19th meeting of the International Argo Steering Team

Sidney, B.C., Canada
March 12-15, 2018

Contents

1. Welcome

Carmel Lowe, the Director of Science at IOS opened the meeting by welcoming everyone to IOS in Sidney, B.C. She noted that Canada has been part of Argo for a very long time and she thanked Howard Freeland for his service to Argo. She wished everyone a successful meeting and thanked Argo for its contribution to oceanography.

Action item 1: Write letter of thanks to local host IOS. AST co-chairs.

2. Local arrangements

Tetjana Ross informed the group on the logistics of the IOC building.

3. Objectives of the meeting/adoption of the agenda

D. Roemmich outlined the objectives of the meeting which he termed as Argo's future challenges. These included the following topics:

- Sustainability
- IOC and EEZs
- Finalizing and implementing design changes

4. Status of action items from AST-18

M. Scanderberg reported on the few action items from AST-18 that had not been completed in the previous year and would not be discussed during the meeting. There was an action item on writing up a one-page document on how dead Argo floats impact the ocean which was not completed and it was kept on the list. Many students ask questions about this topic and B. Klein noted that EuroArgo is composing a short document on this topic that can be distributed to AST members. There was also an action item on compiling a list of general Argo talks and slides describing high impact papers published using Argo. F. Carse submitted a talk and it will be made available to all AST members for use in general Argo talks. Others were encouraged to submit additional talks and slides to make it easier for any AST member to give an Argo talk on short notice. Finally, it was noted that data from Deep Argo floats are not all showing up at the GDACs which makes tracking at the AIC difficult. All DACs processing Deep Argo float data were asked to make creating Deep Argo float netCDF files a priority.

5. Implementation issues

5.1 Update commitments table including global Argo, extensions and equivalent floats

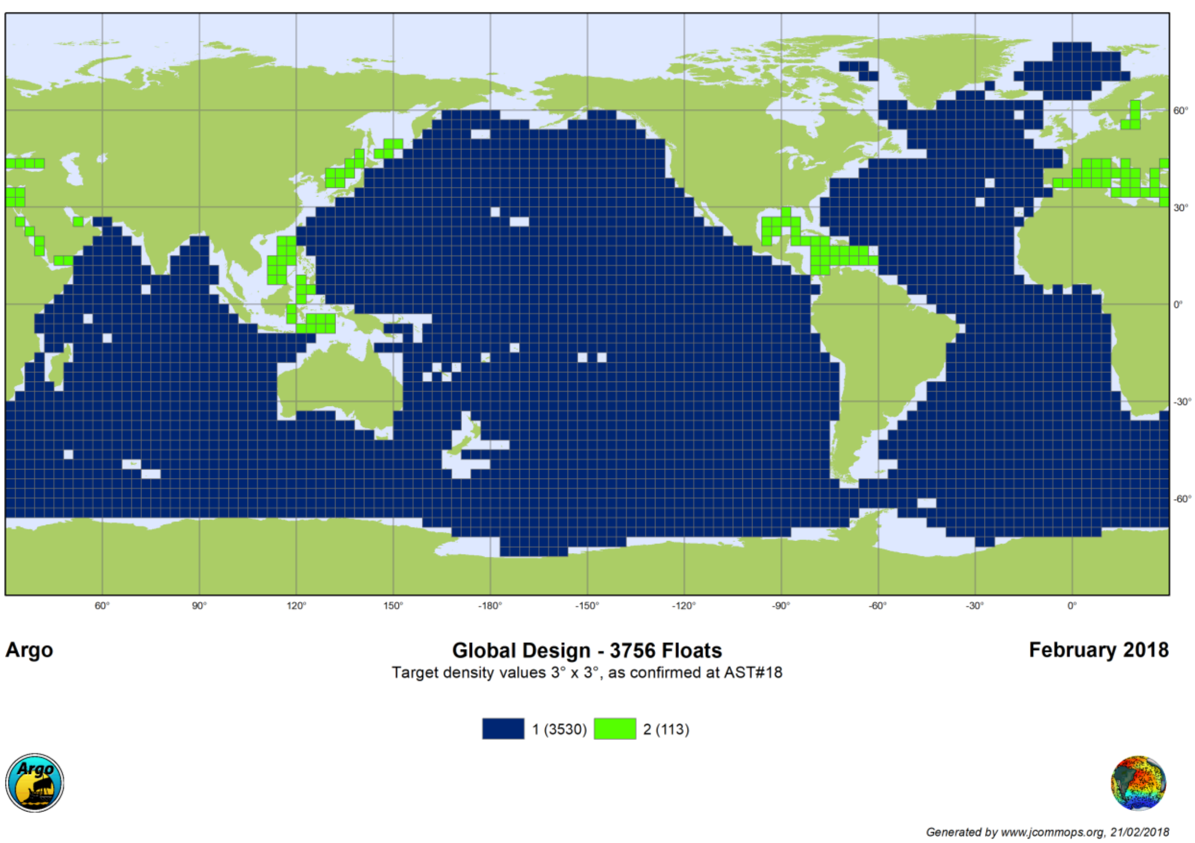
M. Scanderbeg began this section by showing the status of 2017 commitments vs. the actual floats deployed on the AIC website. There were about 150 more floats committed than actually deployed which was about 80 floats short of target deployments for core Argo. This can be due to difficulties finding deployment opportunities, technical problems with floats and not enough floats were actually purchased. In addition, it was discussed that BGC Argo floats do contribute to the core mission, but they are excluded from the numbers here on the commitments table, so core looks a bit under deployed. For

2018, Argo National Programs have currently under committed core Argo deployments by about 230 floats. Again, it is a bit hard to calculate the total number of floats under committed since 145 BGC Argo floats are committed for the year as well as 64 equivalent floats which contribute, at least in part, to the core Argo program. 45 Deep Argo floats are committed for 2018. M. Scanderbeg noted that several countries this year explained how their equivalent floats fit into the global Argo array which was helpful. During discussion, it was suggested that WBC and Equatorial region columns be added to further understand how Argo National Programs are committing floats. The commitments table is always available on the AIC website for reference. If changes to the table are needed, ask M. Scanderbeg to update it.

5.2 AIC Report on the Status of Argo

The Argo status report was introduced by a description of the Canadian contribution, which has deployed about 500 floats so far and sustains a network of 100 floats. Canada is also a supporter of JCOMMOPS and the Argo Information Centre.

The Argo Technical Coordinator reviewed the global design and confirmed that changes discussed at AST17 were implemented: the central arctic was removed, the Southern Ocean was expanded further into the seasonal ice zone, and minor regional updates were made according to implementers' practices. It was noted that these changes to the 3°x3° design involved major technical upgrades at JCOMMOPS as it is the primary source for many performance monitoring tools calculations.



<u>Argo Global Design, with double density in Marginal Seas.</u>

The Argo network definitions (Core, Equivalent, BGC, Deep) were reviewed and called for further discussions to not artificially inflate BGC status with oxygen floats, while also finding a better way to calculate how the extra floats contribute to core Argo.

It was suggested to add a new category for “Argo extensions” for equivalent floats contributing to the Kuroshio and Gulf Stream WBC and TPOS, mainly from the USA, Japan and China.

An “Argo pilot” network could also be defined to monitor the pilot sensors that meet the new requirements to be an Argo float and the proposal to IOC Member States for Argo’s future evolutions.

The TC presented the latest developments made on Performance Indicators, and targets based on a 150, 10-day cycle lifetime.

While the target was reviewed for the Marginal Seas (based on a 150, 5-day cycle lifetime), it would be appropriate to review it as well for the Southern Ocean seasonal ice zone where life expectancy is shorter.

Basin	**Argo Global Design**	
	Activity	Intensity
Atlantic	793	193
Indian	697	170
Pacific	1595	388
Southern	376	92
Arctic	69	17
Marginal Seas	226 (113 x 2)	110
Global Argo	3756	970
TPOS [-30°;30°]	894	218
Mediterranean Sea	64 (32x 2)	31
North Atlantic	343	83
South Atlantic	450	110
North West Pacific	285	69
North East Pacific	439	107
South West Pacific	425	103
South East Pacific	446	109

Instrumentation	
Mortality Rate Argo Global	25.23% 2017 ↘
Mortality Rate Argo Global - Southern Ocean	22.52% 2017 ↘
Mortality Rate Argo Global - Indian Ocean	18.84% 2017 ↘
Mortality Rate Argo Global - Pacific Ocean	24.03% 2017 ↘
Mortality Rate Argo Global - Atlantic Ocean	27.24% 2017 ↗
Mortality Rate Argo Global - Mediterranean Sea	58.66% 2017 ↗
Mortality Rate Argo Global - Arctic Ocean	37.77% 2017 ↗
Mortality Rate Argo Global - Marginal Seas	25.19% 2017 ↗

