apply real time adjustment to all R files when a D mode adjustment becomes available. This means going back and re-processing R files after last D mode file and current R files coming in.	BODC, CSIRO for core, JMA, MEDS, INCOIS, KMA, KORDI, CSIO	ADMT-22	R	CSIRO - done, JMA - in progress, INCOIS - no progress, BODC - no progress KMA - in progress
17	DACs to include TEMP_CNDC and NB_SAMPLE_CTD in the core-files as intermediate parameters, ie. no _ADJUSTED, no _ADJUSTED_QC, no _ADJUSTED_ERROR.	DACs	ADMT-22	R	aoml TEMP_CNDC by ADMT-22, NB_SAMPLE_CTD - challenge ... (maybe develop one tool for all DACs that can update profile nc files, for particular float types example APEX/NAVIS iridium), CORIOLIS - done CSIRO - in progress JMA - no progress MEDS TEMP_CNDC included for RBR floats, still needs to work on NB_SAMPLE_CTD, INCOIS - no progress BODC - no progress
18	Ask DACs to apply the greylist test to trajectory files	AOML, BODC, JMA, CSIO, CSIRO, KMA, KORDI, INCOIS	ADMT-22	L	aoml - target AST-23, CSIRO - done in Python-based RT code JMA - in progress, CSIO - not done, BODC - not done, INCOIS - not done
	Format				
19	add way to calculate float energy capacity in battery variables				
20	Decide on end of transition period for BGC floats, during which both v3.1 and v3.2 traj files can exist, at ADMT22.	DACs, BGC Argo	ADMT-22	R	CORIOLIS : ready to provide v3.2 JMA - no progress, CSIO-not done
21	Annie Wong to solicit help from other ADMT members to investigate how to record CTD sampling frequency in Argo data files, either as a technical file parameter or as a meta file config parameter, taking into account the CTD frequency can change between profiles and within a profile.	A. Wong, other ADMT members	ADMT-22	R	This action item started because of a need to estimate ascent rate for sensor response correction. This has been changed to describing how to estimate ascent rate for various float types in the QC Manual.
22	ADMT exec committee work on finding best way to manage list of proposed changes by file type and present at ADMT-22.	ADMT exec	ADMT-22	R	Using a google doc: https://docs.google.com/document/d/1DSFcJa1LCuZQxPJorX_Z00GQkF1OlEdXdVWlH1NexN0/edit?usp=sharing
23	Add WIGOS-ID to list of things to be added to next version of the metafile.	ADMT exec	ADMT-22	R	Using a google doc: https://docs.google.com/document/d/1DSFcJa1LCuZQxPJorX_Z00GQkF1OlEdXdVWlH1NexN0/edit?usp=sharing
24	Activate TEMP_CNDC in Ref Table 3, with long_name = "Internal temperature of the conductivity cell".	DACs with RBR floats	ADMT-22	R	overlap with item 17, CORIOLIS : checker compliant CSIRO - in progress BODC- not done
25	Expand NB_SAMPLE to NB_SAMPLE_<short_sensor_name> in Ref Table 3, with long_name = "Number of samples in each pressure bin". <short_sensor_name> is as listed in Ref Table 27	DACs	ADMT-22	R	overlap with item 17, CORIOLIS : done - CSIRO - not done BODC not done

26	Move TEMP_CNDC and NB_SAMPLE_CTD from the b-files to the core-files as intermediate parameters in Ref Table 3. The other NB_SAMPLE_<short_sensor_name> from BGC sensors will remain in the b-files as intermediate parameters.	DACs	ADMT-22	R	overlap with item 17, CORIOLIS : done - CSIRO - not done BODC not done
	The CF standard name for PSAL has been updated from 'sea_water_salinity' to 'sea_water_practical_salinity' and Argo will need to change to this eventually. Record this change in the NVS GitHub repository to keep track of it for future rewrites.	T. Carval	ADMT-22	R	Using a google doc: https://docs.google.com/document/d/1DSFcJa1LCuZQxPJorX_Z00GQkF1OlEdXdVWlH1NexN0/edit?usp=sharing In the NVS Argo parameters: "http://vocab.nerc.ac.uk/collection/R03/current/PSAL/ Same as http://vocab.nerc.ac.uk/collection/R03/current/PSAL/ Broader http://vocab.nerc.ac.uk/collection/P07/current/IADIHDIJ/ "
	NVS server ref tables				
27	NVS will become the master copy of the Argo references tables as of January 2021		########	R	Still some tables missing to be able to endorse this change
28	Proposal on how to manage content of NVS version of Argo ref tables was accepted. GitHub will be used to track suggested changes to tables and proposed changes will be advertised for 2 weeks. After that, final approval will be given by ADMT exec and implemented by vocab editors	NVS vocab editors, ADMT exec	########	R	
29	Adopt ICES platform codes for ships to constrain the DEPLOYMENT_PLATFORM field. Details to be addressed by the Argo Vocab Task Team.	DACs, NVS vocab editors	ADMT-22	R	CORIOLIS : wait for the metadata name, then add raw in the deployement file (and synchro with OceanOps needed) CSIRO - adopted, BODC in progress
	User Manual Update				
30	Update the User Manual and Trajectory Cookbook with the v3.2 traj format.	A. Wong, T. Carval	AST-22	H	done
31	Update the Users Manual and all QC manuals with the improved version of the Argo QC flag table and accompanying footnotes.	A. Wong, T. Carval	AST-22	H	done
32	Update Ref Table 3 in Users Manual.	A. Wong, T. Carval	AST-22	H	done
33	Clearly identify which sensors are accepted and which are pilot in ref table 27. This needs to be in User Manual and NVS tables	T. Carval, M. Scanderbeg, C. Schmechtig, V Paba, Mark	AST-22	R	Not done yet, require further discussion The table 27 is a googlesheet https://docs.google.com/spreadsheets/d/1Aw8B7FFUjG4e9MveD5qqvl7ZbB-z_x32lQnpHZbXVZA/edit?usp=sharing Ajouter une colonne operational/pilot/obsolete ?"
34	Update ref table 15 to allow MC 100 as part of surface oxygen measurements	T. Carval, M. Scanderbeg	AST-22	R	done
37	The proposal on how to include an optional time stamp for technical data was approved. Update User Manual with new optional variables for tech file.	T. Carval	AST-22	R	done
	to AST				

35	The ADMT suggests a working group, possibly led by Peter Oke, to organize a joint Argo-OceanPredict workshop that will feature both science and data talks to encourage better communication and engagement between Argo and the operational community. Topics to consider include data timeliness, descending profiles, using QC flags in BUFR format, etc.	P. Oke, ADMT co-chairs, others?	first half of 2021?	H	Peter O. will provide update at ADMT-2021 / CORIOLIS has started discussions at a European level during the BGC and deep EuroSea meeting and as part of a CMEMS working group (Bio Data Assimilation WG)
	Pilot data				
36	A. Wong & V. Thierry to draft up documentation for DACs on how to apply the cpcor correction in real time for Deep Argo data and send to DACs for feedback on whether this is feasible to implement.	A. Wong & V. Thierry	AST-22	R	done
37	S Wijffels to lead discussion with AST and ADMT to form a proposal on how to approach testing and validating dynamic corrections for C from on board the floats before S is calculated, binned and transmitted.	S. Wijffels	ADMT-22	R	Conversation about how to implement small, incremental changes on sensors has begun with the sensor manufacturers at AST
	DMQC				
38	The Fast Salty Drift (FSD) Working Group will document the suggested procedures for handling FSD floats in the relevant Argo Documentation by February 2021.	J. Gilson, B. Klein, C. Cabanes, CSIRO, M. Alkire, K. Wlicka, SeaBird, Uday, Kanako Sato, Annie Wong	########	H	done
39	Ask DMQC operators to fill in spreadsheet on FSD floats to help monitor the impact on the Argo data set. If operators prefer to send their information to B. Klein, she will fill in the spreadsheet.	DMQC operators	AST 22	R	done, CSIRO - spreadsheet updated in November 2021, INCOIS - done, JAMSTEC - done BODC done KMA - done
40	Ask SeaBird to confirm the Serial Numbers after 11250 should be when they changed their manufacturing process to solve the Fast Salty Drift issue so that Argo can monitor if the issue still remains in the current fleet.	K. Martini, J. Klinke	AST-22	H	Serial numbers > 11252 for 41; Serial numbers > 5724 for 61
41	Ask DMQC operators to obtain an ORCID for recording in D and BD prof files. Add this ORCID to AIC system		ADMT-22	R	Coriolis : done for some; CSIRO - done, INCOIS - in progress, JAMSTEC - in progress, BODC-done, KMA-done
42	Ask DMQC operators to add their name to the global attributes section of the D- and BD- files, as per the agreed format described in Section 3.7 of the QC Manual.		ADMT-22	R	Coriolis : done for some; CSIRO - done, INCOIS - in progress, JAMSTEC - in progress, BODC- not done, KMA - done
	ref DB				
43	Ask C. Coatanoan to release an updated version of the CTD ref db with clear flags indicating the GO-SHIP Easy Ocean data that can be easily selected for use in OWC.	C. Coatanoan	AST-22	R	done in March 2021
44	Ask John Gilson to apply suggested filters except the one to thin out the Argo ref db and release that version of Argo ref db. Afterwards, ask John to explore thinning data by region	J. Gilson	ADMT-22	R	
	GADR				
45	Ask T. Boyer and M. Belbeoch to work together on finding a way to include Argo GDACs as part of the Marine Climate Data System.		ADMT-22	R	
	ARC				

	Other				
46	Keep the format of the action items as a Google Sheet with the link appearing on the ADMT-21 meeting website and ADMT meetings page.	ADMT co-chairs	End of 2020	R	done
47	Review incomplete actions from ADMT-20 to see which need to be carried on to ADMT-21	ADMT co-chairs	End of 2020	R	done
48	Ask for feedback about sharing data via cloud services to consider how to host Argo data on the cloud.	T. Boyer, T. Carval, other cloud service experts	ADMT-22	R	Tim negotiates the inclusion of Argo GDAC dataset into NCEI NOAA Big Data Program. Data could be regularly pushed on either Goggle, AWS or Azure cloud. There are 2 topics: • Argo data cloud access (such google big query API) • Argo data cloud archive
	Monitoring				
49	Ask M. Belbeoch to include the alerts from MinMax and OA from Coriolis in addition to altimetry one.	M. Belbeoch	ADMT-22	R	
50	M. Belbeoch to capture DM operators for each float at OceanOPS for notification purposes. Depending on the float, it could be just one operator, one core and one BGC operator, or several operators for each sensor. M. Belbeoch to coordinate with DM operators for best solution.	M. Belbeoch	ADMT-22	R	
51	Ask M. Belbeoch to perform an audit of metadata at OceanOPS vs what is at the DACs and present it at the DAC Workshop.	M. Belbeoch	ADMT-22	R	
52	M. Belbeoch find out if the WIGOS ID is required for BUFR on the GTS.	M. Belbeoch	ADMT-22	R	
	Workshops				
53	There is a recognized need for more DMQC workshops with different focuses: training core DMQC operators, Deep Argo data and BGC data. The core and Deep workshops could be combined, but the BGC one will be separate. G. Maze, B. King, A. Wong, V. Thierry are thinking of a virtual core & Deep workshop in June or July 2021. T. Maurer and C. Schmechtig will keep a BGC workshop in mind.	G. Maze, B. King, A. Wong, V. Thierry, T. Maurer, C. Schmechtig	ADMT-22	R	BGC and Deep workshop done 27 Sep - 1st Oct
54	ADMT endorses continuing the DAC Workshop and finding ways to collaborate more effectively.	ADMT co-chairs	ADMT-22	R	
55	Ask M. Donnelly and C. Schmid to consider adding a topic to the next DAC workshop on improving data delivery strategies. It could be that some DACs could improve their timeliness based on suggestions from other DACs. Also consider adding the results of an audit of metadata consistency between DACs and OceanOPS.	M. Donnelly, C. Schmid	2nd DAC Workshop	R	collect ideas: see item 17; bufr reader; 2nd DAC workshop is delayed until 2022
	Communication				
56	Educate users on the new v3.2 trajectory file format (e.g., via website).	M. Scanderbeg	AST-22	H	
57	Find ways to effectively share the environmental impact statement. EuroArgo is developing a leaflet on this which can be shared. Other ideas include creating an infographic and slides.	M Bollard/Euro-Argo ERIC and AST+ADMT Chairs	First Draft for AST22	R	done
58	Work on collecting Best Practices information for core Argo on float deployment, float storage, data practices, etc. and first step make it available on WWW page	Tammy Morris to lead, Megan, Deb West,	ADMT-22	R	in progress

59	Form working group to better document, explain and include data access & visualisation tools on AST and ADMT websites taking into account different user levels	M. Scanderbeg, S. Diggs, C. Gourcuff, C. Gordon, H. Bittig, G. Maze, H. Claustre	ADMT-22	R	
60	Improve NVS Argo vocab links on ADMT website. Ask the vocab group & OceanOPS to create and post a list on the ADMT website of ICES platform codes to make it easier for DACs to use in the creation of metafiles.	T. Carval, Argo Vocab Task Team	ADMT-22	R	in progress

7. Annex III - ADMT22 Action List

	Action	Who	When	Priority	Status
	Yellow actions are from ADMT-21 and have updated assignments, if applicable.				
	GDACs				
1	Transition the File Checker to reading NVS versions of the Argo ref tables to allow for automatic updates to the FileChecker when NVS tables are updated and to help in constraining the fields appropriately.	NVS team, M. Ignaszewski, T. Carval,	AST-23	H	
2	Ifremer to set up a GitHub repository for the GDAC FileChecker to allow for co-development and as a place to issue requests for updates to the FileChecker.	T. Carval	AST-23	H	
3	Update the File Checker to accept v3.2 trajectory files.	M. Ignaszewski, T. Carval	juin 2022	R	
4	Run all existing v3.1 files through the current FileChecker and export results to ADMT	M. Ignaszewski	ADMT-23	R	
5	Update the File Checker to accept time series data in the technical files.	M. Ignaszewski, T. Carval	ADMT-23	L	
	DACs				
6	Ask DACs to put floats that fail MinMax test for drift on the greylist. Information for this is found in the first table in the monthly report from Coriolis and OceanOPS has begun sending emails to float PIs/DM operators. Additionally, starting in Jan 2022, a column will be added with greylist recommendations. DACs should automatically put these floats onto the greylist without contacting the PI. The PI can then review the floats in dmode and can use this indication to put a higher priority on these floats in dmode.	All DACs, AOML, JMA	AST-23	H	
7	DACs to apply real time adjustment to all R files when a D mode adjustment becomes available. This means going back and re-processing R files after last D mode file and current R files coming in.	BODC, JMA, MEDS, INCOIS, KMA, KORDI, CSIO	AST-23	H	Are all those DACS concerned ?
8	Ask DACs to implement new global range test	BODC, KMA	AST23	H	
9	DACs to change BGC 'count' parameters to integer data type. Store RAW_DOWNWELLING_IRRADIANCE* , RAW_DOWNWELLING_PAR, NB_SAMPLE_CTD, NB_SAMPLE_<parameter sensor name> as 16 or 32-bit integers in NC_USHORT with NC_FILL_USHORT as fillvalue.	DACs	janv2022	H	
10	DACs to implement refined deepest pressure test for shallow profiles. If profiles fail this test, they will be assigned a qc flag of '3' unless they are already flagged as '4'.	DACs	ADMT-23	R	
11	Consider using the GitHub repository for real time tools for DACs: https://github.com/ArgoRTQC	DACs	ADMT-23	R	
12	Start to implement the v3.2 traj file format for BGC floats.	DACs	post June 2022	R	
13	Replace RTQC gradient test T&S with the new MEDD test. Refer to QC Manual for instructions on MEDD test	AOML, BODC, CSIRO, JMA, MEDS, KMA, INCOIS	ADMT-23	R	

14	DACs to include TEMP_CNDC and NB_SAMPLE_CTD in the core-files as intermediate parameters, ie. no _ADJUSTED, no _ADJUSTED_QC, no _ADJUSTED_ERROR.	DACs	ADMT-23	R	Are all dacs concerned ? AOML: TEMP_CNDC part will go operational the week of 12/13
15	Ask DACs to apply the greylist test to trajectory files	AOML, BODC, JMA, CSIO, KMA, KORDI, INCOIS	ADMT-23	L	
	Manuals				
16	Update Users manual with NVS version of the Argo ref tables (when available) and include instructions for DACs & users on how to apply the tables.	V. Paba, T. Carval, A. Wong	mars 2022	H	
17	Update QC manual with refined deepest pressure test	A. Wong, T. Carval, C. Schmid, J-P. Rannou	mars 2022	R	
18	Update DAC Trajectory Cookbook with instructions on how to fill BGC parameters & grounded flag	M. Scanderbeg, T. Maurer, C. Schmectig	AST-23	R	
19	Update QC manual with instructions on how to adjust salinity in real time and delayed mode for RBR floats.	A. Wong, M. Dever	mars 2022	R	
20	Update QC manual with instructions on how to create dmode trajectory files.	A. Wong, M. Scanderbeg, J-P Rannou	mars 2022	R	
21	Remove <PARAM>_MED and <PARAM>_STD from § 2.3.5 of the Users Manual: because these statistical variables are intermediate parameters which will be added in the Ref Table 3.	T. Carval	janv 2022	R	
22	Annie to include best practices chapter in QC Manual on how to deal with salinity drift in delayed-mode, including ASD.	A. Wong	mars 2022	R	
	Format				
23	DACs to change BGC 'count' parameters to integer data type. Store RAW_DOWNWELLING_IRRADIANCE* , RAW_DOWNWELLING_PAR, NB_SAMPLE_CTD, NB_SAMPLE_<parameter sensor name> as 16 or 32-bit integers in NC_USHORT with NC_FILL_USHORT as fillvalue.	DACs	janv2022	H	
24	Decide on end of transition period for BGC floats, during which both v3.1 Btraj and v3.2 traj files can exist, at ADMT-23.	DACs	ADMT-23	R	
25	Find agreement on vocabulary around format changes and content changes. Within Argo, we need a clear way of talking about format changes and content changes.	ADMT exec	ADMT-23	R	
26	For SENSOR_MODEL, move towards using the manufacturer's model name in this variable. For sensors that are identical, but the company changed, include a comment about this in the NVS Argo ref table for SENSOR_MODEL	DACs, NVS team	AST-23	R	
27	Ask NVS team to find a machine to machine solution to find identical sensors, even if name is changed in Argo vocabulary.	NVS Team	ADMT-23	R	

28	Ask T. Carval to open a discussion ticket on how to directly link the Argo netCDF files to the NVS tables. Right now the 'conventions' point to 'Argo reference table 2', but it would be nice to have this point directly to the NVS tables.	T. Carval, NVS Team	ADMT-23	R	
29	Finalize float ending cause content after consultation with manufacturers and possibly the new technical group. Suggest either filling the 'anomaly' field, adding a new variable, or update existing field END_MISSION_STATUS in the netCDF files. In the meantime, it is suggested to use the OceanOPS system to populate this metadata field.	NVS Team, R. Cancouet, B. King,	AST-23	R	
	Pilot data				
30	Ask DACs with RBR floats to flag real time temp, pres with qc flag of 1. Raw salinity from post-April2021 RBR CTDs can be flagged with PSAL_QC='1'. All data can be distributed onto GTS.	DACs with RBR floats	AST-23	R	
31	Ask DACs with floats with pre-April2021 RBR CTDs to keep psal qc flag of 3. Ask DACs to please go back and flag pres, temp qc flags as 1. All data can be distributed onto the GTS.	DACs with RBR floats	AST-23	R	
32	Ask DACs with floats with RBR CTDs to implement real-time salinity adjustment as per QC Manual, and flag PSAL_ADJUSTED_QC = '1' in 'A' mode. Real time adjusted data can be distributed onto GTS.	DACs with RBR floats	ADMT-23	R	
	DMQC				
33	Ask DMQC operators to inform Susan Wijffels if floats with SBE41cp CTD serial number > 11252 or SBE61 CTD serial number > 5724 exhibit signs of abrupt salty drift.	DMQC operators	ADMT-23	H	
34	Ask DMQC operators to prioritze DMQC of floats identified by Coriolis monthly anomalies report sent by C. Coantanoan and available here: https://data-argo.ifremer.fr/etc/Report_ObjectiveAnalysisWarning/ CSV versions are available in the csv_drift folder. OceanOPS is also sending out emails to PIs/DM operators.	DMQC operators	ADMT-23	H	
35	Ask Cecile Cabanes to set up a Google sheet/database for dmqc operators to record the optimized cpcor values along with CTD serial number. This can help track cpcor values to see if there is any batch dependence. Tools for making cpcor estimates can be found here: https://github.com/ArgoDMQC/DM_CPcor	C. Cabanes, DMQC operators	juin 2022	R	
36	DMQC operators are asked to consider testing the OWC python tool available here: https://github.com/euroargodev/argodmqc_owc Feedback is requested to be sent to Kamila Walicka (kamwal@noc.ac.uk) or argo@bodc.ac.uk.	DMQC operators	ADMT-23	R	
37	Ask DMQC operators to continue filling in the spreadsheet for salty drifters at least once per year. https://docs.google.com/spreadsheets/d/1TA7SAnTiUvCK7AyGtSTUq3gu9QFbVdONj9M9zAq8CJU/edit#gid=0	DMQC operators	ADMT-23	R	
38	Ask DMQC operators to respond to A. Wong's audit of delayed mode salinity data. Email was sent on 16 Aug 2021 with pdf of audit.	DMQC operators	AST-23	R	
39	ADMT encourages work done to improve position estimates for profiles under-ice and to applying such methods in delayed mode work. A python toolbox for estimating under-ice positions is available here: https://github.com/euroargodev/terrain-following People are encouraged to test it and provide feedback.	DMQC operators	ADMT-23	R	

40	Ask. K. Yamazaki to continue investigating how under-ice position estimates could be applied in delayed mode. This may involve coordination with others interested in this such as E. van Wijk, U. Bhaskar, P. Oke, others. Please report back at ADMT-23.	K. Yamazaki, others?	ADMT-23	R	
41	Ask DMQC Trajectory working group to finalize guidelines on applying PARAM corrections from profile files to trajectory files.	M. Scanderbeg, J-P. Rannou, C. Cabanes, N. Kolodziejczyk, J. Gilson, D. Mack-West, A. Wong	ADMT-23	R	
42	Ask DMQC Trajectory working group to consider developing tools for non-float specific tasks.	M. Scanderbeg, J-P. Rannou, C. Cabanes, N. Kolodziejczyk, J. Gilson, D. Mack-West, A. Wong	ADMT-23	R	
43	Ask DMQC operators to obtain an ORCID for recording in D and BD prof files. Add this ORCID to AIC system	Coriolis, INCOIS, JAMSTEC, others?	ADMT-23	R	
44	Ask DMQC operators to add their name to the global attributes section of the D- and BD-files, as per the agreed format described in Section 3.7 of the QC Manual.	BODC, Coriolis, INCOIS, JAMSTEC, others?	ADMT-23	R	
	NVS				
45	NVS task team to finalize the Argo Vocab and identify cleary what is managed at NVS/BODC, what is managed at OceanOPS and what are the tables where another solution needs to be found	Argo vocab team, V Paba Magali K	juin 2022	H	
46	Clearly identify which sensors are accepted and which are pilot or experimental in ref table 27. This needs to be in User Manual and NVS tables	Argo vocab team, T. Carval	ADMT-23	R	
	GADR				
47	Ask T. Boyer to continue exploring the ability to archive Argo data in the cloud on a profile basis. Argo supports this and would be happy to provide a letter of support if needed.	T. Boyer	ADMT-23	R	
	ARCs				
	Monitoring				
48	Ask OceanOPS to work with BGC-ADMT co-chairs to develop useful metrics on data quality of BGC parameters	OceanOPS, C. Schmectig, T. Maurer	ADMT-23	R	
49	Ask OceanOPS to read in the 'SPECIAL_FEATURES' string in meta files to look for additional experimental sensors that need to be included in float notifications to comply with IOC rules.	OceanOPS	ADMT-23	R	

	Communication				
50	Improve guidelines on ADMT website for DACs/PIs who wish to add something to the Argo ref tables on the NVS. This process will take place on GitHub and each submission will be reviewed by the appropriate team. When accepted, the NVS table will be updated and so will the FileChecker when it is able to read in the NVS tables.	V. Paba, T. Carval	AST-23	R	
51	Advertise on Argo websites and through email/communication channels that RBR ctd data will be marked with improved quality flags moving forward and that users should be sure to use the adjusted parameters.	M. Scanderbeg, T. Carval, A. Wong	AST-23	R	
52	M. Scanderbeg to work with C. Schmectig & T. Maurer to identify BGC tools that are appropriate for all to use and be listed on AST website.	M. Scanderbeg, C. Schmectig, T. Maurer	ADMT-23	R	Updated https://argo.ucsd.edu/data/argo-software-tools/ and https://argo.ucsd.edu/links/#TOOLS
	Workshops				
53	Consider holding a virtual second DAC workshop. Ask C. Bellingham and C. Schmid to compile survery results from DACs about where they needed the most help and use that to begin planning the content of the workshop. Could consider having a day for DACs in conjunction with the planned BGC DMQC workshop. Need to identify a planning committee for this workshop.	C. Bellingham, C. Schmid, Uday?	ADMT-23	H	
54	Consider holding a DMQC Trajectory Workshop or a series of seminars to begin familiarizing DM operators with tasks necessary for DMQC of trajectory files.	M. Scanderbeg, J-P. Rannou, C. Cabanes, N. Kolodziejczyk, J. Gilson, D. Mack-West, A. Wong	ADMT-23	R	
	Other				
55	ADMT supports using alternate source of PSAL to calculate BGC_ADJUSTED in 'D' mode when float salinity become too bad for use. These recovered BGC_ADJUSTED values should be accessible in the BD- and SD- profiles. The ADMT does not support including PSAL_PROXY (or any alternate source of psal) in the main data files. The BGC PSAL recovery working group will finalize the details of how this can be implemented.	C. Schmechtig, R. Sauzede, T. Mauer, A. Wong, M. Alkire, H. Bittig	ADMT-23	R	
56	If anyone is interested in joining the core Argo Best Practices Working group, please email Tammy Morris		AST-23	R	
57	Add question to National Reports asking countries to review the Argo visualizations, products and tools on the AST website and to include any new ones in the report. If there is a peer-reviewed paper that goes along with the viz/product/tool, please include that citation as well.	M. Scanderbeg	ADMT-23	R	

8. Annex IV - National Reports

Australian Argo National Data Management Report prepared for ADMT22, November 2021

Peter Oke[1], Joel Cabrie[2], Annie Foppert[3], Craig Hanstein[1], Catriona Johnson[1], Lisa Krummel[2], Jenny Lovell[1], Pat McMahon[1], Gabriela Pilo[3], Steve Rintoul[1], Tatiana Rykova[1], Christina Schallenberg[2], Roger Scott[1], Dirk Slawinski[1], Pete Strutton[3], Tom Trull[1], Esmee Van Wijk[1]
[1]CSIRO, [2]BoM, [3]UTAS

1. Status

Data acquired from floats

We maintain an operational fleet of about 350 Core, 10 BGC, and 3 Deep floats for which we receive, process, and disseminate data 4 times per day. Our real-time (RT) system is run asynchronously at CSIRO and BoM (for redundancy), and CSIRO maintains primary real-time server in Hobart, and a secondary server in Perth.

Argo Australia celebrated the deployment of our 1000th Argo float on 10 May 2021 (Peter's 28th birthday). We raised a virtual glass to the team to celebrate, with a special acknowledgment to Susan Wijffels – who will forever be considered the queen of Argo Australia.

Data issued to GTS

All data is issued to GTS in near-real-time (NRT). Figure 1 shows the monthly timeliness of data delivery for floats with Argos and Iridium telecommunications processed by the legacy RT code (our Matlab-based system). The RT system continues to perform well, with an average of 91.4% of floats delivered on time – within 6 hours of measurement for Iridium floats.

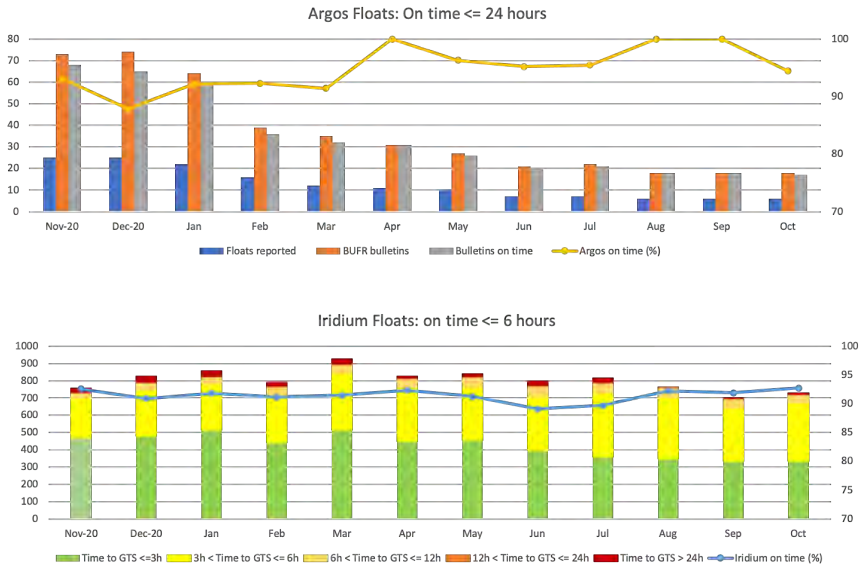


Figure 1: Timeliness of BUFR files delivery to the GTS for floats with Argos telecommunications (top), and floats with Iridium telecommunications (bottom). Data shown are monthly averages.

Figure 2 shows the daily timeliness of data delivery considering both the legacy RT code and our new RT code (our Python-based system). This figure includes floats with SBD telecommunications, in addition to the floats with Argos and Iridium telecommunications. Since June 2021, an average of 96% of the BUFR files were delivered to the GTS within 12 hours after float upload. In both February and July, CSIRO had a power outage, and no files were processed for a few days. This power outage, however, did not impact the monthly means substantially (Figure 1). The small dip in July was a result from internal upgrade that was performed on the servers.

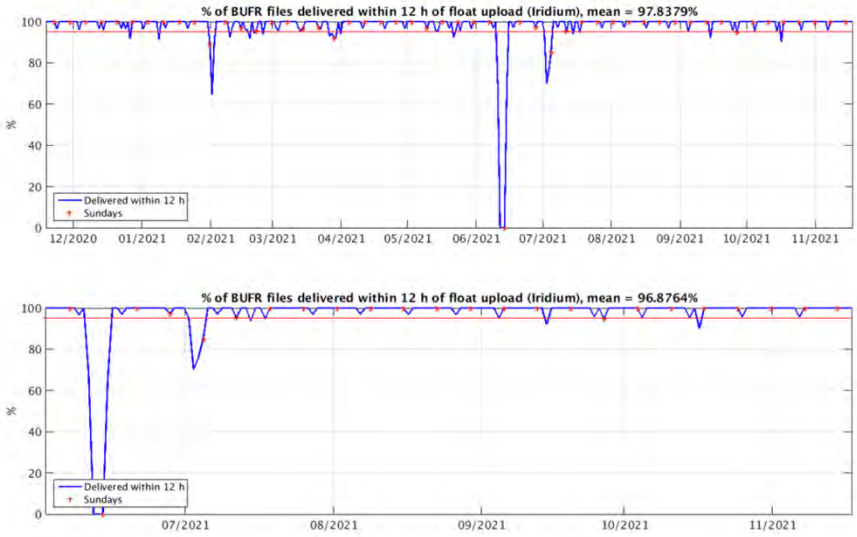


Figure 2: Daily percentage of BUFR files delivered within 12 hours of float upload between December 2020 and November 2021 (top) and June 2021 and November 2021 (bottom). The red vertical line indicates the 95% submission rate.

Data issued to GDACs after real-time QC

All data is issued to GDACs in NRT, with 96% of the data reaching the GTS within 12 hours of float upload. In the last year, a number of improvements have been made to our RT system including:

- Implementation of the global range test for temperature and salinity (in both our Matlab and Python system);
- Implementation of a RT PSAL adjustment, with values provided by the DMQC operators;
- Replacement of gradient test with MEDD test (in our Matlab system only, for now);
- RTQC and RT adjustments are now operational for NITRATE and DOXY variables on BGC floats;
- Correction of some format issues that were reported by the GDACs;
- Cross-validation of data produced in parallel by our Matlab and Python systems and addressed all inconsistencies;
- Implementation of CPcor salinity corrections for data from Deep floats in RT;
- Application of the greylist flags to trajectory files;

- Release of data from 10 Argo-equivalent floats that were deployed on the continental shelf off Antarctica to the GDACs;
- Removal of fully D-moded floats from the greylist; and
- We've addressed most of the actions assigned to us (and other DACs) from ADMT-21. Details have been included in the actions log.

Challenges in real-time processing and operations

We currently maintain two RT processing systems (legacy and new), adding some redundancy in the work related to RT processing. The transition between systems within CSIRO has started – with all floats deployed after May 2021 being only processed by the new system. The next big step for us is to implement the new RT system in the BoM, to ensure redundancy for all the new floats. There has been a delay in implementing the MEDD test in the new RT Python-based system, because the code available in the Argo community is in Matlab, and we still need to translate it to Python.

Over the past year, we've had several issues with float operations. We've had issues with battery passivation in floats, resulting in floats not sampling during ascent. We're referring to this issue as a "CTD switch fault". We have changed these float's mission, as per manufacturer advice, and some of the batteries have recovered. We currently have 16 floats under watch, hoping to recover their battery from passivation. We've also had two floats with problems in the high pressure valve that stops the float from descending to the full profile depth from park depth. We also have 17 floats with bladders that are not fully deflating, and are losing air during parking. This issue impacts the ability of floats to communicate when they reach the surface.

We've also encountered a large number of our APF11 floats are not getting a GPS fix when they surface after their initial profile. As a result, we haven't submitted position data for those profiles until the float transmits data after its second cycle. This is impacting our delivery of data to the GTS.

Data issued for delayed QC

A detailed response was provided for all floats identified in the core DMQC Audit (August 2021) and action has been taken to correct data as required.

Alerts from the Coriolis Objective Analysis are processed regularly and feedback is sent. All floats listed in the summary table of the monthly Anomalies Monitoring report are inspected promptly for addition to the grey-list or other appropriate action and feedback is sent.

There are 31 Australian floats currently listed on the FSD spreadsheet for which details were updated during October 2021.

Delayed data sent to GDACs

Between 1 January 2021 and 1 December 2021, we have performed DMQC on Core variables for 366 floats, producing almost 67,000 profiles that have been sent through to the GDACs. As of 1 December 2021, we estimate that of our fleet of 1021 floats (of which 964 are greater than 12 months post-deployment and are eligible for DMQC) that have collected almost 192,000

profiles, DMQC is currently required on 61 floats (with about 10,000 profiles). This indicates that data from about 95% of eligible floats have been DMQC-ed.

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.

Statistics of Argo data usage

Australian operational systems that use Argo data include:

- OceanMAPS, for ocean forecastwww.bom.gov.au/oceanography/forecasts/;
- POAMA/ACCESS-S, for seasonal prediction (poama.bom.gov.au);
- ReefTemp, for estimating the risk of coral bleaching for the Great Barrier Reef region (www.bom.gov.au/environment/activities/reeftemp/reeftemp.shtml);
- OceanCurrent, for estimating current ocean properties around Australia (oceancurrent.imos.org.au); and
- BoM's SST Analysis (www.bom.gov.au/marine/sst.shtml).

Scientific applications include:

- BRAN2020 (https://research.csiro.au/bluelink/global/reanalysis/)
- Tasman Sea reanalysis that is produced by Colette Kerry, from UNSW (Kerry et al. 2020).
- CAFÉ (https://research.csiro.au/dfp/cafe-csiro-decadal-prediction-system/) that is a contribution to a suite of WMO-endorsed annual-to-decadal climate predictions (https://hadleyserver.metoffice.gov.uk/wmolc/).

Products generated from Argo data

We've developed a system for estimating Argo float trajectories under ice at high southern latitudes. Details of this system are being prepared for publication. The system has been applied to the entire Argo array, including 521 floats and 2370 "gaps", where no observed position is recorded. An example of an estimated trajectory for a float that spent most of its operating life under ice is presented in Figure 3. The system is simple – identifying continuous trajectories that approximately follow contours of properties that we expect may be approximately preserved along a floats trajectory.

We compare results from our method to estimates that assume a linear trajectory for periods when trajectories are measured using GPS, and find a modest reduction of position error. But we find a significant reduction in the number of inconsistencies (e.g., when the bottom depth is less than the depth of the deepest measurement – see Figure 3a between year 2 and 3). The novel aspect of the new system is the use of multiple different constraints to estimate trajectories. We use potential vorticity, mean sea-level, and density at 1000 m depth. The system can currently produce three estimates of a floats trajectory under ice. We wonder if these estimates could be provided to the community routinely – perhaps at the end of each winter season – and could be considered for inclusion into D-files after assessment by a DMQC Operator. We're also considering using estimated trajectories from this system for R-files instead of linear estimates.

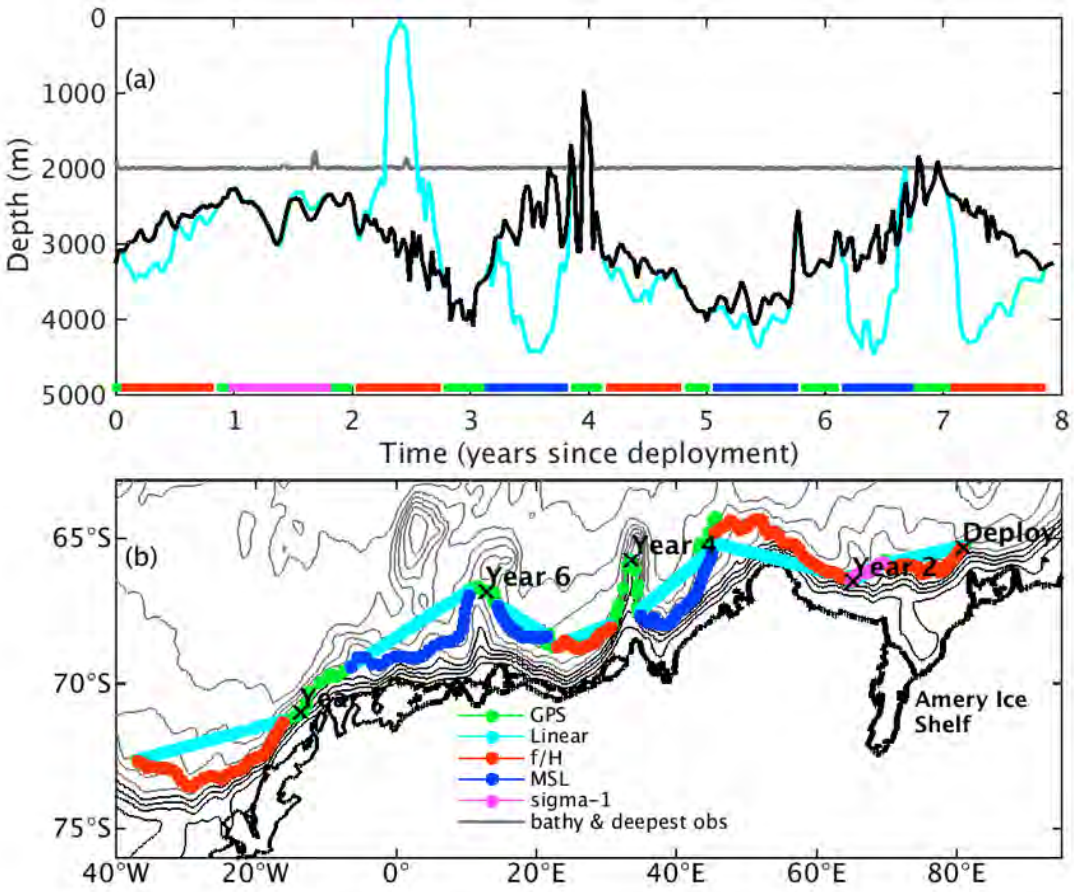


Figure 3: Example of the estimated trajectory for float 7900310. Panel (a) shows time-series of the depth of the deepest measurement (grey), and the bottom depth beneath the trajectory using a linear method to fill gaps (cyan) and using the multiple-constraints method (black) that is introduced here. Panel (b) shows the float trajectories measured by GPS (green), and estimated from the linear method (cyan), and the multiple-constraint method - showing when the constraint used is f/H (red), MSL (blue), and sigma-1 (magenta). The coloured lines along the bottom of panel (a) also show which method is used for estimating oat positions as a function of time. Time references along the trajectory are shown in panel (b) for several points along the float's path.