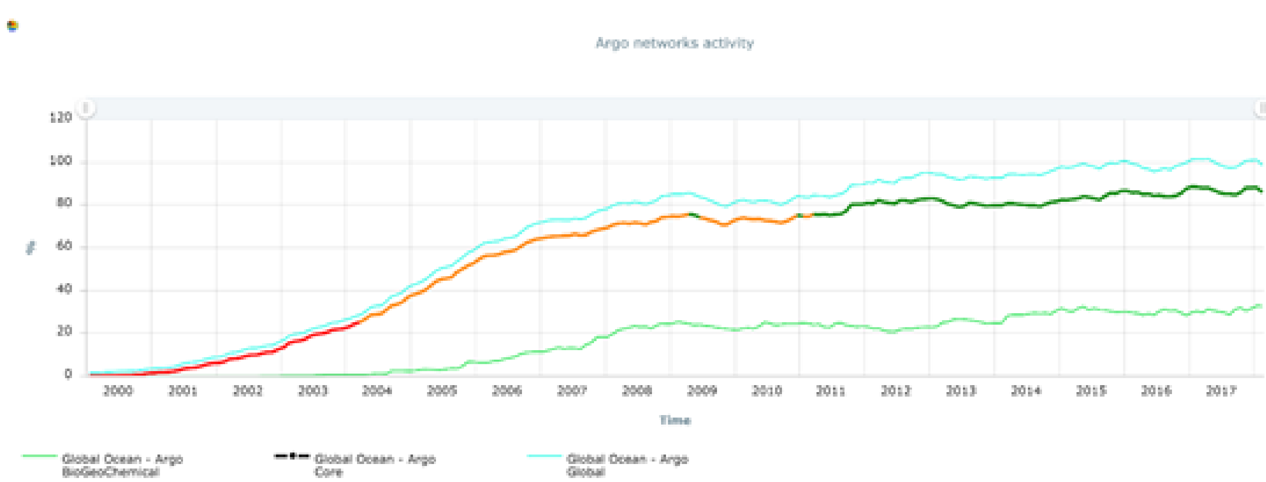
Instrumentation	
Life Expectancy Argo BioGeoChemical	2.42 2017 ↘
Life Expectancy Argo Global - Indian Ocean	6.66 2017 ↗
Life Expectancy Argo Global - Pacific Ocean	6.74 2017 ↗
Life Expectancy Argo Global - Atlantic Ocean	5.25 2017 ↗
Life Expectancy Argo Global - Mediterranean Sea	2.51 2017 ↗
Life Expectancy Argo Global - Southern Ocean	2.67 2017 ↘
Life Expectancy Argo Global	5.52 2017 ↗
Life Expectancy Euro Argo	3.98 2017 ↘

Argo activity and intensity (Nb of units to be deployed yearly) targets for each basin, mortality rate and life expectancy.

TC proposed to improve the tracking on ice avoidance metadata to refine lifetime statistics in the Southern Ocean (SO).

TC recalled that Core Argo was short by 15%, and that extra contributions were essential to meet the global target. While a plateau has been reached for all contributions, Argo oscillates today between 3800 and 3900 operational floats.

All activity performance indicators are optimal except in Marginal Seas (65%) and SO (39%). The contribution from BGC Argo in the SO is clearly visible. The Mediterranean Sea activity is dropping.



Activity evolution for main Argo networks

The Atlantic Ocean shows the highest activity (122%) and a reserve of 100 units. The rebalancing between the North and the South Atlantic is progressing. The Pacific Ocean overall status is maintained thanks to good float reliability. The recent SE deployments by R/V Kaharoa balance the decrease everywhere else. The NW status is dropping and many TPOS region old floats died recently. Additional contributions are vital to sustain the PO.

The status of both the Indian and Arctic Ocean is fine.

The Argo spatial distribution is slowly but continuously improving (+4 % vs last year). Extra participation that was more than expected led to this improvement. There is still a margin for improvement everywhere.

Implementation	
Coverage (Yearly) Argo Global	68.65% 2017 ↗
Coverage (Yearly) Argo Global - Pacific Ocean	75.17% 2017 ↗
Coverage (Yearly) Argo Global - Atlantic Ocean	74.65% 2017 ↗
Coverage (Yearly) Argo Global - Indian Ocean	70.73% 2017 ↘
Coverage (Yearly) Argo Global - Southern Ocean	26.33% 2017 ↘
Coverage (Yearly) Argo Global - Mediterranean Sea	78.13% 2017 ↘
Coverage (Yearly) Argo Global - Arctic Ocean	78.26% 2017 ↗
Coverage (Yearly) Argo Global - Marginal Seas	42.48% 2017 ↗

Coverage (Yearly) Argo Global - Pacific Ocean - North West	79.3% 2017 ↘
Coverage (Yearly) Argo Global - Pacific Ocean - North East	71.3% 2017 ↘
Coverage (Yearly) Argo Global - Pacific Ocean - South West	82.35% 2017 ↗
Coverage (Yearly) Argo Global - Pacific Ocean - South East	69.51% 2017 ↗
Coverage (Yearly) Argo Global - Atlantic Ocean - North	77.84% 2017 ↘
Coverage (Yearly) Argo Global - Atlantic Ocean - South	72.22% 2017 ↗

Coverage status for main basins.

There is a slow decreasing trend in the intensity of deployments for Argo Global and Core due to the flat funding of several key partners, while BGC intensity is stabilizing at too low a level (50%). The expansions discussed in the Argo2020 design are not yet followed by the agencies.

The AST recommended to highlight this lack of commitments on the Argo 2020 design map.

Implementation

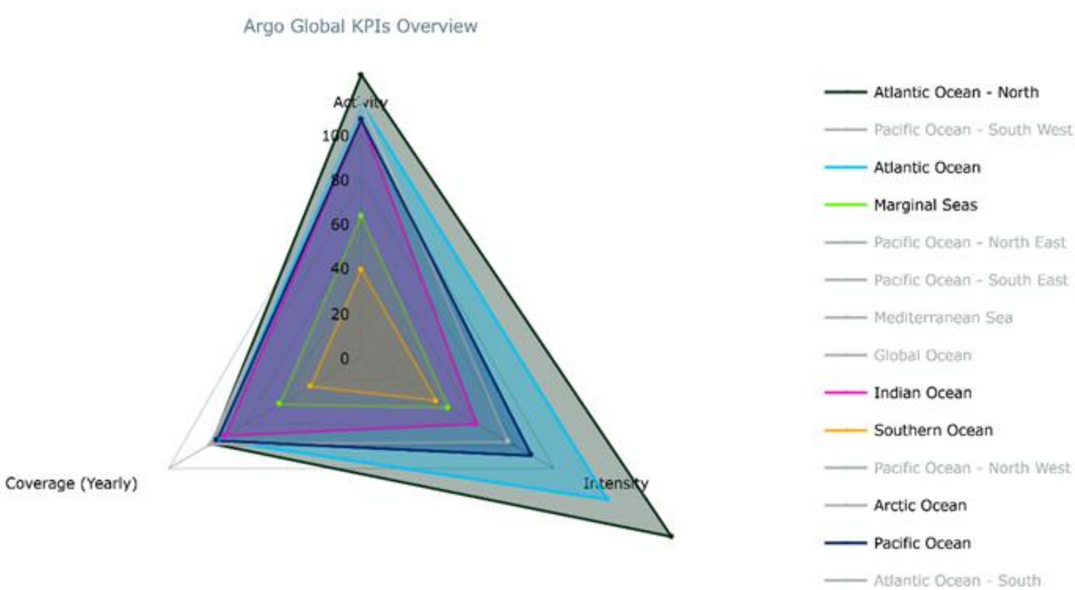
Intensity Argo Global	82.47% 2/2018 ↘	800 Raw count	970 Target
Intensity Argo Global - Atlantic Ocean	127.98% 2/2018 ↗	247 Raw count	193 Target
Intensity Argo Global - Pacific Ocean	88.66% 2/2018 ↗	344 Raw count	388 Target
Intensity Argo Global - Indian Ocean	60% 2/2018 ↘	102 Raw count	170 Target
Intensity Argo Global - Southern Ocean	39.24% 2/2018 ↘	31 Raw count	79 Target
Intensity Argo Global - Mediterranean Sea	61.29% 2/2018 ↘	19 Raw count	31 Target
Intensity Argo Global - Arctic Ocean	76.47% 2/2018 ↗	26 Raw count	34 Target
Intensity Argo Global - Marginal Seas	45.45% 2/2018 ↘	50 Raw count	110 Target

Intensity Argo Global - Pacific Ocean - North West	107.25% 2/2018 ↗	74 Raw count	69 Target
Intensity Argo Global - Pacific Ocean - North East	75.7% 2/2018 ↘	81 Raw count	107 Target
Intensity Argo Global - Pacific Ocean - South West	63.11% 2/2018 ↘	65 Raw count	103 Target
Intensity Argo Global - Pacific Ocean - South East	113.76% 2/2018 ↗	124 Raw count	109 Target
Intensity Argo Global - Atlantic Ocean - North	161.45% 2/2018 ↗	134 Raw count	83 Target
Intensity Argo Global - Atlantic Ocean - South	104.55% 2/2018 ↘	115 Raw count	110 Target

Intensity status for main basins.

The TC stressed that 225 floats were beyond 7 years old in the central Pacific Ocean so while TPOS extensions (double Argo in -10/10) are being discussed the current status is already problematic.
The Indian Ocean intensity needs to be tracked regularly as it shows a 40% deficit in deployments in the last twelve months.

One recommendation was discussed to better use the reserve of extras floats deployed in the North Atlantic (50 units / year) and redirect them to other places like the Southern Ocean. It was recommended by the AST to better study how these extras deployment were adding to the overall coverage, and if they were really required to sustain this region. The diagram below shows that these extra floats do not improve the spatial coverage.



Summary of activity/coverage and intensity indicators.

TC concluded the Argo was doing remarkably well with less means, and could even do better.
It remains fragile with no security margin beyond float performance improvement to absorb a national budget cut or a technical issue.
Its core part is still underfunded and the flat funding situation and continuous decreasing deployments are no more compensated by the extras contribution such as Argo BGC.
The Southern Ocean and in particular its seasonal ice zone is a considerable challenge and calls for a major cooperative effort.
The Indian Ocean deficit should be carefully monitored, and equivalent contributions in NW Pacific are critical.
North Atlantic partners were challenged to better distribute their deployments globally.

Action item 2: Think about better way to show collaboration between BGC and core floats in order to track global coverage. M. Belbéoch, AST co-chairs, BGC co-chairs.

5.3 JCOMM Observing Program Support Centre

The JCOMMOPS Lead summarized the status of the Centre recent developments, staff and budget.
He recalled how critical the sustained Argo support was in this evolution.

While the JCOMM V conference granted further responsibility to the team (metadata submission to WMO/WIGOS for all marine systems), he mentioned that the center was $50k underfunded (15%) to maintain its current team and activities.

The way forward is to bring all networks under the Argo monitoring and metadata golden standard, key to the cross program/platform perspective (EOV/ECV), and then move closer to the regional and coastal systems.

JCOMMOPS office will host the next Observation Coordination Group in Brest, and a review process was launched to deliver its recommendation by November 2018.

5.4 AIC Funding

Funding contributed in 2017 for the AIC has been provided by Australia, **China,** France, Germany, India, **Italy,** Japan, UK, USA, and **EuroArgo,** where the bold entries represent either increased or new contributions. While this funding does cover present activities, additional funding could help increase activities. Within the Argo Program, we would like expand JCOMMOPS funding to be proportional to number of floats provided by member countries. Contributions towards JCOMMOPS funding can be made through UNESCO, WMO, IOC, CLS and through projects.

DBCP funding of JCOMMOPS is used to augment funding in the other programs, which means that AIC expenditures are approximately 150% of the Argo contributions. Argo funding represents approximately one third of this additional funding.

5.5 BGC-Argo and the IOC

A Circular Letter to the IOC with three Annexes, which informs the Member States on Argo extensions, was discussed. The Annexes provide further detail on Biogeochemical-Argo and the 6 proposed BGC parameters (oxygen, nitrate, pH, chlorophyll, optical backscatter by particles, and irradiance) and a proposed framework for the addition of new parameters to Argo. The final Annex is a draft decision for the IOC to approve the addition of the 6 new parameters to the Argo network and to approve the framework for addition of new parameters. It was noted that these documents do not alter the rights of coastal states for notification of approaching floats, a listing of parameters measured by the floats, or their ability to request that sensors be turned off. Steering Team members were encouraged to contact their IOC representatives in support of these proposals. Contact K Johnson or S Wjiffels for a copy of the draft letter.

> **Action item 3:** Write to AST members from IOC executive committee nations to ask them to brief their representatives in preparation for the IOC meeting. AST co-chairs.

5.6 Canadian Argo

Blair Greenan described the organization and current status of the Argo Canada program. The Argo program is supported by 9 staff from Fisheries and Oceans Canada (DFO), most of which contribute part of their time to logistics and data management; this results in a contribution of approximately 3 Full-Time Equivalents (FTEs) to Argo Canada.

In terms of the present status of the Argo Canada program:

- DFO has allocated ongoing funding for the O&M expenditures related to the International Argo program.
- Shared Services Canada (SSC) is responsible for the costs related to Iridium telecommunications (covers the costs for up to 85 core Argo floats – telemetry costs for additional floats is responsibility of DFO).
- Ongoing capital for float purchases has not been identified and, therefore, it remains necessary to request capital resources on an annual basis to obtain the funding required to purchase new floats.
- Fisheries and Oceans Canada (DFO) committed $449k for purchases of core Argo floats in 2017.
- Department of National Defence (Canada) purchased of 5 MetOcean NOVA floats to support core Argo.
- Funding is expected to remain stable at approximately this level for the next few years.

In terms of ocean monitoring, research and operational use of Argo data, the following examples summarize the present situation:

- Development of close links between the Argo Canada program and both the operational meteorology and operational oceanography R&D activities at the Canadian Meteorological Centre (Dorval, Québec) has been beneficial.
- An inter-departmental (Environment and Climate Change Canada, Department of National Defence, Fisheries and Oceans) Memorandum of Understanding entitled CONCEPTS (Canadian Operation Network of Coupled Environmental PredicTion Systems) has provided strong advocacy for the Argo program. Fraser Davidson will present on this on Wednesday morning.

- The CONCEPTS Global Ice Ocean Prediction System (GIOPS) assimilates Argo data on a weekly basis producing operational forecasts.
- The Department of National Defence Navy (DND) scientists routinely use real time Argo vertical profiles of temperature into their Ocean Work Station to aid in the computation of sound velocity profiles for support of at-sea operations.
- Argo floats deployed in the Labrador Sea support the DFO Atlantic Zone Off-shelf Monitoring Program (AZOMP). These floats are also an important element of an NSERC Climate Change and Atmospheric Research (CCAR) project entitled VITALS (Ventilation, Interactions and Transports Across the Labrador Sea) led by the University of Alberta.
- In 2017, Canadian researchers contributed to 13 journal publications which utilized Argo data and 1 M.Sc. thesis was completed on dissolved oxygen data collected on Argo floats in the Labrador Sea.

In addition to the annual challenge of securing capital funding for the acquisition of Argo floats, support for the program in Canada is also challenged by the fact that the research vessel fleet operated by the Canadian Coast Guard is rapidly aging and reliability of the ships is declining; this results in difficulties in scheduling Argo float launches.

In January 2017, MEOPAR (meopar.ca) and DFO co-sponsored a BGC-Argo Canada workshop which brought together scientists and managers from both DFO and the university community. A report summarizing the outcome of the workshop is available at http://archimer.ifremer.fr/doc/00413/52451/53335.pdf. We are presently forming a national steering committee for BGC-Argo and exploring options for funding.

5.7 Discussion items from National Reports and a quick oral round table of highlights or key issues

Australia: The Australian Argo program has been dealing with lots of turnover including S. Wijffels, A. Thresher and J. Dunn and the new leader, P. Oke, is still learning about Argo. However, he is bringing his ocean forecasting background to the team.

China: China deployed 21 floats last year including 2 Deep Argo floats in the Southern Ocean. They are still waiting to hear if the Silk Road proposal has been funded which would provide 100 more floats. Currently, some of the floats planned for deployment in 2018 will be in the TPOS region. If more money is found, more floats will be deployed in the TPOS region. China would like to host the AST-20 meeting in Hangzhou.

EuroArgo: For the past three years, there has been funding to deploy an additional 150 floats, but this appears to be ending. EuroArgo is still pursuing this and wants to help with global coverage at the European level.

France: Only 65 floats were deployed last year which is less than the usual 80 or so that is planned for 2018. The past year was spent developing a stronger coordination between all the groups at Coriolis involved with Argo. There was a 40% increase in French publications and work done on sensor analysis and development of Deep Arvors.

Germany: AST was informed about the problems at the Alfred-Wegener-Institute at Bremerhaven to find a supplier for floats with an integrated RAFOS hydrophone. Since the tender exercise from last year failed and no floats will be available for deployment 2018/2019 it was decided that the western part of the sound source array in the Weddell Gyre will not be redeployed during the field campaign 2018/2019 and only be put back into the water during the following year.

India: India plans to deploy 50 floats per year until 2020. Of those 50, 20 will be BGC-Argo floats. Argo data are being assimilated into ocean models and used by operational agencies in India. There is a large demand for BGC data within India which is reflected by 20 out of 50 floats being BGC-Argo. There has also been an increase in the number of publications by Indian authors.

Italy: Italy plans to deploy 20 – 30 floats a year in the Mediterranean Sea, Black Sea and Southern Ocean. Some of the marginal seas floats are BGC-Argo floats.

Japan: In the past year, JAMSTEC deployed 35 floats and JMA deployed 36 Argo equivalent floats, 12 of which were Western Boundary Current enhancement floats. The G7 helped increase JAMSTEC funding of Argo and extra floats were purchased for deployment throughout 2018 and 2019. This will include 34 core Argo floats, 27 equivalent floats, 12 WBC floats, 5 BGC-Argo floats and 20 Deep Argo floats.

Korea: Two floats were deployed in the Yellow Sea for the first time and the float was not correctly ballasted which meant the float couldn't reach the surface for the first two months which were during the summer. Three more were deployed later and these were more successful.

New Zealand: New Zealand is hoping to continue deploying two floats per year. In addition, the Kaharoa replacement is supposed to be functioning in 2022. The replacement should be able to accommodate Argo floats in a similar manner and may be able to go farther south, but this will be determined later when costs are better known. It is understood that Argo is the single biggest user of the Kaharoa and they hope it will be true of the replacement as well. In addition, they'd like to get the Tangaroa down to the Southern Ocean and float deployment opportunities are available on that ship. Please let Phil Sutton know if you are interested.

Poland: Poland deployed three floats last year in the Nordic Seas. One float was unable to cross the pycnocline in the region. This year, they are trying again with an Arvor float equipped with a dissolved oxygen sensor.

South Africa: T. Morris noted in the South African National Report that there are several float deployment opportunities coming up. Please contact her if interested.

UK: The UK had a record deployment year with 53 floats. Many of those were BGC and Deep floats that came from research money. The UK requested ideas on how to get core profiles from BGC Argo floats out in a timely manner. The UK usually aims to deploy around 30 core floats per year. Our target for financial year 2018/9 is 25 core floats.

USA: In the short term, meaning fiscal year 2018 – 2019, funding looks fine within NOAA. To help minimize risks to Argo by cuts in funding, the US Argo Program is focusing on getting longer lifetime in floats and CTDs.

5.8 Argo Data Paper, Argo Best Practices papers and OceanObs19 abstracts

S. Wijffels presented on the numerous papers that could be written by Argo in the coming 1- 2 years. She started with the four submitted OceanObs19 abstracts on Global Argo, BGC Argo, Deep Argo and Argo Data Management. Lead authors were chosen for each paper: D. Roemmich, T. Suga and S.

Wijffels for Global Argo; H. Claustre and K. Johnson for BGC Argo; G. Johnson, V. Thierry and N. Zilberman for Deep Argo; S. Pouliquen and M. Scanderbeg for Data Management. She outlined the next steps which result in paper submission in September.

Next, she presented on the GOOS OCG Best Practices Papers which will be published in Frontiers of Marine Systems which is peer-reviewed and citeable. The goal of these papers is to capture technical information to assist new players and to encourage cross-network exchanges. Much discussion followed which focused on whether this was worth spending time on. In the end, lead authors were identified and Argo agreed to move forward with them. The BGC-Argo paper will be led by H. Bittig. The Data System paper will be lead by S. Pouliquen and the core Argo implementation paper will be led by S. Hosoda, B. Owens, S. Riser and B. King if he is interested.

Finally, Susan presented on the Argo data paper which has stalled in progress. She said this paper is still needed to document more about the sensors used in Argo and she agreed to write a rough outline of the paper with B. Owens help. After that, they would reach out to the DMQC community to identify some coordinating lead authors. The thought is that there will be many authors on this paper since so many have contributed to the Argo dataset.