The Australian Argo team have developed a new product that is called Blue Maps. Blue Maps is a gridded product with 1/10 degree horizontal resolution that combines Argo data with satellite data to produce weekly maps. To date, Blue maps has been used to produce fields for the period spanning March 2006 and December 2020. Blue Maps is still an immature product that needs careful assessment, but it offers some features – including high-resolution, and synthesis of multiple observation types in a single step – that may prove worthwhile. Data from version 1p0 of Blue Maps is available at:
https://dapds00.nci.org.au/thredds/catalog/gb6/BRAN/Blue_Maps/MAPS-v1p0/catalog.html

The Argo Australia team were also involved in the production of BRAN2020 (Chamberlain et al. 2021). This is the latest high-resolution (1/10th degree) ocean reanalysis performed by the Bluelink team in Australia. The new aspect of BRAN2020, compared to previous versions, is the adoption of a multi-scale data assimilation. This approach has virtually eliminated the model bias that has plagued all previous versions of this reanalysis product. Data is available at: https://geonetwork.nci.org.au/geonetwork/srv/eng/catalog.search#/metadata/f9372_7752_2015_3718

CSIRO has also updated the CSIRO Atlas for Regional Seas (CARS – internally referred to as ARGO_for_DMQC_2020V03) – producing an Argo-only product that grids all Argo data, using the methods described by Ridgway et al. (2002). Argo Australia use this climatology for DMQC.

Deployments

Argo Australia has deployed 68 floats between October 2020 and October 2021, including 9 floats with BGC sensors. Figure 4 shows the deployment location of these floats. Nine different vessels contributed to these deployments, and the floats were funded by IMOS, CSIRO, AAPP, IMAS, BOM, and the Royal Australian Navy.

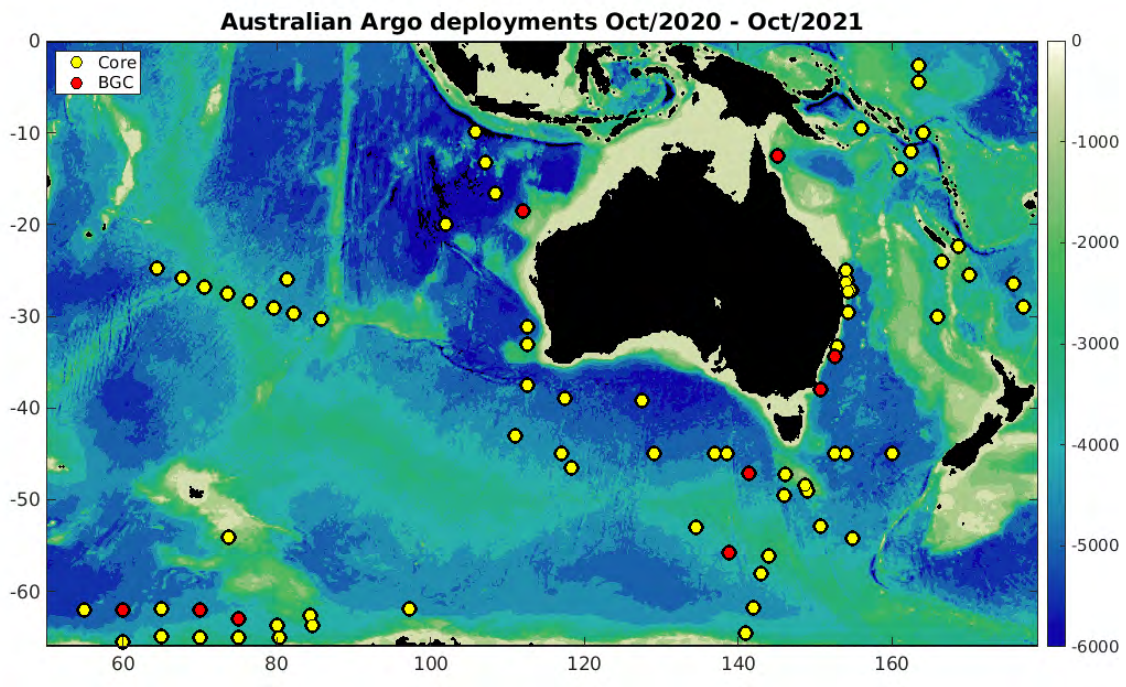


Figure 4: Map of Argo Australia deployments between 1 October 2020 and 1 October 2021, showing deployment locations for BGC floats (red) and Core floats (yellow). The background is bathymetry.

2. Delayed Mode QC

We have maintained a Matlab-based DMQC system that is employed by three DMQC Operators. Our DMQC system is maintained by Dirk Slawinski, and our active DMQC team includes Catriona Johnson, Jenny Lovell, Tatiana Rykova. The team is supported by Esmee Van Wijk for

problematic floats. Our Matlab system is also used by Argo China (CSIO, Xiaofen Wu) and has previously been used by Argo India (INCOIS). Uday Bhaskar has recently obtained an updated version so we expect that he will resume using it again. The team provides occasional support to these external users to enable their activity, including code changes to accommodate different float specifics as well as trouble-shooting errors. These collaborations have resulted in a more robust and flexible code base.

Our DMQC system has long been used to perform DMQC on pressure, temperature, salinity, and dissolved oxygen (DOXY). Recently the workflow has been modified to allow the DOXY QC to be done by a separate operator after completion of the physical parameter QC, this is still in testing phase. We introduced this option to allow Christina Schallenberg to perform DMQC on our DOXY measurements without having to perform DMQC on core variables at the same time. We understand that decoupling the DMQC of DOXY and T/S/P isn't ideal, with a loss of information that may inform DOXY DMQC decisions. We may revert to always performing DMQC on T/S/P/DOXY together. But we're trying to play to the relative strengths of different team members, and we'll revisit our strategy regularly.

At present, our DMQC system cannot handle floats with data from five or six BGC variables, but a work-around that will allow us to still perform DMQC on core variables (T, S, P) and DOXY for those BGC floats is in progress. We plan to trial an intermediate file reformat so that the data can be provided to the software system in the form that is expected and then once BD files containing D-mode DOXY_ADJUSTED are created, they can be re-merged with the other BGC parameters to create the final BD files for submission to the GDAC and as a basis for DMQC of the other parameters. This script-based reformatting and merging will be undertaken in coming months and is necessary to do all the DMQC of Core variables of our BGC floats. Currently only two floats are impacted.

Except for DOXY, we don't plan to perform DMQC for BGC variables with our DMQC system. We use the SAGE system for DMQC of NITRATE and PH (with NITRATE adjustments made in RT based on the latest DMQC; the same is in the process of being implemented for PH), while DMQC of CHLA and BBP will be done offline at the end of a float's life. For CHLA and BBP, the adjustments and QC that are envisioned in real time (not fully implemented at our DAC yet, but work is in progress) should allow these variables to be used with confidence for scientific applications, so it's less crucial for DMQC to be done periodically throughout a float's life.

DMQC for the 3 deep floats has been performed independently (outside of our current DMQC software) and science results and data quality is reported on in Foppert et al. 2021 (submitted to JGR). We intend to update our DM system to cater for Deep floats in 2022.

Reference data for OWC has been updated to the latest releases. We are using OWC-V3 with ARGO_for_DMQC_2020V03 and CTD_for_DMQC_2021V01. We have not started using pyOWC but have engaged with the developers periodically to make comments on priorities. We have installed pyOWC and intend to test it during the next year. Delayed-mode PSAL adjustments are now passed to the RT processing system so that PSAL_ADJUSTED can be produced in real-time. We maintain a high priority for DMQC of floats that may be susceptible to fast salty drift and have updated the details for identified fast drifters on the FSD spreadsheet (currently 31 Australian floats are on the spreadsheet).

DMQC issues we've encountered include:

- We have several floats with RBR CTD sensors that are eligible for DMQC. But we're waiting on final recommendations from the RBR working group before we implement these corrections in our DMQC system.
- Considerable effort has been taken to separate the physical parameter workflow from DOXY DMQC and gain calibration to enable a specialist BGC DMQC operator to work on this data, work is ongoing to accommodate more complex data formats as they unfold
- During the installation process of the pyOWC code it was discovered particular versions of Python and libraries were required. Installing this on an "open" system seems to be fine, however, in an organisations like CSIRO, were our systems are managed to a specific security model, our installation required some effort by our IT Staff to install compliant versions of the various sub-components. A potential solution could be a Docker or Singularity container so all the required components were in place without the need to build pyOWC.
- For the PH variable, some uncertainty remains about how to implement the SAGE output with our RT Python code. But we're in the process of figuring it out (hopefully!).

3. GDAC Functions

Nothing additional to report.

4. Regional Centre Functions

Nothing additional to report.

5. References

Chamberlain, M.A., Oke, P.R., Fiedler, R.A., Beggs, H.M., Brassington, G.B. and Divakaran, P., 2021. Next generation of Bluelink ocean reanalysis with multiscale data assimilation: BRAN2020. *Earth System Science Data Discussions*, pp.1-31.

Foppert, A.,Rintoul, S.R., Purkey, S.G., Kobayashi, T., Sallee, J.B., van Wijk, E.M and Wallace, L.O. (2021). Deep Argo reveals bottom water properties and pathways in the Australian-Antarctic Basin. submitted to JGR.

Kerry, C. G. and M. Roughan, Powell, Brian, Oke, Peter (2020). A high-resolution reanalysis of the East Australian Current System assimilating an unprecedented observational data set using 4D-Var data assimilation over a two-year period (2012-2013). Version 2017. UNSW.dataset. DOI: 10.26190/5ebe1f389dd87.

Oke, P.R., Chamberlain, M.A., Fiedler, R.A., Bastos de Oliveira, H., Beggs, H.M. and Brassington, G.B., 2021. Combining Argo and satellite data using model-derived covariances: Blue Maps. *Frontiers in Earth Science*, *9*, p.485.

Ridgway, K.R., Dunn, J.R. and Wilkin, J.L., 2002. Ocean interpolation by four-dimensional weighted least squares—Application to the waters around Australasia. *Journal of atmospheric and oceanic technology*, *19*(9), pp.1357-1375.

Argo Canada National Data Management Report

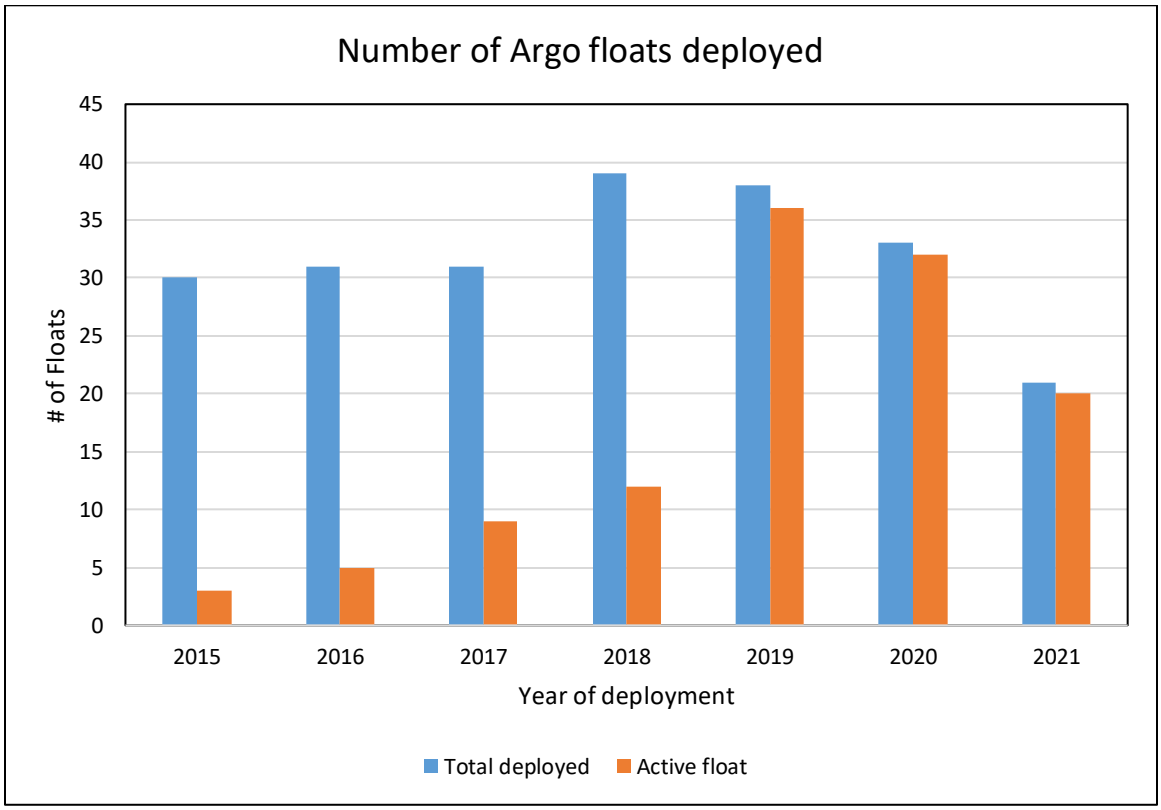
ADMT22 - Virtual Meeting

Dec 6 – 10, 2021

1. Status

- Data acquired from floats

  As of the end of November 2021, we are tracking 117 floats of which 1 floats may have failed to report within the last 4 months. The plot below shows the total number of floats deployed per year and the number of floats which are still active as of November 2021.

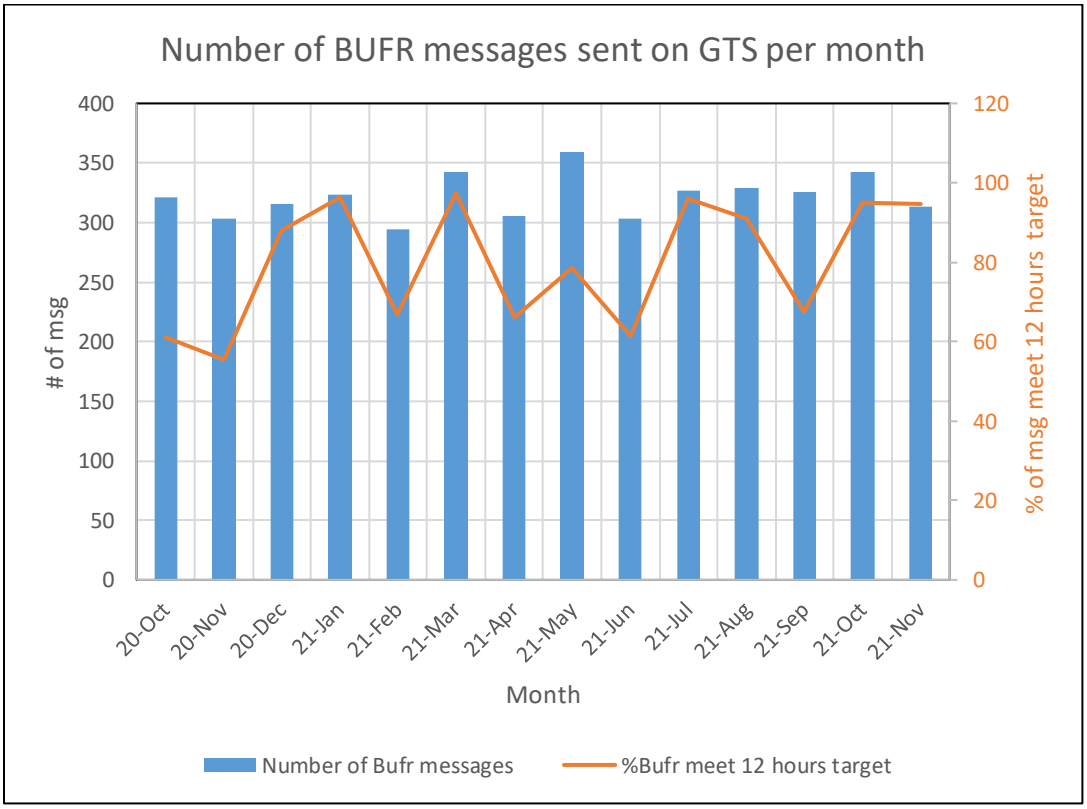


Since November 2020, we deployed 26 new ARVOR-I floats of which 5 floats are equipped with dissolved oxygen sensors and 2 floats are equipped with RBR sensor. One of the two RBR floats that deployed in 2021 suffered a CTD failure a month or so after deployment. However, it

was recovered, and RBR diagnosed that the conductivity cell was defected, and caused a leak. All floats were acquired from NKE and are reporting on the Iridium satellite system.

- Data issued to GTS

  All data are issued to the GTS in BUFR formats. Since November 2020, on average, 80% of data were issued on the GTS within the 12 hour target in BUFR formats. A monthly average of 316 BUFR messages were transmitted on the Argo network between November 2020 and November 2021. During the year, we have experienced some difficulties with the server updates and has caused a drop in the transmission time on the GTS.



- Data issued to GDACs after real-time QC

  The profile, technical, trajectory and meta files are transmitted to the GDACs in NetCDF format version 3.1 on an operational basis with some

additional delay, compared to the data sent on the GTS, because the two processes run on different servers. There are still a number of trajectory NetCDF files of dead floats that are not in format version 3.1 at the GDACs.

- Data issued for delayed QC
  Data are available for delayed mode QC as soon as they are sent to the GDACs, but only floats deployed for at least 6 months are qualified for fully DMQC

- Delayed data sent to GDACs
  During last year, the majority work was focused on QC profiles (temperature and salinity) of core Argo floats. Specifically, float's profiles reported more than 6 months ago was conducted with a full quality-control cycle which includes pressure adjustment, visual QC on vertical temperature and salinity profiles, and the Owens-Wong-Cabanes (OWC) method on salinity time series. On the other hand, float's profile within 6 months was quality-controlled in a partial cycle containing pressure adjustment and visual QC. In both cases, their QCed profiles were converted to D-files and transmitted to GDACs.
  During last year, significant efforts were made to improve BGC DMQC tool and to establish a feasible working environment for the DMQC tool. Therefore, less efforts were attempted to QC BGC profiles. We have begun to DMQC some of the BGC profiles of inactive floats. These profiles will be submitted to the GDACs shortly.

- Web pages
  http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/argo/index-eng.html
  We maintain web pages that show float tracks and all data collected by Canadian floats. Links to both real-time and delayed mode data are also available for download directly from GDAC. The pages are updated daily.

Argo Canada data is discoverable from the Government of Canada Open Government Portal, https://open.canada.ca/en.
It provides links to download data in NETCDF and web services to access float positions.

- Statistics of Argo data usage （operational models, scientific applications, number of National Pis… ）
    a. Argo data have been used to generate monthly maps and anomaly maps of temperature and salinity along line P in the Gulf of Alaska. Line-P has been sampled for 50 years and has a reliable monthly climatology. For more information on the Line-P products and other uses of Argo to monitor the N.E. Pacific go to: http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/argo/canadian-products/index-eng.html.
    b. The Canadian Meteorological Centre (Dorval, Québec) of Environment Canada is assimilating real-time Argo data in operational mode.

2. Delayed Mode QC

2.1 Statistics

As of November 17, 2021, 71% of all active floats, had their profiles DMQCed according to the latest delayed-mode procedures at least once, in comparison to last year's percentage of 67%. About 6,785 profiles across 65 core Argo floats have been DMQCed within the last year. There are 3,694 fully QCed core profiles while the number of partially QCed profiles is 3,091.

Of all BGC floats, 13% have been either visually QCed or fully DMQCed at least once on their profiles. It should be noted that DMQC only applies to DOXY for Argo B-profiles.

2.2 DMQC Tool

The DMQC tool for core Argo floats has been updated to the latest OWC method as well as the most recent climatology and reference database. The DMQC tool for BGC Argo floats focusing on DOXY is coded by python and under development with notable improvements. All source codes have been shared on Github (https://github.com/ArgoCanada/bgcArgoDMQC).

2.3 Anomaly Report and Audit

The monthly anomaly reports issued by Ifremer (French GDAC) were carefully reviewed and the anomalies were flagged and updated to GDAC NETCDF files. The audit especially targeted on delayed-mode salinity data reported by John Gilson and Annie Wong's analysis was reviewed and corrected accordingly. Actions were made to re-evaluate the salinity data in 'D' mode with suggested reference database and updated D-files were re-submitted to GDACs.

3. GDAC Functions

Canada forwards TESAC data to the GDACs in Ifremer (France) and USGODAE (USA) three times a week. Canada also monitors the timeliness of Argo data on the GTS in BUFR format.

4. Regional Centre Functions

Canada has no regional centre function.

Chinese Argo National Data Management Report

Virtual meeting, 6-10 December, 2021 (ADMT-22)

Zenghong Liu[1], Xiaogang Xing[1], Xiaofen Wu[1]

1) Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou, China

1. Status

- Data acquired from floats

This year China acquired 5,825 temperature and salinity (additionally 597 O2, 567 CHLA, 567 BBP, 532 CDOM, 978 DOWN _IRRADIANCE and 431 NITRATE) profiles from 124 operational floats including 15 APEX, 47 PROVOR, 56 HM2000, 5 ARVOR_D and 1 NAVIS floats (Fig.1). It is worth nothing that Pilot National Laboratory for Marine Science and Technology, Qingdao (QNLM) sent historical core profiles obtained from 39 HM2000 floats with earliest deployment in 2018 to CSIO, which contributed 3,959 TS profiles in the period 2018-2021 to Argo community.

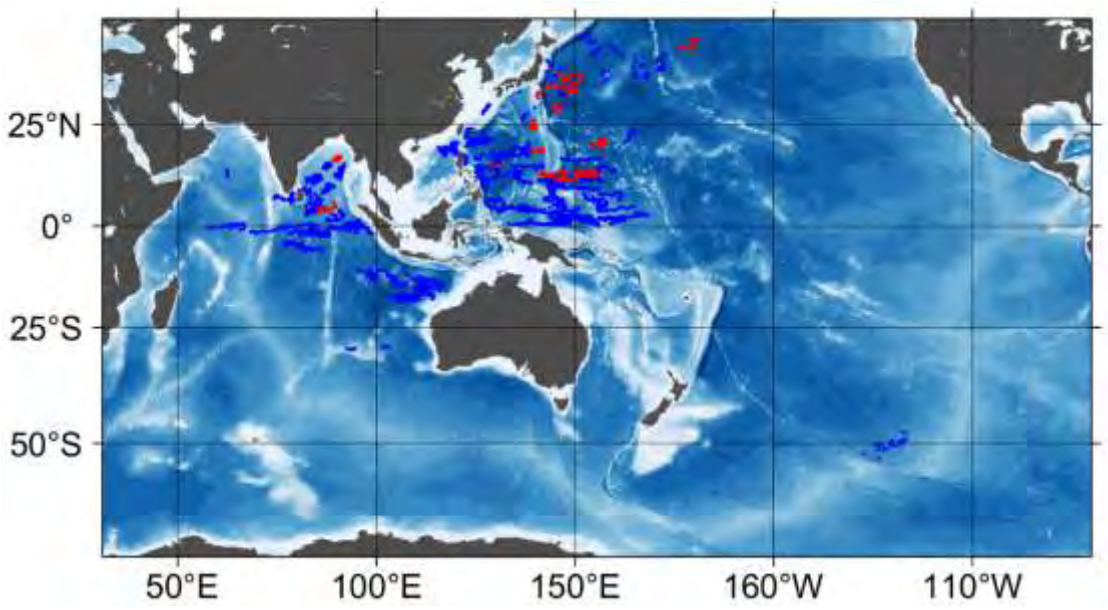


Fig.1 The geographic distributions of Core (blue) and BGC (red) profiles

- Data issued to GTS

At CSIO, the JMA BUFR generation script is being applied. BUFR bulletin is generated for each Argo profile and transferred to China Meteorological Administration (CMA), who will insert bulletin into the GTS. Besides T/S profiles, O2 profiles are able to be converted into BUFR and inserted into GTS.

- Data issued to GDACs after real-time QC

Meta, technical, trajectory and profile files are submitted to GDAC in netCDF format version 3.1 on an operational basis. The MEDD test has been added into our RTQC procedure according to the latest QC manual. The Global range test was revised according to the ADMT-21 action items. The real-time adjustment for CHLA has been added into our system.

- Data issued for delayed QC

At CSIO, under Zenghong's help with decision-making and DMQC team members' (Dirk, Catriona, Jenny, etc.) help at CSIRO, Ms. Xiaofen Wu was still in charge of DMQC for core profiles this year.

- Delayed data sent to GDACs

About 15,853 D-files were sent to GDACs. Totally about 78% of the core profiles have been DMQC'd, and D files of some old floats have received the second DMQC processing.

- Web pages

The website (http://www.argo.org.cn) of the China Argo Real-time Data Centre (Hangzhou) was maintained by CSIO, from which the latest progress on China Argo, the real-time observations from Chinese floats including data file and related plots are provided.

- Statistics of Argo data usage (operational models, scientific applications, number of National Pis…)

  Operational uses: Argo data have been used into most ocean data assimilation systems operated by department or institutions such as NMEFC, NMDIS, IAP, QNLM, etc.

Scientific applications: The Argo data are mainly used in from seasonal to decadal ocean variations in global and regional scales, air-sea interactions, ocean's role in global climate change.

- Until now, about 21 PIs from 11 institutions and universities have deployed profiling floats and share data with Argo community.

- Products generated from Argo data …

  BOA_Argo: It is now a biannually updated gridded Argo product developed by CSIO (ftp://data.argo.org.cn/pub/ARGO/BOA_Argo/). The product is based on the post-QC'd Argo dataset maintained by CSIO.

  GDCSM_Argo: It is a gridded Argo product jointly developed by SHOU (Shanhai Ocean University) and CSIO based on a Gradiente-dependent Correlation Scale Method (ftp://data.argo.org.cn/pub/ARGO/GDCSM/).

  IAP data set: IAP data set is a global ocean gridded data se developed by Lijing Cheng from IAP. In contrast to BOA_Argo, other available profiles from various instruments (e.g. XBT, MBT and shipboard CTD, etc.) are also used while producing the data set. It includes 1°×1° monthly temperature fields since 1940 from the sea surface to 2000 m.

  Post-QC'd global ocean Argo dataset: The dataset is based on a FAST post-QC toolbox developed by CSIO, with which we can make a synchronization with GDAC server twice a day and conduct a post-QC procedure to each profile (ftp://ftp.argo.org.cn/pub/ARGO/global/core/). The daily high-quality Argo data derived from this toolbox are now transferred to several operating departments.

  Global ocean BGC-Argo dataset: The dataset is derived from the B-files on the GDAC, and is separated into various txt files according to BGC parameters. The dataset is also expected to be quarterly updated depending on the CSIO resources (ftp://ftp.argo.org.cn/pub/ARGO/global/bgc/).

2. Delayed Mode QC

(Please report on the progress made towards providing delayed mode Argo data, how it's organized and the difficulties encountered and estimate when you expect to be pre-operational .)

CSIO is now still using the DMQC system developed by CSIRO to process Chinese floats (mainly Core Argo and Deep Argo floats). This year, we had updated the system and made it suitable for HM2000 float. Next, we may also try to go to the OWC Python software.

3. GDAC Functions

(If your centre operates a GDAC, report the progress made on the following tasks and if not yet complete, estimate when you expect them to be complete)

None.

4. Regional Centre Functions

(If your centre operates a regional centre, report the functions performed, and in planning)

None.

Argo data management report 2021

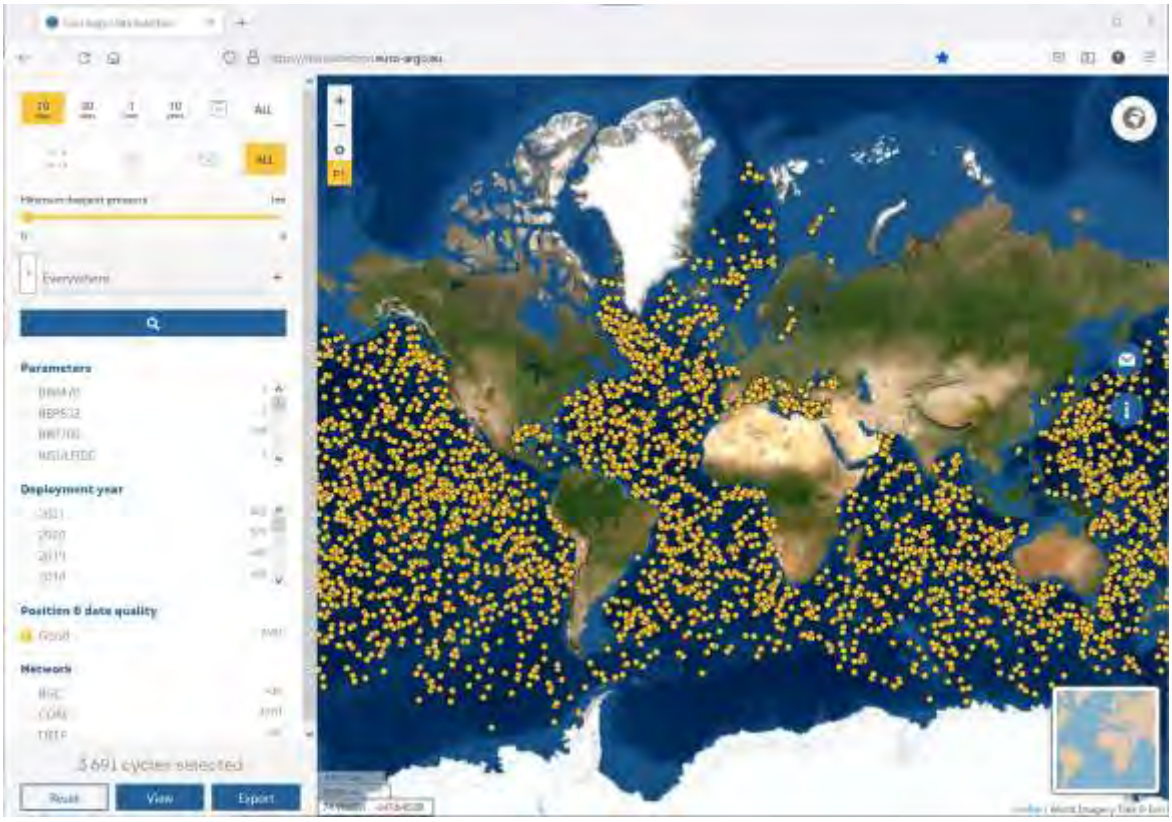
Coriolis DAC & GDAC

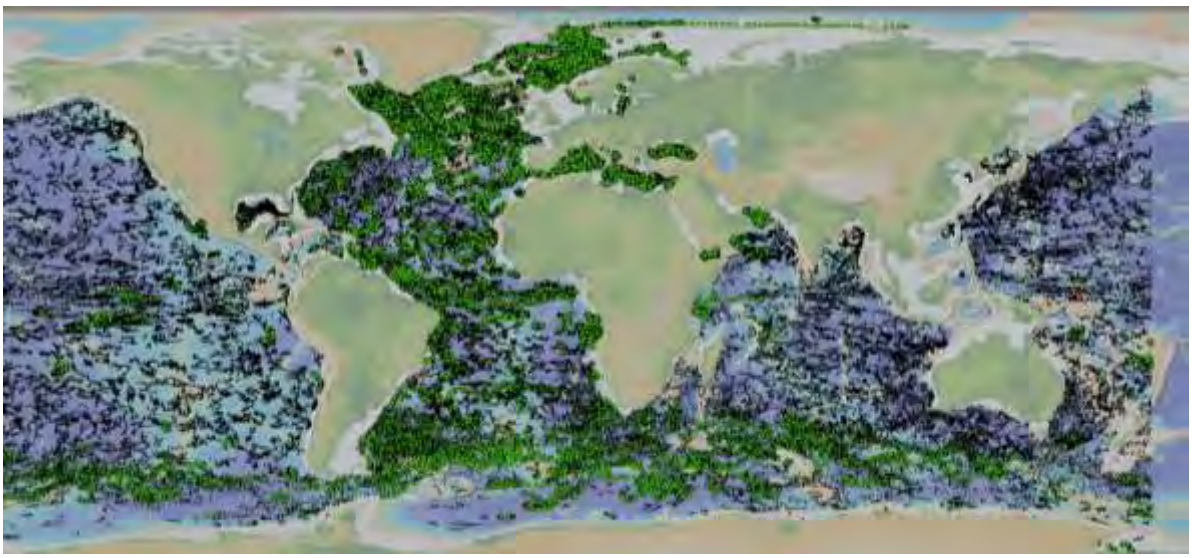
Data Assembly Centre and Global Data Assembly Centre

Annual report November 2021

Version 1.0

https://doi.org/10.13155/84949





1 DAC status

This report covers the activity of Coriolis DAC (Data Assembly Centre) for the one-year period from September 1st 2020 to October 30th 2021.

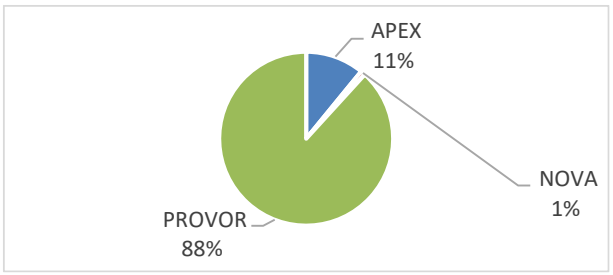
1.1 Data acquired from floats

1.1.1 Active floats for the last 12 months

These last 12 months, **58.535 profiles from 828 active floats** were collected, controlled and distributed.
Compared to 2020, **the number of profiles is fairly increasing (+12%), the number of floats increased by 5%.**
These figures illustrate a good momentum in Coriolis DAC activity.

The 828 floats managed during that period had 52 versions of data formats.

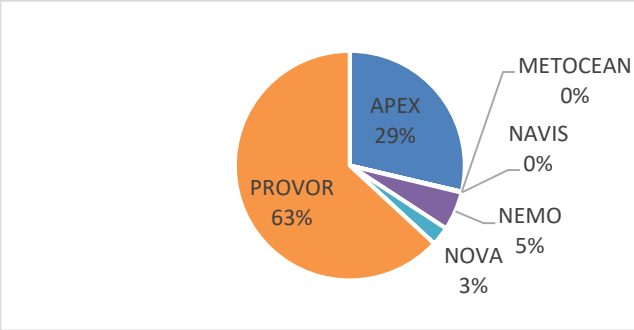
Coriolis DAC, active floats in 2021			
Float family	nb versions	nb floats	nb core p
APEX	19	70	6 385
NOVA	2	12	504
PROVOR	31	746	51 646
Total	**52**	**828**	**58 535**

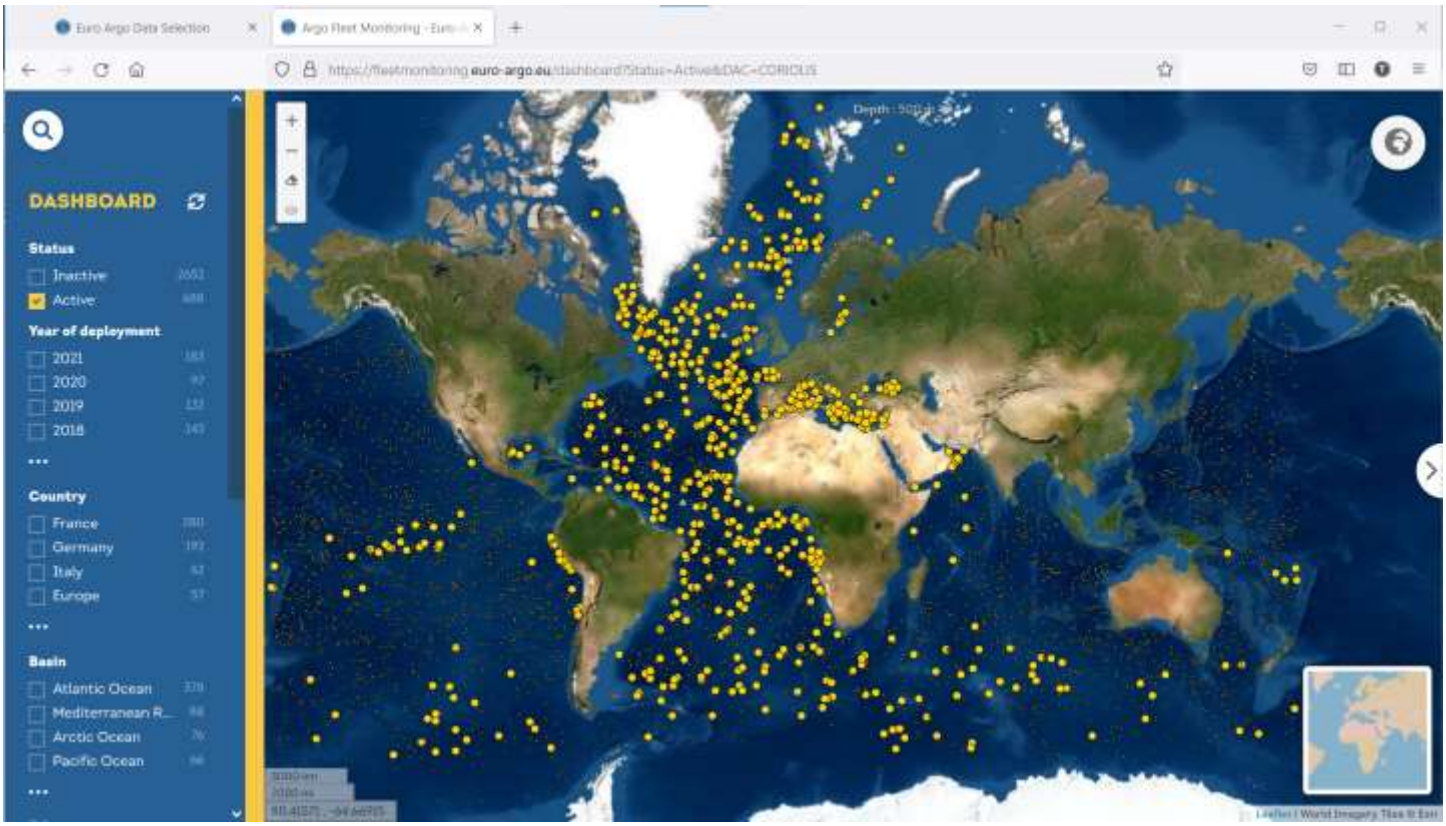


1.1.2 All floats managed by Coriolis DAC

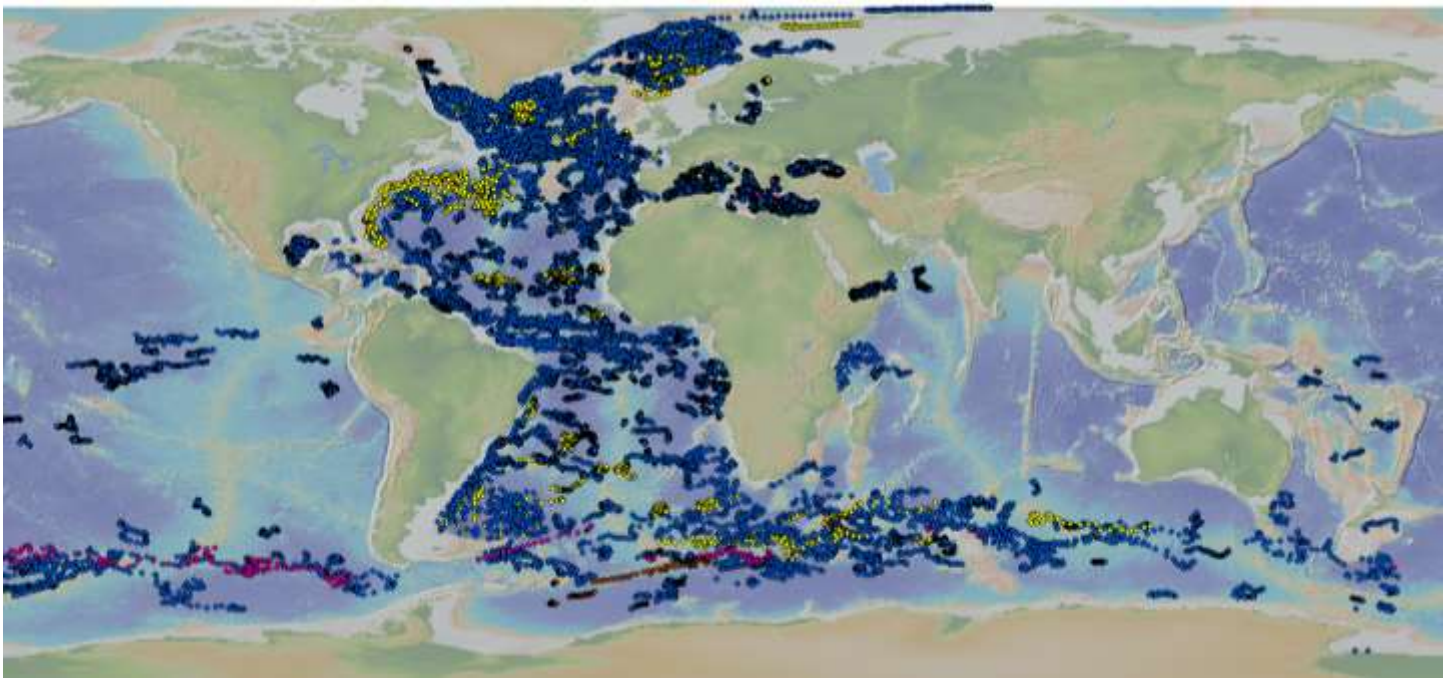
Coriolis DAC manages a total of 3.200 floats with 165 versions, from 6 families.
These floats reported 586.373 core Argo vertical profiles.