Action item 4: Submit OceanObs19 abstracts and white papers on global Argo, BGC Argo, Deep Argo, and Data Management. Leads for global Argo: T. Suga, S. Wijffels, B. Greenan, and D. Roemmich. Leads for BGC Argo: H. Claustre, K. Johnson. Leads for Deep Argo: N. Zilberman, V. Thierry, G. Johnson, S. Hosoda. Leads for Data Management: S. Pouliquen, M. Scanderbeg

Action item 5: Move ahead with OCG Best Practices paper on core implementation. Leads will be S. Riser, B. Owens, S. Hosoda and maybe B. King.

Action item 6: Move ahead with Argo data paper. S. Wijffels, S. Riser and B. Owens to develop a draft outline and then reach out to DMQC operators to help write the paper.

6. Data Management and related issues

6.1 Feedback from ADMT-18

M. Scanderbeg reported on the ADMT-18 meeting which was held in Hamburg, Germany in December 2017. In general, the status of the data system is good with excellent data delivery times, small improvements in the number of Delayed Mode files, and most DACs now producing almost all real time files in v3.1. The quality of the salinity dataset is declining a bit which is something we need to continue monitoring. Results from the quarterly comparison with altimetry were shown and it was noted that more floats (115) are on the problem list now. There was a productive discussion on the topic at the ADMT-18 meeting in December and floats will now be sorted into two categories when owners and DACs are notified. The first category is 'blk' which means the float might need to be greylisted due to many problematic profiles being identified. The second category is 'chk' which means usually only one profile per float is identified. WHOI has put this as a high priority to look at and has already provided feedback on several floats. UW and India have also made progress on this. PMEL and NAVO still need to look at their floats. The list can be found here: ftp://ftp.ifremer.fr/ifremer/argo/etc/argo-ast9-item13-

AltimeterComparison/QC_ARGO_ALTI_082017.txt In addition, it can be accessed at the AIC website under 'search', 'floats', 'quality control', 'QC Feedback', 'Pending feedback', 'type is Coriolis/CLS Altimetry QC'. The comparison also noted a slight degradation for real time files. It was noted that the ADMT is considering a new real time QC test that would create a gradient climatology from Argo to perform a MinMax test on the data to try and identify biased profiles quickly and accurately.

At the AST-18 meeting last year, S. Pouliquen raised the issue of the frequency of DMQC and if we could relax the need to do it every year as it is costly in terms of manpower and money. B. King performed an analysis on the frequency of DMQC in the data system and what would happen if DMQC was done at 12 months and then not again until 36 months. He did this using archived index files up to September 2017, with a focus on the period of 2010 – 2018. He found the first and second DQMC dates from when the file first went into D mode and then when the file had a changed 'update date' after that. What he found was the on average, the first DMQC happens at about 12 months and the second one occurs one year later. He also found that for cycle 10, more adjustments are positive than negative, but as floats age, the correction becomes more negative. About 5% of floats have salinity adjustments greater than 0.005 at cycles 36, 72 and 108. About 3% change their adjustment from cycle 36 to 72 and from cycle 36 to 108. Therefore, the ADMT decided to keep the requirement that DMQC be done for the first time at one year. The second DQMC time may be relaxed to three years for groups struggling with DMQC. Although the AST pointed out that with a known fast salinity drift appearing in certain floats, this may not be a good idea.

The GDACs served about 9% more files in 2017 than in 2016 with a 65% increase in the number of BGC Argo files available. GDAC availability is excellent with an FTP weekly average performance of 99.87%. The AUX directories have been set up on both GDACs and some technical files with additional timing information are available there along with some fragment profiles. It was noted that the data are not consistent in format and may never be quality controlled, but it is available. The AST reinforced the idea that this data must be clearly explained and that a contact email should be provided. With the new process of acceptance into the Argo data stream, the National Programs will be the ones who need to work together to decide what floats should be Argo and which should be experimental.

Finally, M. Scanderbeg noted that several ARCs continue to perform tasks that add to the quality of the Argo data set. Near real time QC is being done monthly at PARC and is available at: http://www.jamstec.go.jp/ARGO/argo_web/argo/?page_id=100&lang=en Consistency checking of D files is being done at the NA-ARC. Several ARCs are adopting orphan floats for DMQC and searching for additional CTD profiles for the reference database.

Overall, the data system is doing well and is recovering from the reformatting into v3.1. It is now time to refocus on the quality and consistency of the data that goes into the files.

6.2 Update on meta and tech tables

The presentation given on behalf of John Gilson presented feedback from the technical workshop held in Seattle in 2017 and discussions at ADMT-18. In order to improve sensor and float reliability and do analysis on technical issues it was recommended at the technical workshop to clear up information on variables such as controller board version, improve firmware version by directly sending this from the float and include more information on batteries. In order to reduce the number of controller board version from the presently 99 entries a managed table with far fewer entries is suggested. Battery_type and battery_packs will need to change their dimension to accommodate the use of more than one battery pack in a float and new information on battery_manufacturer, battery_model, battery_energy and battery_energy_use is suggested. The review of the CONFIG_ parameters in the meta files suggests splitting these into two groups. The proposal is to curate a smaller subset of mission-critical parameters and to leave the others on a non-curated list. An annual audit is proposed to increase consistency across DACs and float types, only mandatory configs will be audited for presence in metafiles and value will not be checked. In terms of the used vocabulary and to increase machine-to-machine readability it is suggested to explore using the NERC Vocabulary Server (NVS). An Argo vocabulary governance committee needs to be set up to develop the vocabulary (terms, definitions, etc.). Significant work would need to be done to import the Argo reference tables into the NVS and EuroArgo is working on a proposal to fund this work. The presentation concludes that meta files will need to be re-written to accommodate some changes.

Action item 7: AST suggests meta data working group reconsider the battery information stored in the meta files and consider simplifying it to specify the battery energy in MJ, manufacturer and type of cells. R. Cowley, B. King, M. Scanderbeg

6.3 DAC Trajectory Workshop Report

M. Scanderbeg reported on the DAC Trajectory Workshop held immediately following the ADMT-18 meeting in Hamburg in December. The goals of the workshop were to improve the consistency of the trajectory v3.1 files by improving the measurement code tables by float type, reviewing the real time QC tests done on trajectory files, study the trajectory File Checker rejections and to consider code sharing to reduce the burden on DACs when new floats arrive. The working group activity to match data from floats to measurement codes was very productive and continues on via email. The improved tables will be available in a new version of the DAC trajectory cookbook by ADMT-19. R. Cowley showed the results of her real time QC test analysis where she ran all the current trajectory files through her real time QC tests to see if QC flags were being applied properly. For most tests this was true. However, for the global range test, most DACs were not applying this test at all. A small amount of time was spent thinking about what else could be done in real time such as applying known pressure and salinity drifts in real time, adjusting qc flags for greylisted floats and possible improvements to qc test for GPS positions.

M. Ignaszewski led the group through a series of examples of rejected trajectory files from the File Checker which is in test mode right now. The group ended up agreeing with all the rejection results and a couple more are being considered to add to the File Checker. As of November 2017, about 12% of trajectory files were being rejected. This number has plateaued since the introduction of the File Checker and the AST suggested asking Mark for more information on what types of files are being rejected and primarily from which DACs. Based on this information, the ADMT can figure out when to make the File Checker live with the hope that it will be live before the ADMT-19 meeting.

Finally, there was a discussion on how to better share codes for developing float decoders and QC tests to improve consistency and to reduce the burden on each DAC to develop similar code. The group discussed two approaches with the first being to request decoders as part of the tender process. The second was to explore developing one decoder for new floats for all DACs. The code would be shared on GitHub and a small group would have access to edit the code. This group would need to include float experts and probably someone from the manufacturer. The desired outcome of the decoder was discussed as either an ascii file or a netCDF Argo file. B. King and R. Cowley agreed to take the lead on developing an APF11 decoder with TWR.

Action item 8: Investigate files that trajectory File Checker rejects. Which DAC, what float type, which transmission system, etc. can help determine when it can go live. M. Scanderbeg, M. Ignaszewski, DACs

6.4 Positioning for under-ice floats

A summary of the discussions at ADMT-18 was given to AST-19 about proposed changes to the data system in order to store information on under ice-positions. During ADMT-18 it had been discussed how to add information on position error and/or accuracy together with an appropriate position QC, information on the positioning system (GPS, Iridium, RAFOS etc.) and the method used to derive position (if not directly returned by a positioning system). The original proposal at ADMT-18 had contained suggestion for changes in the profile files and the trajectory file. ADMT-18 agreed on a solution for profile files and referred questions about the trajectory files back to the working group because it could not reach a consensus. For the profile files it is suggested to add two optional variables, namely POSITION_ERROR and POSITION_COMMENT. These optional fields will only be created for a subset of profiles if it can be estimated, e.g. for under ice profiles where the float did not surface and did not obtain a GPS or Iridium position (these profiles can typically be identified by POSITION_QC = 8 meaning 'estimated'). The working group suggests to allow free text for the POSITION_COMMENT for the moment and to provide some examples in the manual which can be updated when on-going work on the estimation methods have been published (P. Chamberlain, K. Reeves).

In terms of the trajectory file the discussion at ADMT_18 had reached no conclusion on the underlying questions if positions with lower accuracy should be allowed into the trajectory files. Currently the ADMT has restricted the trajectory file to contain only 'good' quality position fixes (i.e. Argos and GPS only). Lower quality positions (i.e. Iridium, estimated, interpolated) can still go in the profile files where the accuracy is not as important. It was already decided at AST-18 to place the RAFOS timing information (TOA+COR) into the auxiliary files. The working group agreed that all reported positions should be stored somewhere in case we need them for future use. But until there is a strong case for them to go into the traj-files it is recommend DACs store these in the aux-files. For the RAFOS positions the working group proposes for the moment to keep the underway positions in aux-files. In principal RAFOS positions should be of comparable quality to GPS and Argos and could go into the trajectory files when estimated.

AST supports the proposal and suggested that iridium positions can go into the trajectory files when no GPS is available. AST also suggested including RAFOS positions in the trajectory files, when they are computed with good enough accuracy, which needs to be shown from ongoing work.

Action item 9: AST asks ADMT to investigate putting Iridium positions with their known error in trajectory files when GPS fix is not available. Make sure this works within trajectory v3.1 file format without reformatting. Under-ice working group: E. Van Wijk, B. Klein, C. Schmidt, M. Scanderbeg, A. Wong

Action item 10: AST supports putting the RAFOS positions in the trajectory file when the best method to calculate these positions is finalized.

Action item 11: AST supports adding two optional variables (position accuracy and method) to profile file to accommodate under-ice positions.

6.5 CTD Reference data & how to describe the quality of each station

Action item 12: Try to get CTD casts done with deployment of Deep Argo floats stored at CCHDO. These can be kept private if needed. CCHDO, Deep Argo float deployers.

6.6 BUFR format for BGC floats

The distribution of Argo data in TESAC (FM-64) format via the WMO GTS will cease on 1st July 2018. This notification was published on 11 January 2018:

Following the recent Argo Data Management Team meeting, it has been decided that the issuing of real-time Argo float profile data to the GTS in FM-64 TESAC format will cease on 1 July 2018. Thereafter the float profile data will only be available on the GTS in BUFR TM3-15-003 format (but will still be available in netCDF through the two Argo Global Data Assembly Centres). Note that this change only refers to Argo float data and that profile data from marine mammals and ships will continue to be available on GTS in TESAC format.

During 2017, more messages were being transmitted in BUFR TM3-15-003 than in TESAC (figure 1). Timeliness of all data formats are good, with 90-95% of messages distributed on the GTS within 24 hours of the observation time.

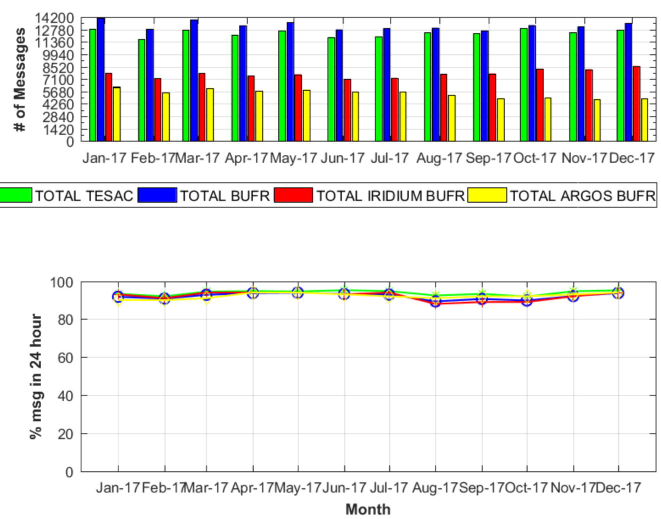


Figure 1. Global BUFR and TESAC outputs (from Anh Tran, MEDS)

The status of UK Argo BUFR production, as at 6 March 2018, is as follows:

- BODC currently generates both TESAC and BUFR messages from UK, Irish and Mauritius floats for distribution on the GTS.
- Parallel running to generate BUFR TM3-15-003:
  - JMA-provided Perl software at BODC
  - Python2.7 software at Met Office
- Only temperature and salinity profiles from core floats netCDF v3.1 files are handled.
- Testing of Met Office system is nearly complete:

- MO system generates between 20 and 40 BUFR messages per day
- BODC and MO files identical in terms of data content ☺
- MO needs to finalise how to handle ‘duplicates’ (re-issued netCDF files lead to repeat BUFR messages)
- Switch routing so that Met Office becomes the source of UK Argo real-time BUFR data to the GTS (aim for April 2018). See figure 2.
- BODC will continue to generate TESAC messages until the 1st July 2018 switch-off deadline.

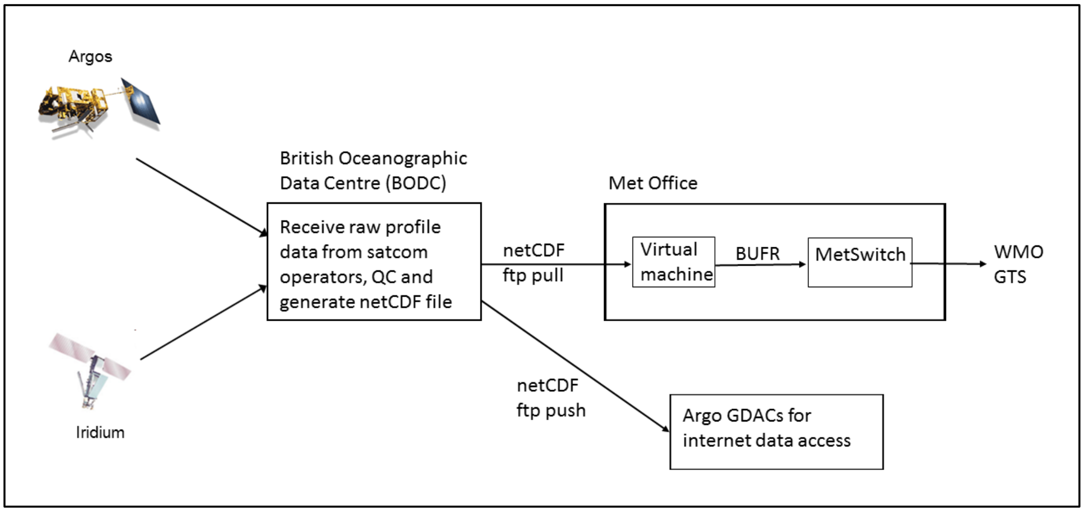


Figure 2. Met Office netCDF to BUFR conversion (planned for April 2018)

During 2018, the Met Office plans to extend the Python2.7 software to extract additional temperature and salinity data that is present in netCDF v3 files and incorporate this into TM3-15-003 message. Specifically, this includes:

- Secondary temperature and/or salinity profiles from, for example, auxiliary sensors, near-surface sampling, bounce sampling (vertical sampling schemes listed in reference table 16 of Argo Users Manual).
    - **Temperature only** data will use additional sequence **3-06-017**
    - **Temperature and salinity** data will use additional sequence **3-06-018**
- Include real-time BGC data from b-files
    - **Dissolved oxygen** is the only WMO-approved BGC parameter (additional sequence **3-06-037**).

We are happy to share Met Office Python2.7 conversion software with the Argo community. Please contact Fiona Carse and Jon Turton.

We also hope to develop BGC BUFR beyond dissolved oxygen later in 2018. Four of the five remaining BGC parameters now have profile sequences that were “approved for validation” at a WMO IPET-DRMM meeting in 2016:

- Chlorophyll-A: 3-06-044
- Nitrate: 3-06-045
- pH: 3-06-046

- Backscattering: 3-06-047

The UK is ready to carry out validation of these sequences and we are seeking partners to help us carry out the 'buddy' checks required by WMO in order to achieve final acceptance of the sequences. This entails several (at least two) centres demonstrating that they can encode the BUFR file and decode a BUFR file created by the other centre(s). The Met Office and MEDS carried out this procedure for secondary T/S profile sequences during 2015.

Action item 13: UK is looking for a partner to check and validate the BGC parameter BUFR formats so that they can be sent out on the GTS. F. Carse, J. Turton, A. Tran?

7. Regional science, education and outreach

7.1 Roberta Hamme – "Oxygen saturation surrounding deep-water formation events in the Labrador Sea from Argo-O2 data"

7.2 Fraser Davidson – "Canadian Operational Network for Coupled Environmental PredicTion Systems (CONCEPTS)"

7.3 Tetjana Ross - "Changes in stratification in the North Pacific and implications for primary productivity" + Patrick Cummins – "Upper ocean variability over the Alaska Gyre from Argo"

8. Technical issues

8.1 Report from Argo Platform and Sensor Technical Workshop

The second Float/CTD Technical Workshop was held at UW in Seattle from 11-15 September 2017. Fifty-four people attended the meeting. The goals of the meeting were (1) to discuss how to increase float reliability; (2) to examine changes in float and CTD technology since the first technical workshop, which was held in 2005; and (3) to increase communication between groups deploying floats and float hardware manufacturers. A detailed workshop report was prepared and is available at http://www.argo.ucsd.edu/Report_floattechnicalworkshop_2017.pdf. Workshop recommendations included the necessity of pre-deployment checks of floats whenever possible, avoiding the use of alkaline batteries, improved capture of technical data and parameters from floats, and the documentation of float failure modes. An important feature of the meeting was the presentations by many commercial vendors and manufacturers of floats, CTDs, and other float systems.

Action item 14: Ask AIC to set up private mailing list with techs and PIs within Argo to share technical information. AIC.

Key issues for AST:

CTD testing activities

A number of issues related to CTD systems on Argo floats were discussed. It was noted that in recent years there are an increasing number of instances of "salty drift" of the CTD; early-on in Argo it was expected the any salinity drift was likely to be negative (towards fresher values over time), and this was borne-out over the first decade of Argo. In the past few years we have been experiencing a large number of positive drifting sensors (towards more saline values) over time, with drifts sometimes so large that the sensors cannot be corrected. The cause of these positive drifts is not well understood by the users or manufacturers. New types of CTDs were also discussed, including the RBR inductive CTD that has been tested on a few floats. This CTD unit is promising, although there have been a number of failures and there are still problems in some units with drift and spikiness. Argo groups were encouraged to use this sensor, and the ADMT and AST have approved the data from these sensors to appear in the GDAC data, marked with a flag QC=3 (possibly questionable data) until the performance of the sensor is fully documented. The topic of pressure sensor calibration was revisited from previous meetings, noting that there are known negative biases in the Druck pressure sensor used on SBE 41CP CTD units, with the negative bias increasing as a function of increasing pressure and decreasing temperature. SBE has found the source of this problem (an improper calibration equation) and has reportedly fixed it. As the units with the new equation appear, they will be tested and examined for evidence that the problem has been fixed. It was noted that UW is producing a new APF11 controller for APEX floats that should be tested soon and will hopefully be available for use by the end of 2018. Finally, the group was encouraged to recover as many floats as possible in order to examine aging of the float and CTD, with the possibility of a working group being formed to attempt to recover as many as 20 floats for this purpose.