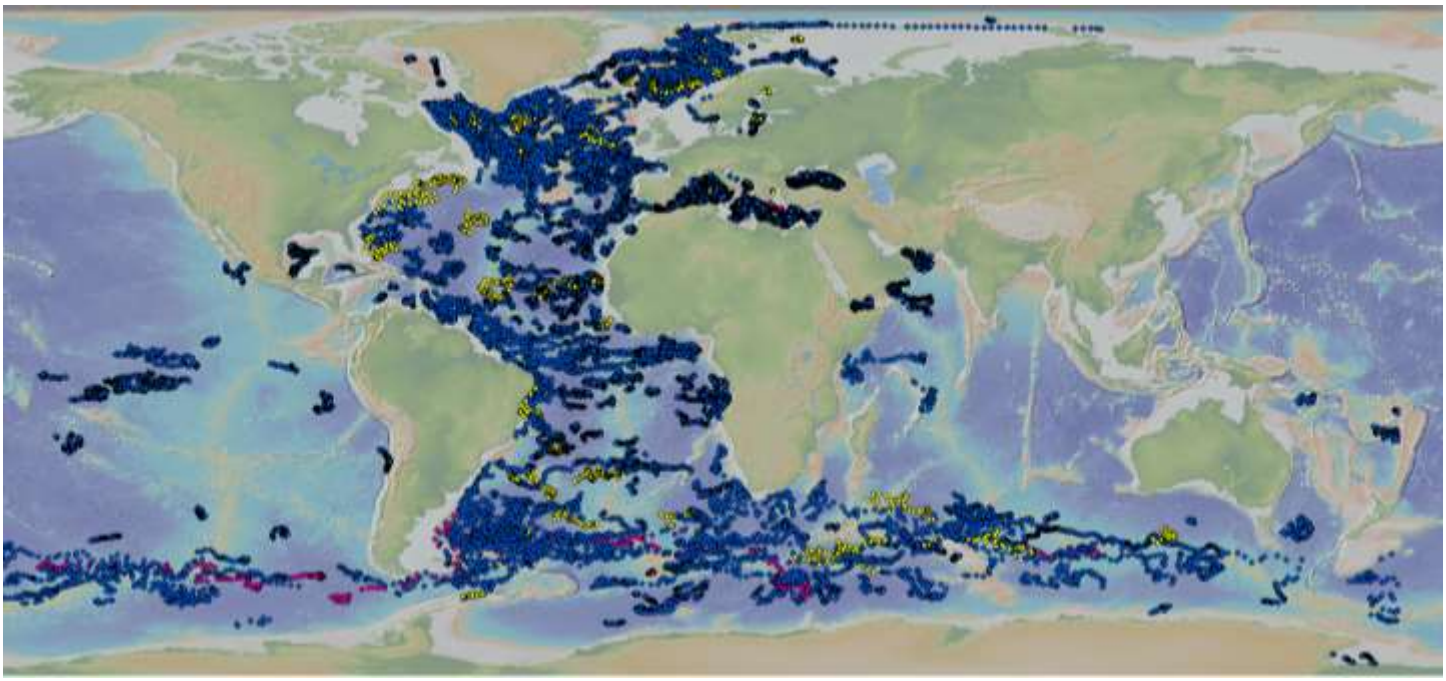
Coriolis DAC, all floats, 2021			
Float family	nb versions	nb floats	nb core p
APEX	78	917	143 320
METOCEAN	1	1	52
NAVIS	1	3	1 932
NEMO	8	174	18 960
NOVA	3	85	9 337
PROVOR	74	2 020	412 772
Total	**165**	**3 200**	**586 373**





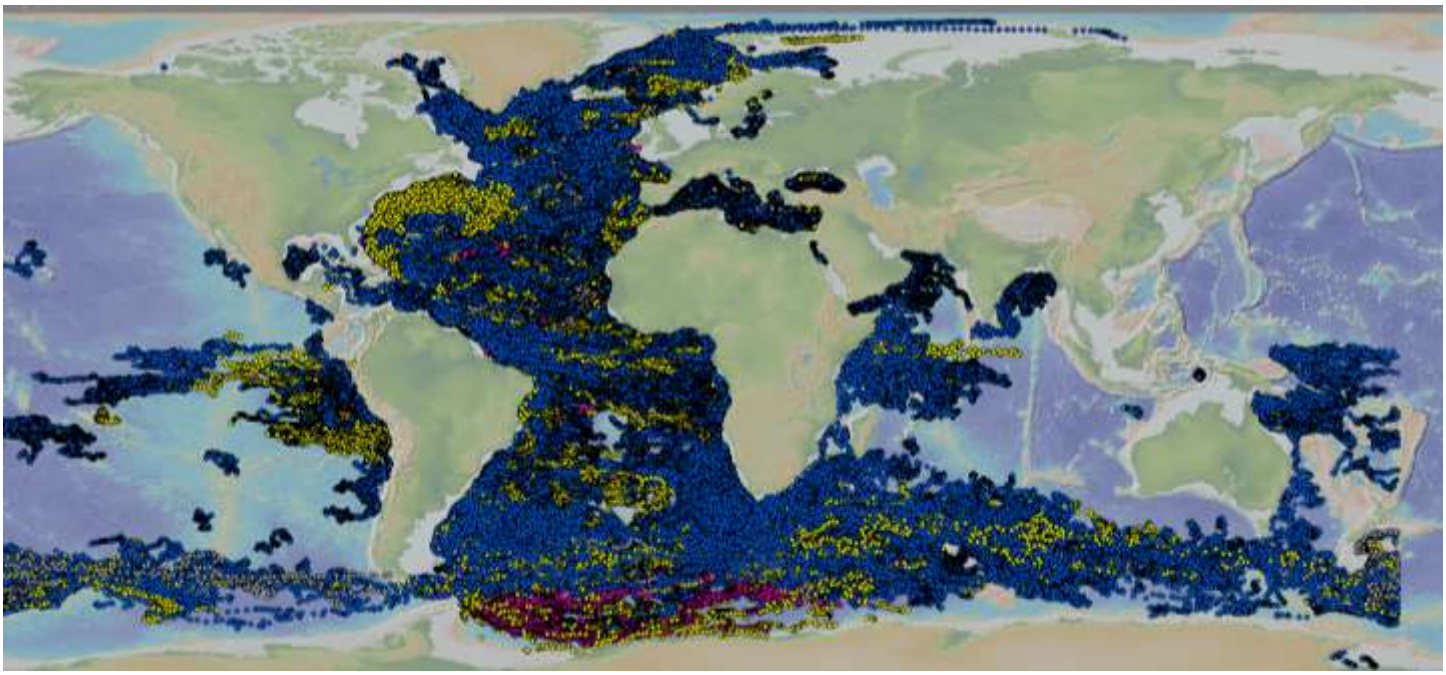
Map of the active floats on December 1st decoded by Coriolis DAC, among others DACs (small dots) as displayed on Euro-Argo floats dashboard https://fleetmonitoring.euro-argo.eu/dashboard





Map of the 58.535 profiles from 828 active floats decoded by Coriolis DAC this current year
Apex Nova Provor

Map of the profiles from active floats decoded by Coriolis DAC this current year, among the other DAC's profiles (Coriolis: green, other DACs: grey)



Map of the 586.373 profiles from 3.200 floats managed by Coriolis DAC
Apex **Metocean** **Navis** **Nemo** **Nova** **Provor**

1.1.3 BGC-Argo sensors on Coriolis floats

The data processing chain for data and metadata from Coriolis BGC-Argo floats is continuously improved. These are advanced types of floats performing bio-geo-chemical (BGC) measurements.

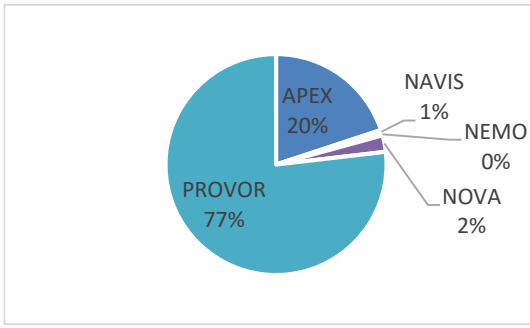
Coriolis DAC manages 622 BGC-Argo floats from 5 families. They performed 79.192 cycles.

The data processing chain is freely available:

- Coriolis Argo floats data processing chain, http://doi.org/10.17882/45589

BGC-Argo floats processed by Coriolis DAC

Float familly	nb versions	nb floats	nb profile	nb cycles
APEX	33	124	19 336	15 565
NAVIS	1	3	551	551
NEMO	1	2	297	297
NOVA	1	15	1 195	1 170
PROVOR	44	478	172 343	61 609
Total	**80**	**622**	**193 722**	**79 192**



General characteristics

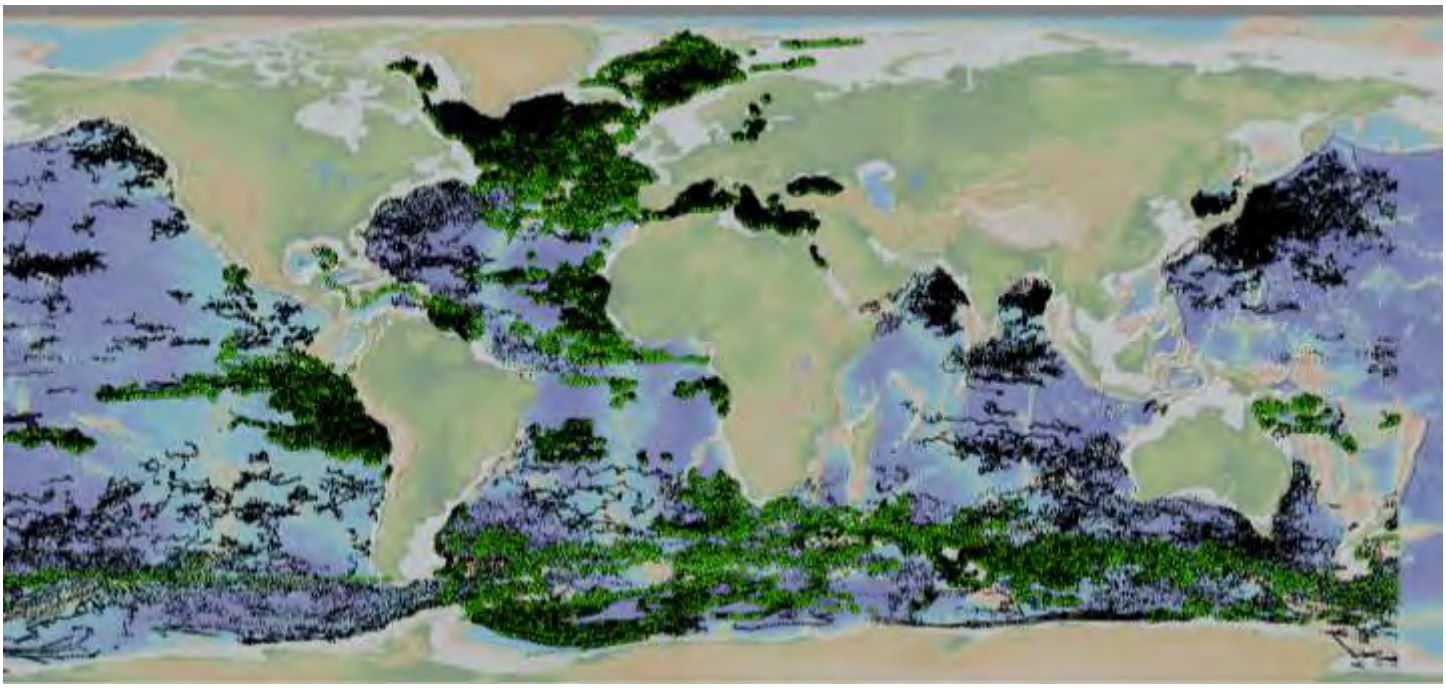
- Iridium sbd or rudics bi-directional communication or Argos
- Fourteen sensors are fitted on the floats
- Eleven BGC parameters reported

Coriolis BGC-Argo floats s	nb floats	nb profiles
AANDERAA_OPTODE_3830	528	72116
C_ROVER	18	4713
ECO_FLBB	240	132510
ECO_FLNTU	10	5366
OPUS_DS	2	732
RAFOS	10	72
RAMSES_ACC	7	610
SATLANTIC_OCR504_ICSW	206	163044
SEAFET	31	3147
SUNA_V2	82	15948
UVP6-LP	6	287

The 11 types of sensors mounted on Coriolis BGC-Argo floats

BGC parameter	nb files
DOXY	238 000
DOWN_IRRADIANCE	131 808
BBP	103 491
CHLA	96 129
NITRATE	50 967
CDOM	44 055
DOWNWELLING_PAR	42 524
PH_IN_SITU_TOTAL	29 039
CP660	4 928
UP_RADIANCE	2 508
TURBIDITY	2 109
BISULFIDE	1 225

The 12 main BGC parameters reported by Coriolis BGC-Argo floats



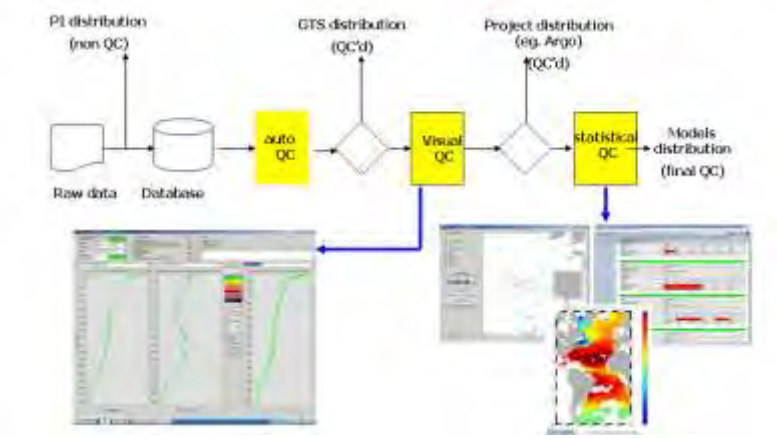
Map of the 622 BGC-Argo floats managed by Coriolis DAC (grey dots: the others DACs bio-Argo floats). They measure parameters such as oxygen, chlorophyll, turbidity, CDOM, back-scattering, UV, nitrate, bisulfide, pH, radiance, irradiance, PAR.

1.2 Data issued to GTS

Vertical profiles processed by Coriolis are distributed on the GTS by way of Meteo-France. This operation is fully automated. After applying the automatic Argo QC procedure, the Argo profiles are inserted on the GTS every hour. The profile files are sent as BUFR messages.

Vertical profiles are distributed on GTS if they are less than 30 days old. Once a day, floats data are checked with ISAS objective analysis that triggers alerts and visual inspection for suspicious observations.
The corrected data are not redistributed on GTS.

In July 2019, Coriolis stopped the TESAC messages distribution; only BUFR messages are now distributed.



Coriolis DAC Argo data flow

1.3 Data issued to GDACs after real-time QC

All meta-data, profiles, trajectory and technical data files are sent to Coriolis and US-GODAE GDACs. This distribution is automated.

All Coriolis floats, number of profile files on GDAC				
Family	nb floats	nb profile	RT profile	DM profiles
APEX	917	143 331	41 261	102 070
METOCEAN	1	52	-	52
NAVIS	3	1 932	1 411	521
NEMO	174	18 960	14 219	4 741
NOVA	85	9 337	4 913	4 424
PROVOR	2021	412 960	200 955	212 005
Total	**3 201**	**586 572**	**262 759**	**323 813**

Distribution of Coriolis DAC real-time and delayed mode profiles

1.4 Data issued for delayed mode QC

Delayed mode profiles

All profile files are sent to PIs for delayed QC.

1.5 Delayed mode data sent to GDACs

An Argo delayed mode profile contains a calibrated salinity profile (psal_adjusted parameter).

- A total of **103.891 new or updated delayed mode profiles** was sent to GDACs this year.
- **A total of 323.813 delayed mode profiles** where sent to GDACs since 2005.

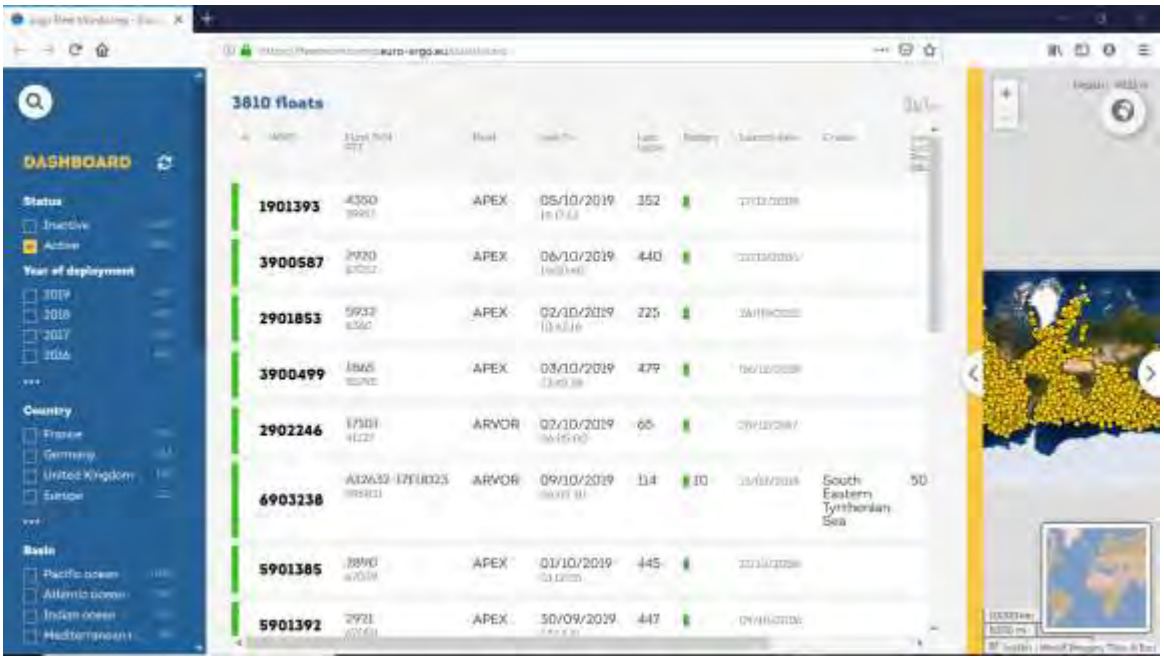
  The number of delayed mode profiles decreased by 45% this year compared to 2020.

1.6 Web pages

1.6.1 Argo dashboard

The Argo floats dashboard developed in 2019 by Coriolis team is available at:

- https://fleetmonitoring.euro-argo.eu/dashboard

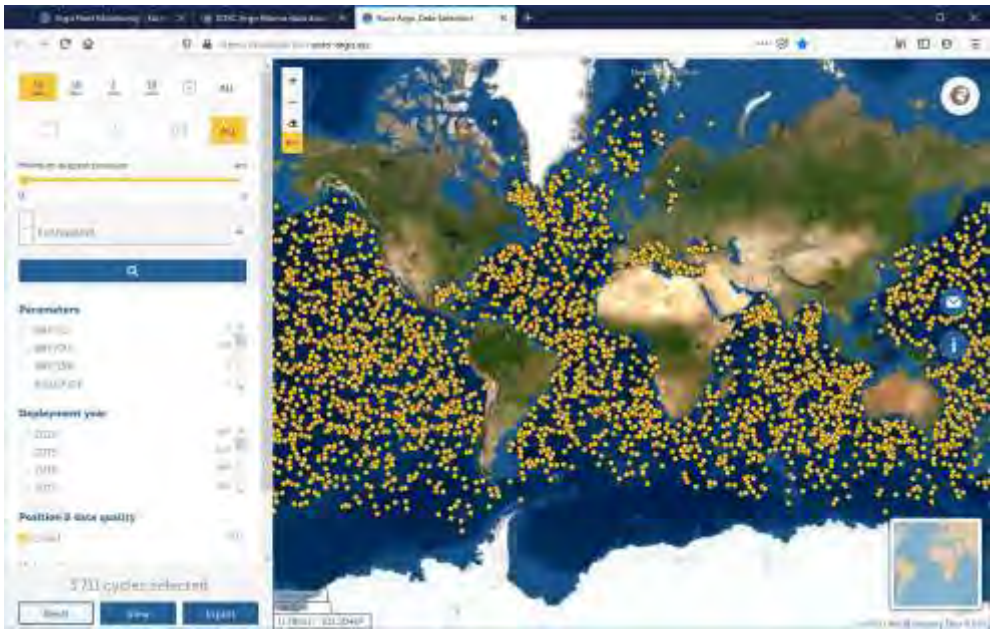


It displays all Argo floats, with facetted interrogations and instantaneous answers. The dashboard is developed on cloud and big-data techniques.

- Cloud techniques: a metadata and a data APIs, opened to internet machine to machine queries
- Big-data techniques: Argo metadata are hourly indexed in an Elasticsearch index, Argo data are hourly indexed in a Cassandra data base. Elasticsearch and Cassandra allows instant answers on dataset having billions of observations.

The Argo data selection was developed in 2020. The initial version is online at https://dataselection.euro-argo.eu/

It proposes data discovery with facetted search on temporal and spatial coverage, parameters, deployment years or quality codes. The selected data are downloadable in NetCDF and CSV formats.



Argo data selection https://dataselection.euro-argo.eu

1.6.2 Argo data on EU BlueCloud

A collaboration is underway with NASA-JPL and the European Blue Cloud to use the CMC (Common Mapping Client) client as the front office of Argo dashboard to provide in situ – satellite – model integration.

- http://bluecloud.odatis-ocean.fr

1.6.3 Interoperability services (ERDDAP API,…)

The APIs used by Argo dashboard and Argo data selection web portals are open and publicly available to interested users at the following endpoints OpenAPI (swagger):

- https://fleetmonitoring.euro-argo.eu/swagger-ui.html
- https://dataselection.euro-argo.eu/swagger-ui.html

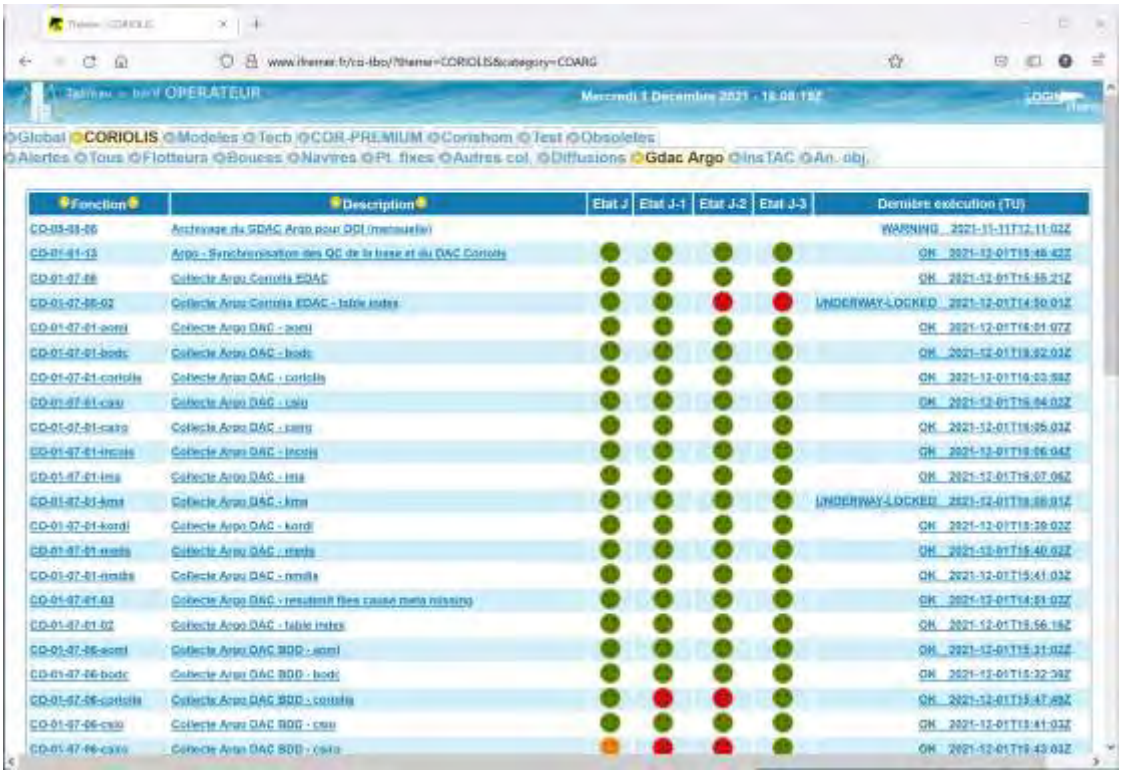
More information available on https://www.euro-argo.eu/Argo-Data-access

This web page describes all Argo floats interoperability services from Coriolis:

- http://www.coriolis.eu.org/Data-Products/Data-Delivery/Argo-floats-interoperability-services2
    - Argo data through ERDDAP data server (www.ifremer.fr/erddap)
    - Display an individual float's data and metadata in HTML or XML format
    - Display all Argo floats, display a group of floats
    - Argo profiles and trajectories data selection (HTML or XML)
    - All individual float's metadata, profile data, trajectory data and technical data
    - Argo profiles data on OpenDAP, OGC-WCS and http
    - Argo data through Oceanotron data server
    - Argo profiles data through GCMD-DIF protocol
    - Argo data through RDF and OpenSearch protocols
    - Display Argo profiles and trajectories with GoogleEarth

1.6.4 Data centre activity monitoring

Coriolis operators perform an activity monitoring with an online control board.



Argo GDAC operations monitoring: every working day, an operator performs diagnostics and take actions on anomalies (red or orange smileys)

1.7 Statistics of Argo data usage (operational models, scientific applications, number of National Pis…)

Operational oceanography models; all floats data are distributed to:

- EU Copernicus Marine service models (Mercator, Foam, Topaz, Moon, Noos, Boos)
- French model Soap (navy operational model)

Argo projects: this year, Coriolis data centre performed float data management for **72 Argo scientific projects and 60 PIs (Principal Investigators).**

List of Coriolis scientific PIs and project names

project	nb floats
coriolis	138
argo-bsh	138
argo italy	81
euro-argo	61
mocca	56
mocca-eu	50
naos wp1	33
ovide	33
argo bsh	27
naos	26

Top 10 of Coriolis DAC projects having active floats

pi name	nb active flo
birgit klein	181
pierre-marie poulain	101
christine coatanoan	54
damien desbruyeres	42
virginie thierry	41
kjell arne mork	34
sabrina speich	31
romain cancouet	24
bernard bourles	24
pedro velez	23
laurent coppola	22

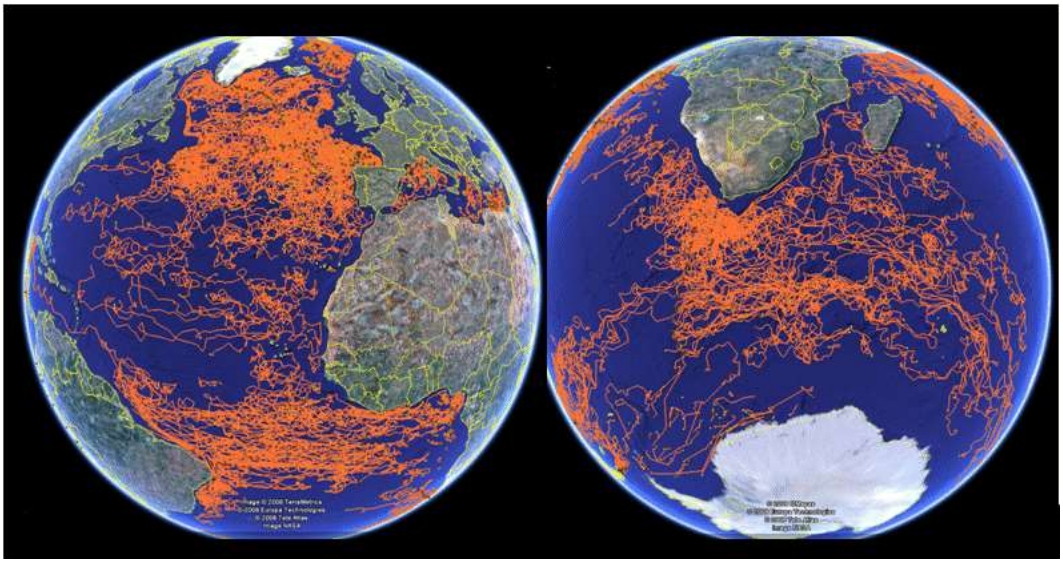
Top 10 of Principal Investigators (PI) in charge of active floats

1.8 Products generated from Argo data

Sub-surface currents ANDRO Atlas

Based on Argo trajectory data, Ifremer and CNRS team are regularly improving the "Andro" atlas of deep ocean currents. The ANDRO project provides a world sub-surface displacement data set based on Argo floats data. The description of each processing step applied on float data can be found in:

- Ollitrault Michel, Rannou Philippe, Brion Emilie, Cabanes Cecile, Piron Anne, Reverdin Gilles, Kolodziejczyk Nicolas (2021). **ANDRO: An Argo-based deep displacement dataset**. SEANOE. https://doi.org/10.17882/47077



Argo trajectories from Coriolis DAC are carefully scrutinized to produce the "Andro" atlas of deep ocean currents.

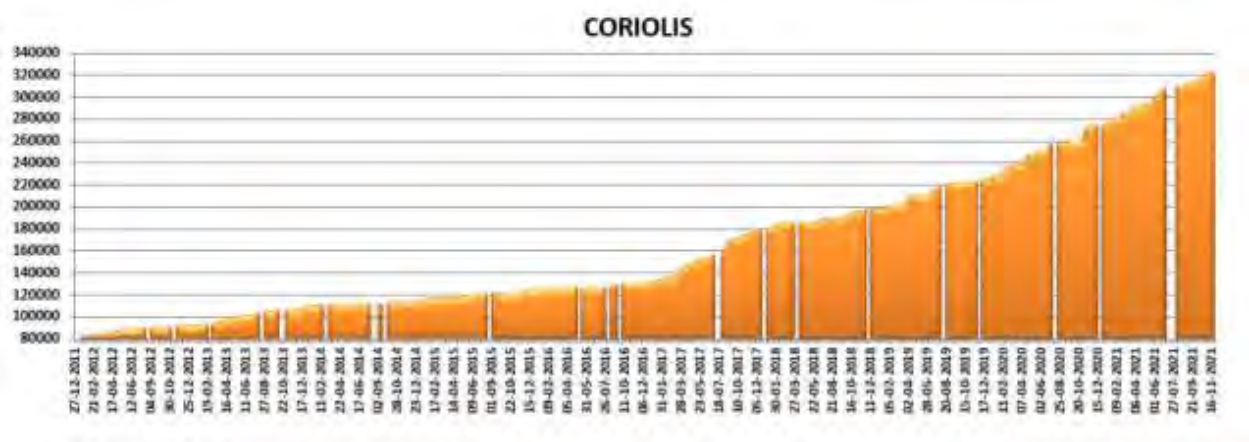
2 Delayed Mode QC

At the Coriolis data centre, we process the delayed mode quality control following four steps. Before running the OW method, we check carefully the metadata files, the pressure offset, the quality control done in real time and we compare with neighbor profiles to check if a drift or offset could be easily detected. As each year, we have worked on this way with PIs to strengthen the delayed mode quality control.

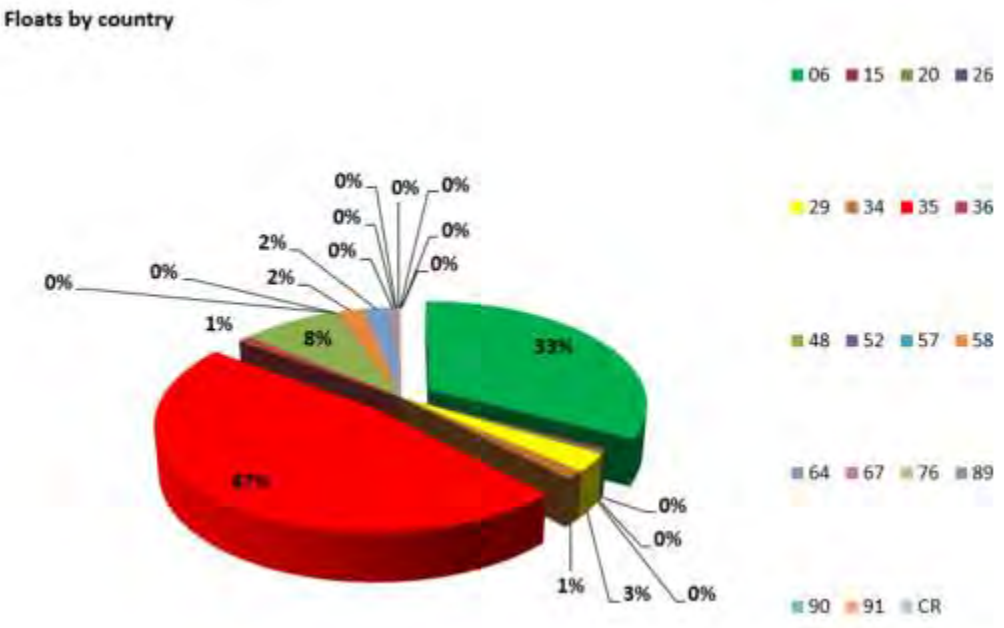
Some floats have been deployed from some projects, meaning a lot of PIs and a lot of time for explaining the DM procedure to all of them. A few PIs are totally able to work on DMQC following the four steps but this is not the case for most of them. Since the unavailability of the PIs leads to work by intermittence and then extend the period of work on the floats, we did the work with a private organism (Glazeo) to improve the realization of the DMQC, exchanging only with the PIs to validate results and discuss about physical oceanography in studied area. Working in this way, we largely improve the amount of delayed mode profiles.

A lot of work is always done from BSH (Birgit Klein) taking into account also floats from other German institutes and OGS (Antonella Gallo/Giulio Notarstefano) for the MedSea as well as Alberto Gonzalez Santana for IEO.

In the last 4 years, an important effort has been dedicated to improve the delayed mode quality control status.

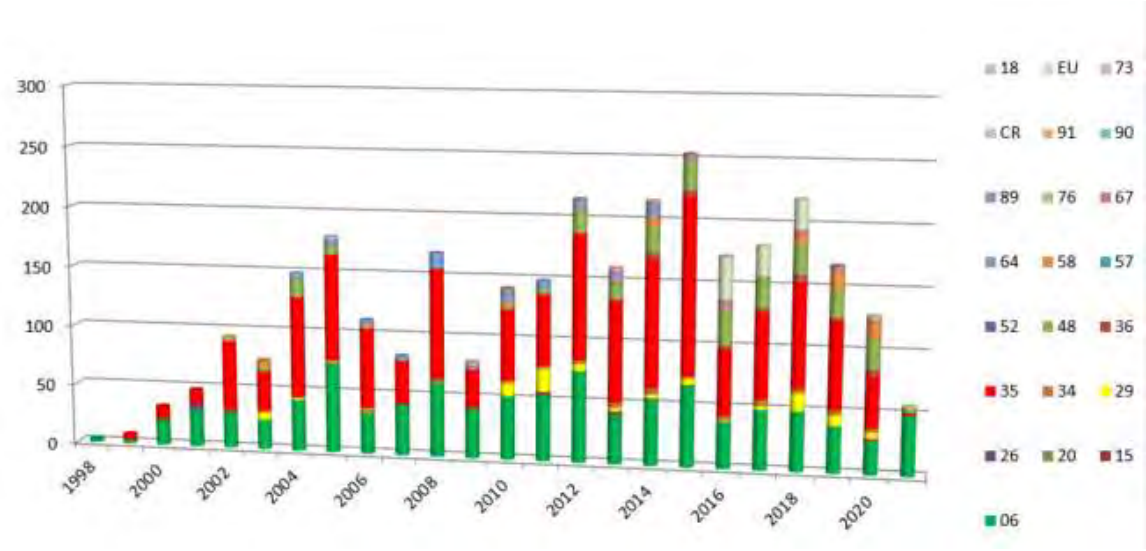


Evolution of the DM profiles' submission versus dates in last 10 years



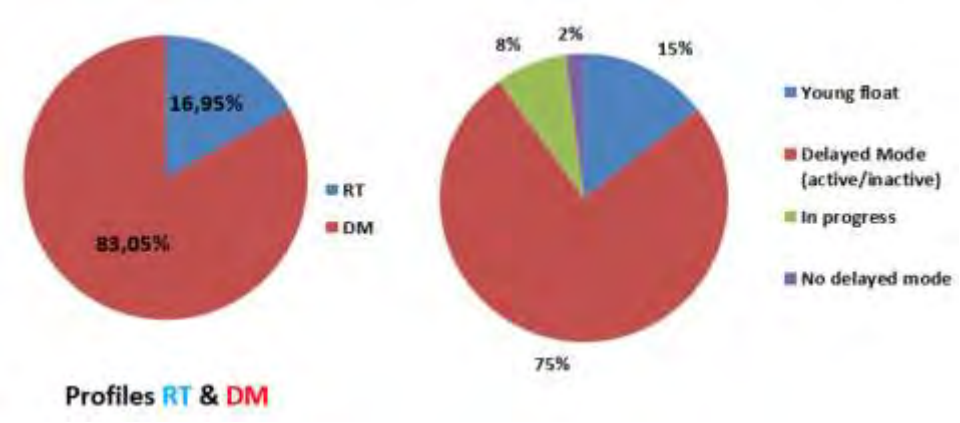
Percentage of floats by country in the Coriolis DAC.

Codes for the countries: 06 : Germany - 15 : Bulgaria - 20 : Chili – 26 : Denmark – 29 : Spain – 34 : Finland - 35 : France – 36 : Greece - 48 : Italy – 52 : Lebanon - 57 : Mexico - 58 : Norway – 64 : Netherlands – 67 : Poland – 76 : China – 89: Turkey - 90 : Russia – 91 : - South Africa - CR : Costa Rica



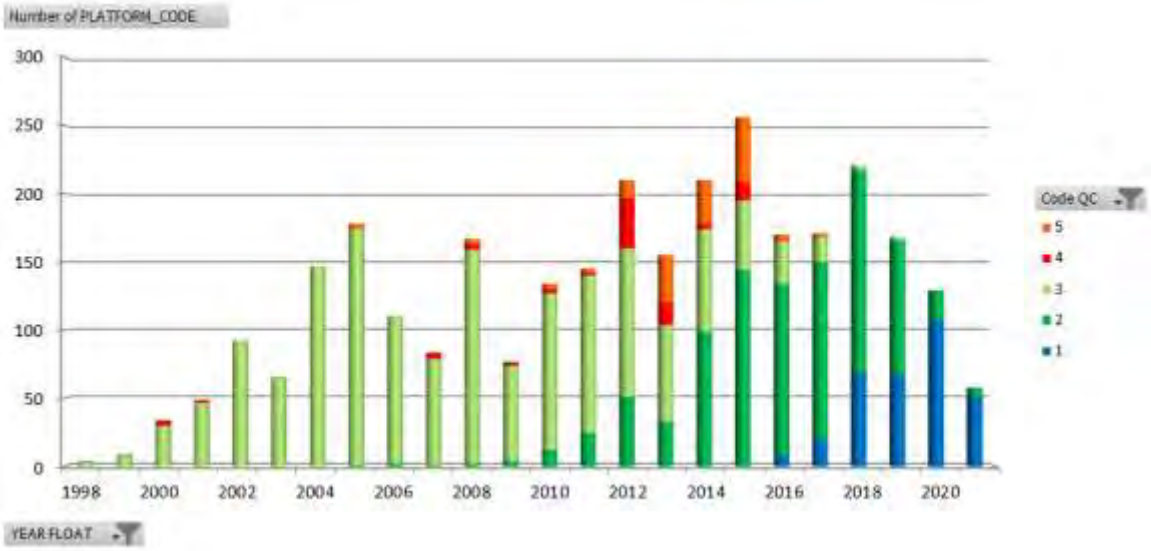
Number of floats by country and by launch's year in the Coriolis DAC

During the last year (from November 2020 to November 2021), 49671 new delayed mode profiles where produced and validated by PIs. A total of 323450 delayed mode profiles where produced and validated since 2005.



Status of the floats processed by Coriolis DAC.
Left: in terms of profile percent and right: in terms of float percent (DM : delayed mode – RT : real time).

The status of the quality control done on the Coriolis floats is presented in the following plot. For the three last years (2019-2021), most of the floats are still too young (code 1) to be performed in delayed mode. For the years 2012-2013-2014, we are still working on the DMQC of some floats. The codes 2 and 3 show the delayed mode profiles for respectively active and dead floats.

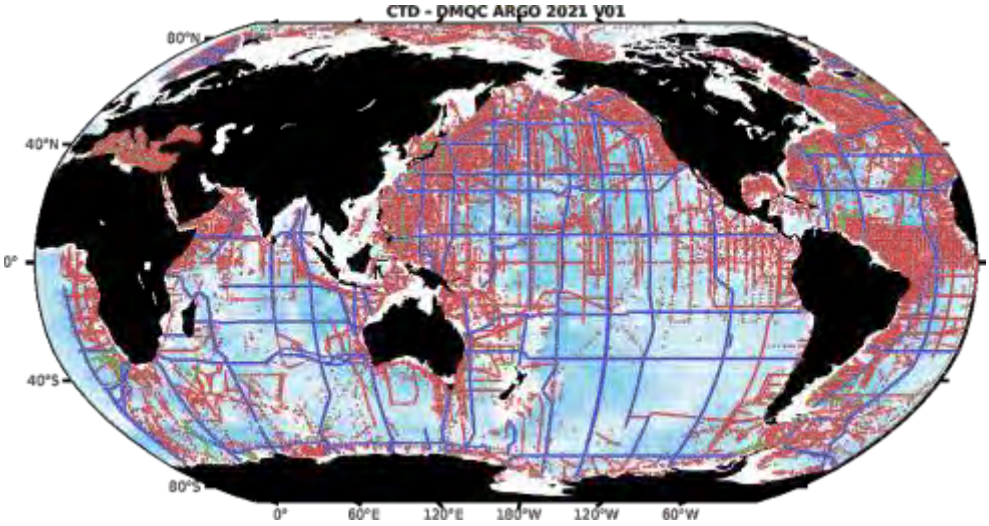


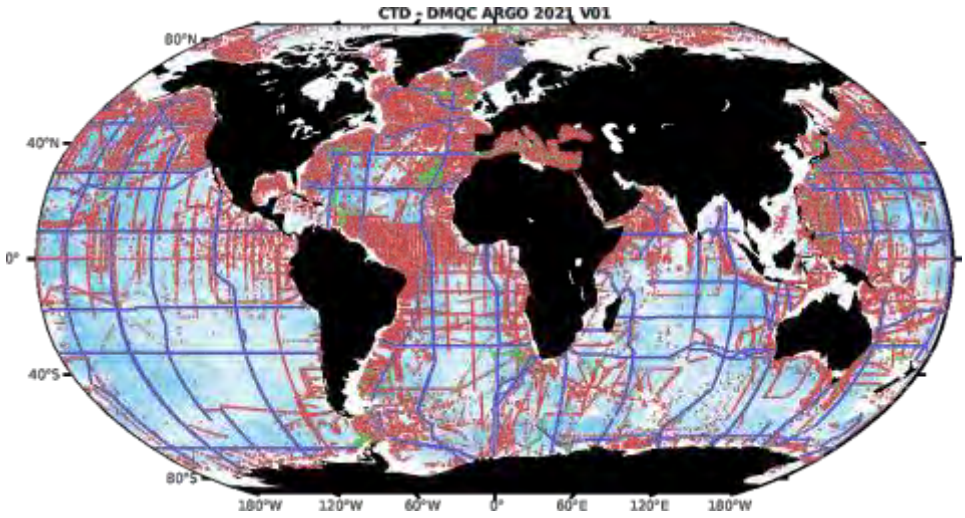
Status of the quality control done on profiles sorted by launch's year, code 1: young float, code 2: active float, DM done, code 3 : dead float, DM done; code 4 : DM in progress, code 5 : waiting for DM, code 6 : problems with float.

Reference database

In March 2021, an updated version 2021V01 was provided including the GO-SHIP EASY ocean data product (16231 stations) for the DEEP reference database. Where the GO-SHIP profile from CCHDO existed in the previous version, it has been replaced by the easy product version (higher QC'd version). In the reference database, these data can be identified with the QCLevel GSD (for GO-SHIP Deep Argo).

In this version, Ingrid Angel Benavides (BSH) worked on cleaning the CTD reference database in the Atlantic Ocean, Arctic and Nordic seas, removing out of range or incomplete samples, and duplicate checks as well as adding new data for the European and Asian Arctic region.





Version 2021V01: GSD Easy-Ocean, GSH GO-SHIP and Others

A next version, 2021V02, is in preparation and will include some new CTDs (deployment CTDs, scientists' CTDs) as well as some corrections from the US-Audit DM feedback.

Like the others, the last version is available on the Ifremer ftp site (ask login/password at codac@ifremer.fr) and is divided in smaller tar balls, one by wmo box area (1-3-5-7): for instance, CTD_for_DMQC_2021V01_1.tar.gz for all boxes starting with wmo 1, then we will have 4 tar files.

3 GDAC Functions

(If your centre operates a GDAC, report the progress made on the following tasks and if not yet complete, estimate when you expect them to be complete)

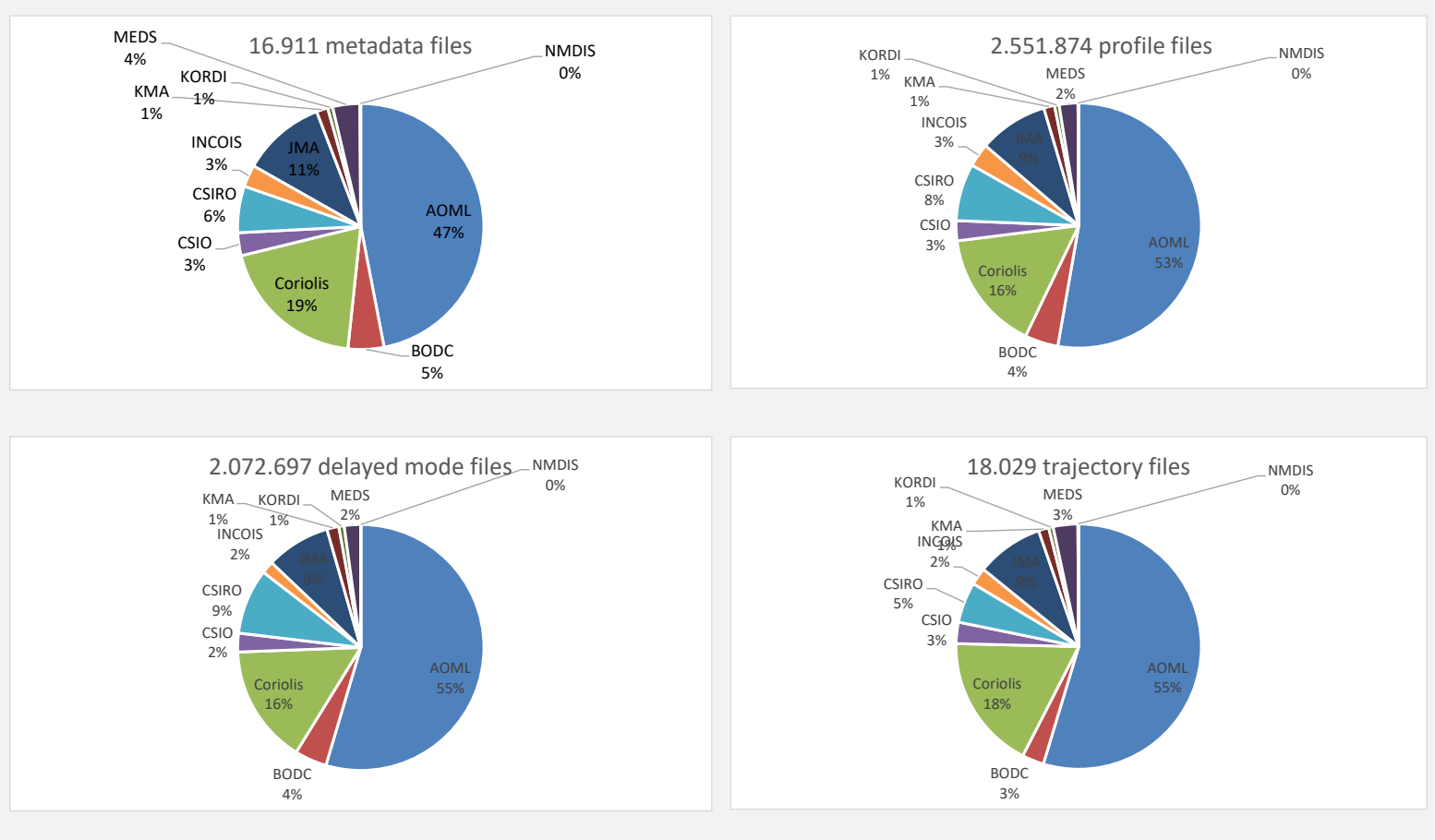
- National centres reporting to you
- Operations of the ftp server
- Operations of the www server
- Data synchronization
- Statistics of Argo data usage : Ftp and WWW access, characterization of users (countries, field of interest : operational models, scientific applications) …

3.1 National centres reporting to you

Currently, 11 national DACs submit regularly data to Coriolis GDAC. On November 2021, the following files were available from the GDAC FTP site.

3.1.1 GDAC files distribution

DAC	metadata files 2021	increase	profile files	increase2	delayed mode profile files	increase3	trajectory files	increase4
AOML	7 941	4%	1 345 968	7%	1 131 308	9%	9 854	4%
BODC	798	6%	112 039	11%	87 276	16%	519	1%
Coriolis	3 298	7%	404 850	11%	323 813	19%	3 219	8%
CSIO	509	13%	67 509	13%	50 954	19%	507	14%
CSIRO	1 035	8%	192 827	8%	178 313	9%	967	9%
INCOIS	491	0%	78 729	4%	33 950	1%	412	0%
JMA	1 854	4%	232 674	6%	175 111	9%	1 596	2%
KMA	253	2%	36 325	3%	32 590	41%	244	3%
KORDI	110	1%	15 350	0%	14 505	0%	107	0%
MEDS	603	4%	63 143	7%	44 832	14%	585	4%
NMDIS	19	0%	2 460	0%	45	-	19	0%
Total	**16 911**	**11%**	**2 551 874**	**17%**	**2 072 697**	**32%**	**18 029**	**10%**



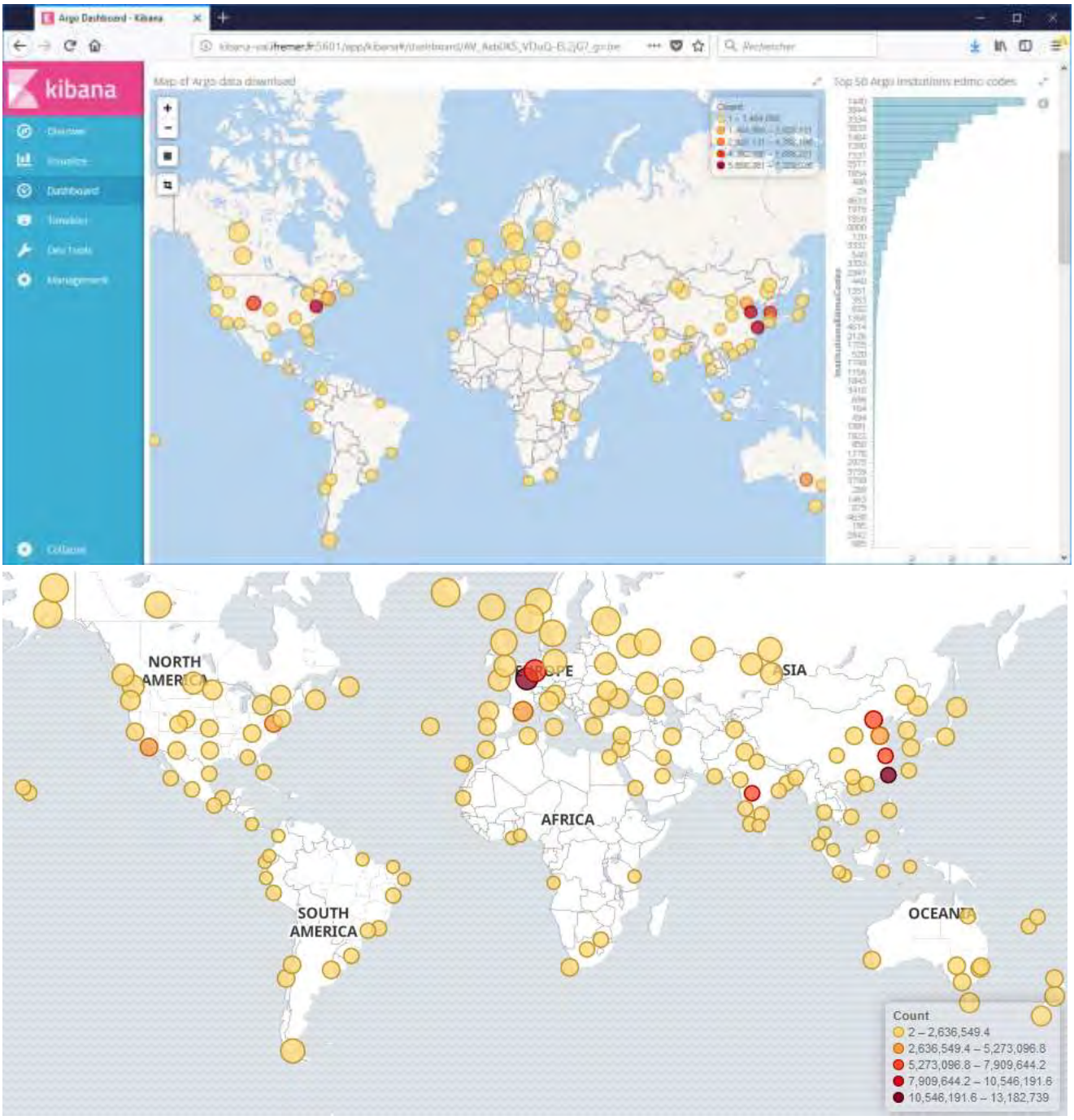
Number of files available on GDAC, November 2021

3.1.2 Argo Semaphore dashboard: give credit to data providers

Within EU AtlantOS project, Ifremer is setting up a dashboard (Semaphore) to monitor data distribution and give credit to data providers such as Argo floats.

FTP downloads log files are ingested in an Elsaticsearch index. A link between downloaded files, download originators, floats included in the downloaded files and institution owners of the floats is performed. These links are displayed in a Kibana dashboard.

This dashboard will offer the possibility to give credit to Floats owner institutions such as how many data from one particular institution was downloaded, by whose data users.



Geographical distribution of GDAC ftp downloads in 2018 - 2019

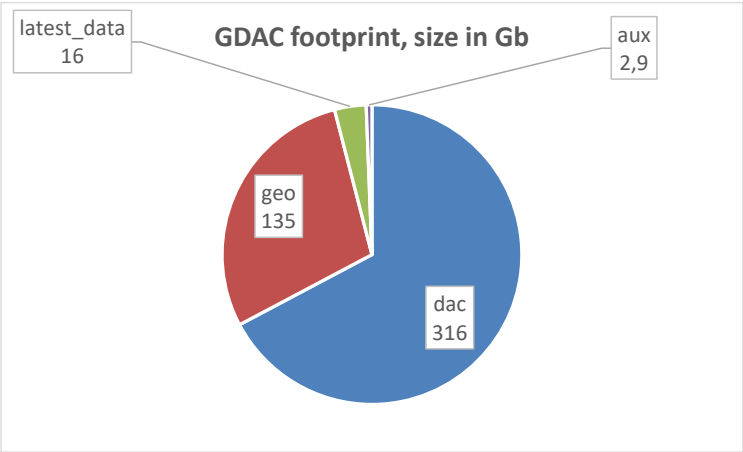
The majority of users (red dots) are located in USA, China, Australia and of course Europe. The right side histogram sorts the floats institution code (1440: PMEL, 3844: WHOI, 3334: INCOIS, 3839: UWA, 1484: CSIRO, …).

3.1.3 GDAC files size

- The total number of NetCDF files on the GDAC/dac directory was 3.124.121 (+9% in one year)
- The size of GDAC/dac directory was 316Gb (+11%)
- *The size of the GDAC directory was 572Gb (- 4%)*

More on: http://www.argodatamgt.org/Data-Mgt-Team/News/BGC-Argo-M-prof-files-no-more-distributed-on-GDAC

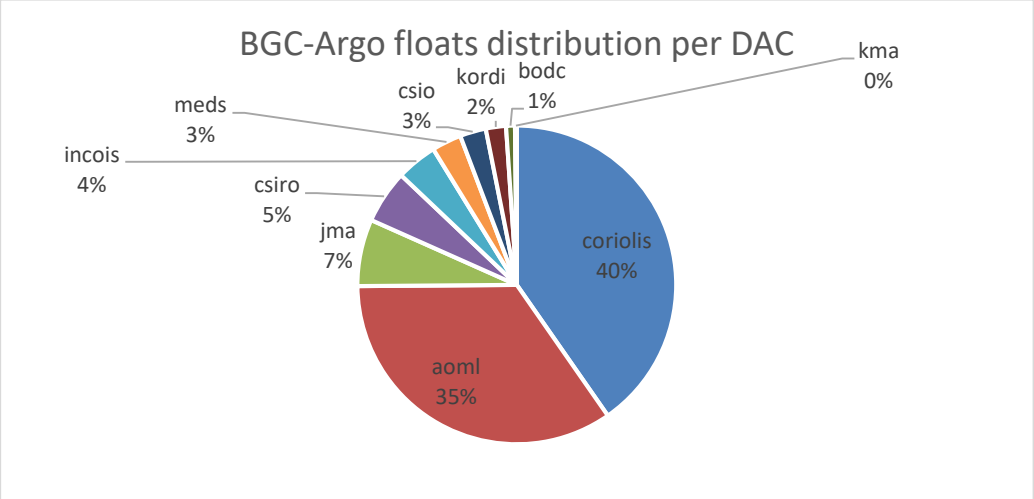
branch	GDAC size in Go	yearly increase	N-1
dac	316	11%	284
geo	135	13%	119
latest_data	16	7%	15
aux	2,9	38%	2
gdac total	661	16%	572

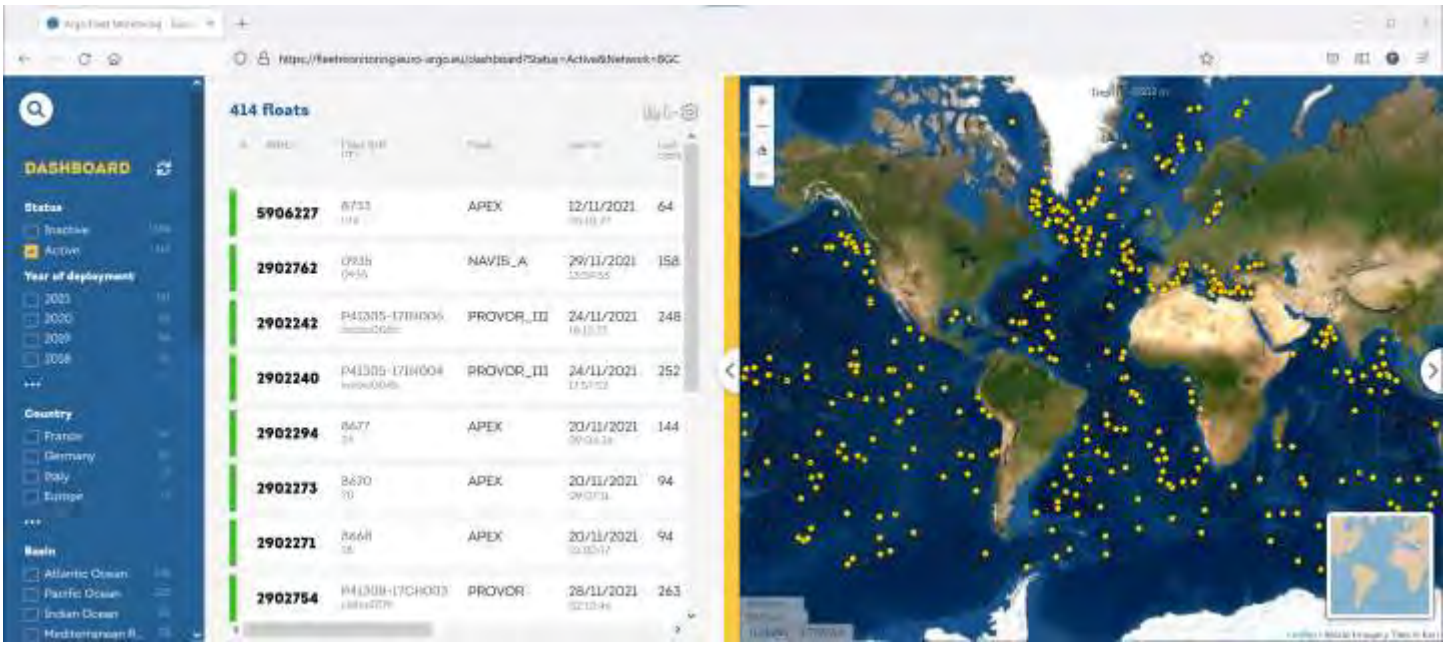


3.1.4 BGC-Argo floats

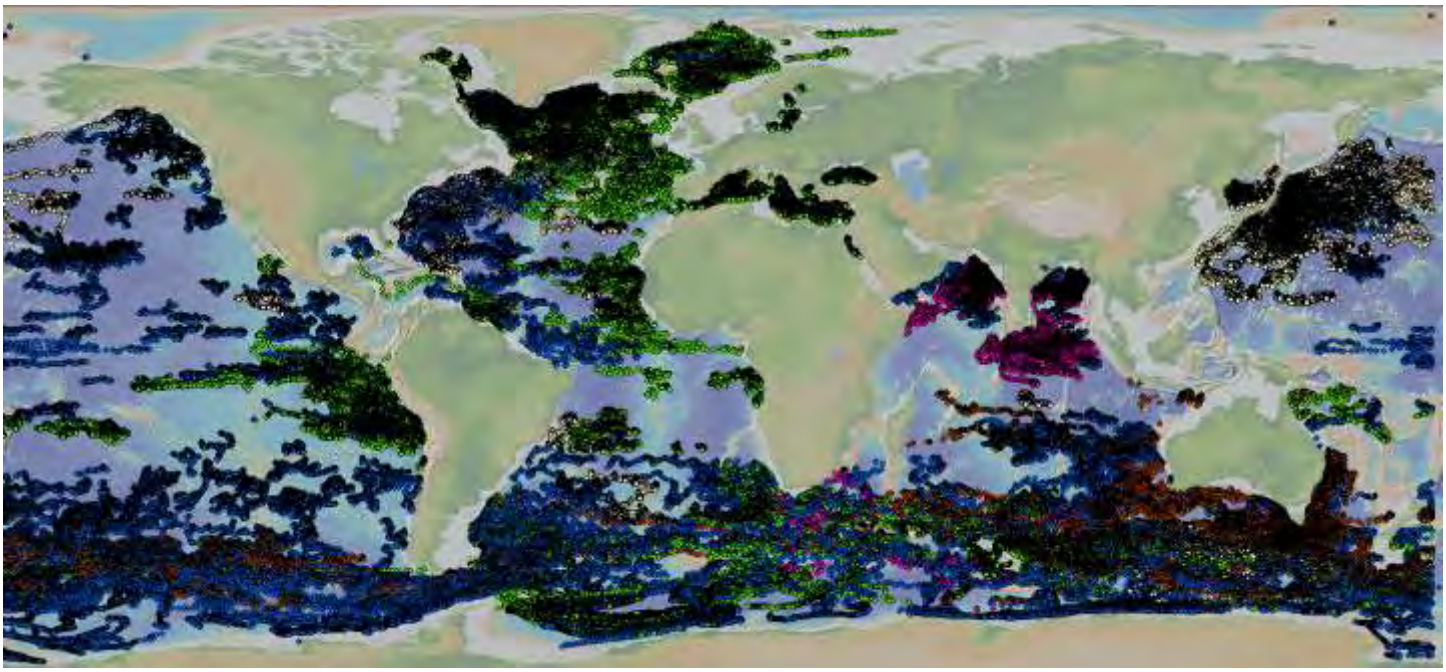
In November 2020, 225.135 BGC-Argo profiles from 1664 floats were available on Argo GDAC. This is a strong increase compared to 2019: +19% more floats and +19% more profiles.

DAC	nb bgc float	nb bgc file
coriolis	671	90 817
aoml	575	86 014
jma	113	18 027
csiro	90	22 203
incois	69	11 352
meds	50	4 910
csio	44	9 170
kordi	34	3 416
bodc	15	4 723
kma	3	106
Total	**1664**	**250 738**



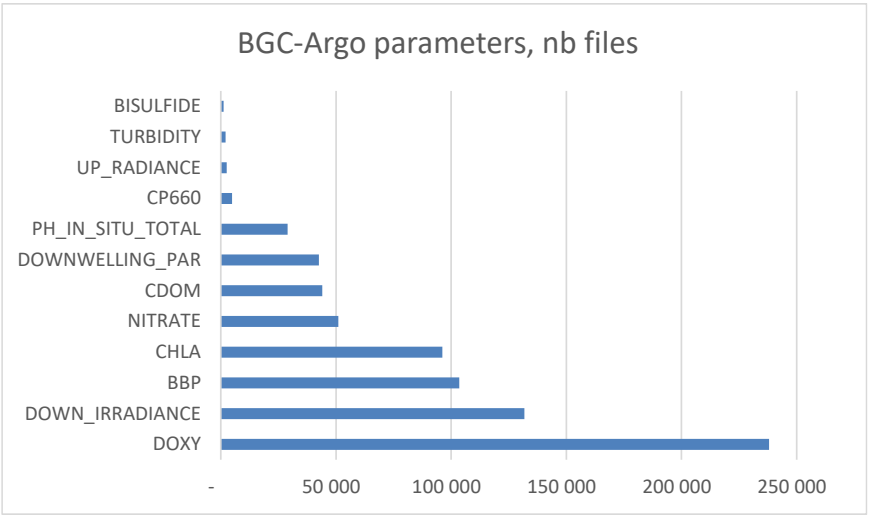


Map of 414 BGC-Argo floats (active: yellow, other: grey) from https://fleetmonitoring.euro-argo.eu/dashboard



BGC-Argo profiles, colored by DACs

BGC parameter	nb files
DOXY	238 000
DOWN_IRRADIANCE	131 808
BBP	103 491
CHLA	96 129
NITRATE	50 967
CDOM	44 055
DOWNWELLING_PAR	42 524
PH_IN_SITU_TOTAL	29 039
CP660	4 928
UP_RADIANCE	2 508
TURBIDITY	2 109
BISULFIDE	1 225



Main BGC-Argo physical parameters, number of profiles

3.2 Operations of the ftp and web server

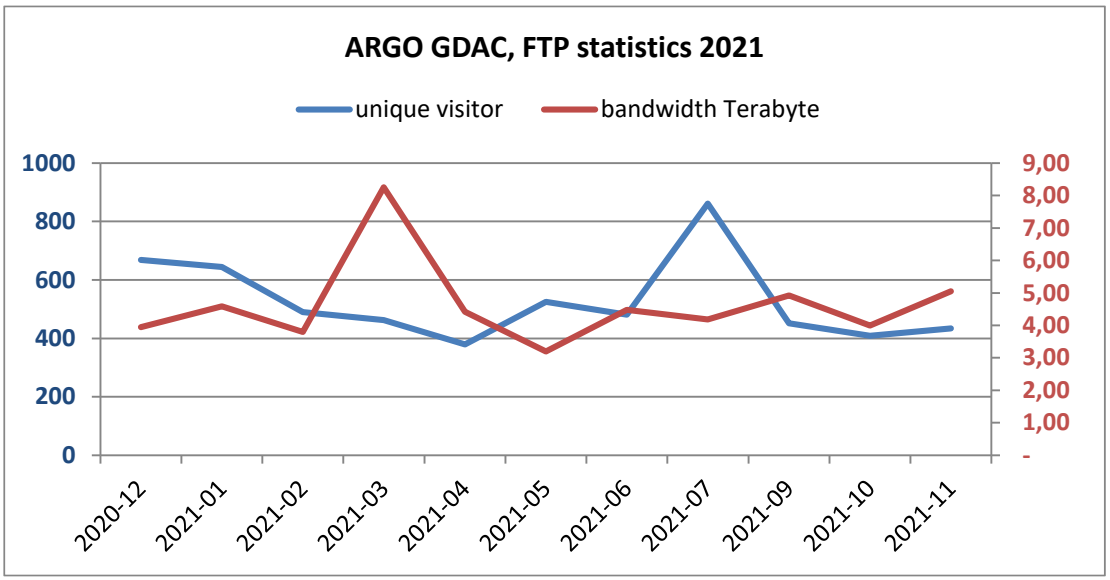
For each individual DAC, every 30 minutes, meta-data, profile, trajectory and technical data files are automatically collected from the national DACs. The 11 DACs are processed in parallel (one process launched every 3 minutes).

Index files of metadata, profiles, trajectories, technical and auxiliary data are hourly updated.

GDAC ftp address: ftp://ftp.ifremer.fr/ifremer/argo

Statistics on the Argo GDAC FTP server: ftp://ftp.ifremer.fr/ifremer/argo

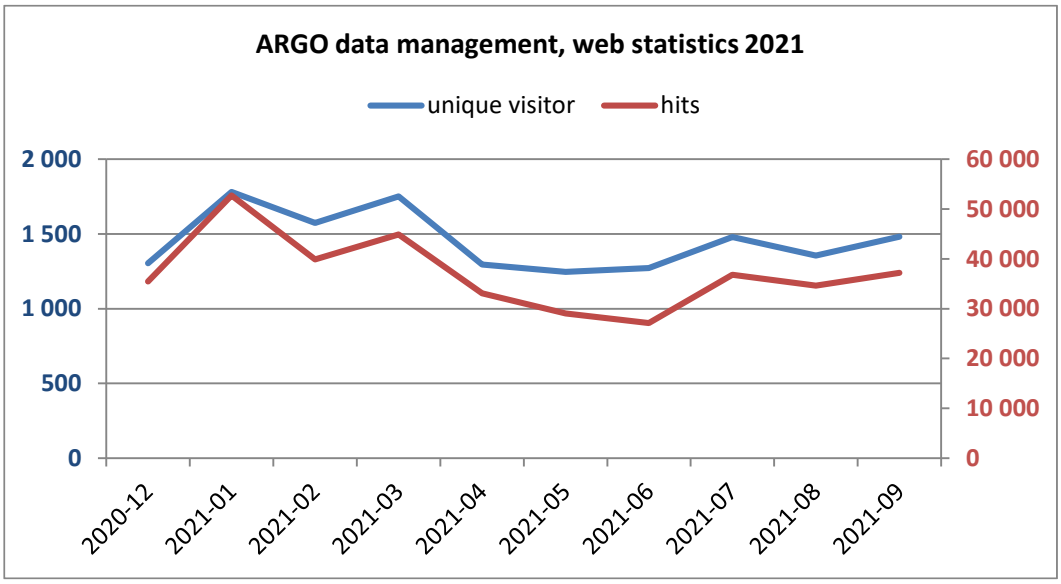
There is a monthly average of 633 unique visitors, performing 5218 sessions and downloading 4.53 terabytes of data files.



ARGO GDAC FTP statistics				
month	unique visitor	number o	hits	bandwidth terabyte
2020-12	669	5 952	9 589 480	3,95
2021-01	644	6 097	11 225 139	4,59
2021-02	490	4 775	2 995 564	3,80
2021-03	462	4 383	7 557 743	8,25
2021-04	379	4 340	15 033 602	4,42
2021-05	525	4 806	5 042 736	3,20
2021-06	481	5 427	5 110 916	4,48
2021-07	861	5 310	5 319 054	4,18
2021-08	1787	6 184	7 375 238	3,50
2021-09	451	4 770	8 787 532	4,92
2021-10	409	4 957	7 093 178	3,99
2021-11	434	5 610	7 145 900	5,05
Average	**633**	**5 218**	**7 689 674**	**4,53**

Statistics on the Argo data management web site: ***http://www.argodatamgt.org***

There is a monthly average of 1400 unique visitors, performing 2200 visits and 37000 hits. The graphics shows a slightly stable number of unique visitors.



ARGO GDAC web statistics					
month	unique vis	visits	pages	hits	bandwidth Go
2020-12	1 684	2 534	5 044	36 842	1,1
2021-01	1 371	2 174	3 997	34 018	1,1
2021-02	1 305	2 046	4 255	35 483	1,3
2021-03	1 781	3 118	6 752	52 755	2,7
2021-04	1 574	2 443	4 873	39 921	1,6
2021-05	1 751	2 845	6 593	44 917	1,1
2021-06	1 296	2 086	4 735	33 105	1,2
2021-07	1 246	2 088	4 431	29 054	0,9
2021-08	1 272	1 772	3 684	27 099	1,1
2021-09	1 479	2 078	4 506	36 819	1,1
2021-10	1 355	2 008	4 485	34 600	0,7
2021-11	1 481	2 083	4 259	37 191	1,1
Average	**1 454**	**2 257**	**4 857**	**37 094**	**1,3**

3.3 GDAC files synchronization

The synchronization with US-GODAE server is performed once a day at 03:55Z

Synchronization dashboard in November 2021: the daily sync. time takes on average 1 hour, with a failure on October 19th.

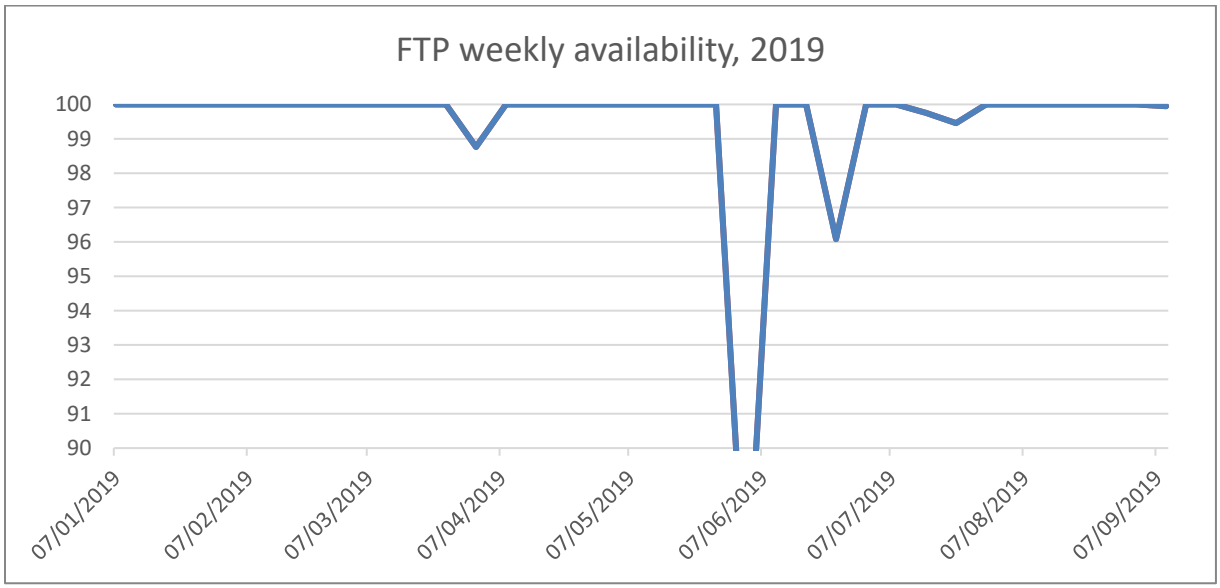
3.4 FTP server monitoring

The Argo GDAC ftp server is actively monitored by a Nagios agent (http://en.wikipedia.org/wiki/Nagios).

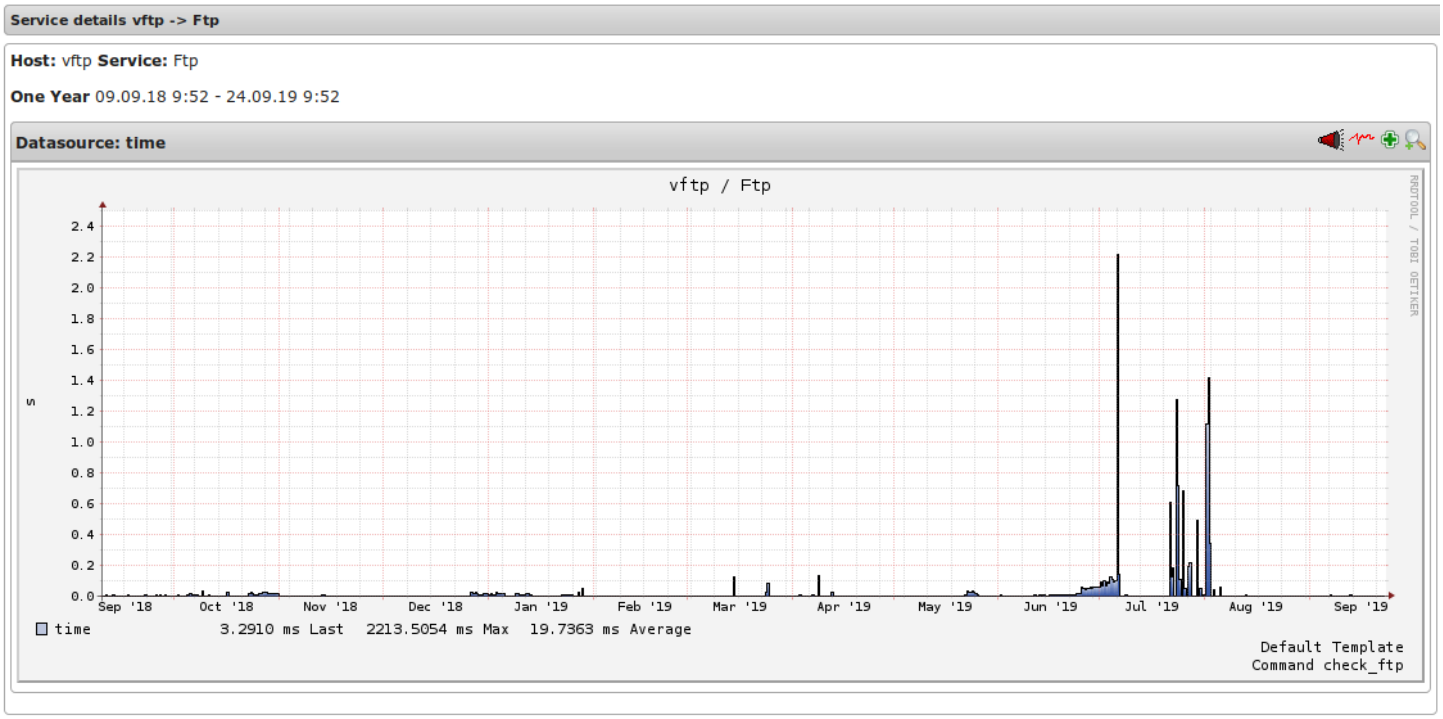
Every 5 minutes, an ftp download test and an Internet Google query are performed. The success/failure of the test and the response time are recorded. The FTP server is a virtual server on a linux cluster.

On the last 9 months, the FTP server was operational on 99.540% of time, non-operational during 1 day and 2 hours (0.421%). This is a very poor performance compared to last year (only 14 minutes non-operational in 2018). The main explanation is electricity maintenance work, which will hopefully improve the future FTP availability. The graphics below shows that the major FTP outages occurred on June 7th and then in July 6th 2019.