Action item 15: AST recommends National Programs consider taking an SBE41, SBE61 or RBR CTD on cruise to do a comparison with shipboard CTD. Both manufacturers have agreed to supply a CTD for this purpose. National Programs, Greg Johnson of RBR, Dave Murphy of SeaBird, W. Walczowski of Argo Poland

Corrosion in APEX

At the float/CTD workshop in 2017 it was noted that, while the overall longevity of floats has increased over the years, nearly 50% of the floats still fail prior to exhausting their batteries for largely unknown reasons. One possible explanation for some of these losses was recently offered. Two recovered APEX floats, one from near New Zealand and one from near Bermuda, show evidence of strong corrosion in the area where the float endcap meets the hull. In one case the corrosion breached the hull, leading to flooding and catastrophic failure of the float. In the second case the float showed similar corrosion and was recovered just prior to the time when the corrosion would have likely breached the hull. The cause of this corrosion is presently unknown, but the signature of the corrosion (a slow gain of buoyancy over the first 100 or so profiles after deployment, followed by a rapid loss of buoyancy just before failure) has now been found on hundreds of floats after a reexamination of the engineering data. Tests on the recovered float and other floats are now underway at UW and engineers are working with the manufacturer to better understand and remedy this problem.

The pathway for new sensors entering Argo and how we distribute and label pilot data

A summary of a document, http://www.argo.ucsd.edu/guidelines_Argo_data_stream_v5.docx, on the requirements for a float to be accepted into the Argo Data Stream and the process for a new parameter or sensor to be approved for inclusion in Argo was presented. It was requested that the AST approve this document to aid the Argo National Programs in determining whether a float is an Argo float. These requirements and targets include:

1. A float must be operated in accordance with Argo governance, which includes notification of the AIC prior to deployment
2. All float scientific data has to be available within 24 hours of the time of the measurements.
3. The funding and path to provide D-mode quality controlled data into the Argo Data Stream is identified prior to deployment. The float mission should provide data from stable water masses to enable adequate DMQC.
4. Target profiling depth and cycling intervals are 2000 dbar and 10 days, respectively. Float that do not meet these targets, but extend Argo coverage and satisfy the first 3 requirements are acceptable.

A process to transition a new sensor or parameter into the Argo Data Stream is proposed, which involves going through 'Experimental' and 'Pilot' stages to 'Approved.' An Argo float with an 'Experimental' sensor must include an 'Approved' CTD. The acceptance of an 'Experimental' sensor on an Argo float will be made by the national Argo program. These sensors should measure appropriate climate science based parameters. The data from the 'Experimental' sensor will be stored in the un-curated 'aux' directory at the GDAC. The structure and means to access the 'aux' data must be documented in the directory by the float operator. At the end of a successful 'Experimental' phase, a sensor should have demonstrated that it has the engineering and scientific potential to be deployed over the global Argo array. A 'Pilot' study, which must be approved by the AST, involves the deployment of the floats with the new sensor in a wide range of oceanographic regimes to demonstrate that it can be used in the global Argo Array. The appropriate entries in the sensor and parameter tables should be approved by the ADMT. The data from 'Pilot' floats will be stored in the Argo netCDF files at the GDACS, but the sensor data will be included in the Grey List and their QC flags set to '3.' With concurrence from the broader Argo DMQC group, the DMQC flags for these sensors can be set to lower values. After a successful 'Pilot' study, the AST can designate the sensor as 'Approved' and the data will be treated in the same way as other Argo data.

Action item 16: Finalize document on guidelines for what is an Argo float and process for entering data stream and send it to ADMT and AST for final approval. When approved, publish documentation on Argo websites and distribute to National Programs. B. Owens, S. Wijffels, B. King, M. Scanderbeg

Batteries and energy budgets

After the Seattle Argo Technical Workshop, Lee Gordon carried out an analysis of battery performance for APEX, Navis and Solo-II floats. He submitted a report that is summarized in the Workshop report and is available on the Argo website, http://www.argo.ucsd.edu/Argo_battery_report.pdf. Estimates of the internal battery resistance for all three floats show that the battery performance is degraded due to passivation, where the Solo-II floats using only ElectroChem primary lithium batteries shows very significant loss of available energy. Scripps and Woods Hole are now deploying Solo-II floats equipped with Tadiran batteries, which have lithium ion batteries which are trickle charged from the lithium primary batteries and can provide high currents to the floats without passivation. To monitor the Argo fleet, it is recommended that the voltage and current from the float battery be monitored prior to the ascent, at the beginning of ascent (maximum current demand) and after the passivation layer has been removed. If currents are not measured, then battery voltages are sufficient to monitor the health of the batteries.

Summaries of the energy per cycle, battery capacity and battery energy extraction for each float type are given in Table 1.

Float	Battery type	Energy/cycle [KJ]	Battery capacity [MJ]	Total battery energy extracted [%]	Nominal maximum dives
Apex	ElectroChem	16	5.3	70 %	230
Navis	ElectroChem	13	5.3	60 %	245
Solo-II	ElectroChem (2 pack)	10	3.8	50 %	190
	ElectroChem (3 pack)	10	5.7	50 %	285
Solo-II	Tadiran (2 pack)	10	3.8	75 %	285
Solo-II	Tadiran (3 pack)	10	5.7	75 %	425

A Solo-II float equipped with 3.8MJ of Tadiran batteries was deployed in 2015 and has completed 320 cycles, but on a roughly 1 day cycle which mitigates passivation. Twenty-five floats with ElectroChem batteries and twenty-four floats with Tadiran batteries were deployed from the R/V Kaharoa in fall 2016. These floats are on a ten-day cycle time. A summary plot of their performance can be found at: http://sio-argo.ucsd.edu/Tadiran_web.html. After 18 months, these floats show the expected behavior from both battery types. Improvements to the Solo-II by the Instrument Development Group at SIO should reduce the energy per cycle to 8 KJ which could lead to a nominal lifetime of greater than 500 cycles.

From these results, it is clear that all floats equipped with ElectroChem batteries have less energy available due to passivation, but the Solo-II floats are the extreme. It is recommended that plots similar to those in the report be used to monitor battery health. While it has not been demonstrated that the hybrid packs with Lithium Ion batteries will perform up to expectations for projected float lifetimes, it appears that this battery configuration will extend float lifetimes, assuming that there are no other unforeseen failure modes. Improved battery performance and decreased energy demand per cycle have the potential to significantly enhance the Argo array.

Action item 17: AST asks float deployers to consider trialing Tadiran batteries to extend float lifetime. Link to Gordon's battery report: http://www.argo.ucsd.edu/Argo_battery_report.pdf Float deployers, manufacturers

8.2 EuroArgo in-situ monitoring system

A short presentation was given on the in-situ monitoring system that was set-up in the context of the MOCCA project within the EuroArgo Eric. The goal of this in-situ monitoring system is to observe the proper functioning of the European fleet and detect failures early on. The web interface includes basic float information and temperature and salinity data in form of sections, TS diagrams and profile plots. The section of technical parameters offers plots of a variety of technical data obtained in different phases of a float cycle. Examples were shown of floats deployed in the South Atlantic in Drake Passage, Scotian Arc and south of Cape Town, which showed difficulties to maintain the programmed park depth within the specified limits of ± 50 dbar in the presence of strongly sloping isopycnals. Numerous valve and pump actions were reported by the floats during the drift phase. Relaxing the threshold to ± 75 dbar resolved the problem and no more excessive pump and valve actions were observed. The question was posed to AST if there were objections to a larger margin on the park pressure. AST did not see any large impact on velocity calculations given the small shear at depth and suggested to contact both velocity climatology groups on the issue. The overall impact of the excessive valve and pump actions should be calculated. The topic should be discussed at next ADMT.

8.3 Recent float performance evaluation of array

The Argo TC used the argo.jcommops.org website to give an overview of the performance of different float groups, and also, demonstrate the website capabilities.

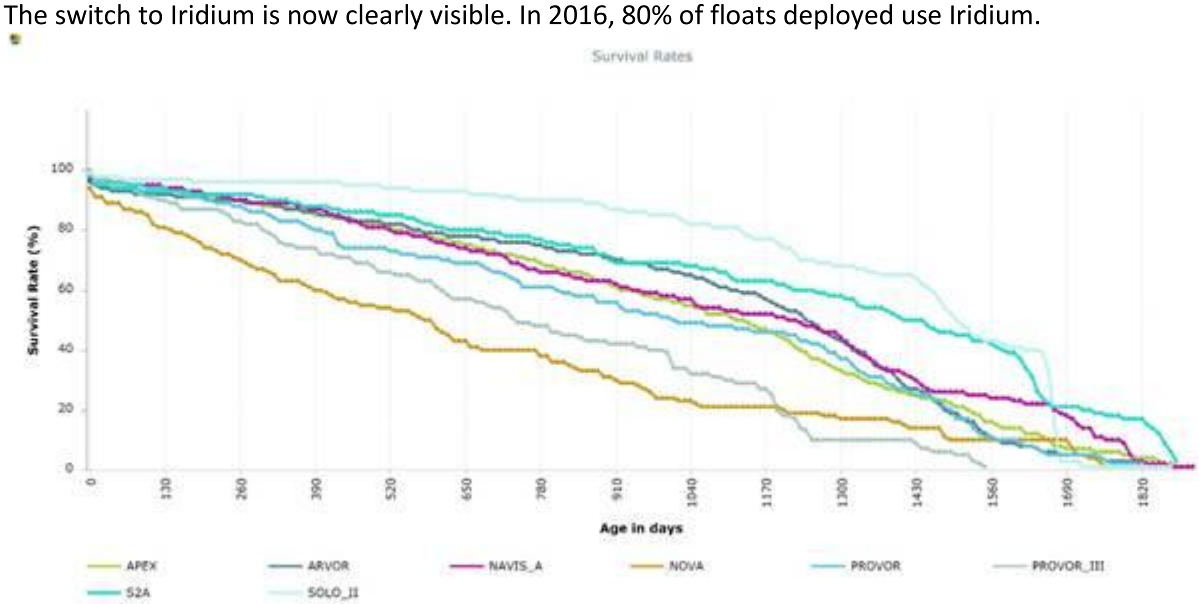
The instrument reliability is promising. The half-life hasn't been reached yet for 2011 deployments.