FTP server monitoring 01/01/2019 - 24/09/2019			
Status	percentage	duration	comment
OK	99,540%	256d 3h 7m 20s	operational
Warning	0,039%	0d 2h 10m 10s	poor performance
Unknown	0,000%	0d 0h 0m 0s	
Critical	0,421%	1d 2h 56m 22s	non operational

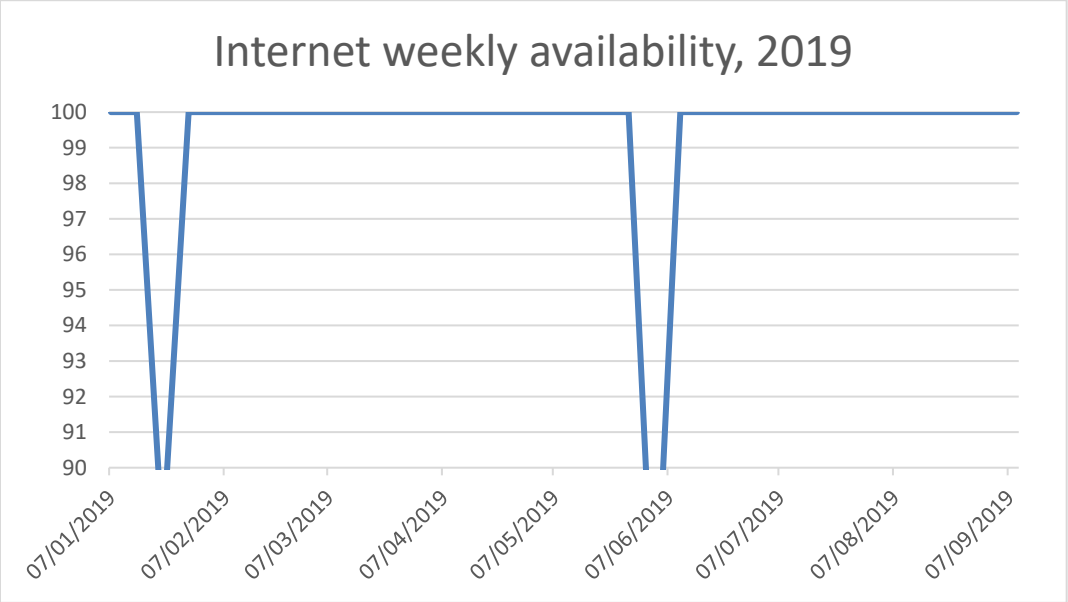


Nagios ftp monitoring: between January and September 2019



FTP server response time monitoring, poor performances end of June and in July

Internet access monitoring 01/01/2019 - 16/09/2019			
Status	***percentage***	***duration***	***comment***
OK	*99,816%*	*265d 20h 33s*	*operational*
Warning	*0,000%*	*0d 0h 0m 0s*	*poor performance*
Unknown	*0,000%*	*0d 0h 0m 0s*	
Critical	*0,184%*	*0d 11h 46m 12s*	*non operational*



Nagios Internet monitoring: between January and September 2019, poor performances in January and June.

3.5 Grey list

According to the project requirements Coriolis GDAC hosts a grey list of the floats which are automatically flagged before any automatic or visual quality control. **The greylist has 2100 entries** (November 2021), compared to 2210 entries one year ago.

DAC	nb floats
aoml	991
coriolis	454
bodc	214
csiro	175
jma	140
kma	38
meds	32
incois	24
csio	23
kordi	9
Total	**2100**

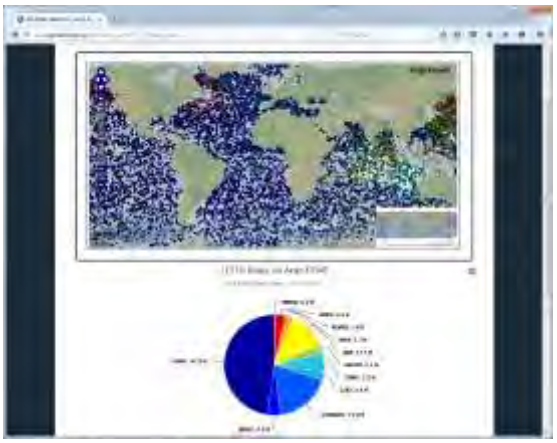
Distribution of greylist entries per DAC and per parameter

Coriolis reports many BGC greylist entries.

Parameter	nb entries
PSAL	1427
TEMP	192
PRES	154
BBP700	83
DOXY	83
CDOM	62
CHLA	51
BBP532	18
CP660	6
DOWN_IRRADIANCE380	4
DOWN_IRRADIANCE412	4
DOWN_IRRADIANCE490	4
DOWNWELLING_PAR	4
NITRATE	4
PH_IN_SITU_TOTAL	3
PH_IN_SITU_FREE	1

3.6 Statistics on GDAC content

The following graphics display the distribution of data available from GDAC, per float or DACs. These statistics are daily updated on: http://www.argodatamgt.org/Monitoring-at-GDAC



3.7 Mirroring data from GDAC: rsync service

In July 2014, we installed a dedicated rsync server called vdmzrs.ifremer.fr described on:

- http://www.argodatamgt.org/Access-to-data/Argo-GDAC-synchronization-service

This server provides a synchronization service between the "dac" directory of the GDAC with a user mirror. From the user side, the rysnc service:

- Downloads the new files

- Downloads the updated files
- Removes the files that have been removed from the GDAC
- Compresses/uncompresses the files during the transfer
- Preserves the files creation/update dates
- Lists all the files that have been transferred (easy to use for a user side post-processing)

Examples

Synchronization of a particular float

- rsync -avzh --delete vdmzrs.ifremer.fr::argo/coriolis/69001 /home/mydirectory/...

Synchronization of the whole dac directory of Argo GDAC

- rsync -avzh --delete vdmzrs.ifremer.fr::argo/ /home/mydirectory/...

3.8 Argo DOI, Digital Object Identifier on monthly snapshots

A digital object identifier (DOI) is a unique identifier for an electronic document or a dataset. Argo data-management assigns DOIs to its documents and datasets for two main objectives:

- Citation: in a publication the DOI is efficiently tracked by bibliographic surveys
- Traceability: the DOI is a direct and permanent link to the document or data set used in a publication
- More on: http://www.argodatamgt.org/Access-to-data/Argo-DOI-Digital-Object-Identifier

Since July 2019, the DOI monthly snapshot of Argo data is a compressed archive (.gz) that contains distinct core-Argo tar files and BGC-Argo tar files. A core-Argo user can now ignore the voluminous BGC-Argo files.

Argo documents DOIs

- Argo User's manual: http://dx.doi.org/10.13155/29825

Argo GDAC DOI

- Argo floats data and metadata from Global Data Assembly Centre (Argo GDAC) http://doi.org/10.17882/42182

Argo GDAC monthly snapshots DOIs

- Snapshot of 2018 November 8th http://doi.org/10.17882/42182#59903
- Snapshot of 2014 October 8th http://doi.org/10.17882/42182#42280
- Snapshot of 2012 December 1st http://doi.org/10.17882/42182#42250

Argo National Data Management Report 2021

- BSH (Federal Maritime and Hydrographic Agency), Germany

1. Status

(Please report the progress made towards completing the following tasks and if not yet complete, estimate when you expect them to be complete)

- Data acquired from floats
  Presently there are 202 active/operational German floats which belong to BSH except for 6 associated to AWI and 6 to ICBM. 68 floats have been deployed in 2021 to date. 20 more are on their way to deployment locations in the South Atlantic. 10 of which will be deployed still in 2021 during PS127 and a SANAE cruise by South African colleagues in December. The remaining 10 are going to be deployed early next year. Data from all presently active floats are available from the GDACS.
- Data issued to GTS
  All German floats are processed in real-time by Coriolis and immediately inserted into the GTS.
- Data issued to GDACs after real-time QC
  All profiles from German floats are processed by Coriolis following the regular quality checks and are routinely exchanged with the GDACs.
- Data issued for delayed QC
  At present (29.11.2021) the German Argo fleet comprises 1085 floats which have sampled 92797 profiles. 81625 profiles of all eligible files are already available as D-files and 6512 are still pending. The total rate of eligible D-files provided to the GDACs is 92%.
- Delayed data sent to GDACs
  The D-files are submitted by email to Coriolis together with the diagnostic figures and a short summary of the DMQC decision taken and are inserted into the GDAC after format testing.
- Web pages
  BSH is maintaining the new Argo Germany Web site at https://www.bsh.de/DE/THEMEN/Beobachtungssysteme/ARGO/.
  It provides information about the international Argo Program, the German contribution to Argo, Argo array status, data access and deployment plans. It also provides links to the original sources of information.
- Statistics of Argo data usage
  Currently no statistics of Argo data usage are available. The German Navy uses Argo data on a regular basis for the operational support of the fleet and uses their liaison officer at BSH to communicate their needs. The SeaDataNet portal uses German Argo data operationally for the Northwest European Shelf. Based on the feedback from the national user workshop (Argo data are routinely assimilated in the GECCO reanalysis, which is used for the initialisation the decadal prediction system MiKlip. They are also routinely assimilated into the Earth-System-model of the Max-Planck Society in various applications reaching from short term to decadal predictions and are used for model validation. At BSH the data are used

within several projects such as KLIWAS, RACE, MiKlip, ICDC and Expertennetzwerk BMVI. Data are also used in various research groups at universities.

- Products generated from Argo data
  A quality screened subset of float data in the Atlantic has been created on the yearly basis and has been exchanged with the universities.

2. Delayed Mode QC
(Please report on the progress made towards providing delayed mode Argo data, how it is organized and the difficulties encountered and estimate when you expect to be pre-operational).
The overall percentage of D-files from all German programs is remaining at a quota of 92%. BSH had adopted floats from all German universities and agreed last year to perform similar services for the AWI floats. A DMQC for the subset of 36 re-processed AWI floats (now in V3.1) has now been performed after the reference database was updated with more recent reference data from Pangea. The associated d-files will be submitted as soon as permission has been received from the PI. At the moment 8666 profiles are available from the 216 AWI floats and only 41% are available as D-files. For all other floats (869 floats) the DMQC quota is at 98%.

German Floats/ Program Name	Number of profiles	Number of D-files	D-files pending	Comments
Argo BSH	67310	61412	1273	Overall 98%
Argo AWI	8666	3548	5083	Overall 41%, DMQC for 36 reprocessed Nemo float files has been carried out after the update to the reference database and wait for approval of PI.
Argo GEOMAR (129 floats)	13474	13407	67	Reprocessing nearly finished Overall 99 %
Argo U. HH (28 floats)	3347	3258	89	Reprocessing nearly finished Overall 98 %
Argo Denmark (5 floats)	371	360	11	Old floats associated with U. HH, reprocessing nearly finished Overall 97%

BSH has also adopted floats from Finland (30 floats), the Netherlands (104 floats), Norway 30 floats) and Poland (14 floats) for DMQC and is performing DMQC on parts of the MOCCA fleet (44 floats) from the European Union. The progress in these programs providing D-files is generally good, but redecoding of older file-formats and pending DMQCs for floats in the Baltic are resulting in lower numbers in some programs. Since Argo-Norway has received fundings

from the national research council to increase the number of Norwegian floats deployed per year, the program will get more involved in the dmqc activities. Floats deployed from 2019 onward will be covered by Norwegian DMQC operators. The same is true for Argo-Poland which also will perform DMQC on their own floats from 2019 onward. The statistics shown below are already a mixture of dmqc performed by BSH and the national DMQC-operators.

Germany has recently started to deploy BGC floats and dmqc of the BGC parameters has been organized within the research project DArgo2025. The host of BGC parameters is divided between research institutes based on their expertise: GEOMAR will oversee pH and O2, IOW will care for nitrate and ICBM will oversee the bio-optical sensors from the radiometers.

There are remaining issue with floats from Finland, Poland and MOCCA which are operating in the Baltic and will receive their DMQC decisions from regular laboratory calibrations performed when floats are recovered annually or from nearby calibration stations. The system for the DMQC is set-up within the EuroArgo ERIC in research projects as MOCCA and EArise. These floats had been assigned by their association to the country, but since there are dm-pathways established in these countries, their dmqc should be carried out

Adopted floats/ Program Name	Number of profiles	Number of D-files	D-files pending	Comments
Argo Poland (14 floats)	1489	1182	289	Baltic floats pending Overall 34%
Argo Finland (30 floats)	2944	795	2149	Only Baltic floats pending Overall 27%
Argo Netherlands (104 floats)	12552	11723	279	Overall 94%
Argo Norway (30 floats)	4808	4665	39	New dm-operators involved Overall 72%
MOCCA (44 floats)	9158	6060	2436	5 Baltic floats pending Overall 66 %
US Navy (10 floats)	1940	1790	150	Overall 93% Overlooked new cycles from one float
NAAMES/US (E. Boss) (13 floats)	2743	2641	102	Overall 96%

Investigations of fast salty drifters were continued and consolidated with the entire European fleet. Information is now available in a shared in a spreadsheet

https://docs.google.com/spreadsheets/d/1TA7SAnTiUvCK7AyGtSTUq3gu9QFbVdONj9M9zAq8CJU/edit#gid=974650348

3. GDAC Functions
(If your centre operates a GDAC, report the progress made on the following tasks and if not yet complete, estimate when you expect them to be complete)

- National centres reporting to you
- Operations of the ftp server
- Operations of the www server
- Data synchronization
- Statistics of Argo data usage : Ftp and WWW access, characterization of users (countries, field of interest : operational models, scientific applications) …

4. Regional Centre Functions
(If your centre operates a regional centre, report the functions performed, and in planning)

BSH is part of the SOARC consortium and is working in EArise to updating the CTD Reference data base for the Weddell gyre. In 2021 all available data from the PANGEA data base have been downloaded and these will be added to the upcoming release of the data base.

As part of work performed in the European projects MOCCA and EArise we are presently working on reference data for the Nordic Seas and Arctic proper. The reference data base for these areas will be updated/established. The main data sources are data from the Norwegian and Polish monitoring cruises and from NABOS for the Arctic. A meeting was held with the Norwegian program to discuss dmqc applications and an audit for the data set from the Norwegian Sea. A follow-up meeting was proposed for early next year with the active dmqc-operators in the area.

5. References

Argo National Data Management Report (2021) – India

1. Status

- **Data acquired from floats**
  India has deployed 01 new floats between November 2020 and November 2021 in the Indian Ocean taking its tally to 494 floats so far. Out of these 83 floats are active. All the active floats data are processed and sent to GDAC.

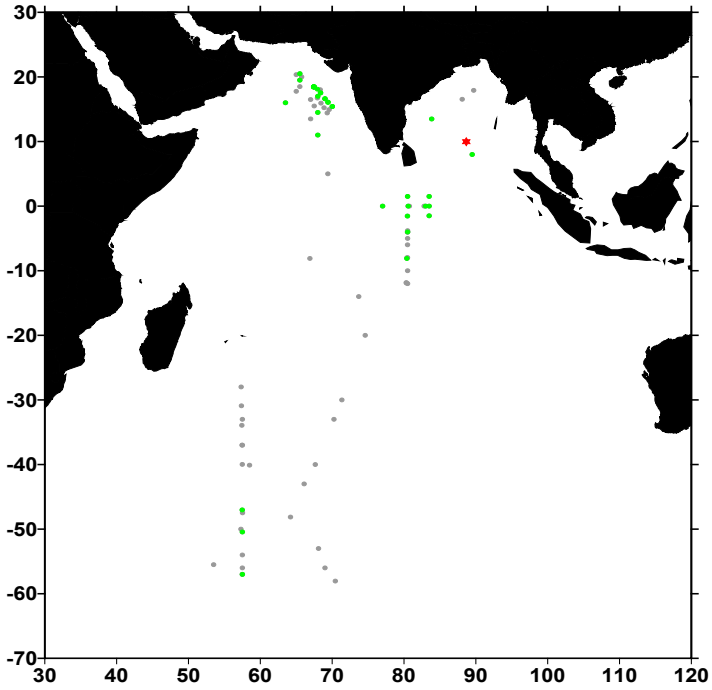


Fig. Status of Argo floats deployed (red) by India, Active BioArgo (green) and CoreArgo (grey) floats in the Indian Ocean.

- **Data issued to GTS**
  All the active floats data is being distributed via RTH New Delhi. Processing time schedules are changed to minimize the time difference in dissemination to GTS and GDAC.

- **Data issued to GDACs after real-time QC**
  All the active floats (83) data are subject to real time quality control and are being successfully uploaded to GDAC.

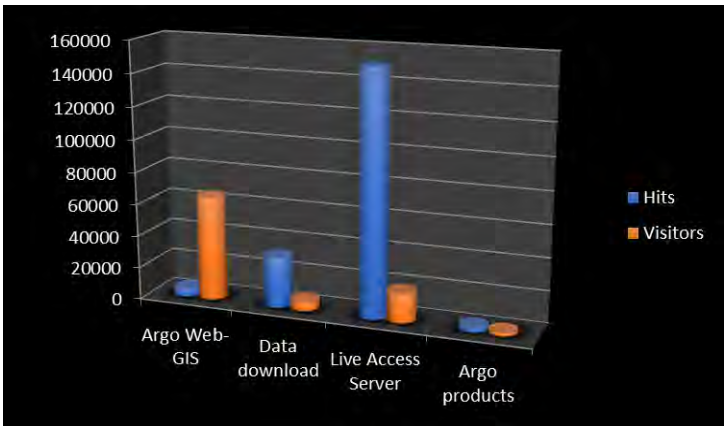
- **Data issued for delayed QC**
  In total ~55% of the eligible profiles for DMQC are generated and uploaded to GDAC. Some of the old DMQCed floats with old version 2.3 are converted to V 3.1 and uploaded to GDAC. Also floats identified to be having problem and audit report shared is reworked and uploaded.

- **Web pages**
  - INCOIS is maintaining Web-GIS based site for Indian Argo Program. It contains entire Indian Ocean floats data along with trajectories. Further details can be obtained by following the

link http://www.incois.gov.in/Incois/argo/argo_home.jsp. Apart from the floats deployed by India, data from floats deployed by other nations in the Indian Ocean are received from the Argo Mirror and made available in the INCOIS website. User can download the data based on his requirement.

- Statistics of Indian and Indian Ocean floats are generated and maintained in INCOIS web site. The density maps for aiding people for new deployments are made available on a monthly basis. For full details visit http://www.incois.gov.in/Incois/argo/argostats_index.jsp.

- **Trajectory**
  INCOIS Ver 3.1 trajectory files for all APEX Argo and Iridium floats are still found to be having issues and are being rejected. The problem is still being worked out.
- **Statistics of Argo data usage**
  Argo data is widely put to use by various Organisations/ Universities/ Departments. Indian Meteorological Department (IMD) is using Argo data for their operational purpose. Scientists, Students and Researchers from INCOIS, NIO, SAC, C-MMACS, NRSA, IITM, NCMRWF, IISc etc are using Argo data in various analysis. Many paper based on Argo data were also published in reputed journals. See the references below.
  - Argo data is assimilated in ROMS model using LETKF and product names RAIN is being generated and made available to users.
  - Continued to use BGCArgo data for validation of Biogeochemical model like ROMS.



INCOIS Argo web page statistics (for the past one year) are as shown below

Page	Hits	Visitors
Argo Web-GIS	5001	65117
Data download	32005	5804
Live Access Server	150225	18297
Argo products	3027	2014

- **Products generated from Argo data**
    1. Value added products obtained from Argo data are continued. Continued to variational analysis method while generating value added products. Many products are generated using Argo temperature and salinity data. The Argo T/S data are first objectively analysed and this gridded output is used in deriving value added products. More on this can be see in the RDAC functions.
    2. Version 2.2 of DVD on "Argo data and products for the Indian Ocean" is released to public for use with data corresponding to Dec 2020 updated. This DVD consists of ~ 3,75,000 profiles and products based on the Argo T/S. A GUI is provided for user to have easy access to the data. DVD product is discontinued and it is being made available via INCOIS and UCSD web sites.
    3. To cater to many users of INCOIS LAS, it is enhanced in term of capacity. New Server is procured and new products viz., model outputs, new wind products (OSCAT), fluxes are made available. New products as per the request received from the users in future are being made available. For further details visit http://las.incois.gov.in.
    4. The Argo and value added products derived from Argo data are also alternatively made available through ERDDAP. Here the provision for individual data and the derived products is also enabled for users.

2. Delayed Mode QC

- INCOIS started generating and uploading D files to GDAC form July 2006, and as of today, profiles belonging to all eligible floats have been subjected to DMQC.
- DMQC S/W obtained from Cecil, IFREMER is being used. Using this s/w all the eligible floats are reprocessed to tackle pressure sensor offset problems, salinity hooks, thermal lag corrections, salinity drifts. COW S/w is mainly used for performing DMQC of Provor/Arovor floats.
- Under the data search and archeology data from our own sister concerns is being obtained and put to use in the delayed mode processing.
- About 55% of the eligible profiles are subjected to DMQC and the delayed mode profiles are uploaded on to GDAC. Majority of the old dead float which are passed through DMQC are converted to Ver 3.1 and uploaded to GDAC.

3. GDAC Functions

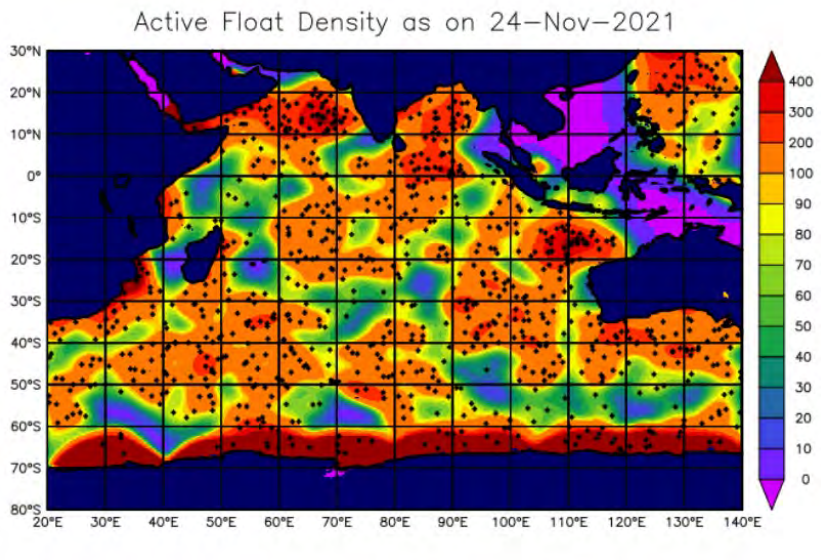
INCOIS is not operating as a GDAC.

4. Regional Centre Functions

- Acquisition of Argo data from GDAC corresponding to floats other than deployed by India and made them available on INCOIS web site.
- All these data sets are made available to the user through a s/w developed with all GUI facilities. This s/w is made available through FTP at INCOIS and UCSC web sites.
- Delayed Mode Quality Control (Refer 2.0 above)

- Data from the Indian Ocean regions are gridded into 1x1 box for monthly and 10 days and monthly intervals. These gridded data sets are made available through INCOIS Live Access Server (ILAS). Users can view and download data/images in their desired format.
- ERDDAP site was set up for the data and data products derived from Argo floats.
- Additionally SST from TMI, AMSRE and Wind from ASCAT, Chla from MODIS and OCM-2 are also made available on daily and monthly basis.
- Global wind products from OSCAT is also generated and made available on LAS along with TROP flux data sets.
- Data Sets (CTD, XBT, Subsurface Moorings) are being acquired from many principle investigators. These data are being utilized for quality control of Argo profiles.
- Value added products:
  Two types of products are currently being made available to various user from INCOIS web site. They are:
  (i) Time series plots corresponding to each float (only for Indian floats).
  (ii) Spatial plots using the objectively analysed from all the Argo floats data deployed in the Indian Ocean.
  These valued added products can be obtained from the following link http://www.incois.gov.in/Incois/argo/products/argo_frames.html

- Regional Co-ordination for Argo floats deployment plan for Indian Ocean. The float density in Indian Ocean as on 24 Nov, 2021 is shown below.



Publications:

INCOIS is actively involved in utilization of Argo data in various studies pertaining to Indian Ocean. Also INCOIS is encouraging utilization of Argo data by various universities by funding them. Some of the publications resulted from Argo data which includes scientists from INCOIS are given below:

1. Ganguly, D., K. Suryanarayana, and M. Raman, 2021: Cyclone Ockhi Induced Upwelling and Associated Changes in Biological Productivity in Arabian Sea. Marine Geodesy, 44, 70-89, https://doi.org/10.1080/01490419.2020.1838675.
2. Jayaram, C., T. V. S. U. Bhaskar, N. Chacko, S. Prakash, and K. H. Rao, 2021: Spatio-temporal variability of chlorophyll in the northern Indian Ocean: A biogeochemical argo data perspective. Deep Sea Research Part II: Topical Studies in Oceanography, 183, 104928, https://doi.org/10.1016/j.dsr2.2021.104928.
3. Jayaram, C., J. Pavan Kumar, T. V. S. Udaya Bhaskar, I. V. G. Bhavani, T. D. V. Prasad Rao, and P. V. Nagamani, 2021: Reconstruction of Gap-Free OCM-2 Chlorophyll-a Concentration Using DINEOF. Journal of the Indian Society of Remote Sensing, https://doi.org/10.1007/s12524-021-01317-6.
4. Kuttippurath, J., N. Sunanda, M. V. Martin, and K. Chakraborty, 2021: Tropical storms trigger phytoplankton blooms in the deserts of north Indian Ocean. npj Climate and Atmospheric Science, 4, 11, https://doi.org/10.1038/s41612-021-00166-x.
5. Maneesha, K., D. H. Prasad, and K. V. K. R. K. Patnaik, 2021: Biophysical responses to tropical cyclone Hudhud over the Bay of Bengal. Journal of Operational Oceanography, 14, 87-97, https://doi.org/10.1080/1755876X.2019.1684135.
6. Mathew, T., S. Prakash, L. Shenoy, A. Chatterjee, T. V. S. Udaya Bhaskar, and B. Wojtasiewicz, 2021: Observed variability of monsoon blooms in the north-central Arabian Sea and its implication on oxygen concentration: A bio-argo study. Deep Sea Research Part II: Topical Studies in Oceanography, 184-185, 104935, https://doi.org/10.1016/j.dsr2.2021.104935.
7. Pradhan, M., A. Srivastava, S. A. Rao, D. S. Banerjee, A. Chatterjee, P. A. Francis, O. P. Sreejith, M. Das Gupta, and V. S. Prasad, 2021: Are ocean-moored buoys redundant for prediction of Indian monsoon? Meteorology and Atmospheric Physics, 133, 1075-1088, https://doi.org/10.1007/s00703-021-00792-3.
8. Prakash, K. R., T. Nigam, V. Pant, and N. Chandra, 2021: On the interaction of mesoscale eddies and a tropical cyclone in the Bay of Bengal. Natural Hazards, https://doi.org/10.1007/s11069-021-04524-z.
9. Pramanik, S. and S. Sil, 2021: Assessment of SCATSat-1 Scatterometer Winds on the Upper Ocean Simulations in the North Indian Ocean. Journal of Geophysical Research: Oceans, 126, e2020JC016677, https://doi.org/10.1029/2020JC016677.
10. Prasanth, R., V. Vijith, V. Thushara, J. V. George, and P. N. Vinayachandran, 2021: Processes governing the seasonality of vertical chlorophyll-a distribution in the central Arabian Sea: Bio-Argo observations and ecosystem model simulation. Deep Sea Research Part II: Topical Studies in Oceanography, 183, 104926, https://doi.org/10.1016/j.dsr2.2021.104926.
11. Raju, N. J., M. K. Dash, P. K. Bhaskaran, and P. C. Pandey, 2021: Numerical Investigation of Bidirectional Mode-1 and Mode-2 Internal Solitary Wave Generation from North and South of Batti Malv Island, Nicobar Islands, India. Journal of Physical Oceanography, 51, 47-62, https://doi.org/10.1175/JPO-D-19-0182.1.
12. Sabu, P., M. P. Subeesh, J. V. George, N. P. Anilkumar, and M. Ravichandran, 2021: Enhanced subsurface mixing due to near-inertial waves: observation from Seychelles-Chagos Thermocline Ridge. Ocean Dynamics, https://doi.org/10.1007/s10236-020-01430-z.
13. Seelanki, V., T. Nigam, and V. Pant, 2021: Upper-ocean physical and biological features associated with Hudhud cyclone: A bio-physical modelling study. Journal of Marine Systems, 215, 103499, https://doi.org/10.1016/j.jmarsys.2020.103499.
14. Udaya Bhaskar, T. V. S., V. V. S. S. Sarma, and J. Pavan Kumar, 2021: Potential Mechanisms Responsible for Spatial Variability in Intensity and Thickness of Oxygen

Minimum Zone in the Bay of Bengal. Journal of Geophysical Research: Biogeosciences, 126, e2021JG006341, https://doi.org/10.1029/2021JG006341.
15. Valsala, V., M. G. Sreeush, M. Anju, P. Sreenivas, Y. K. Tiwari, K. Chakraborty, and S. Sijikumar, 2021: An observing system simulation experiment for Indian Ocean surface pCO2 measurements. Progress in Oceanography, 194, 102570, https://doi.org/10.1016/j.pocean.2021.102570.
16. Vidya, P. J., M. Balaji, and R. Mani Murali, 2021: Cyclone Hudhud-eddy induced phytoplankton bloom in the northern Bay of Bengal using a coupled model. Progress in Oceanography, 197, 102631, https://doi.org/10.1016/j.pocean.2021.102631.
17. Vijay, A., K. Munnooru, G. Reghu, A. Gera, R. R. Vinjamuri, and M. V. Ramanamurthy, 2021: Nutrient dynamics and budgeting in a semi-enclosed coastal hypersaline lagoon. Environmental Science and Pollution Research, https://doi.org/10.1007/s11356-021-15334-y.

1. Status

- **Data acquired from floats:** more than 79000 Argo profiles were acquired in the Mediterranean and in Black Seas between 2001 and September 2021. The temporal and spatial distribution of these profiles is depicted in Figure 1, sorted by the different float types used (Core-Argo, Core-Argo with DO, Bio-Argo, Deep-Argo and BGC-Argo); the monthly and yearly distribution is shown in Figure 2. More than 80 floats per month have been operated simultaneously in the basins in 2021 and more than 5500 profiles have been acquired (up to September 2021) by different float models (Figure 3).

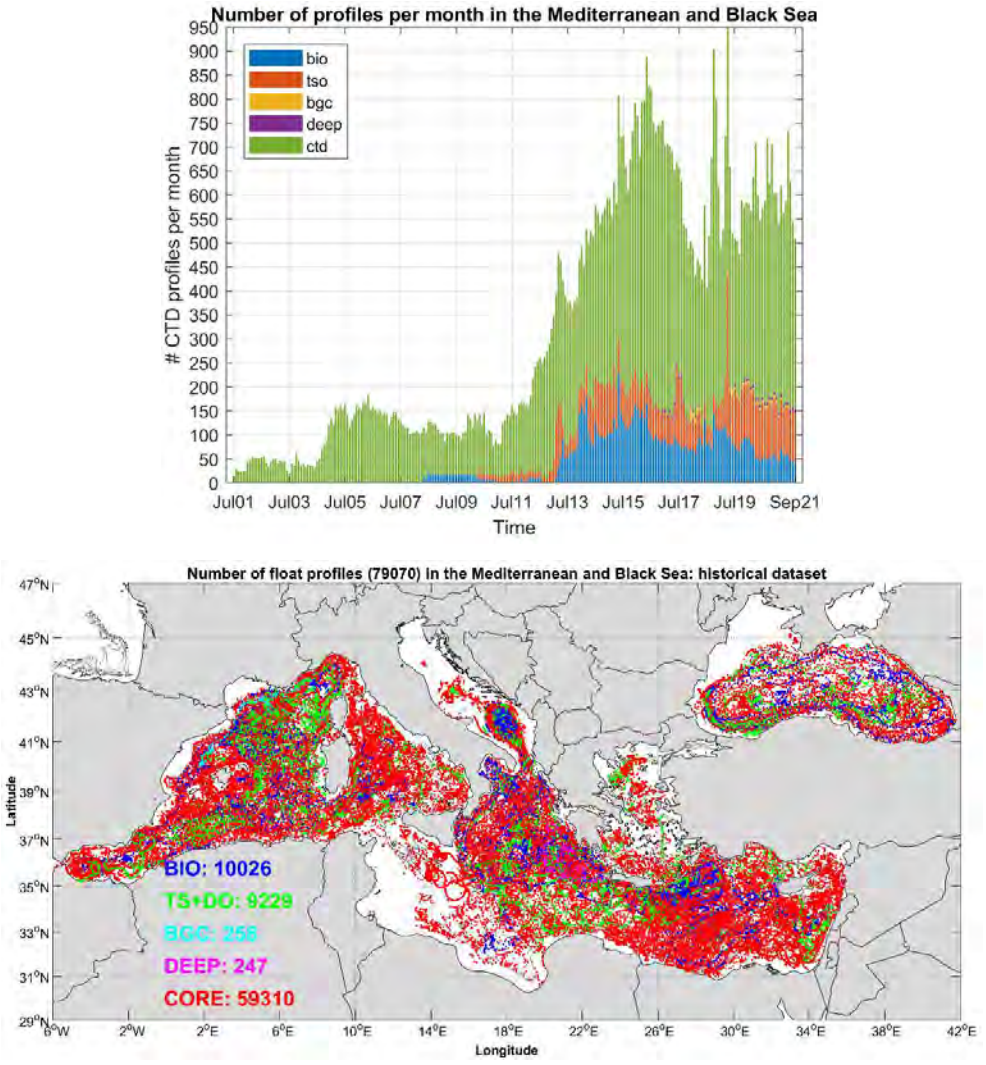


Figure 1. Temporal (upper panel) and spatial (bottom panel) distribution of float profiles in the Mediterranean and Black Sea between 2001 and 2021.

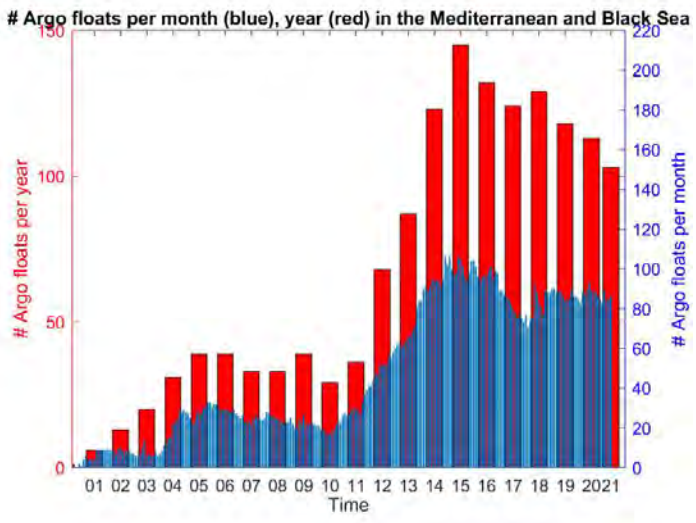


Figure 2. Monthly (blue bars) and yearly (red bars) distribution of Argo floats in the Mediterranean and Black Sea between 2001 and 2021.

The number of profiles acquired by Argo-extension floats in 2021 is about 1550 whilst the ones collected by the core Argo floats are about 4000. EU, Spain, Greece, France, Bulgaria and Italy contributed to maintain/increase the Argo population in 2021: a total of 23 new floats have been deployed both in the Mediterranean and in the Black Seas (Figure 3); 13 out of 23 platforms are core-Argo, 7 are core-Argo with DO, 1 is a Bio-Argo, 1 is a BGC-Argo and 1 is Deep-Argo. The deployment strategy was chosen according to the project's targets and to replace dead floats or under-sampled areas.

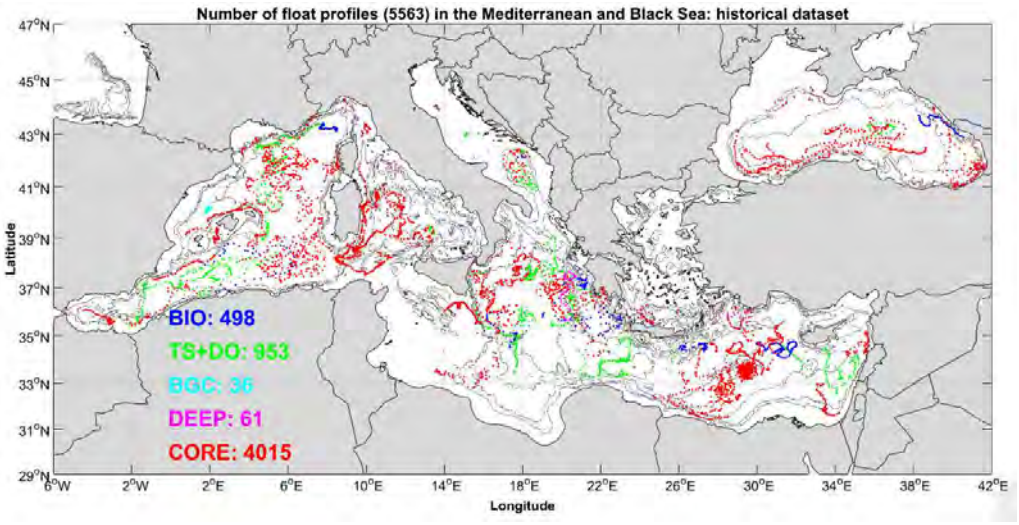


Figure 3. Spatial distribution of profiles collected by Argo floats in 2021 (January-September) in the Mediterranean and Black Sea: locations are color-coded per float type.

Statistics have been computed to assess the fleet performance. The survival rate diagrams produced are separated by transmission mode (figure 4). The maximum operating life is more than 500 cycles, whilst the mean half life is about 150 cycles (figure 4a). The vertical distance (upward profiles) travelled by floats is computed and used as an indicator of the profiler performance (figure 4b). The maximal distance observed is about 500 km, whilst the mean distance travelled is about 125 km. The balance of the population is in figure 5a and the annual death rate in figure 5b.

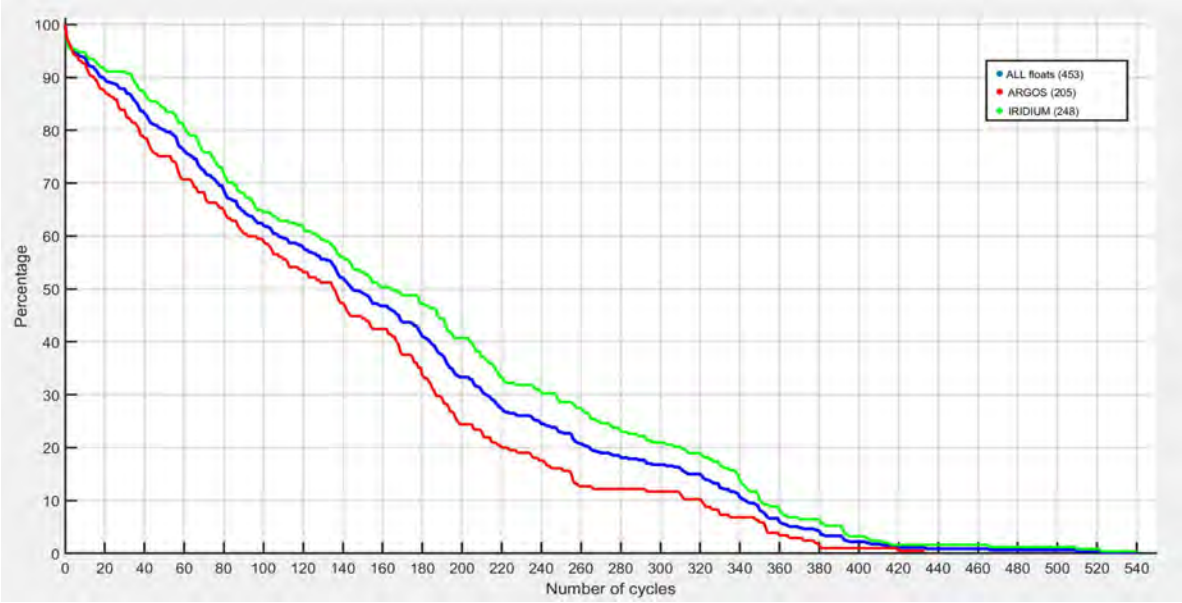


Figure 4a. Survival rate diagrams separated by telemetry system.

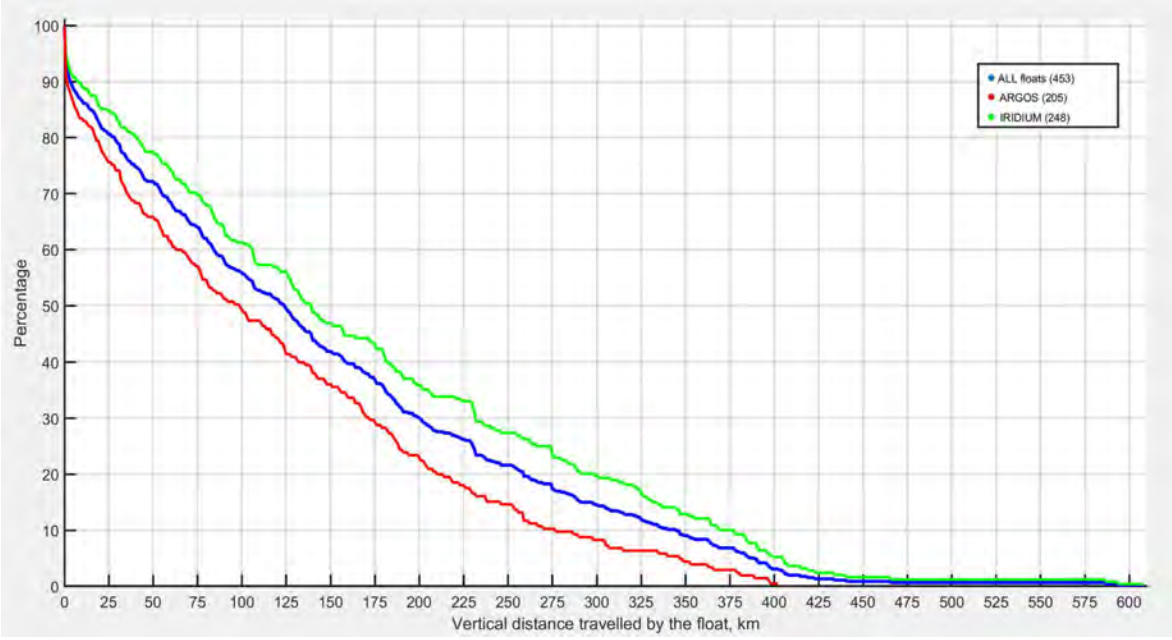


Figure 4b. Diagram of the vertical distance travelled floats, separated by telemetry system.

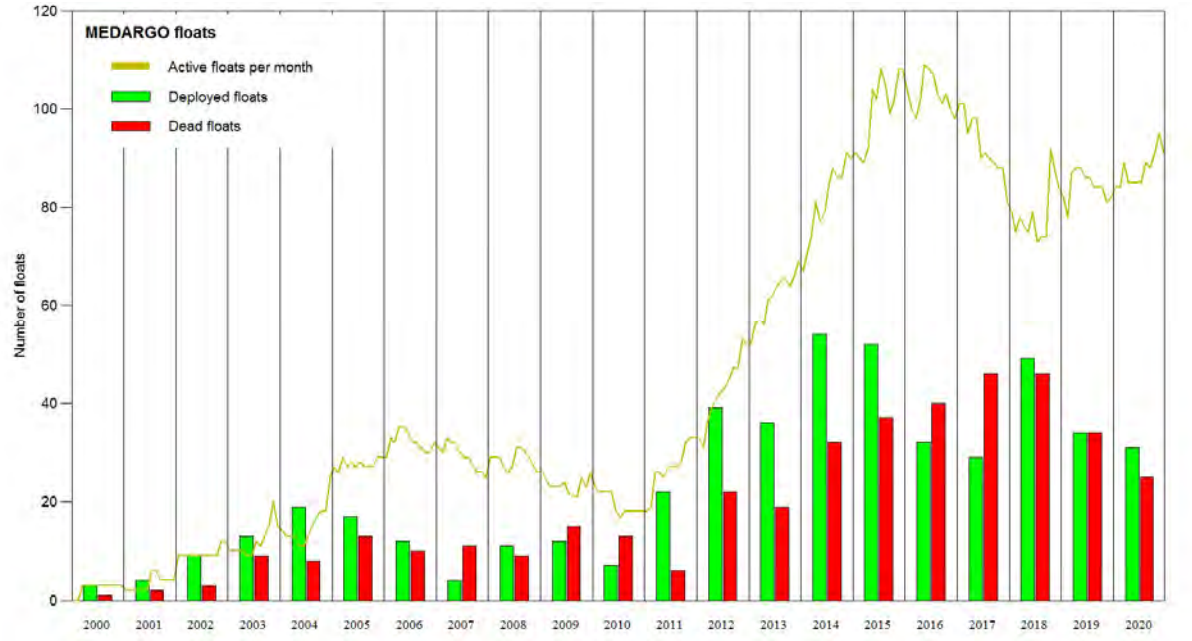


Figure 5a. Balance of the population (rate of population change related to the number of yearly deployments and dead floats).

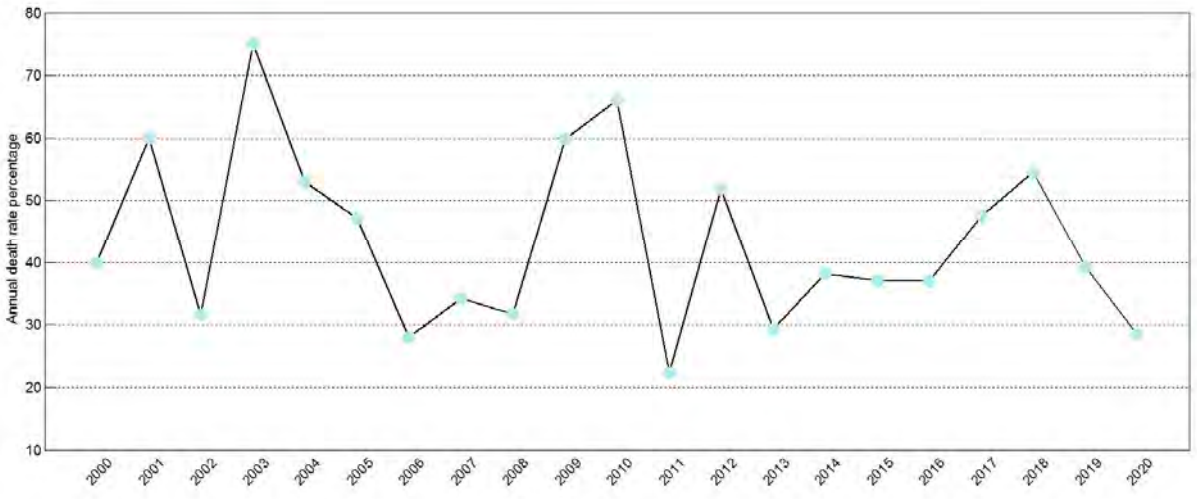


Figure 5b. Annual death rate (ration between yearly failure and yearly average population).

- **Web pages**:

The MedArgo web page (new website is http://maos.inogs.it/medargo/) has been updated. The main improvements are in the drop-down menu that allows users to do more accurate selections. The main page has been cleaned, old links removed and new ones provided. Tables and graphics are updated in near real time. The floats deployed during 2021 have been added to the web page as soon as the technical information is

available. The float positions are plotted daily (Figure 6); the monthly and the whole trajectories are also provided. Links with the Euro-Argo data selection tools and GDAC center (Coriolis) are also available for downloading both the real-time and delayed-mode float profiles.

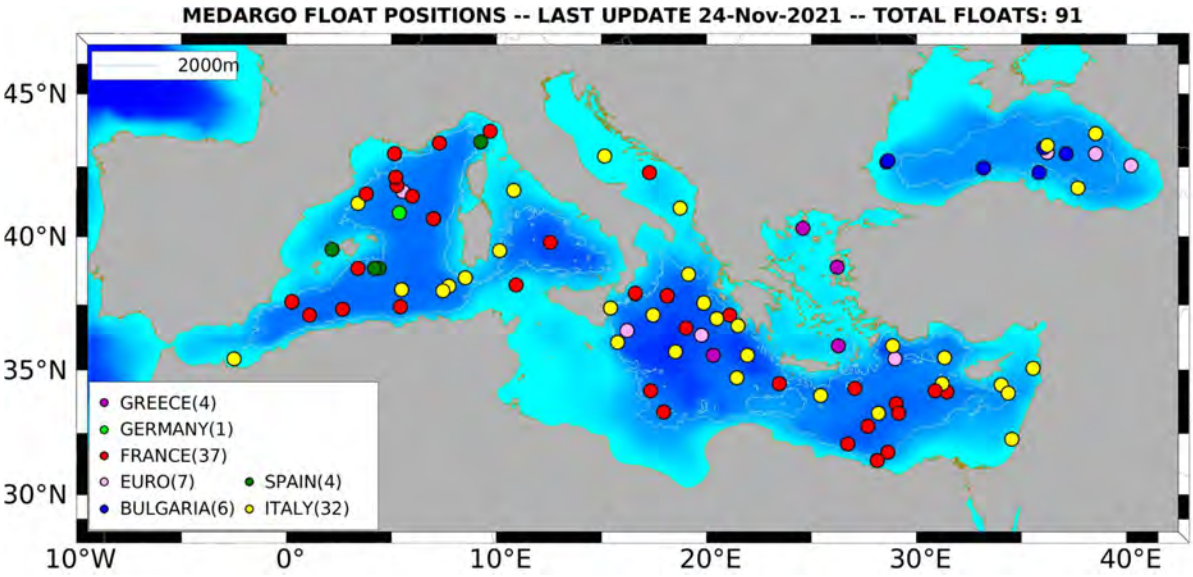


Figure 6. MedArgo float positions as of 24 November 2021 (updated daily).

- **Statistics of Argo data usage:** (operational models, scientific applications, number of National Pis…):
- **Products generated from Argo data:**
    a. Daily maps of float positions (Figure 6)
    b. Monthly maps of float positions and track
    c. Physical and Biogeochemical Argo float data are assimilated in numerical forecasting models by CMCC and OGS; 3D daily maps of Mediterranean ocean forecasting systems are produced and available on CMEMS (Figure 7).

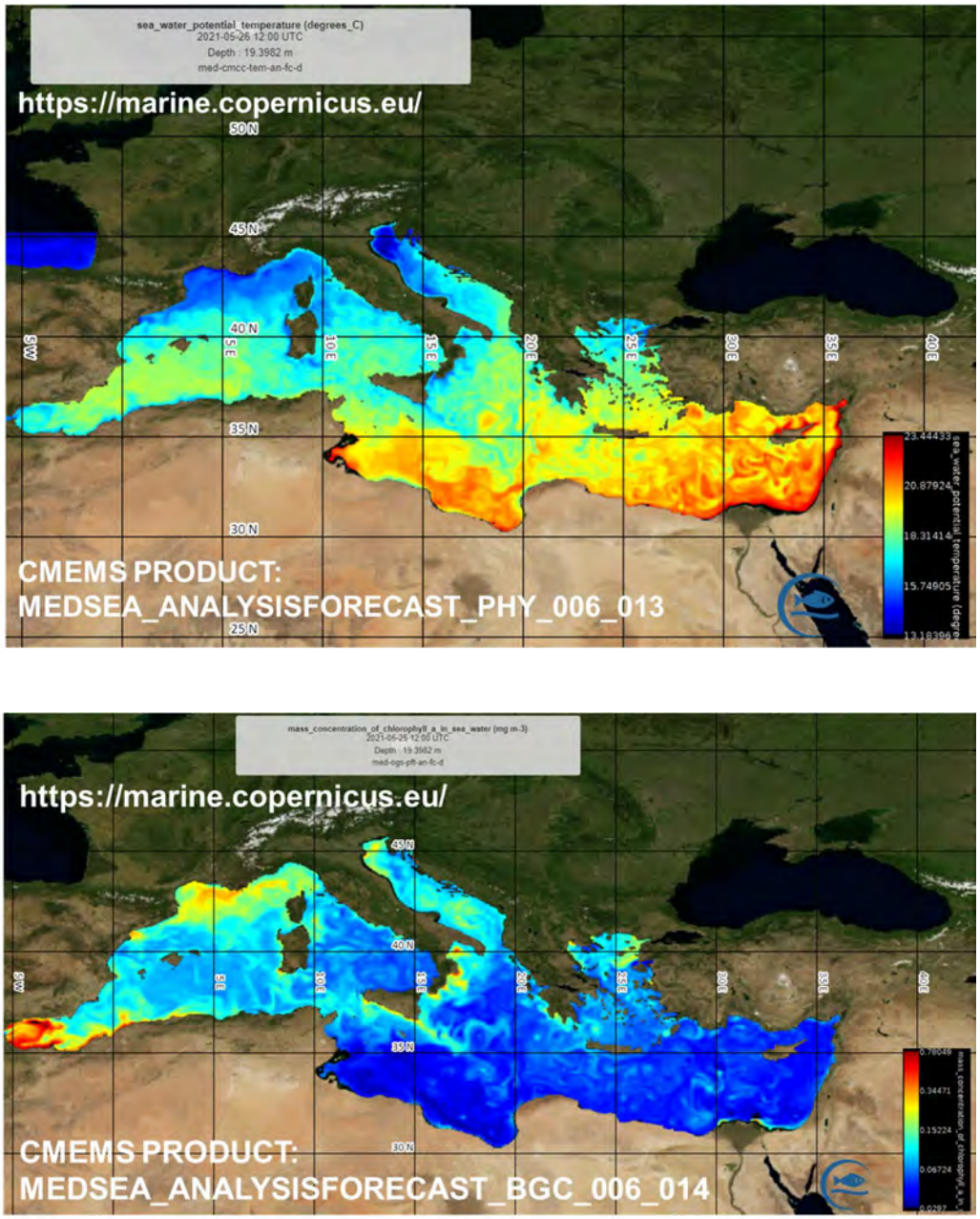


Figure 7. Forecasting models' products available on CMEMS. Physical (top) and biogeochemical (bottom) products.

d. An operational validation system has been developed by SOCIB to systematically assess the model outputs at daily, monthly and seasonal time scales. Multi-platform observations including in-situ measurements (Argo floats included) are used for this systematic validation (figure 8).

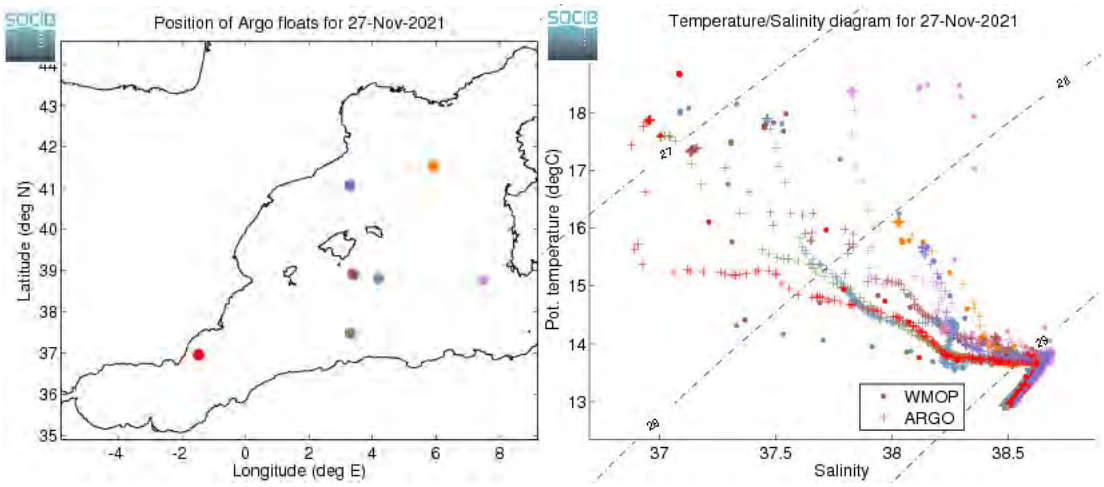


Figure 8. The WMOP temperature and salinity vertical profiles are compared to the last available vertical profiles from Argo floats.

2. Delayed Mode QC

OGS performed the DMQC activity for the Argo data in the Mediterranean and Black Seas. The OW method in conjunction with other procedures is adopted to conduct the quality control analysis for the salinity data.

- The DMQC method was applied to approximately 65% of eligible floats deployed between 2001 and 2020 in the Mediterranean and Black Seas (figures 9 and 10). The method was also applied to another 6.7% of the fleet but the analysis has to be repeated due to problems related to the reference dataset or in the data itself. Each float was quality controlled in delayed-mode for salinity, temperature and surface pressure and the respective D-files were gradually sent to GDAC. The DMQC report/info of each float can be downloaded by the MedArgo web page (http://maos.inogs.it/medargo/table_out.php?active=&med=&prj=&type=&naz=).

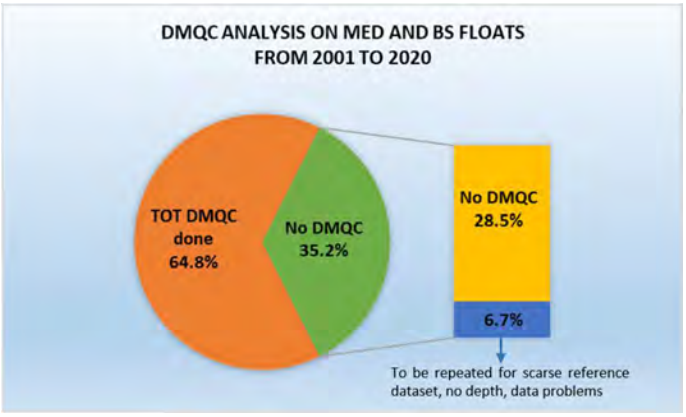


Figure 9. DMQC status.

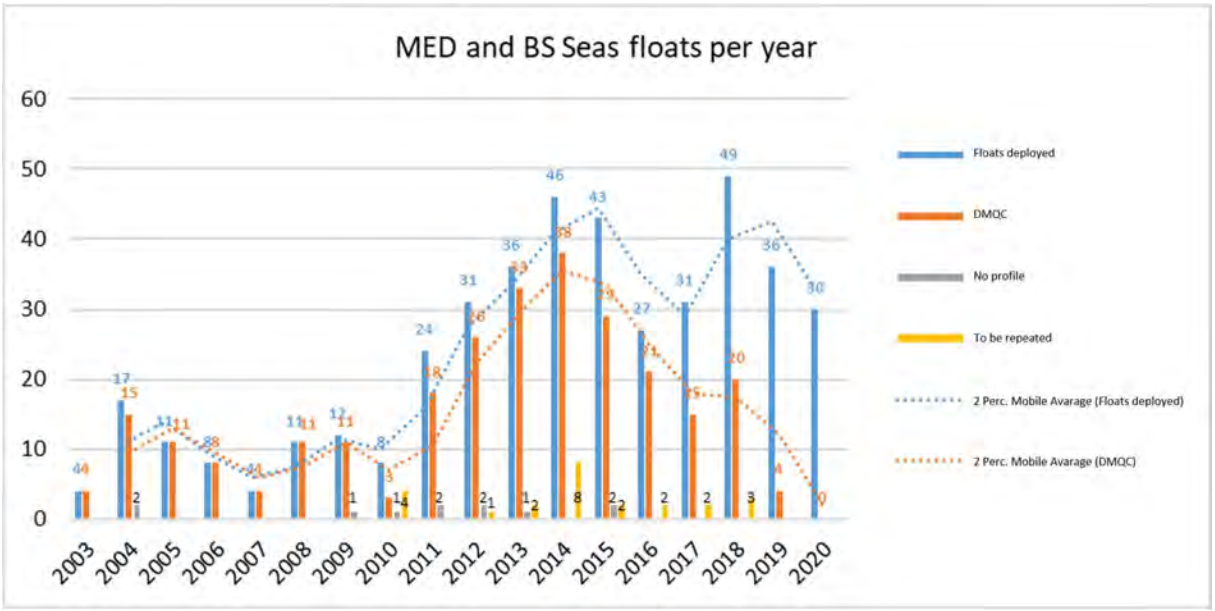


Figure 10. DMQC status per year.

- Salinity anomalies were checked to identify floats that could be affected by fast salinity drift. The results and comments has been reported in a shared spreadsheet (https://docs.google.com/spreadsheets/d/1TA7SAnTiUvCK7AyGtSTUq3gu9QFbVdONj9M9zAq8CJU/edit#gid=1096144849) that is regularly updated to monitor the impact of the rapid salty drift problem at international level.
- The DMQC analysis of deep floats has been conducted on two deep floats deployed close to the Hellenic Trench in the Mediterranean Sea. CPcor corrections have been applied and compared. Two different results were obtained. For one deep float, the best correction was obtained using the nominal CPcor (figure 11). For the second one, the closest in space and time CTD was used because there was no CTD at deployment. The best result was provided by the CPcor default value (Figure 12). Recently, two more deep floats have been deployed in the Mediterranean Sea. OGS will continue to implement delayed mode procedures for adjusting salinity data from Deep-Argo floats with the SBE CTDs in MED Sea, selecting the CPcor correction that provides the best result.

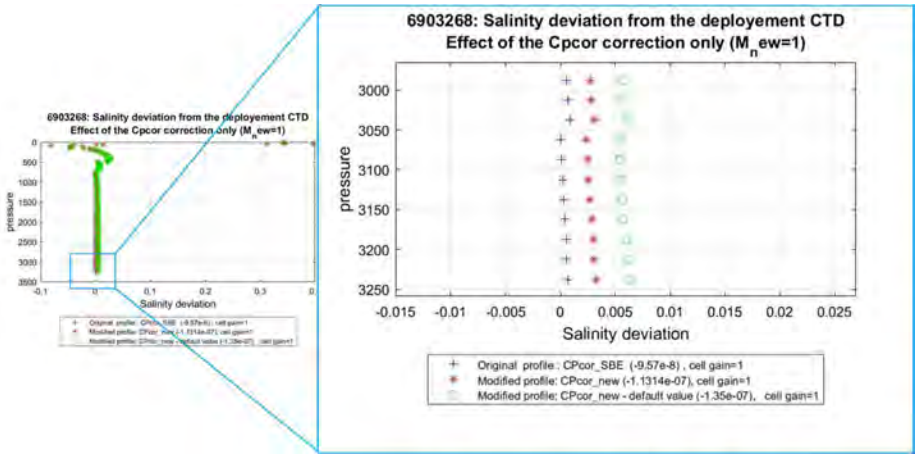


Figure 11. Deep Float 6903268. Salinity deviation from the deployment CTD due to the Cpcor correction using three values: the nominal Cpcor value from Sea-Bird, the Cpcor_new default value obtained by Argo-Deep team and the optimazed Cpcor value obtained in delayed-mode by comparing a deep float profile to a reference profile.

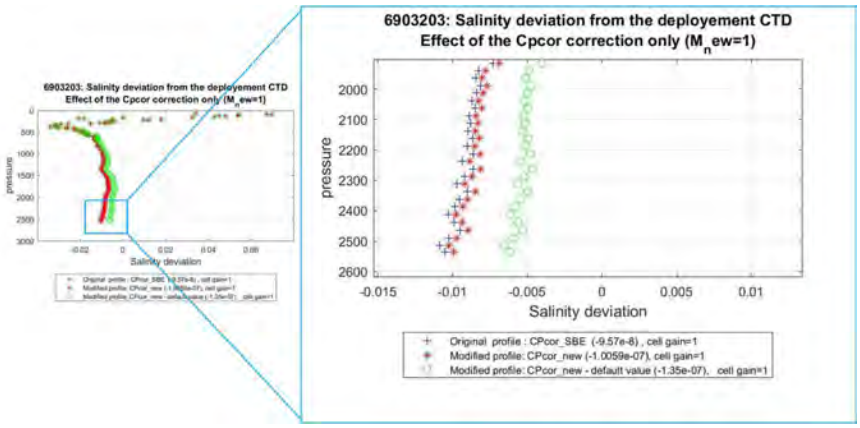


Figure 12. Deep Float 6903203. Salinity deviation from the deployment CTD due to the Cpcor correction using three values: the nominal Cpcor value from Sea-Bird, the Cpcor_new default value obtained by Argo-Deep team and the optimazed Cpcor value obtained in delayed-mode by comparing a deep float profile to a reference profile.

- The high-quality ship-based CTD reference data for QC of core variables was reviewed and improved (figures 13). Data was collected from several research institutes at regional level and the main European Marine Services. Data was

converted in mat format to be used in OWC procedure. A quality control was applied such as an additional visual check to avoid spike or duplication. Data was merged and divided in subsets of WMO boxes according to the climatological areas of the Mediterranean Sea. The updated reference dataset consists of about 67000 CTD profiles, about 10000 CTD profiles more as compared to the previous one. The spatial distribution has improved a lot especially in the Aegean and Levantine sub-basins.

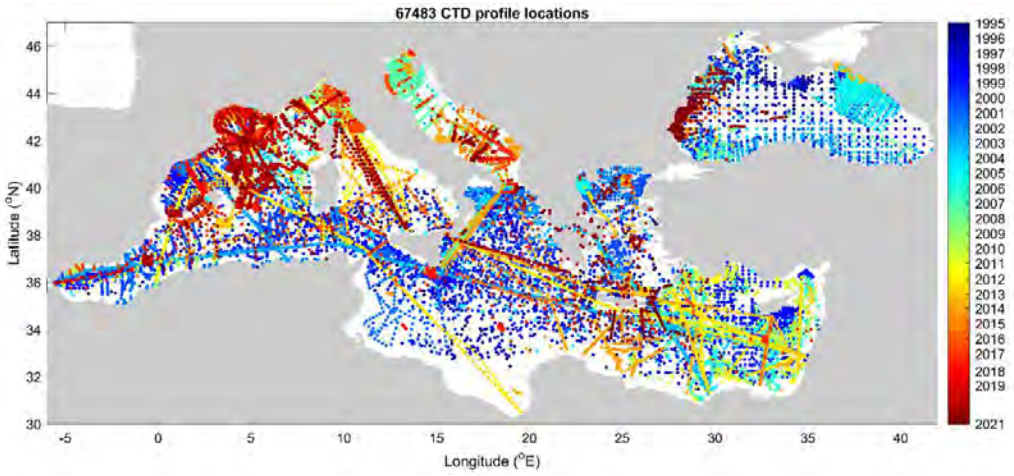


Figure 13. Spatial distribution, color-coded for time, of the CTD profiles in the final version of the CTD reference dataset of the Mediterranean and Black Seas.

3. Regional Centre Functions

- MedArgo is the Argo Regional Centre for the Mediterranean and the Black Sea. OGS, who coordinates the MedArgo activities, established several collaborations with European and non-European countries in order to set the planning and the deployment coordination of floats. Hence, a good coverage is maintained throughout the years. As part of these cooperations the float data are transferred in near real time to MedArgo and 23 new floats have been deployed in the Mediterranean and Black Sea during 2021, through a coordinated activity of deployment opportunities and thanks to scientific projects.
- There are 79 active Argo floats in the Mediterranean Sea and 12 in the Black Sea as of 29 November 2021.
- The main MedArgo partners (Italy, Greece, Spain, France and Bulgaria) are strengthening the collaboration with the riparian countries through the H2020 Euro-Argo RISE project, to improve the Argo activities (deployment plans and

opportunities, sharing reference datasets for QC, sharing expertise, joint activities). Furthermore, in the framework of this project, extension of Argo operations in shallow/coastal waters is ongoing.

- The high-quality CTD reference dataset for DMQC has been improved and updated.
- The D-files of 65% of the eligible profiles (core variables) have been submitted to the GDAC.

Argo National Data Management Report

1. Status

The Japan DAC, the Japan Meteorological Agency (JMA), has processed data from 1851 Japanese Argo and Argo-equivalent floats including 115 BGC floats, of which 225 are active floats including 23 BGC floats, as of November 19th, 2021. There are 11 Japanese PIs who agreed to provide data to the international Argo data management. The DAC is acquiring ARGOS messages from CLS and getting IRIDIUM messages via e-mail and WebDAV server in real-time, thanks to the understanding and the cooperation of PIs. Almost all profiles from those floats are transmitted to GDACs in the netCDF format and issued to GTS using BUFR codes after real-time QC on an operational basis.

The Japan Agency for Marine-Earth Science and Technology (JAMSTEC) is in charge of operating the Delayed Mode QC for all Japanese floats, providing Argo QC'ed data in collaboration with JMA. The delayed mode QC for the 16,027 profiles observed by Japanese floats from November 19th, 2020 to November 19th, 2021 are in progress. JAMSTEC decoded 11,530 profiles of these, which were acquired as ARGOS messages and Iridium messages from November 19th, 2020 to November 19th, 2021. JAMSTEC sent 16,498 delayed profile files (D-files) to GDACs through the Japan DAC, JMA, during the period.

JMA and JAMSTEC have converted the meta-, prof-, tech-, and traj-files of Japanese floats, including APEX, DeepAPEX, PROVOR, ARVOR, NEMO, NOVA, Navis, NINJA, DeepNINJA and S2A. JMA and JAMSTEC have converted most all of Japanese meta-files from v2 to v3.1 and submitted them to GDAC. JMA has converted almost all of Japanese tech-files and submitted them to GDAC. Accordingly, JMA has converted the Rprof-files of Japanese ARGOS floats, except floats with NST sampling scheme and Iridium floats. JAMSTEC has converted all v2 Dprof-files of Japanese floats to v3.1 and submitted them to GDAC. JMA has converted about 30% of Japanese traj-files from v2 to v3.1 and submitted them to GDAC.
JMA has made meta-, tech-, traj-, and Rprof-files v3.1 of the almost all of floats newly deployed since March 2016 and JAMSTEC has made meta-files in v3.1 of JAMSTEC's floats newly deployed since October 2015. JAMSTEC has made Dprof-files in v3.1 since January 2016.

Due to a network security incident occurred at JAMSTEC in mid-March 2021, JAMSTEC's servers could not connect to the internet, and JAMSTEC was temporarily unable to send the raw data files of its Iridium communication floats to JMA. The internet connection of JASTEC has not been completely restored yet, so that the raw data files of the target floats are not sent to JMA in real time at this time. Therefore, the delivery time of the Rprof-/BRprof-files and traj-files to GDAC tends to be delayed, at least over 24 hours. JAMSTEC's internet connection is expected to be fully restored around March next year.

Web pages:

Japan Argo

http://www.jamstec.go.jp/J-ARGO/index_e.html

This site is the portal of Japan Argo program. The outline of Japanese approach on the Argo program, the list of the publication, and the link to the database site and PIs, etc. are being offered. This site has been currently unavailable since mid-March 2021, due to a network security incident at JAMSTEC as described in the previous subsection.

Real-time Database (JMA)

https://www.data.jma.go.jp/argo/data/index.html

This site shows global float coverage, global profiles based on GTS BUFR messages, and status of the Japanese floats.

Delayed mode Database (Argo JAMSTEC)

http://www.jamstec.go.jp/ARGO/argo_web/argo/?lang=en

JAMSTEC's website shows mainly Japanese float list, trajectory map, profile chart, and QCed float data. Brief profile figures of the selected floats are also shown. This site also shows global maps based on objective analysis (temperature, salinity, potential density, dynamic height, geostrophic current, mixed layer depth, etc.). This site has been currently unavailable since mid-March 2021, due to a network security incident at JAMSTEC as described in the previous subsection.

Statistics of Argo data usage:

Operational models of JMA

MOVE/MRI.COM-G2 (Multivariate Ocean Variation Estimation System/ Meteorological Research Institute Community Ocean Model – Global 2)

JMA operates the MOVE/MRI.COM-G2, which replaced the previous version (MOVE/MRI.COM) in June 2015, for the monitoring of El Niño and the Southern Oscillation (ENSO) and for initialization of the seasonal prediction model (JMA/MRI-CGCM2). The MOVE/MRI.COM-G2 consists of an ocean general circulation model (OGCM) and an objective analysis scheme.

For details please visit:

https://ds.data.jma.go.jp/tcc/tcc/products/elnino/move_mricom-g2_doc.html

JMA/MRI-CGCM2 (JMA/MRI - Coupled ocean-atmosphere General Circulation Model 2)

JMA operates JMA/MRI-CGCM2, which replaced the previous version (JMA/MRI-CGCM) in June 2015, as a seasonal prediction model and an ENSO prediction model. The oceanic part of this model is identical to the OGCM used for the MOVE/MRI.COM-G2.

For details please visit:

https://ds.data.jma.go.jp/tcc/tcc/products/model/outline/cps2_description.html

MOVE/MRI.COM-JPN (Multivariate Ocean Variation Estimation System/ Meteorological Research Institute Community Ocean Model - an operational system for monitoring and forecasting coastal and open ocean states around Japan)

JMA operates MOVE/MRI.COM-JPN, which replaced the previous version (MOVE/MRI.COM-WNP) in October 2020. MOVE/MRI.COM-JPN provides daily, 10day-mean and monthly products of subsurface temperatures and currents for the seas around Japan and North Pacific Ocean.

Other operational models

JCOPE2 (Japan Coastal Ocean Predictability Experiment)

JCOPE2 is the model for prediction of the oceanic variation around Japan which is operated by JAMSTEC. JCOPE2 is the second version of JCOPE, developed with enhanced model and data assimilation schemes. In 2019, JCOPE2M, which is updated version of JCOPE2/FRA-JCOPE2 reanalysis, was released. The Argo data are used by way of GTSPP. The hindcast data 6 months back and the forecast data 3 months ahead are disclosed on the following web site:
http://www.jamstec.go.jp/frcgc/jcope/. More information is shown in
http://www.jamstec.go.jp/frcgc/jcope/htdocs/e/home.html
This site has been currently unavailable since mid-March 2021, due to a network security incident at JAMSTEC as described in the previous subsection.

FRA-ROMS

FRA-ROMS is the nowcast and forecast system for the Western North Pacific Ocean developed by Japan Fisheries Research and Education Agency (FRA) based on the Regional Ocean Modeling System (ROMS). FRA started the operation in May 2012. The forecast oceanographic fields are provided every week on the website http://fm.dc.affrc.go.jp/fra-roms/index.html/.

Products generated from Argo data:

Products of JMA

El Niño Monitoring and Outlook / Indian Ocean Dipole

JMA issues on a monthly basis an ENSO diagnosis and six-month outlook as well as an IOD analysis on the following web site. The outputs of the MOVE/MRI.COM-G2 and the JMA/MRI-CGCM2 can be found here.
https://ds.data.jma.go.jp/tcc/tcc/products/elnino/index.html

Subsurface Temperatures and Surface Currents in the seas around Japan

The following parameter outputs of MOVE/MRI.COM-JPN was newly released in December 2021 and can be found on https://www.data.jma.go.jp/goos/data/database.html. They replace the conventional outputs of MOVE/MRI.COM-WNP, the release of which will be stopped in the near future.

- Daily, 10day-mean and Monthly mean subsurface temperatures at the depths of 50m, 100m, 200m and 400m analyzed for approximately 0.1 x 0.1 degree grid points.
- Daily and 10day-mean Surface Currents for approximately 0.1 x 0.1 degree grid points.

Products of JAMSTEC

JCOPE2 (Japan Coastal Ocean Predictability Experiment)

JCOPE2 is the model for prediction of the oceanic variation around Japan which is operated by JAMSTEC. JCOPE2 is the second version of JCOPE, developed with enhanced model and data assimilation schemes. In 2019, JCOPE2M, which is updated version of JCOPE2/FRA-JCOPE2 reanalysis, was released. The Argo data are used by way of GTSPP. The hindcast data 6 months back and the forecast data 3 months ahead are disclosed on the following web site:
http://www.jamstec.go.jp/frcgc/jcope/. More information is shown in
http://www.jamstec.go.jp/frcgc/jcope/htdocs/e/home.html
This site has been currently unavailable since mid-March 2021, due to a network security incident at JAMSTEC as described in the previous subsection.

2. Delayed Mode QC

JAMSTEC has done the DMQC for all Japanese floats. JAMSTEC has submitted the delayed mode files of 175,121 profiles to GDACs as of November 19th, 2021.
The procedure of DMQC in JAMSTEC is as follows.

(JAMSTEC floats and the most of Argo-equivalent floats)

1. (within 10days) data re-acquisition from CLS, bit-error repair (if possible), real-time processing, position QC, visual QC
2. (within 180days) surface pressure offset correction, cell TM correction (Apex only)
3. (after 180days) WJO and OW salinity correction, the definitive judgement by experts, D-netCDF file making

(Argo-equivalent floats that had ceased by 2007)

JMA executes real-time processing again by using the latest procedure. The procedure after real-time processing is executed by JAMSTEC according to the procedure describe above.

The OW software is mainly operated instead of WJO. The calculation result of OW has been used at the definitive judgment. The result OW has been used just for reference.

JAMSTEC has adjusted salinity data of Deep floats by using optimal CPcor for each Deep float. When our Deep float is launched, shipboard-CTD observation is often performed. Therefore, for the optimal CPcor for each Deep float is estimated by comparing its first profile with shipboard-CTD data at its deployment.

And, JAMSTEC has started performing delayed mode QC for our BGC floats. We are now preparing to processing programs for DOXY-DMQC. We are also testing whether Nitrate and pH observed by our BGC floats in the North Pacific are corrected well by SAGE. We aim to start to release D-mode DOXY_Adjusted of our BGC floats to GDAC next year.

3. Regional Centre Functions

JAMSTEC operates PARC in cooperation with IPRC and CSIRO and has extended the responsible region into the whole Pacific.
JAMSTEC is providing the float monitoring information in the Pacific region (e.g., float activity watch, QC status, anomaly from objective analysis, diagnosis plot for sensor correction, etc.), reference data set for DMQC (SeHyD and IOHB), the link to the CTD data disclosure site of Japanese PIs, some documents, and some QC tools on the following web pages (http://www.jamstec.go.jp/ARGORC/). Unfortunately, this site has been currently unavailable since mid-March 2021, due to a network security incident at JAMSTEC as described above.
JAMSTEC has been building the new PARC websites since last year. We plan to develop a few new functions; to share information of technical problems and quality control of data including Core, BGC, and Deep Argo floats among PIs, DMQC operators and users, and to coordinate float development opportunities. The site is going to be more user-friendly than its current version. Since JAMSTEC’s internet connection is expected to be fully restored around March next year, we will release the new version of PARC websites in 2022.

KOREA Argo National Data Management Report

ADMT-22

Virtual Meeting, Dec 6 – Dec 10, 2021

1. Status

1.1. Data acquired from floats

In 2021, the National Institute of Meteorological Sciences of Korea Meteorological Administration (NIMS/KMA) deployed total 6 floats around Korea: 2 for the East Sea, 2 for the Yellow Sea and 2 for South Sea of Korea (Fig. 1). The NIMS/KMA has deployed 259 Argo floats around Korea such as the East Sea, Yellow Sea, and the North Pacific Ocean since 2001, and 18 floats are in active as of November 30, 2021. As one of regional DACs, the NIMS/KMA is acquiring ARGOS messages and Iridium messages via web service from CLS in real-time, and all profile data obtained are transmitted to GDAC with the NetCDF format using BUFR data after the real-time quality-control process on operational system.

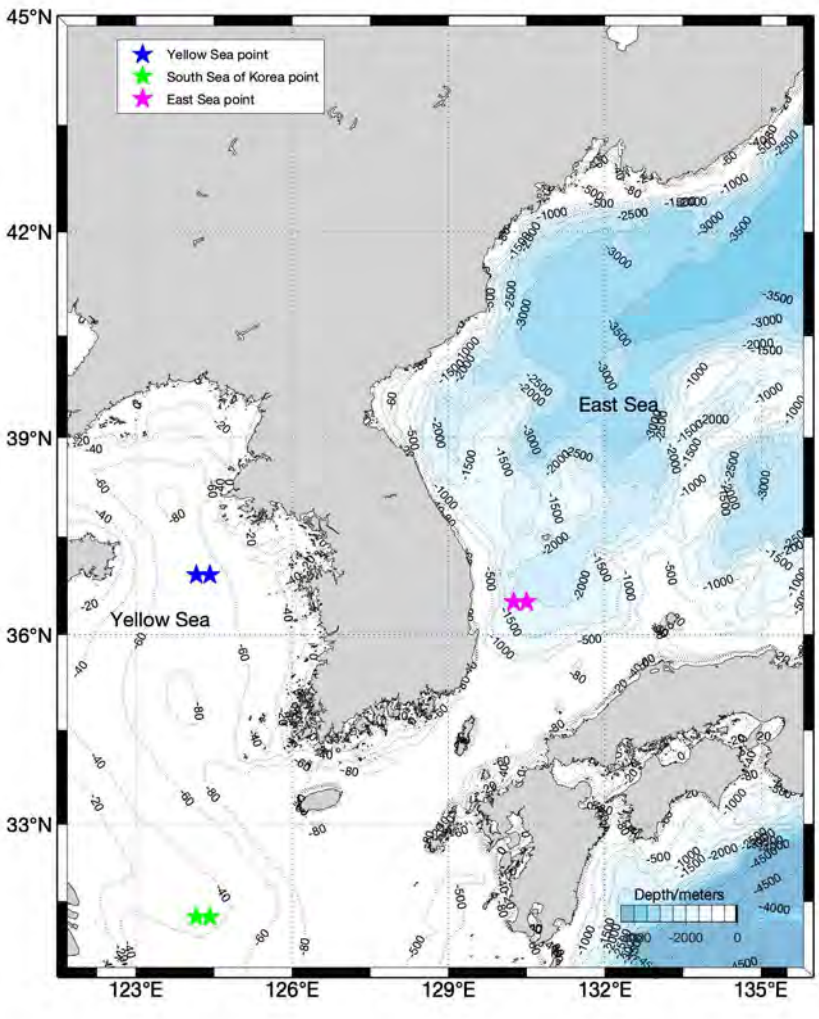


Fig. 1. Deployment location of Argo float by Korea in 2021

1.2. Data issued to GDAC

Total 858 profiles were acquired during January through November in 2021 and sent to the GDAC after the real-time QC processes.

- Data reproduction and resubmission to GDAC by applying Warning Objective Analysis report.
- Implementing the Argo data format check program (New version).
- The RTQC procedure has been updated for grey-list.
- Real-time quality control development and application on shallow sea.
- The RTQC procedure has been updated for MEDD test for the Pacific and Yellow Sea (Gradient test: East Sea)
- The data quality-control system was improved. (e.g. removal of the duplicated data)

1.3 Shallow Argo

This year, four Argo floats were successfully deployed the shallow sea such as the Yellow Sea and South Sea around Jeju Island on November 13~16, 2021. The NIMS/KMA will try to keep this shallow Argo observation network in around Korean peninsular.

1.4. Web pages

The NIMS operates the Argo web page (http://argo.nims.go.kr) as regional data assembling center. and provides profile data and status of Argo floats to the public. It has shown **26,954 hits** by visitors in monthly average. also, It provides figures of vertical profile, spatial distribution and T-S diagram.