Overall, reliability of the main float models keeps improving. It is at around 100 - 125 profiles that we see two groups of floats with diverging results. The excellent performance of the SIO/WHOI/MRV floats deserved to be recognized. The mortality rate for the global array, however, increases in 2016 so it needs to be carefully monitored.

Today 20 % of floats reach 250 cycles, 60% reach 150 (improving by 10%), but 25% do not pass the first 10 cycles.

It is to be noted that some float experts and power users have excellent performances.

The switch to Iridium is now clearly visible. In 2016, 80% of floats deployed use Iridium.



2012-2017 deployments by float model (> 100 deployments).

8.4 Sensor progress:

RBR

A follow-up report from the one given at AST-18 presented the further improvements to the RBR CTD. The drift of the salinity measured from the first generation RBR*argo* CTD in the Solomon Sea is ~0.0006 PSU/yr. Comparable estimates from floats deployed in the North Atlantic are not possible because the floats are not in a region with highly stable water masses. Three Argo Floats with second generation RBR*argo* CTD failed due to an engineering design flaw in the mating O-ring seal of the CTD to the float end-cap. This flaw has been corrected and CTDs have been delivered to Argo float providers. Data from a second generation RBR*argo* CTD on an ALAMO float deployed south of Puerto Rico in a region of double-diffusive (10 m) staircase structure shows that the dynamic response of the CTD is now excellent. Use of the thermistor next to the ferrite core of the conductivity cell corrects for the slow (1 minute) thermal mass response of the ferrite and a correction following Lueck and Picklo (1990) corrects for the faster (8 sec) thermal mass correction. A small (0.2 sec) offset of the conductivity data corrects for an offset between the center of the volume measurement of conductivity and the sting thermistor. These 3 corrections essentially completely remove the density inversions seen in the raw data. Data from further measurements in the ocean and in the WHOI double-diffusive tank can be used to develop a profiling speed dependent correction that will be implemented in the CTD software. Work will have to be coordinated with the float manufacturers to telemeter both the corrected and raw salinity values.

Given these significant improvements, it was proposed to the AST that a global Pilot Study to further evaluate the RBR*argo* CTD should begin. The AST approved this proposal.

Action item 18: AST approves global pilot study with RBRargo sensors. B. Owens to coordinate with AIC and National Programs.

Action item 19: ADMT to send out notice to users that RBR data will be entering the data system and will be marked accordingly. ADMT co-chairs.

Preliminary evaluation of the RBR Argo6000 during the RREX17 cruise

During the RREX17 cruise that took place in the North Atlantic in summer 2017, the RBRargo|6000 CTD was mounted on the rosette near the SBE911 for 125 stations. The RBRargo|6000 CTD is a candidate for the Deep-Argo extension in test phase. The RBRargo|6000 CTD performed well and reported data for the all the casts. Due to specific preparation of the CTD for this experiment (addition of two oxygen sensors on the same logger as the CTD), some un-expected issues came to complicate the analysis of the data: spiking in the pressure and temperature channels and irregular sampling frequencies. A significant work was thus necessary to clean up and correct the data time series before evaluation. Once corrected, the data were compared against the SBE911 (pressure, temperature, conductivity) and bottle chemical measurements (salinity, oxygen) during the upcast and downcast. We found the RBR pressure to be within the initial accuracy of 3db but having a systematic bias dependant on time that could easily be corrected. The RBR temperature bias shows an unexpected large scatter that is probably due to the pre-processing of the data, more work has to be done to clarify this. Note however that the downcast RBR temperature bias against the SBE911 is nearly within the initial accuracy of 0.002degC with a very small pressure dependence. The RBR conductivity, once corrected for static pressure and temperature and dynamic temperature effects is almost within 0.01mS/cm accuracy. But the RBR conductivity and salinity, present a systematic non-linear pressure dependant bias. It can be corrected for this particular sensor. The full analysis of the data is not concluded though. More technical corrections due to the specific electronics of this CTD should be done. In summer 2018 another RBRargo|6000 CTD, along with a SBE61 will be mounted on a rosette for a couple of CTD casts during the OVIDE18 cruise deepest stations (>4000db). These new data will allow us to determine if the bias observed during the RREX17 experiment are truly systematic, and hence correctable. Also in 2018, a triple CTD Deep-Arvor float will be tested (RBRargo|6000, SBE41CP/7000 and SBE61). In 2019, we should start the design of a Deep-Arvor and an Arvor equipped with the RBRargo OEM model on the tap.

SBE61

N. Zilberman reported on the present status of the 6000-m Deep Argo CTD pressure and salinity accuracies, based on observations in the Southwest Pacific Basin. Comparisons between SBE-61 and shipboard CTD data from the P15S GO-SHIP line 2016, show pressure differences as large as 7 dbar. These are of similar magnitude to comparison data from the 2014 Tangaroa cruise. The SBE-61 CTD hasn't reached the accuracy target of ± 3 dbar for pressure, envisioned by the Deep Argo community. Salinity differences are computed between SBE-61 CTDs mounted on Deep SOLO floats, and reference value estimated at Deep SOLO profile locations, based on repeat hydrography data in the Southwest Pacific Deep Argo pilot array. SBE-61 conductivity is estimated using a constant value of SBE-61 CTD cell compressibility provided by SeaBird, based on observations from the 2014 Tangaroa cruise, the 2016 P15S line, and station Aloha. Salinity anomalies projected onto $\Theta = 0.77$°C, are within ± 0.002 PSS-78, except for 3 SBE-61 CTDs; 1 SBE-61 CTD is 0.003 PSS-78 fresh (early cycles, possibly TBT), 1 CTD is 0.003 PSS-78 salty, and one CTD is 0.004 PSS-78 salty (bias is constant with depth, possibly related to calibration coefficient error). Deep Argo salinity estimates in the Northwest Atlantic Basin, computed using the same value of SBE-61 cell compressibility as in the Southwest Pacific, show a 0.002 PSS-78 salty offset at $\Theta = 1.6$°C, compared to reference data along the RAPID line. This suggests that the compressibility of the CTD cell might vary from float to float, and between CTD batches. Two SBE-61 CTDs mounted on Deep SOLO floats in the Southwest Pacific, show positive (salty) drift of > 0.02 PSS-78, 1 year after deployment. Such drift could be related to aging of the seal between the encapsulant and the conductivity cell. Further work is needed to improve estimates of the compressibility of the SBE-61 CTD cell, and to strengthen the sealing of the CTD cell.

Increasing occurrences of fast salinity drifts in SBE41

S. Wijffels reported on an increase in frequency of SBE conductivity sensors drifting high and quickly that was first discussed at the Technical Workshop in Seattle. She has worked with J. Gilson, P. Robbins, and A. Wong to do a salinity drift audit using two different Argo-based global climatologies. This has revealed runs of serial numbers of SBE CTDs that express different rates of drift with over 50% drifting high by more than 0.01 psu by profile 60. This degradation of stability in the CTDs has several implications for Argo including an increased workload for DMQC teams, a possible high salinity bias in the global data set and it is likely to shorten the conductivity sensor's useful life leading to degraded salinity coverage. Argo is working with SeaBird to better understand the number of sensors involved and to eliminate it from future deployments.

In the course of the audit, S. Wijffels noted the v3 metafiles with more information on sensor serial numbers made the task much easier and faster. A report on the group's work is here:

http://www.argo.ucsd.edu/salt_drift_summary_7Mar2018.pdf SeaBird's response is here: http://www.argo.ucsd.edu/DM_report_ArgoPositiveDrifters8Mar2018.pdf

Action item 20: Alert DMQC teams of this high salinity error via email with link to document. Alert Argo users that a larger percentage of real-time data are likely biased high in salinity. ADMT co-chairs.

Action item 21: See if we can determine if the salinity offset remains constant in pressure and temperature as degradation gets worse. How correctable is bias and for how long? J. Gilson, S. Wijffels, DMQC operators, SeaBird

9. Completing the global mission and exploring extensions

9.1 Technical updates on Deep Argo floats:

Deep SOLO

D. Roemmich reported on the status of SIO Deep SOLO profiling floats deployed in regional pilot arrays in the SW Pacific Basin, the South Australian Basin, the Australian Antarctic Basins, and the western North Atlantic. Between January 2016 and October 2017 a total of 20 Deep SOLO floats were deployed in the SW Pacific Basin by RV Kaharoa on 3 separate deployment voyages, as well as by transiting research vessels (RV Nathaniel Palmer and RV Investigator) on GO-SHIP repeat hydrography cruises. An impedance mismatch between the float controller and CTD in the first batch of 7 floats caused occasional data dropouts. Five of these floats were subsequently recovered by Kaharoa for software correction of the problem. One of the 5 had its antenna broken during recovery and was shipped back to the U.S. for repair. Other Deep SOLO deployments have included 8 in the South Australian Basin by RV Kaharoa in October 2016, 6 in the western North Atlantic by RV James Cook in March 2017 and 5 in the Australian Antarctic Basin by RV Investigator in February 2018. In total, 39 Deep SOLO floats have been deployed, of which 38 are presently operational (with some CTD issues reported elsewhere) and 1 was recovered. Plans are being made for an additional 10 SIO Deep SOLOs in the SW Pacific Basin and 5 possibly in the Argentine Basin. Recent improvements in the SIO Deep SOLO include firmware options for sampling on ascent and/or descent and for ice avoidance, and a change to hybrid lithium batteries (reported elsewhere) to extend the battery lifetime of Deep SOLO to over 200 cycles. Roemmich acknowledged the development and ongoing improvement of Deep SOLO by the SIO float laboratory, who are responsible for the extraordinary success of the instrument in initial deployments.