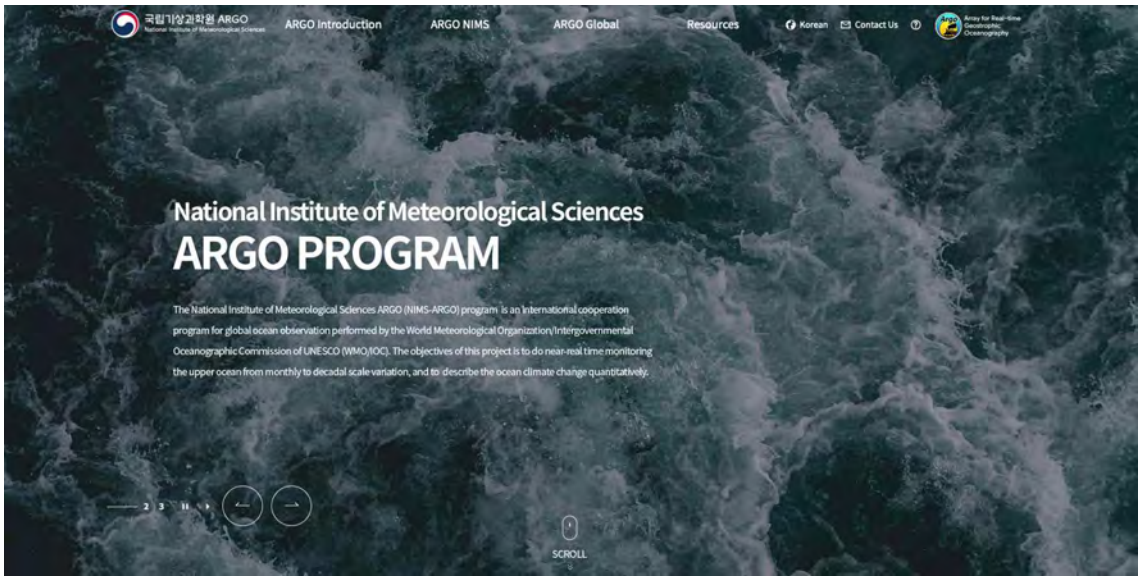


Fig. 2. Argo homepage of NIMS/KMA (http://argo.nims.go.kr)

1.5. Deployment plan for 2022

In 2022, 7 Argo floats will be deployed around Yellow Sea and East Sea in Koera (see Fig. 3). The red square shows a possible area for the floats to be deployed next year aiming at covering the regional seas of Korea.

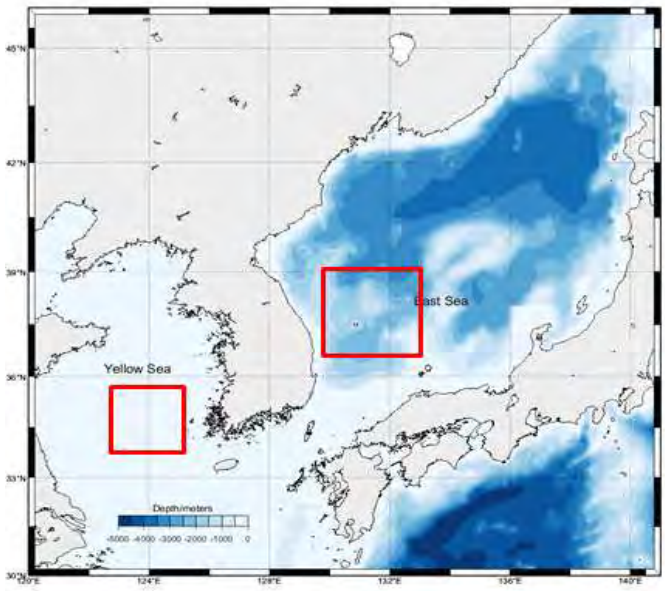


Fig. 3. NIMS/KMA's deployment area in 2022

1.6. etc

The NIMS published the NIMS' Argo Float Operation Report in 2001-2020 and there is a research paper published titled "Assessment of assimilation impact of Argo float observations in marginal seas around Korean peninsula through observing system experiments" (Choo et al., 2021, Atmosphere Vol. 31 (3))

2. Delayed Mode QC

We completed DMQC operation on 1,866 profiles (701 profiles from the East Sea, 37 profiles from the western North Pacific, 1,128 from the Yellow Sea), which had been observed until September 2021. We used the OWC (ver. 3.0.0) for the East Sea and the Northwestern Pacific data with new parameters (spatio-temporal correlation scales etc). The profiles had been sent to the GDAC on November 3, 2021 with the NetCDF format after the successful D-files update. We found the constant salinity offset right after deployment in the Yellow Sea and the salinity offset was obtained from shipboard CTD data. As the Argo floats in the Yellow Sea were observing in a short period of time, we only corrected the offset by LAUNCH_OFFSET in "MAIN_write_dmqc_files"(matlab code). Since the Yellow Sea is prone to change its unusual salinity characteristic every season, only shipboard CTD data collected at the similar time and location were needed to use for OWC. This DMQC prototype could be improved after collecting the enough quantity of shipboard CTD data. -The End-

Argo National Data Management Report – Norway 2021

Institute of Marine Research (IMR), Norway

1. Status

- **Data acquired from floats**

Presently there are **38 operative Norwegian floats,** all in the Nordic Seas/Barents Sea. In 2021, **4158 profiles** were acquired (DM: 2015; DM-pending: 771). The left figure below shows the latest Argo locations while right figure shows the number of deployments in the Nordic Seas/Barents Sea/Arctic Ocean (north of Svalbard). Argo Norway deployed 14 floats in 2021.

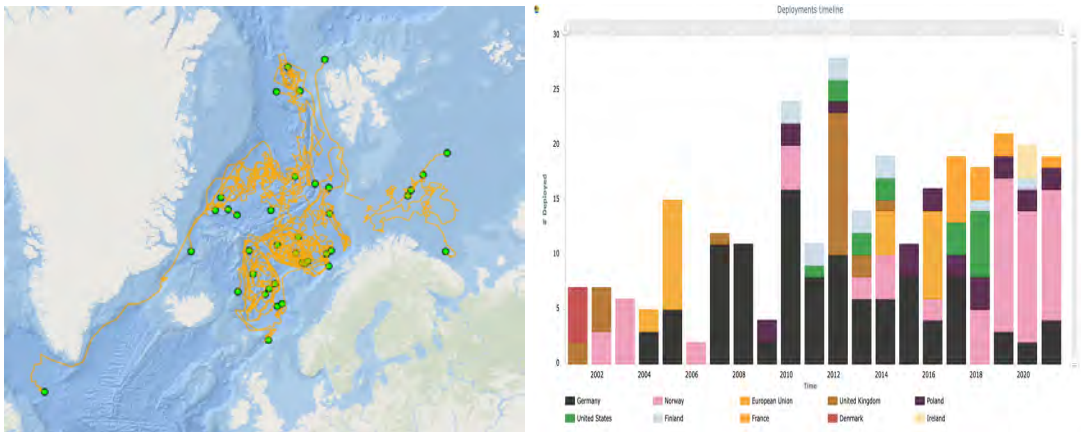


***Figure 1**. Left: Last registered position of the active floats in Argo Norway. Right: Number of deployed floats in the Nordic Seas and Barents Sea for each year country.*

Data from all operational floats are available from the GDACs. Since 2002 Norway has in total deployed 70 Argo floats.

<u>The 38 operative floats consist of:</u>

- 4 BGC floats (all 6 variables)
- 10 Bio floats (1-4 BGC variables: DO, chla, bbp, irradiance)
- 7 Deep floats with DO.
- 17 core floats

- **Data issued to GTS**

All Norwegian floats are processed in real-time by Coriolis and delivered to GTS.

- **Data issued to GDACs after real-time QC**

All profiles from Norwegian floats are processed in real-time by Coriolis and exchanged with GDACs.

- **Data issued for delayed QC**

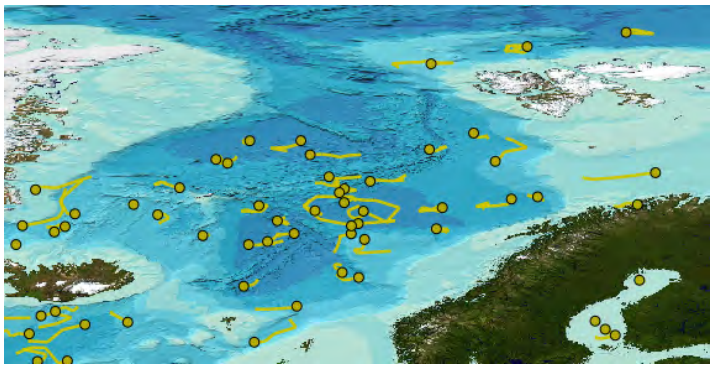
At present (6.12.2021) the Norwegian Argo fleet comprises 70 floats. According to Argo Information Center the floats have so far sampled 8217 profiles with 5966 DM-profiles and 879 DM-pending profiles. In 2021 (1. Jan - 6. Dec), **4158 profiles** were acquired (DM: 2015; DM-pending: 771).

- **Delayed data sent to GDACs**

BSH (Germany) has done the Quality Control of core data from Norwegian floats deployed in 2018 and earlier, and the D-files are submitted to Coriolis with a short summary and diagnosis figures. Norway do now DMQC of floats deployed in 2019 and later. Norway do also DMQC of BGC-floats.

- **Web pages**

A web page for NorArgo (https://norargo.hi.no) has been developed that IMR updates. The web page has a link to daily updates of all operational Argo floats in the Nordic Seas and Arctic Ocean (see figure) and profiles can be visualized.



- **Statistics of Argo data**

IMR uses the data as part of the monitoring program for the marine environment in Norwegian waters. The NERSC routinely assimilates the data into their TOPAZ4 model and assimilation system for operational monitoring and forecast of the ocean climate. The data are used in many research projects and in master and Dr. thesis.

We perfomed a user survey in Norway, and some of the results are shown in the table.

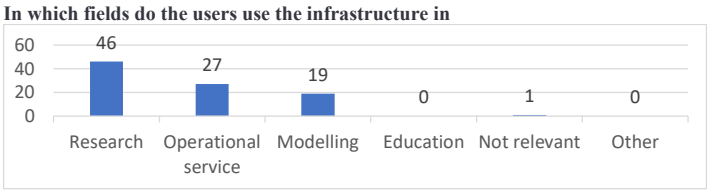


Table 3. Number of users for different fields (several choices can be ticked).

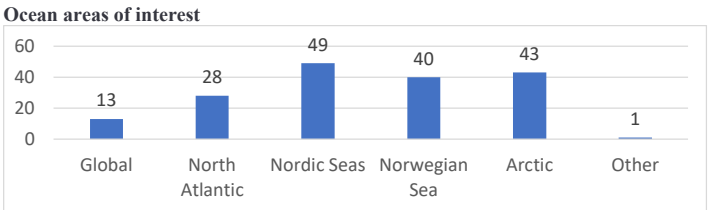


Table 4. Number of users in which the infrastructure are used for in different ocean areas (several choices can be ticked).

- **Products generated from Argo data …**

The ocean heat and fresh water contents of the Norwegian Sea are regularly updated.

2. Delayed Mode QC

BSH has adopted older floats from Norway for DMQC (see report for Germany). Norway do now DMQC of 40 floats deployed in 2019-2021.

There are **3405 profiles for these 40 floats with 1301 DM and 840 DM-pending.** Most of the floats have been QC.

BGC-variables:
DMQC has been performed on the oxygen (NORCE) for 16 Argo floats (in total 1182 profiles), on the pH (NORCE) for one float (125 profile) and on nitrate (IMR) for 4 BGC-floats (398 profiles). We plan to do DMQC on the other BGC-variables (IMR) in near future.

3. GDAC Functions

4. Regional Centre Functions

5. References

UK National Report

Report to the 22nd Argo Data Management Team

Authors

UK Argo data team at the British Oceanographic Data Centre, part of the National Oceanography Centre:

- Contributing authors: Matt Donnelly, Clare Bellingham, Kamila Walicka, Violetta Paba, Robin McCandliss
- Other team members: Roseanna Wright

With contributions from the wider UK Argo team by:

- Jon Turton and Fiona Carse (Met Office)
- Brian King (National Oceanography Centre)
- Giorgio Dall'Olmo (Plymouth Marine Laboratory)

General Status

Data management team

The British Oceanographic Data Centre (BODC), part of the National Oceanography Centre (NOC), is the data assembly centre for UK Argo. It is funded primarily by the UK Natural Environment Research Council (NERC) and is responsible for data management of UK, Irish and Mauritian floats. In addition, UK Argo is a member of Euro-Argo and is continuing to manage some European Union floats as part of the now-ended MOCCA project. As part of the EU H2020 project ENVRI-FAIR, BODC is working towards hosting the Argo reference tables on the NERC Vocabulary Server (NVS). BODC is also the coordinator for the Southern Ocean Argo Regional Centre (SOARC).

BODC Argo Team member	Contributions	Estimated contribution in past year as Full Time Equivalent (FTE)
Matt Donnelly	BODC Argo Lead DAC lead DMQC contributor SOARC coordinating partner	0.67 FTE
Clare Bellingham	DAC operator	0.3 FTE
Kamila Walicka	DMQC lead	1.0 FTE
Violetta Paba	Argo vocabularies lead BGC QC lead DAC operator	0.4 FTE
Roseanna Wright	Metadata investigations	0.05 FTE
	TOTAL	2.42 FTE

In addition to this, there was also just over 0.5 FTE of effort during the year from the software developer team, directly working on Argo system maintenance (e.g. Matlab upgrades) and development work (e.g. continuing OWC Python tasks).

The composition of the Argo team at BODC underwent some changes, with Katie Gowers leaving BODC in January 2021 and Violetta Paba returning from maternity leave on a part time basis for a portion of the year. A long term sickness absence has also hit the team, reducing the FTE

contribution by approximately 0.33 FTE. Justin Buck is the ENVRI-FAIR project manager, which includes BODC contributions to the FAIR agenda wider than just Argo. This project has also involved contributions from wider BODC including Gwen Moncoiffe and Alexandra Kokkinaki for NVS content management support, technical advice and training.

General outlook

Core BODC Argo national capability funding from NERC remains static and is decreasing in real-terms. There is also additional funding from NERC associated with particular research projects and the floats they have procured, including from ORCHESTRA, ACSIS, BoBBLE and RoSES projects, but each of these draws to a close in the next year. BODC has secured set up funding for BGC floats purchased by NOC through NERC Capital funding. Efforts have continued to establish a clear plan for future funding to develop a more sustainable model of UK funding to support the UK contribution to the full-depth multi-disciplinary Argo array, but the funding situation remains challenging.

The Euro-Argo Research Infrastructure Sustainability and Enhancement (Euro-Argo RISE) project provides funding for developing core and deep DMQC (Delayed Mode Quality Control), management of BGC (Bio Geo Chemical) extensions and regional data quality assessments in the Southern Ocean. Additionally, BODC is funded under the EU H2020 project ENVRI-FAIR to introduce the NVS vocabulary server to support Argo vocabulary management.

BODC continues to seek additional sources of funding to support SOARC functions, but a long-term solution for sustained funding is yet to be identified.

Status

DAC functions

Data acquired from floats

BODC retrieves data for all UK, Irish, Mauritius and assigned EU MOCCA floats from a number of sources and archives these for further processing. BODC currently processes data from floats with Argos communications, Iridium Rudics and Iridium Short Burst Data (SBD) from a diverse fleet of floats manufactured by TWR, SeaBird and NKE.

Near real-time data delivery

Processing and delivery of incoming data is normally set up within one week of deployment where the capability already exists for a given float type. Since the last ADMT BODC has enabled capability to deliver two active Irish Arvor floats with oxygen and so the remaining outstanding floats for data delivery at BODC are two UK deep Arvor floats. Eight EU MOCCA floats ceased processing under the current version of the Coriolis decoder used at BODC for NKE floats and so processing has been temporarily transferred to Ifremer until we upgrade to the latest version.

Coriolis has been providing the processing for 13 PROVOR BGC floats and delivering the core data to the GTS on BODC's behalf.

The focus for the coming year is to enable the release of BGC profile data across TWR, SeaBird and NKE float models. Significant progress has been made towards building the infrastructure needed to deliver the near real-time BGC data from the UK floats. This is in preparation in part for the commencement of the ASBAN UK project.

Data issued to GTS

BODC delivers core data in NetCDF format to the UK Met Office four times a day, where it is subsequently issued to the GTS in BUFR format. Over 95% of the NetCDF files are delivered within 24 hours of the data being available to BODC.

Recent updates to the retrieval scripts at the Met Office has meant that Argo oxygen data from floats processed through BODC is delivered to and available for use by the GTS.

Data issued to GDACS after real-time QC

BODC delivers updated meta and tech files for all floats it processes alongside new core profile files to the GDACs as part of every processing run. Delivery of BGC profile data for most floats and many trajectory files are still pending.

During the past year BODC has tried to routinely address Altimetry QC and Objective Analysis reports shortly after receipt and made updates to the meta files following reports from the GDAC file checker.

Data issued for delayed-mode QC and sent to GDACs

The BODC DAC function currently interacts with DMQC operators through two different modes of operation. The first is internal BODC DMQC operators who directly submit DMQC decisions to the BODC Argo System, and for which updated D-mode NetCDFs are automatically generated and submitted. For floats managed through the Coriolis processing chain instance deployed at BODC, both internal and external DMQC operators submit updated NetCDFs which are archived within BODC and submitted to the GDACs.

DAC collaboration

In May 2021 BODC participated in a European Data Management Collaboration meeting where the aspiration was for improving sustained collaboration between key European data management partners including, but in addition to, specific EU-funded project work. Attendees included representatives from BODC and NOC (UK), Euro Argo ERIC, Ifremer, Coriolis, Sorbonne University and IMEV.

The vision from the BODC and Coriolis DACs were generally similar, to find ways to work together to make more rapid progress together in ways such as software development, DMQC, content and tools of the NVS, agreed ways of working, outreach, contributing to the ARCs, data processing and roles in BGC Argo. A follow-up meeting was agreed for early 2022.

BODC has collected responses from the recent DAC survey and is compiling a report which should be available in early 2022. Details of the second DAC workshop are yet to be finalised.

Web pages

NOC continues to maintain the UK Argo website (www.ukargo.net) along with a Facebook page (www.facebook.com/UKArgofloats/) and a Twitter account (twitter.com/ukargo). NOC also maintains the SOARC website (www.soarc.aq).

Data use and data products

Met Office

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. The FOAM suite now includes an improved resolution version of global FOAM with 1/12 degree horizontal resolution. This will continue to make use of Argo data to constrain the T/S fields in the same way as the original ¼ degree resolution system.

- 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 initialisation 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.

- A coupled weather forecasting system which is initialised using coupled data assimilation, is running successfully in 'parallel suite' and is due for full operational implementation in early 2022. Once this is implemented operationally Argo data will directly contribute to operational weather forecasts as well as ocean forecasts. An assessment of the impact of Argo in a lower atmospheric resolution version of that coupled system was detailed in King et al., 2019.

Met Office research & development applications (non-operational) which have made significant use of Argo data:

- A paper was published on OSSEs to investigate potential impact of expanding the Argo array (Mao et al., 2020);

- David Ford has done some OSSEs looking at the impact of the planned BGC-Argo array of floats in a global physical-biogeochemical model where he assimilates synthetic versions of the BGC Argo profiles in conjunction with satellite ocean colour data (Ford, 2021);

- One other project where we made good use of Argo data was in the assimilation of satellite sea surface salinity data from SMOS, Aquarius and SMAP. The near-surface salinity data from Argo was used to bias correct the satellite salinity data and was crucial for the performance of the assimilation of SSS data. That work is written up in Martin et al., 2019.

- Another paper was published investigating impact in FOAM and the Mercator system of satellite SSS assimilation which used Argo for assessment (Martin et al., 2020).

In the Hadley Centre for Climate Science and Services, Argo data is used to make the following products:

- EN4 contains in-situ ocean temperature and salinity profiles and objective analyses. It is updated monthly using real-time Argo profiles and GTSPP data, and annually using delayed-mode Argo profiles (and WOD, GTSPP and ASBO data). EN4 is freely available for scientific research use (see http://www.metoffice.gov.uk/hadobs/en4/). The latest version is EN.4.2.2, which includes a fresh download of all the source data and a substantial update to the XBT/MBT correction schemes. EN.4.2.2 contains four ensemble members where previously there were only two. There is also a new product user guide (based on both the Argo Users' Manual and the HadIOD user guide), including FAQs and example code. EN4 is also forming part of a GEWEX EEI project - comparing Ocean Heat Content calculated from reanalyses, in situ data and satellite products (the project website is https://sites.google.com/magellium.fr/eeiassessment/dissemination/documents?authuser=0).

- HadIOD (Hadley Centre Integrated Ocean Database) is a database of in situ surface and subsurface ocean temperature and salinity observations supplemented with additional metadata including bias corrections, uncertainties and quality flags. The dataset is global from 1850-present with monthly updates. The current version is HadIOD.1.2.0.0, the chief sources of data are ICOADS.2.5.1, EN4 and CMEMS drifting buoy data. This product has been available to the public since mid-2020 via https://www.metoffice.gov.uk/hadobs/.

Met Office science uses of the EN4 product include OHC analysis, contributions to BAMS, Ocean Obs'19 White Paper and an Earth Energy Imbalance paper (von Schuckmann et al., 2020).

National Oceanography Centre

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).

Plymouth Marine Laboratory

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

- investigating different aspects of the biological carbon pump (e.g., mixed-layer pump, fragmentation);
- investigating export fluxes and efficiency in hypoxic ocean regions;
- providing a description of the physical environment in the framework of biological (e.g. mapping eel migration routes) and biogeochemical studies;
- 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.

Real Time Mode QC of BBP data

PML, funded by the H2020 Euro-Argo RISE project, has developed a set of new tests to quality control optical backscattering (BBP) data in real time. These tests have been implemented on all BBP profiles held at the Coriolis GDAC to understand the impact that they would have on the existing global dataset as well as on the datasets held at each separate DAC. Preliminary results were presented in two workshops open to all international Argo members interested in RTQC of BBP data. Feedback from these workshops was incorporated in the latest version of the tests that will be proposed at the next ADMT. A preliminary summary document has been made available for further comments (https://docs.google.com/document/d/1amf58gLxhwuIM_Y3XxUmGdVyJXrm5IU48A_SnOYAu_A/edit). The code has also been made available through the euroargodev GitHub page (https://github.com/euroargodev/BBP_RTQC).

Delayed Mode QC

Core Argo

DMQC core progress

The strategy adopted to deliver the support to national programmes focused on ensuring a high-quality approach and the progressive enhancement of expertise. This involved adopting the latest reference databases, improving BODC's internal processing chain and fixing various technical issues to be able to perform DMQC analysis of the iridium communication floats, which was not possible before. This allowed a significant reduction of the majority of BODC's backlog.

The DMQC analysis has been undertaken on floats deployed in four different regions: the North Atlantic, the South Atlantic, the Southern Ocean, and the Indian Ocean. The analysis has been undertaken in separate batches for each of these regions, with priority given to floats that had already ceased functioning and those with a large number of profiles. This approach provided the opportunity to gain a deeper understanding of the regional oceanography in each region, the variability in float behaviour over time, and the challenges this raises in DMQC.

This work has resulted in a significant improvement in the total amount of delayed-mode profiles delivered by BODC compared with available real-time mode data. From February 2021 until the time of writing, BODC has submitted more than 12,600 profiles. The most recent statistics provided by Ifremer, from October 2021, shows that BODC has delivered around 78.5 % of delayed-mode data from all available data at the DAC. This is a significant improvement compared to the status in December 2018 where only around 45 % of profiles had been through DMQC, and this situation is expected to improve further in the coming year.

DMQC support was offered to any national programme requiring assistance, where BODC has significant physical oceanography expertise. BODC focused on supporting the UK and Irish Argo programmes, data for which are managed by the BODC Argo Data Assembly Centre (DAC) function.

The entire BODC Argo fleet went through the international DMQC audit run by external partners from the DMQC core Argo group. The audit was motivated by the fact that a higher percentage of SBE CTDs are now experiencing sensor drifts, which may not be easily identifiable by only examining individual time series. All of the identified BODC floats were reviewed, any additional revisions or corrections have been completed and re-submitted to GDAC. Additionally, the floats assigned to BODC, but DMQC-ed by external partners have been also reviewed and corrected where it was required.

A combination of the strong focus on comprehensive training provided to BODC Argo team members and the diverse requirements of DMQC ensures future sustainability in providing DMQC analysis and regular delivery of Argo data in delayed mode to the Argo Global Data Assembly Centres (GDACs).

DMQC core working groups

BODC (Kamila Walicka) actively contributed to activities related to the Abrupt Salty Drift (ASD) group, focusing on estimating the best practices, guidance and examples on how to treat salinity data that are affected by sensor drift to produce optimal adjustment in delayed-mode. This involved actively contributing to updating the shared list of floats affected by the salty drift and reviewing documentation related to the draft version of best practices for DMQC operators of core Argo floats. The final version will be incorporated into the QC Manual after the ADMT-22 meeting.

Conversion of core Argo DMQC software OWC from Matlab to Python

BODC (Kamila Walicka and BODC software developers) has continued development works related to the conversion of the DMQC software (OWC package) from Matlab to Python. This initiative is closely associated with the results from a survey about the existing tool and methods used within the DMQC Argo community, which was evaluated as part of the Euro-Argo RISE project Work Package 2 (WP2) last year. The survey identified barriers and opportunities to improve the efficiency and capacity of the overall community effort. A decision was reached to assess the potential for converting the OWC (Owens, Wong, Cabanes) Matlab code used for DMQC analysis to free software, with the widely-used Python being the preferred language.

The converted code is fully functional and waiting for User Acceptance Testing. The international Argo community has been encouraged to perform further testing to detect any unusual code behaviour, occasional errors characteristic for floats from various regions, and to report any further suggestions to improve the functionality of the overall package. However, except for some initial interest from the Argo community, the code has been exclusively tested by BODC's DMQC operator.

The development version of the OWC Python 'pyowc' package is currently available from GitHub Euro-Argo repository argodmqc_owc. The final destination of the code will be in ArgoDMQC where the Matlab version of OWC software is placed. The development work carried out by BODC over 2021 was focused on improving the code performance, readability and fixing any remaining known issues that arrived during testing the floats. The next steps to finalise the project are to continue the User Acceptance Testing involving the broader Argo community, improve code readability and enhance functionality related to configuration and code design. As part of the development work, there has been close collaboration with Guillaume Maze from Ifremer/LOPS to continue the development of the pre-processing procedures of the OWC method.

Combined with the potential to fully parallelize the analysis code, the conversion of OWC Matlab to OWC Python marks a step-change in capability and sets a new standard in quality control software development for the Argo community.

Deep DMQC

NOC (Brian King) was involved in the work of the Deep Argo team related to compiling the new update to the Argo Quality Control Manual for CTD and Trajectory Data, including the procedures for the Real-time QC flag shame and Real-time adjustments on Deep Argo vertical profiles. In April 2021, the Deep Argo team compiled the draft version of the procedures for DMQC of Deep Argo salinity data.

BODC has started development work on automatically applying the CpCor correction for pressure effects on conductivity data of deep Argo floats (>2000 dbar) in the Real-time QC process which was recommended by the Deep Argo team earlier in 2021. These corrections are needed in salinity data to remove the pressure-dependent salinity bias. This step is required to perform further analysis of deep Argo floats in delayed mode. Moreover, BODC is planning to implement the delayed-mode procedures for DMQC analysis of Deep Argo floats in the following year (2022).

BODC (Kamila Walicka) and NOC (Brian King) have been actively involved in the coordination and organisation of DMQC for deep ocean data as a part of the EuroArgo Rise WP3, Task 3.2. This involved organisation and coordination of the intermediate meeting with other European partners within the task and also providing a regular update of progress to the reporting body.

BGC DMQC

BODC (Violetta Paba) has not been able to make progress with DMQC of the UK BGC floats. In November 2021, LOV (Catherine Schmechtig) offered to DMQC the oxygen and radiometry data from the UK Metbio floats on our behalf. If available, Catherine may provide DMQC training to Violetta in the new year, so that BODC can reach the position to take these floats back on.

With regards to the tasked Euro-Argo RISE WP4 deliverable of enhancing the current oxygen QC methods, BODC (Violetta Paba) reviewed a report written by GEOMAR detailing a new methodology they had developed.

DMQC workshops participation and coordination

BODC (Kamila Walicka) and NOC (Brian King) were strongly involved in the co-organisation of the BGC and 3rd Deep Argo workshop led by Ifremer, between 27th September to 1st October 2021. The objectives of the BGC part of the workshop were to review progress made in implementing best practice in the area of floats preparation, float deployment and data management; exchange with the user community (e.g. biogeochemical modellers, ocean colour) to listen to their needs and develop synergies; and to foster interaction with other components of ocean observing system, including Deep Argo. The objectives of the Deep-Argo part of the workshop were to assess the progress of the Deep-Argo mission (from the scientific use of Deep Argo data to the technological ability of floats and sensors), to review end-users needs and to finalize the implementation plan of the global Deep Argo array. Additionally, BODC (Violetta Paba) presented the recent achievements and progress of BODC of the Argo metadata and NVS as a part of the ENVRI FAIR project. PML (Giorgio Dall'Olmo) presented the Real-Time QC tests for BBP data with regards to BGC floats. NOC (Brian King) demonstrated performance and issues of Deep Apex floats and CTD sensors of RBR floats. Moreover, Brian also gave a review presentation of how ocean circulation is being studied using Deep Float data.

NOC has committed to the preparation of hosting the 2nd European Argo/7th International Argo Delayed-mode Workshop for CTD data in Liverpool, UK. This workshop aimed to include the DMQC analysis for both core (2000 m) and deep (4000 m-6000 m) Argo floats, with the latter being a focus of the Euro-Argo RISE project WP3 on developing deep DMQC methods. The agenda and registration were advertised with the support of the Euro-Argo ERIC Office via *2020-DMQC-workshop.* The meeting was originally planned to happen from 12th May to 15th May 2020. However, due to the ongoing COVID-19 pandemic, this workshop has been postponed. The next DMQC workshop for deep Argo floats is planned for 2022 as an in-person event, on the condition of relaxation of international travel restrictions related to COVID-19.

GDAC Functions

NERC Vocabulary Server

Following on from ADMT-21, progress has been made on the EU H2020 ENVRI-FAIR work.

- BODC now hosts a GitHub space dedicated to the Argo Vocabulary Task Team (AVTT), where all NVS-related discussions and updates on Argo metadata tables can take place and be openly accessed: https://github.com/orgs/nvs-vocabs/teams/avtt
- BODC has provided the material to update the 'Argo vocabulary server' web page on the Argo data management website: http://www.argodatamgt.org/Documentation/Argo-vocabulary-server
- BODC (Roseanna Wright) has investigated the yet unconstrained metadata fields used in the Argo NetCDF file, and produced a programme-wide assessment, evaluating issues and proposing solutions. From this stemmed her work to create a new NVS collection for the originally unconstrained PI_NAME NetCDF field, now live on the NVS.
- BODC (Violetta Paba) and Ifremer (Guillaume Alviset) have collaborated on the creation of NVS collections for the trajectory tables. These are now live under collection ID R15 (measurement codes), RTV (cycle timing variables) and RMC (trajectory measurement code categories). Mappings between these tables are being created.
- SENSOR_MODEL collection R27 has been completed, and mappings between it and R26 (SENSOR_MAKER) have been created.
- BODC (Clare Bellingham) is working on creating NVS collection R28, which will capture the CONTROLLER_BOARD_TYPE vocabulary.
- Talks have been initiated with float manufacturers, specifically Teledyne, to improve the sharing and standardisation of metadata. BODC (Violetta Paba) is collating feedback from the ADMT community as to what requirements DACs may have.
- Moreover, a mappings mindmap between Argo NVS collections and beyond has been created to be used as a roadmap for future work.

Southern Ocean Argo Regional Centre

Developing SOARC Partnership

BODC continues to provide the coordinating role between the SOARC partners. This has led to a growth in the partnership to include another partner from the SIO, USA in the SOARC group. BODC (Matt Donnelly) liaised with various organisations improving the partnership and further collaborations:

- Began engaging with the Polar Collective, who are an outreach organisation trying to link scientists within the Southern Ocean (SO). They might be a good partner to sustain links with IAATO.
- Together with other SOARC members, reviewing the OceanOPS activities that may influence and help the SO deployment coordination which led to the draft proposal for regional coordination of Argo floats.
- Began engaging with the UK's Net Zero Oceanographic Capability (NZOC) project regarding improving awareness of Argo's under-ice capabilities.
- Putting the Kent Scouts ReQuest 2021 project, who are undertaking an expedition on Bark Europa, in touch with the Dutch programme manager Andreas Sterl to rekindle float deployments from the ship. Bark Europa is a member of IAATO. Matt created a Google Map of suggested priorities to deployments of their floats in the SO.

Regional data quality assessments

As part of the Euro-Argo RISE project WP5, Task 5.3, BODC (Kamila Walicka) and NOC (Brian King) have been working to establish a method of regional data quality assessment in the SO.

BODC has started a review of the currently available reference data which could be potentially used to support the quality assessment in the SO. This included meeting with Matt Mazloff from SCRIPPS and BSH partners to better familiarize with the model-based reference data developed by Matt Mazloff to form the basis for establishing regional data quality assessments for core Argo in the SO and potentially other applications including future BGC data quality assessments and observing system design. This could be useful for both undertaking regional data quality assessments and also highlighting where we are lacking sufficient observations on a finer granularity than we currently have available to us.

BODC updated and set up the internal local mirror of the entire set of GDAC Argo profiles. This dataset is updated weekly on NOC's server and will be used as a source of Argo data for regular quality assessment of all floats from the SO.

BODC reviewed and tested the tool for characterisation of Southern Ocean Argo float profiles that was developed by the University of Bristol https://github.com/argosoarc/soarc_floatchar. This code characterises profile location into zones according to core profile data in accordance with literature-based criteria of the ACC fronts and zones. This method reduces the impact of selected reference data from other zones in the SO during the quality checks of salinity data of Argo floats.

BODC (Kamila Walicka) and NOC (Brian King) organised a meeting with Andrea Garcia Juan from Ifremer to familiarise with the newly developed tool for the reference data characterisation. The code is based on the machine learning methods and was developed in Ifremer as a part of the Euro-Argo RISE WP2 package, related to improving tools of quality control of core Argo floats. BODC is going to review this code and assess the possibility of the future use of the code in Argo floats and reference data classification approach to improve the regional quality assessment of Argo floats in the SO.

BODC has started the review of the assessment method of the DMQC-ed floats used by Coriolis ARC in the North Atlantic to identify if some elements of this method could be used in the assessment in the SO.

Another step is to review the quality and identify any common patterns of analysis of already DMQC-ed floats from the SO from various DACs. Moreover, the work in reviewing other potentially useful reference databases and review of the assessment method used in Atlantic ARC will be continued. BODC will also review the currently available machine learning techniques to classify ocean vertical profiles for DMQC, developed in Ifremer as a part of the Euro-Argo RISE WP2 project, to determine a base for further cooperation and potential use of this technique in quality assessment in the SO.

References

Cabanes Cecile, Angel-Benavides Ingrid, Buck Justin, Coatanoan Christine, Dobler Delphine, Herbert Gaelle, Klein Birgit, Maze Guillaume, Notarstefano Guilio, Owens Breck, Thierry Virginie, Walicka Kamila, Wong Annie (2021). DMQC Cookbook for Core Argo parameters. https://doi.org/10.13155/78994

Ford, D. (2021). Assimilating synthetic Biogeochemical-Argo and ocean colour observations into a global ocean model to inform observing system design. Biogeosciences, 18:2,509-534, doi:10.5194/bg-18-509-2021

King, R.R., D.J. Lea, M.J. Martin, I. Mirouze and J. Heming. The impact of Argo observations in a global weakly-coupled ocean-atmosphere data assimilation and short-term prediction system. Q J R Meteorol Soc. 2019; doi:10.1002/qj.3682

Mao, C., R. King, R.A. Reid, M.J. Martin and S. Good (2020). Assessing the Potential Impact of An Expanded Argo Array in An Operational Ocean Analysis System. Front. Mar. Sci., 7: 905, doi: 10.3389/fmars.2020.588267.

Martin M.J., King R.R., While J., Aguiar A.B. (2019). Assimilating satellite sea-surface salinity data from SMOS, Aquarius and SMAP into a global ocean forecasting system. Q J R Meteorol Soc 2019;145:705-726. https://doi.org/10.1002/qj.3461

Martin, M. J., E. Remy, B. Tranchant, R. R. King, E. Greiner & C. Donlon (2020). Observation impact statement on satellite sea surface salinity data from two operational global ocean forecasting systems, Journal of Operational Oceanography, DOI: 10.1080/1755876X.2020.1771815.

von Schuckmann, K., Cheng, L., Palmer, M. D., Hansen, J., Tassone, C. , Aich, V. , Adusumilli, S. , Beltrami, H. , Boyer, T., Cuesta-Valero, F. J., Desbruyeres, D., Domingues, C., Garcia-Garcia, A., Gentine, P., Gilson, J., Gorfer, M., Haimberger, L., Ishii, M., Johnson, G. C., Killick, R., King, B. A., Kirchengast, G., Kolodziejczyk, N., Lyman, J., Marzeion, B., Mayer, M., Monier, M., Monselesan, D. P., Purkey, S., Roemmich, D., Schweiger, A., Seneviratne, S. I., Shepherd, A., Slater, D. A., Steiner, A. K., Straneo, F., Timmermans, M.-L., Wijffels, S. E.. Heat stored in the Earth system: where does the energy go? Earth Syst. Sci. Data 2020; 12, 3, 2013-2041. https://doi.org/10.5194/essd-12-2013-2020.

US NATIONAL DATA MANAGEMENT REPORT

21st ADMT

November 21, 2020 - December 1, 2021

STATUS

US Argo Data Assembly Center at AOML

The US Argo Data Assembly Center (DAC) at AOML is responsible for processing of Argo data obtained from all US floats. During the reporting period the DAC has received real-time data from 2,092 floats and sent more than 87,000 profiles to the GDACs. In addition to this, the US Argo DAC distributed meta, technical and trajectory files in the Argo NetCDF files to the GDACs as part of the real-time processing.

The DAC distributed over 86,900 Argo profiles to GTS in the BUFR format. Both for GDACs and GTS 92% of the profiles reached the system within 24 hours. If floats with large delays are excluded (e.g. new deployments and floats under ice), then 98% of the profiles are available in 12 hours and 99% of the profiles are available in 24 hours.

The DAC also passes the files on to the GDACs that come from delayed-mode processing, BGC float processing and auxiliary files. For this purpose, the DAC maintains an ftp server for file exchanges, both for providing reprocessed R-mode and meta files as well as for receiving D-mode files, real-time submission of data from Iridium floats and the submission of deployment information.

Overall, the US Argo DAC has 1,346,053 R-files, 1,131,360 D-files, 86,038 BR-files, and 81,448 BD-files. The corresponding numbers for non-profile files are 7,941 meta, 7,777 tech, 7,775 Rtraj and 2,079 Dtraj files.

The US Argo DAC added 287 new floats to the processing system, 28 of them were deployed in collaboration between AOML and WHOI . As part of this collaboration, the US Argo DAC is finding ships of opportunity and provides ship riders for selected cruises. Recent maps showing their positions with link to graphics of the data collected by the floats can be found at:

https://www.aoml.noaa.gov/phod/argo/opr/php_forms/deployment_maps.php

The US Argo DAC is maintaining a website that provides documentation and information about the operations: http://www.aoml.noaa.gov/phod/argo/index.php

Developments at the US Argo DAC

2.3: Software Development at the US Argo Data Assembly Center (DAC)

During the current reporting period, one Argo team member moved on to a new career.

As in the past, changes in float technology or core Argo floats, sensor configuration on BGC floats as well as decisions by the IADMT, of which AOML is a major contributing partner, will be the main reasons for changes to existing software and the development of new software. The trajectory NetCDF file format version 3.2 has been defined in user manual 3.41 (July 2021). The format checker will be updated to check such files (target date June 2022). We already started developments needed for adding BGC data to the traj 3.2 files. We started this after setting up the data processing system for APEX Iridium BGC floats deployed in September 2021 by AOML (to receive their data the DAC set up a Rudics server; a secondary Rudics server is hosted by UW). This required expanding the decoding and quality control capabilities to include the processing of BGC beyond oxygen. The processing system for these floats handles nitrate, pH, chlorophyll-a fluorescence, and suspended particles. The data are processed following the cookbooks and the quality control manuals for oxygen as well as these new parameters and the resulting data files are distributed via the GDACs. Beyond revising the decoder, this required (1) updating the software that checks and expands the information in the meta files containing all information needed to process the data and write the meta files in compliance with Argo NetCDF standards; (2) updating the quality control software package; and (3) updating the software generating the profile NetCDF files. At this time, we are working on the expansion of the BGC processing system to handle radiometer data. AOML continues to collaborate closely with the US Argo partners on the expansion of our BGC capabilities and provide feedback related to the new SOLO BGC float data processing. Thanks to the recent hiring of two new team members that will get our team back to the size we need in the near future we will be able to make faster progress on pending work (e.g. MEDD test, adding error ellipse information to the trajectory NetCDF files).

We implemented improvements to the software checking the content of the ASCII meta files that are needed for the processing of float data, and we set up a system to expand their content by adding sensor pre-deployment calibration information from various files provided by US Argo groups. We also interacted with US Argo partners expanding to BGC to help them create such ASCII meta files for their floats (APEX, NAVIS, SOLO Iridium floats). The expansion to processing radiometer data is underway.

The US DAC moved the mirror processing system from a Unix server at a fixed location to a virtual linux server in the cloud. This mirror system can handle real-time processing and distribution as well as pushing delayed-mode data to the GDACs. It is running all the time, and can take over distribution if necessary (i.e., if the main processing system is down for more than a few hours).

Adaptations throughout the processing system were made to accommodate data from floats with the new RBR CTD. This sensor has an additional temperature measurement taken inside the conductivity cell, and it requires special treatment during the quality control. Changes to accommodate these data were needed in the profile, meta and trajectory data processing modules.

For float profiles that are received without a position, additional steps were implemented to allow adding an interpolated position if a profile with a position comes in at a later time.

All software was revised to accommodate cycle numbers exceeding 999, which became necessary due to improvements of float life times. The global range tests for pressure, temperature and salinity were updated after revisions were approved during ADMT-20. Similarly, adaptations were implemented to expand capabilities for storing more extensive information on the batteries in the floats in the meta NetCDF files.

We gave recommendations to facilitate using the relatively new quality control reports based on an min/max test.

DELAYED MODE QC:

The US Argo DAC receives the Delay mode Argo profiles from US delayed-mode operators and verifies their contents to ensure soundness of the files if requested.

Each US Argo institution has provided information on their delayed-mode processing which was added to this report.

NOAA/PMEL

As of 28 November 2021, PMEL had 206,593 D-files at the GDAC that were more than one year old, comprising 86% of the total of 241,040 PMEL profiles that were older than one year at that time. Last year, on 18 November 2020, PMEL had 194,681 D-files at the GDAC that were more than one year old, comprising 88% of the total of 220,238 PMEL profiles that were older than one year at that time. So, John Lyman's and Kristene McTaggart's DMQC efforts resulted in a net increase of 11,912 DMQC profiles for profiles older than one year, about 57% the 20,802 profiles that became older than one year during that time. This reduction in the DMQC rate was largely owing to the continued challenges of COVID-19, teleworking, and a hard drive failure in early August which left us without a computer for months.

Lyman and McTaggart are continuing their DMQC work. Lyman is also continuing work on streamlining our DMQC GUIs and processing. Lyman has updated mapping in OWC for use with deep Argo floats. This was done by limiting the reference data set to CTD greater than 3000 m that are in the same basin as a given deep Argo profile. The process is made possible by using deep basin definitions provided by Sarah Purkey.

The PMEL float DMQC procedure currently consists of the following steps: We perform an

automated correction, with visual check, of reported pressure drifts and correction for the effect of these pressure drifts on salinity, as well as an automated correction of conductivity cell thermal lag errors following Johnson et al. (2007). We do visual inspection and modification of quality control flags for adjusted pressure, temperature, and salinity using the SIO GUI and the Lyman GUI. We overwrite the raw Param_QC flags during this step as required. We use OWC Version1.1, currently with CTD (CTD_2021v1) and Argo (2020v03) reference databases, and adjust run parameters to get appropriate recommended salinity adjustments. Errors in OWC are computed directly from the least squares fit. We accept or reject the OWC recommendations on the basis of comparison with nearly historical profiles using a new PMEL GUI recently written for this step.

Scripps Institution of Oceanography

Scripps Institution of Oceanography (SIO) has evaluated, as part of delayed-mode quality control (DMQC), a total of 295,628 Argo stations (profiles). This is an increase of 20,409 stations (559 nominal float years) since the previous Argo Data Management Team (ADMT) Report (November 23, 2020). This count represents 96.7% of the SIO DMQC-eligible stations (older than 12 months). The above numbers include SIO Core and Deep Argo floats, all Argo New Zealand floats, presently active NAVOCEANO floats deployed from the Peruvian vessel Zimic and 1 float donated to Argo Mexico.

SIO expects to maintain a high DMQC completion percentage during the coming year and will hope to return to a 7-9 month revisit schedule. The past year has been a challenge. Remote DMQC is a slower process due to bandwidth issues. Even with the ability to DMQC through remote access, personnel availability has been squeezed. The DMQC of SIO’s deep floats have been delayed while the CpCorr and the pressure sensor studies are ongoing. DMQC of all SIO Deep SOLO floats should commence early 2022. The consensus standard DMQC procedures for SOLO/SOLOII/Deep profile data were continued in 2021.

The timeliness of SIO real time data arrival at the GDAC has been excellent. A recent analysis of SIO data collected between 1 Oct 2020 and 30 Sep 2021 showed 97.6% of profile data reaching the GDAC within 24 hours and 89.9% reaching the GDAC within 6 hours. This calculation used the float surfacing time, so the span includes the time of transmission, SIO SBD/directIP processing, and AOML DAC netCDF creation.

SIO has actively participated in moving forward the priorities of the Argo Program during the year. A non-exhaustive list follows. Megan Scanderbeg's continued work to improve data access descriptions for users and to communicate more often with operational users. SIO continues to update the Argo Climatological Dataset for OW salinity calibration. John Gilson has worked with Annie Wong to provide an Argo-wide audit on the profile netCDF salinity adjustments. Nathalie Zilbermann and Dean Roemmich have worked with Seabird to improve the calibration of the SBE61 CTD (0-6000dbar capability). Sarah Purkey and Jeff Sherman (IDG lab) have led the development of the SIO BGC SOLO.

The SIO IDG built and designed SOLOII/Deep SOLO float firmware has been unchanged over

the course of the year, except for minor internal bug fixes.

University of Washington

Delayed mode processing at UW has produced 28,817 D-files and 26,244 BD-files for the year 2021. These total file numbers include newly processed files as well as those re-processed due to changes in calibration or identification of anomalies that were subsequently corrected. In terms of active floats (those that have transmitted new data within the last two years), the UW fleet is >90 % up to date with respect to core (P, T, S) Argo profiles. With respect to both active and legacy floats equipped with DOXY, UW floats that are not handled by MBARI are >95 % up to date. Work has begun to prepare for the production of V3.2 Dtraj files, which will include surface air O2 for SOCCOM and GO-BGC floats. For other pilot data, UW has been active with other Argo groups in developing data management procedures for Deep Argo and RBR CTD. One activity of note at UW in 2021 was a global Argo delayed-mode salinity audit, which was done in collaboration with SIO, and which resulted in a best practices chapter for the QC Manual.

MBARI (Monterey Bay Aquarium Research Institute)

Biogeochemical data from 153 operational five-sensor BGC-Argo floats are currently being processed and subjected to real-time and delayed mode quality control by MBARI. This includes 102 active SOCCOM floats in the Southern Ocean, 31 active “SOCCOM-equivalent” partner floats in various locations, and 20 active floats deployed as part of the recently funded Global Ocean Biogeochemistry (GO-BGC) array. All float data is managed by Tanya Maurer, Josh Plant and new MBARI team-member, Emily Clark.

Despite impacts from COVID19, float deployments continued throughout 2021, although numbers were reduced compared to previous years. Only 1 SOCCOM cruise went out, resulting in the successful deployment of 10 5-sensor floats at the start of 2021 (all are operating). The GO-BGC multi-institutional float program was successfully launched, starting with the initial cruise along the A20/A22 GOSHIP lines in March-April, 2021. One of 12 APEX floats was declared dead upon deployment; all other floats continue to operate, despite a few isolated sensor issues which have been appropriately handled in the data system (through RT and DM QC measures). GO-BGC deployments are ongoing. In addition to SOCCOM and GO-BGC, MBARI continues to assist with data processing and management for floats within programs outside of these programs, including 2 WHOI 5-sensor Navis deployed in May, 2021 in the northeast Atlantic, as well as 1 Navis and 1 APEX NOAA/PMEL float deployed in the North Pacific in October, 2021.

MBARI has also been involved in processing and management of data from various test-floats, including 2 APEX with SBS83 optodes, 2 APEX with OCR, and one 5-sensor APEX with a Gasket DuraFET (GDF) pH sensor (a new pH sensor design developed by the Johnson lab at MBARI). All test deployments have been successful thus far.

BR- files are being generated and transferred to the Argo GDACs for all 5-sensor operational floats (Navis and APEX) at a frequency of twice per day. Delayed-mode quality control assessment of oxygen, pH and nitrate data is performed on a tri-annual basis. BD-designated files generated at MBARI signify that at least a preliminary DM assessment has been performed, although BD* files are subject to updates periodically throughout a float's life. MBARI-developed MATLAB software used to perform BGC DM assessment is publically available through the SOCCOM github at https://github.com/SOCCOM-BGCArgo/ARGO_PROCESSING and methods are described in Maurer et al (2021).

MBARI continues to generate a semi-annual audit on DOXY profiles to assist DACs with furthering the amount of adjusted DOXY data at the GDAC. Work is ongoing and international response to this audit has been successful thus far (information on the audit can be found on the MBARI ftp: ftp://ftp.mbari.org/pub/BGC_argo_audits/DOXY/). Documentation outlining quality control methods for NITRATE (including real-time and delayed mode procedures) was produced this year as well with contributions from MBARI and recently published on the Argo Data Management Team web site (https://doi.org/10.13155/84370). Additionally, MBARI continually supports the ADMT; Tanya Maurer serves as co-chair of the BGC-ADMT task team and MBARI data team members remain active in ADMT working groups focused on various BGC parameter topics.

Wood Hole Oceanographic Institution

During 01 October 2020 – 30 September 2021, WHOI deployed 57 new Argo floats representing three different hardware platforms: 48 MRV S2A, 6 MRV Alto, and 3 SBE NAVIS-BGC. Over this time period the active fleet consisted of 416 unique platforms reporting a total of 15,852 new profiles. The WHOI contribution to the GDAC now comprises 23,5958 total profile files (201,477 D-mode files, 3,4481 R-mode files). Of those older than one year (219,475 in total),199295 files are in D-mode status representing a completion rate of 90.8%. WHOI currently has 116 floats on the greylist for sensor issues (85% of which are active floats). We have identified at least 24 CTDs with conductivity sensor drift consistent with the 'fast salty drifter' cohort.

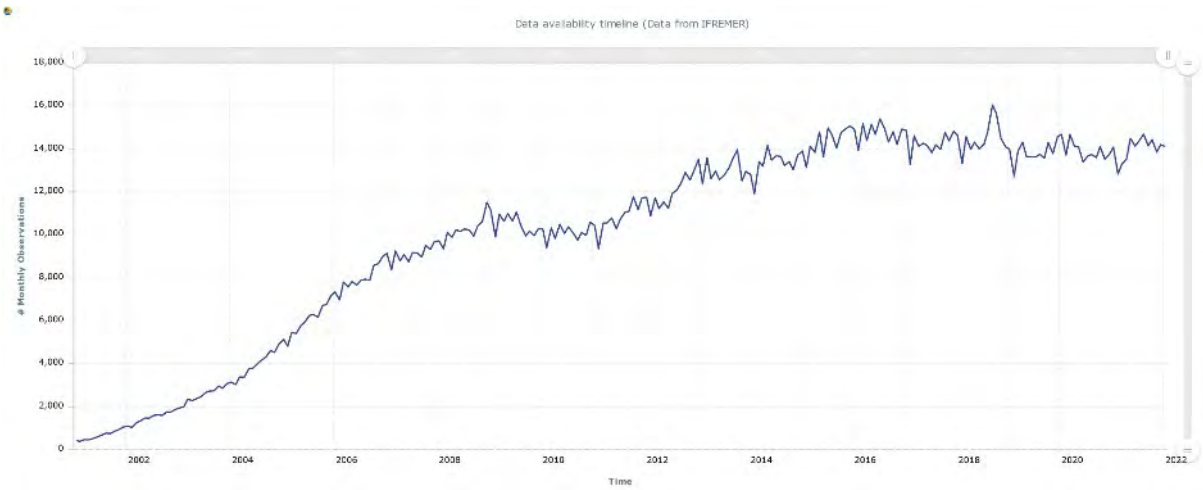
OceanOPS ADMT report 2021

Data availability

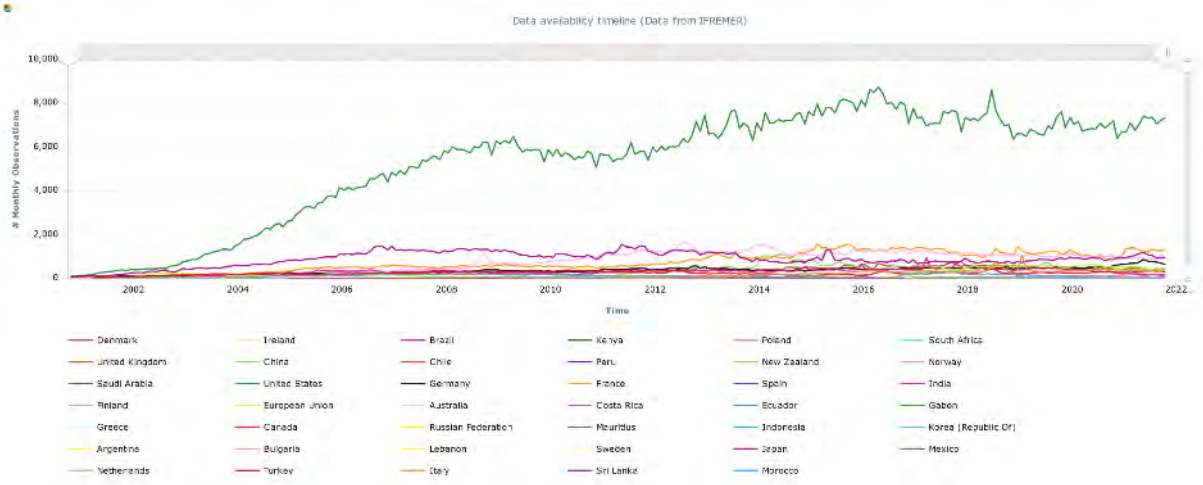
The timeseries below show the stability of the monthly available observation globally (first figure) and sorted by countries (second figure). This respectively shows the overall good health of the Argo program, providing a steady number of observations since 2015. The third timeseries shows the same information without the US in order to visualize more clearly the contribution of each country to the argo program and the increase in a significant number of countries' contribution to the network . Finally the fourth figure shows the percentage of contribution of each country to the Argo program in terms of observations, with the USA continuing to support around 1/2 of the observations provided by the network.

Key features :

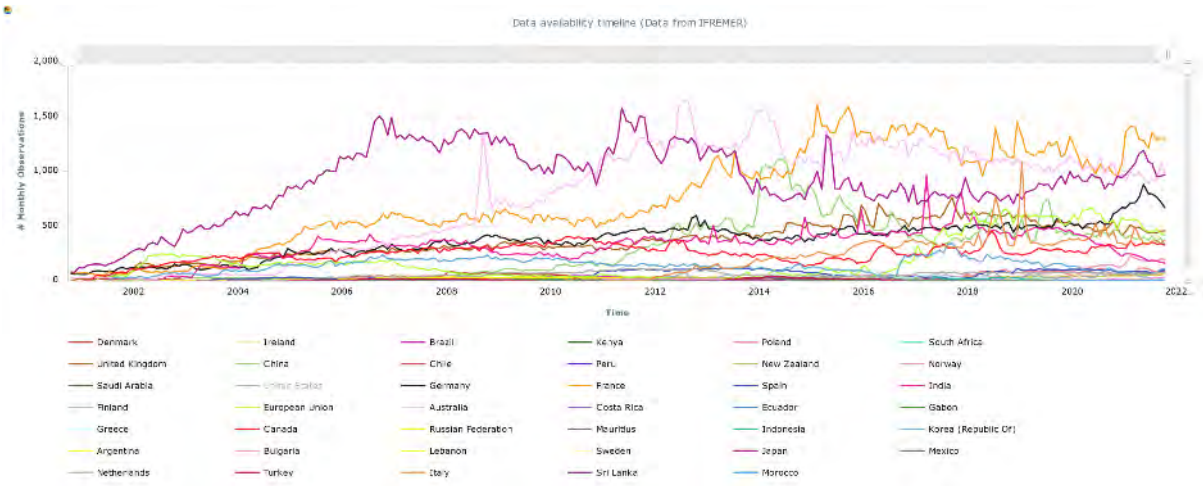
- Nb of daily obs: between 450-500 profiles
- Monthly : 14 000 profiles
- Yearly : 168 000 profiles
- 2550000 cumulated profiles



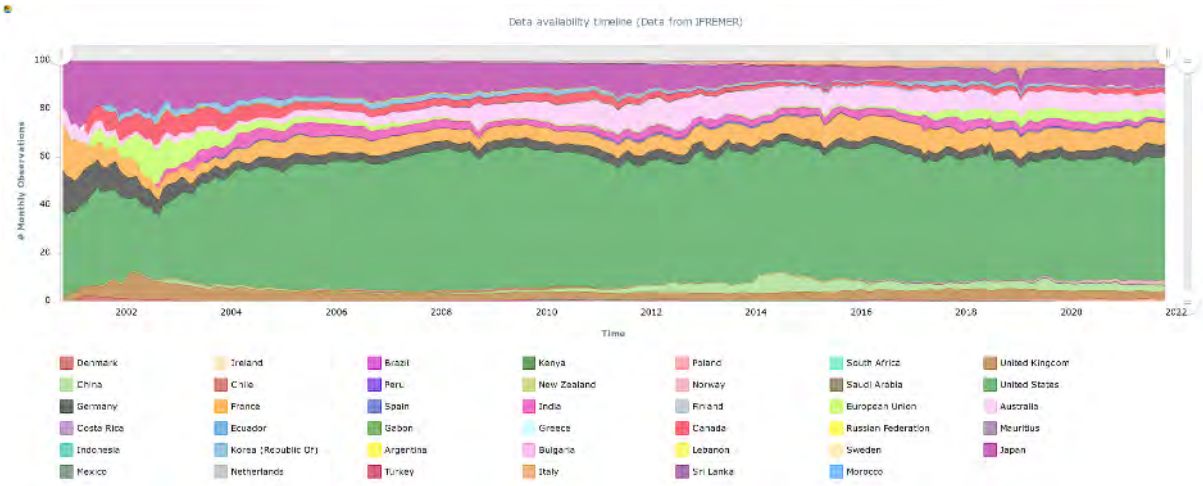
Number of monthly observations available since 2006



Number of monthly observations provided by countries since 2006



Number of monthly observations provided by countries since 2006 - focus without US

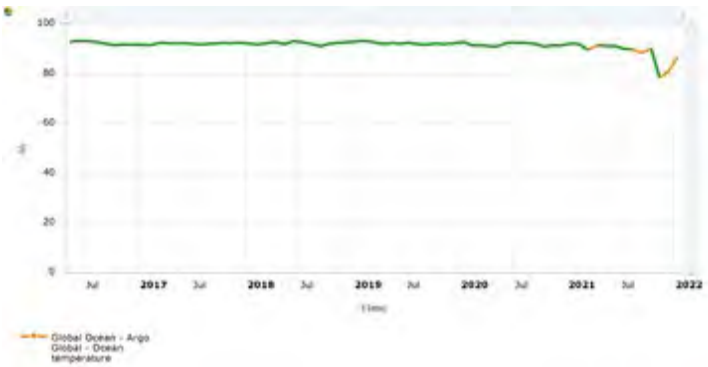


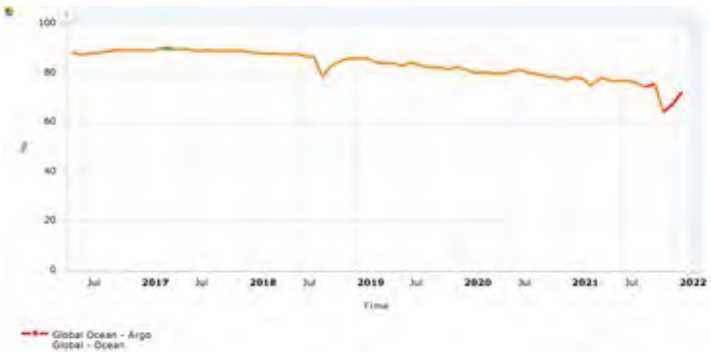
National contributions to the Argo observations

Data Quality by variable

These KPIs show, by variable, the percentage of observations with the highest level of quality “A” (adjusted in Real Time). The raw count is the number of observations in the last month at a quality “A”. This is a new statistic for BGC variables available since January 2022 computed from the GDAC index file that includes most of the existing available data sets.

Core variables





These two times series show the evolution of the quality indicator. Salinity (right) is slowly dropping below 80% partially due to the Abrupt Salinity drift of SeaBird CTD while quality of temperature data remains very good. The drop in late 2021 should be investigated further.

BGC variables

OceanOPS initially computed BGC statistics following the Core Argo procedure. Consequently, the results below have generated many discussions within the BGC data community to try to understand why those values were misleading and how we should process them in the future.

Requirements from BGC data chairs to compute useful statistics on quality are :

- **Quality indicators will only be computed only for floats with a data mode “A” and “D” since raw, unadjusted BGC parameter data (by definition) should never receive a quality flag of "1".**
- **The floats and variables with no “profile_param_qc” should be considered in the computation.**
- **The data mode distribution of a float sample will be computed.**
- **“profil_param_qc” A and B will be considered as good quality, since it is not uncommon for BGC profiles to have a small percentage of data flagged 'bad' in real time due to various specific sensor behaviors (ie 'oxygen hook' at depth).**

- **In these conditions of computation, a target of 90% of good quality will be kept for each variable.**

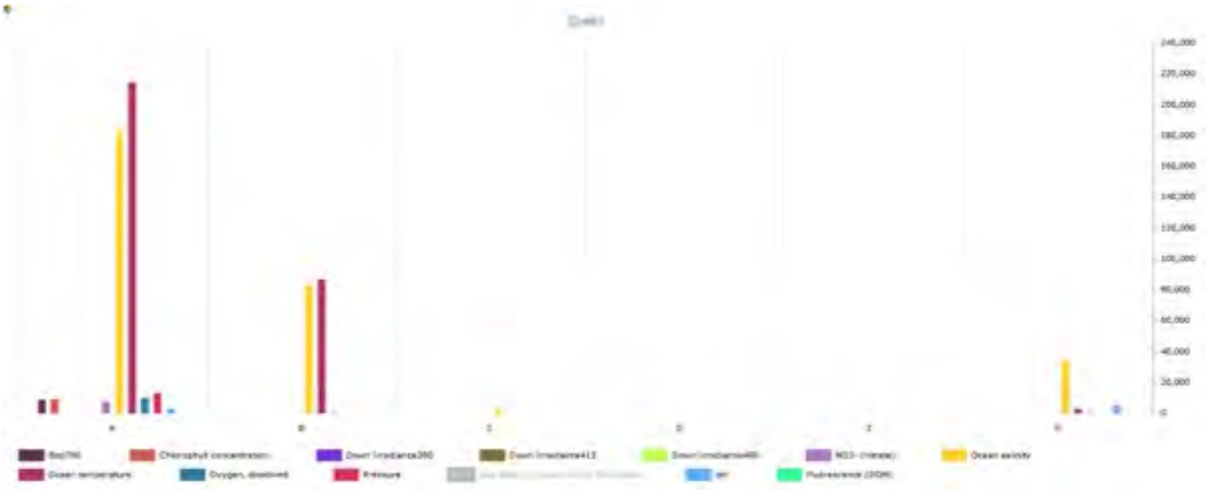
Below are the current values of the quality statistics for BGC variables. We have decided to maintain those statistics in the report to keep track of the discussion at this stage.

Data Flow

Quality (variable) Argo Global - pH	28.67% 1/2022	164 Raw count	90% Target	# of monthly obs of best quality - pH
Quality (variable) Argo Global - Chlorophyll concentration	43.44% 1/2022	384 Raw count	90% Target	# of monthly obs of best quality - CHLOROPHYLL
Quality (variable) Argo Global - Oxygen, dissolved	59.6% 1/2022	1012 Raw count	90% Target	# of monthly obs of best quality - DOXY
Quality (variable) Argo Global - NO3- (nitrate)	67.39% 1/2022	343 Raw count	90% Target	# of monthly obs of best quality - NITRATE
Quality (variable) Argo Global - Bbp700	69.46% 1/2022	614 Raw count	90% Target	# of monthly obs of best quality - BBP700

The KPI above has been computed for the first time in January 2022 considering all data mode profiles. But the BGC data needs adjustment before being used and this adjustment requires for some variables a few cycles before being made. The target % will need to be revised with the ADMT BGC team as 90% within a month is impossible to reach for many variables and probably a quarter would make more sense for most EOVs that need scientist intervention for this assessment.

It is now possible to display the global quality of each variable of a subset of floats. The chart below shows the distribution of the data quality by variable for the operational fleet in February 2022. It has been computed for data mode R,A,D. The horizontal axis is the level of quality of each observation, the vertical axis represents the number of observations, and the colors represent the variables. The number of profiles with no “profil_param_qc” should be removed from the computation and their percentage in the subset should be indicated in the statistic.



Distribution of the data quality ranking for each variable

Reminder: A = 100¨% of good profiles / B = 75% to 100% of good profiles / C = 50% to 75% of good profiles / D = 25% tot 5° % of good profiles / E = 0% to 25% of good profiles / F = 0% of good profiles.
For each variable, the percentage of available profiles at quality “A” is over 75% for all the variables except PH (35%), Chlorophyll (46%) and dissolved oxygen (69%). Fluorescence and down Irradiance 443 and Down Irradiance 555 are weak in terms of data quality should not be taken into account at this stage of the implementation of this KPI. The procedure to qualify Fluorescence, and down Irradiance quality has been agreed during the last ADMT meeting and still need to be implemented..

Data Quality – Delayed mode processing
This indicator shows the availability of delayed mode data files after a year. 87% of the Temperature & Salinity observations older than a year have been processed in delayed mode and are available. This is a great percentage, continuously growing as shown in the time series below.

The time series shows the evolution of the KPI above.

Such performance highlights the effort made by the DM operators to continuously process the data sets in delayed mode in due time, especially to correct from the ASD rapidly .

.

Data quality – Timeliness

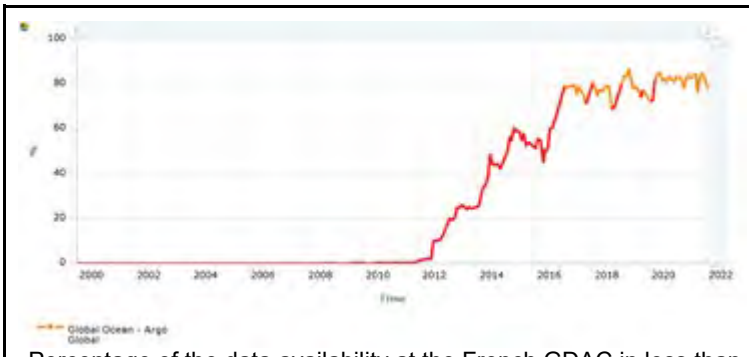
The table below aggregates the KPIs showing the percentage of availability of observations at the US and French GDAC level and on the GTS (Meteo France node) after 12h and 24h.

	12h	24h
GDAC US	81.49% 1/2022 ↗	86.95% 1/2022 ↗
GDAC FR	77.61% 1/2022 ↘	82.68% 1/2022 ↘
GTS FR	95.39% 1/2022 ↗	98.27% 1/2022 ↗

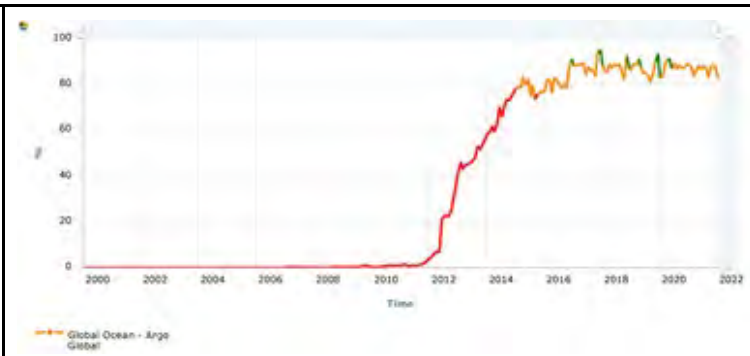
It is noticeable that almost the full Argo data set is available on the GTS in less than 12h, making the global array fully usable by the modeling and forecasting community.

It is also important to note that the performance of the French and US GDACs are stable since 2018 for the 12h and 24h due time.

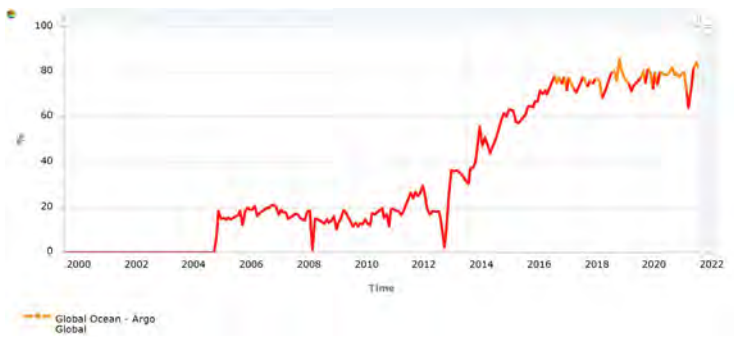
The computation of the trend (i.e. arrow) will be improved to reduce its variability. The trend will be calculated on a 3 to 6 month window compared to one month currently.



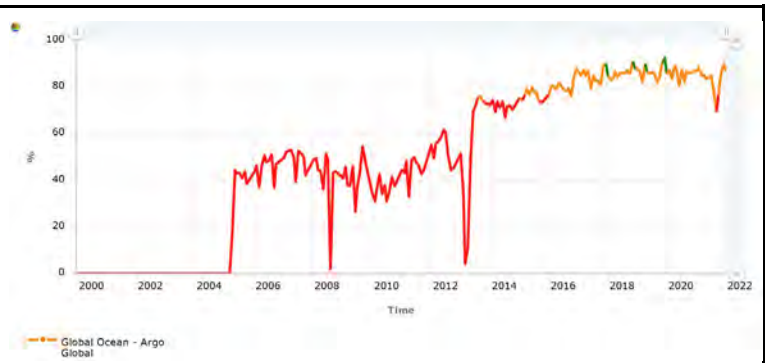
Percentage of the data availability at the French GDAC in less than 12h



Percentage of data availability at the French GDAC in less than 24h



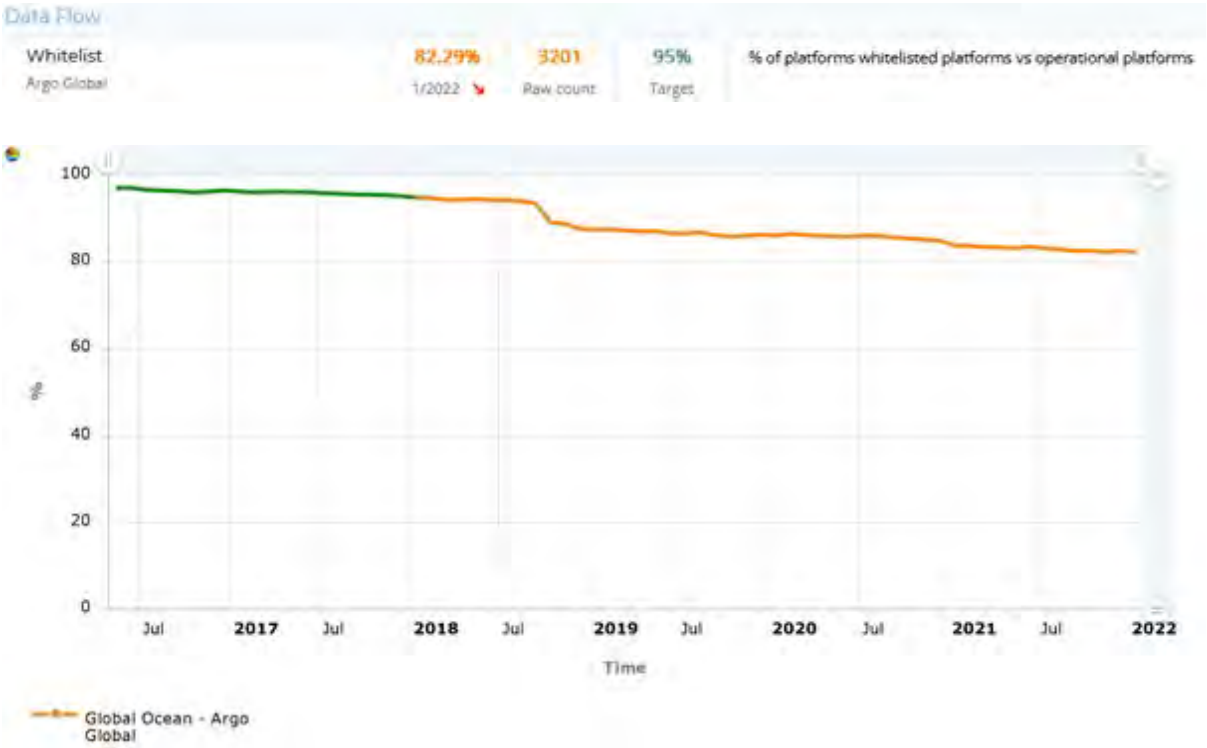
Percentage of the data availability at the US GDAC in less than 12h



Percentage of data availability at the US GDAC in less than 24h

Argo whitelist

The KPI below shows the percentage of platforms whitelisted vs the percentage of operational platforms. The timeseries show the evolution of this indicator since it is computed.

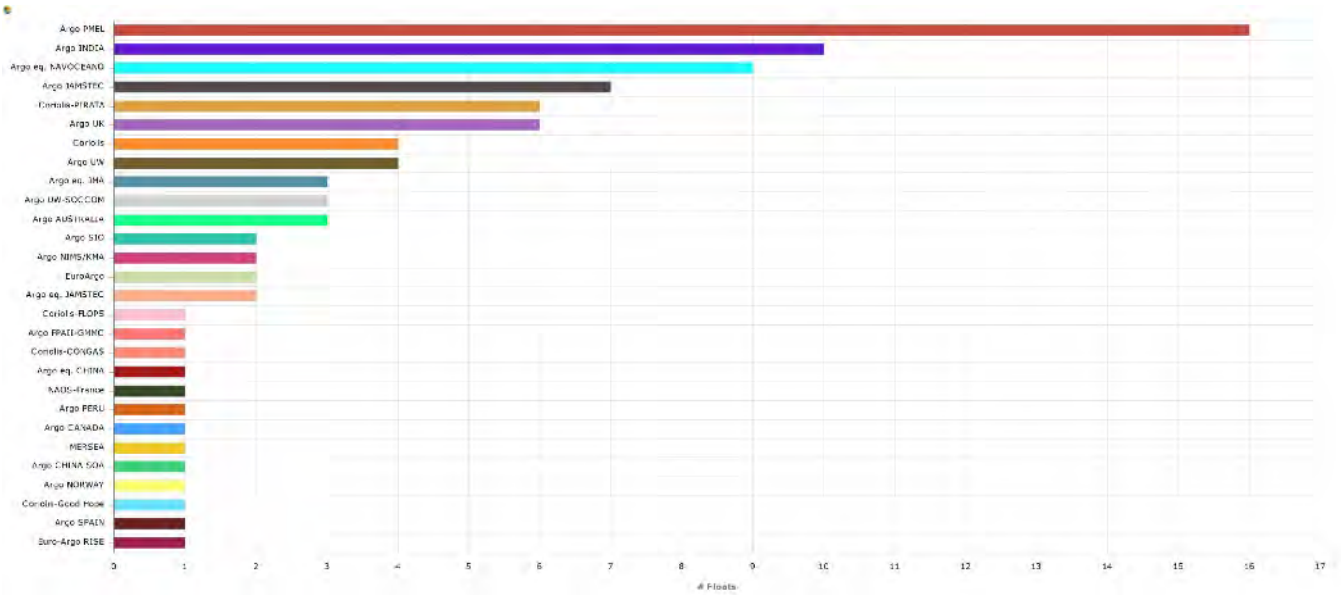


It is noticeable that this indicator is continuously decreasing since it has been computed in 2017. **The reasons for such a monotonic trend since 2018 may be linked to the salinity problem on SeaBird sensors**. Despite that 89% of the argo fleet have an SBE41CP* sensor model onboard, it is more than 95% of the blacklisted floats that is carrying a SBE41CP* sensor model.

Pending QC

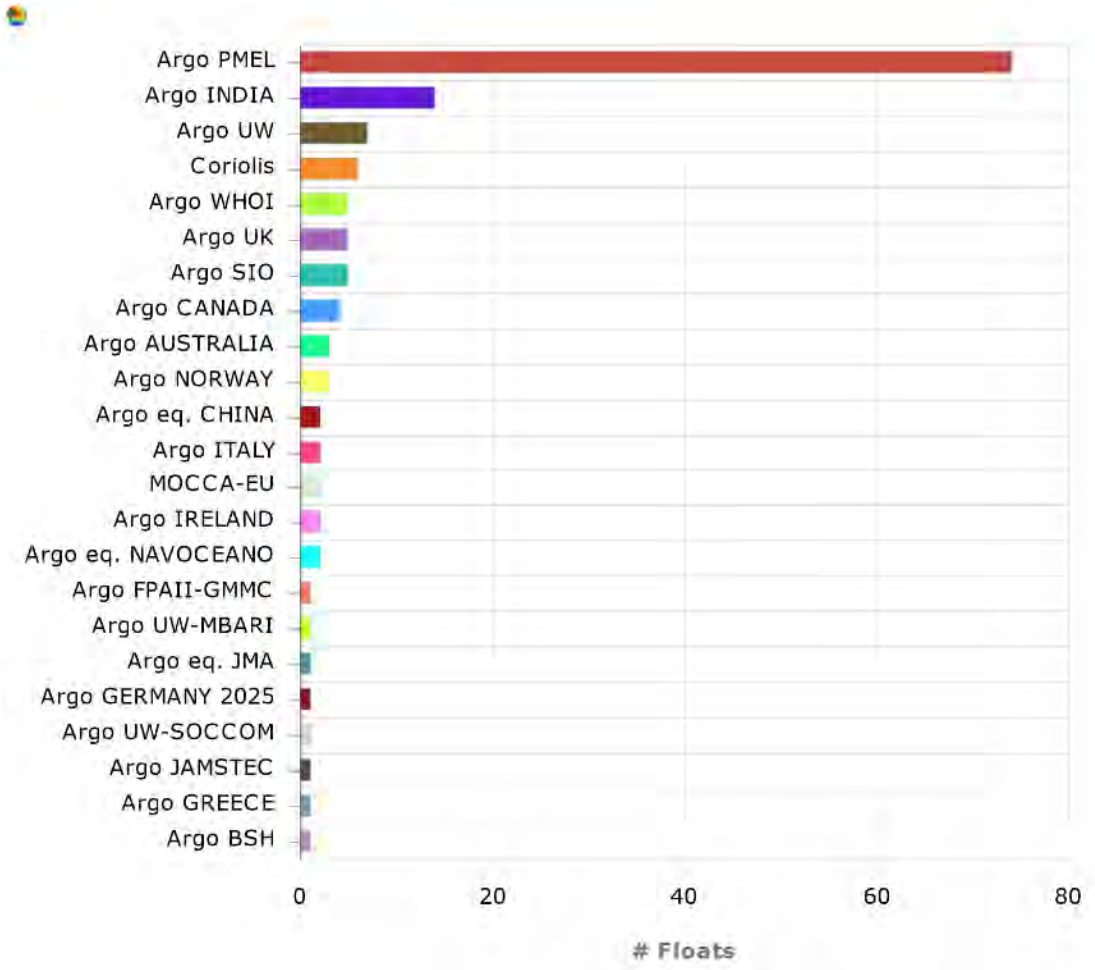
The number of float with pending QC for Coriolis min/max test and CLS Altimetry test is displayed in the two bar charts below

.



The 90 floats, sorted by program, with pending QC for CLS altimetry test

Note that, 93% of the floats that did not pass the CLS altimetry QC have been treated. 7% (90 floats) must still be treated by delayed mode operators.



The 144 floats, sorted by programs, with pending QC for Coriolis min/max test

The monitoring of this QC has been implemented at OceanOPS very recently. So far 230 floats did not pass the Coriolis Min/Max test and 144 must still be treated by delayed mode operators.