Deep APEX

Regarding recently deployed Deep APEX status in the UK (S/N 18,19,20,21) and Japan (S/N 17,26,28,29), lots of trouble occurred with the deployed floats and the data. 3 floats (S/N 17, 18, 20) are dead or did not return any profiles. 5 floats are working mechanically, but 5 floats have permanently bad noisy salinity, intermittently bad salinity or biases (>0.005psu). Focusing on oxygen sensor performance on JAMSTEC's floats (one JFE Advantec RINKO (AROD-FT): S/N 26 and two Aanderaa Optode4835(S/N 28, 29)), one Optode oxygen sensor has a permanently large negative bias with large variability (>0.2 psu), and the RINKO has only very shallow profiles (<500m). JAMSTEC and UK are still asking TWR and SBE to investigate cause of problems.

Many Deep APEX are to be deployed in 2018, with 4 in the Drake Passage from the UK and 14 in the Southern Ocean and North Pacific from JAMSTEC. To improve the situation, we will share data and information and will continue to discuss with the manufacturers.

Deep NINJA

An update on Deep NINJA was presented by Toshio Suga on behalf of Taiyo Kobayashi (JAMSTEC). JAMSTEC, Tsurumi-Seiki (TSK) Co., Ltd. and JFE Advantech Co., Ltd. have developed a new model of Deep NINJA equipped with RINKO-DO sensor, AROD-FT. AROD-FT is a deep sea mode (< 6700m) of the fast optical DO sensor. Two prototype floats were assembled; one of them was deployed at K2 station in the western subarctic North Pacific in July 2017 from R/V Mirai. It halted its operation due to a mechanical failure after the measurement of the 9th profile. The other one was deployed in the Southern Ocean in January 2018 from R/V Investigator, CSIRO, along with other two Deep NINJA floats as part of the Australian-Antarctic Basin pilot array and has been operational so far. The DO data acquired by the former float were compared with shipboard CTDO cast data obtained near the K2 station by R/V Mirai. The comparison showed that the RINCO-DO deviation from the shipboard CTDO data was well represented as a liner function of DO passing through the origin and the adjustment could be easily made based on a one point reference.

Deep Arvor

The Deep-Arvor float model, designed by Ifremer and commercialized by NKE, is an Argo float extending the capacity of the Arvor, as well as the accuracy of the SBE41CP, down to 4000m (Le Reste et al, JAOT 2017). 36 Deep-Arvor have been deployed since 2014 by 6 countries. 10 are operational today. Floats behave very well and according to multiple mission parameters, which can be modified on the fly with Iridium. Scientific analysis of the Deep-Arvor measurements is promising (see below for the North-Atlantic deep pilot array). One can note that survival rates are heterogeneous. We now suspect that the software management of grounding is the major cause of premature failure of the floats.

At this time, the problem occurs when a Deep-Arvor is grounded, waiting for the end of the "drift" at parking depth, or for the time to start the ascending profile. Currents flowing along the bottom boundary layer can drag the float out of its grounded pressure level tolerance interval (typically 50 dbar). In this case, the float activates its hydraulic system to remain within the accepted pressure range. But because the float is grounded during this action, its progressive loss of buoyancy will put the ballast at risk, up to its full collapse. This issue will be fixed with a software update for new models, while existing floats can lower this risk by simply increasing the pressure tolerance to 100db or more. Evolution of the Deep-Arvor will also include the design of a model equipped with the RBRargo|4000 OEM CTD and two test floats equipped with both the SBE61 and RBRargo|4000 CTDs.

Action item 22: Make Deep Argo label that works on all Deep Argo float models. M. Belbéoch, M. Scanderbeg

9.2 Early results from Deep Pilot Arrays

N. Atlantic

The North Atlantic Subpolar gyre (NASPG) is a privileged region for the formation of the water masses of the lower limb of the Meridional Overturning Circulation by winter heat loss. The formation of these dense water masses contributes to the uptake and transfer of anthropogenic carbon and dissolved oxygen (O2) to the deep ocean. While knowledge in deep circulation is required for understanding long term changes in heat content, acidification and ventilation of deep ocean interior, the spatio-temporal variability of the deep circulation and its driving mechanisms are still poorly documented. To address such issues, the Laboratoire d'Océanographie Physique et Spatiale (LOPS, Plouzané) deployed five Deep-Arvor below 2000m depth in the Iceland-Scotland Overflow Water (ISOW) between 2015 and 2016. The Deep-Arvor is an Argo profiling float able to sample temperature, salinity and O2 down to 4000m. While the trajectory of floats deployed in the Irminger Sea in 2016 was predictable, results from the three Deep-Arvor floats launched at the Charly Gibbs fracture zone during summer 2015 are unforeseen. None of these floats circulated northward in the Irminger basin as initially expected considering recent general deep circulation schemes [e.g. Daniault et al., Prog. Oceanogr. 2016], and one of them revealed a new pathway westward till the western boundary current (WBC). Based on all float trajectories combined to satellite observations, we show that surface circulation strongly influenced float displacements and that the North Atlantic Current shaped the deep circulation between the eastern and western parts of the NASPG, as well as with the subtropical gyre. Finally, analysis of the water masses characteristics from the Deep-Arvor data set are also used to estimated westward mixing of ISOW toward the western boundary current. These results will be compared to those obtained from the 4 additional Deep-Arvor floats deployed in ISOW during summer 2017.

SW Pacific Basin

N. Zilberman presented results on the top-to-bottom ocean circulation in the Southwest Pacific Basin. A preliminary approach for estimating geostrophic velocity based on Deep Argo data is to consider Deep Argo float pairs. Absolute velocity estimates are computed at 32°S between 174°-157°W, using Deep Argo temperature-salinity profiles, and Core Argo float trajectories. Velocities are oriented southward below 2000 m depth, and show highest values (0.2-0.4 cm/s) between 2000-4000 m, consistent with an inverse solution based on WOCE repeat hydrography, WOCE float trajectories, and moored data by Wijffels et al (2001). The transport at 32°S, integrated between 174°- 157°W and 2000-5200 m, shows an apparent seasonal cycle with transport values stronger in the winter compared with summer. The 2016-2017 averaged transport integrated between 174°-157°W is 8.3 ± 1.6 Sv southward. The goal of future work is twofold: (i) to study the along-flow variability of the deep western boundary current along the Tonga Kermadec Ridge and recirculation in the Southwest Pacific Basin, and (ii) to improve our understanding of the steric contribution to sea level budget in the Southwest Pacific.

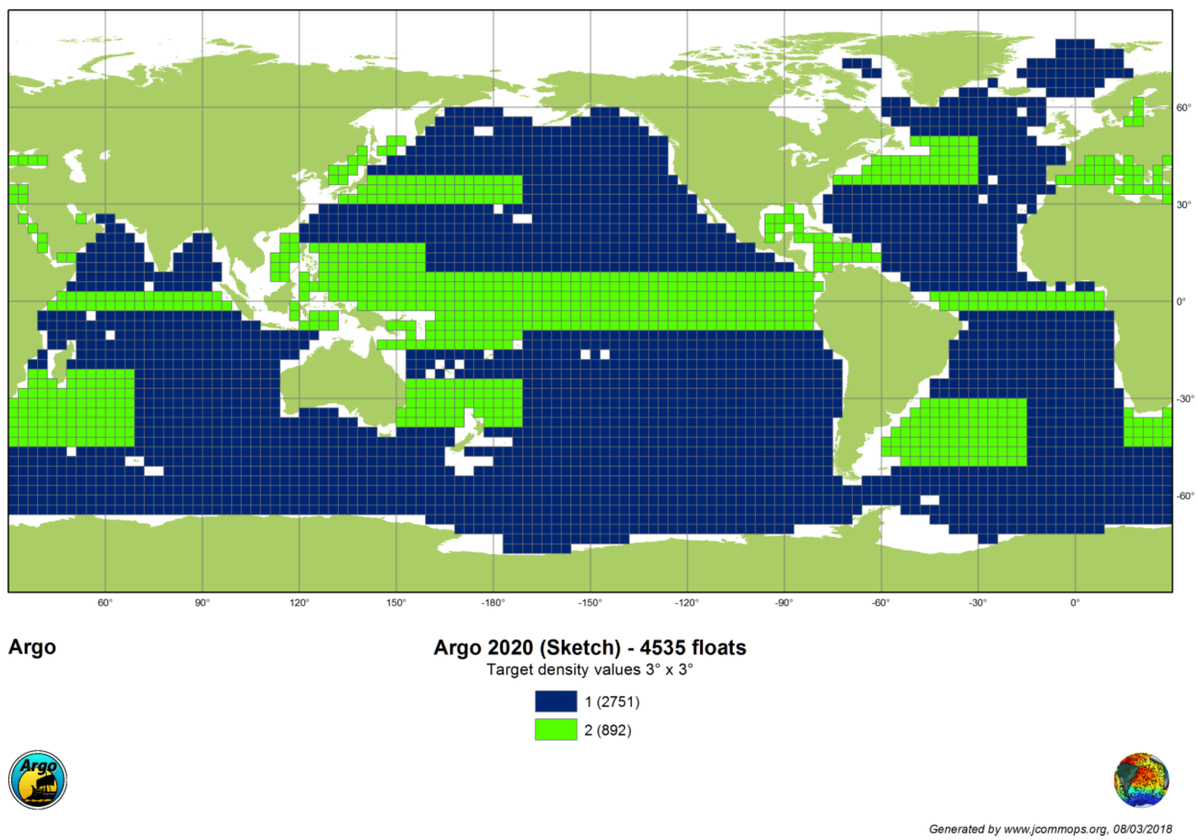
9.3 Deep Argo partnership with Paul G. Allen Foundation

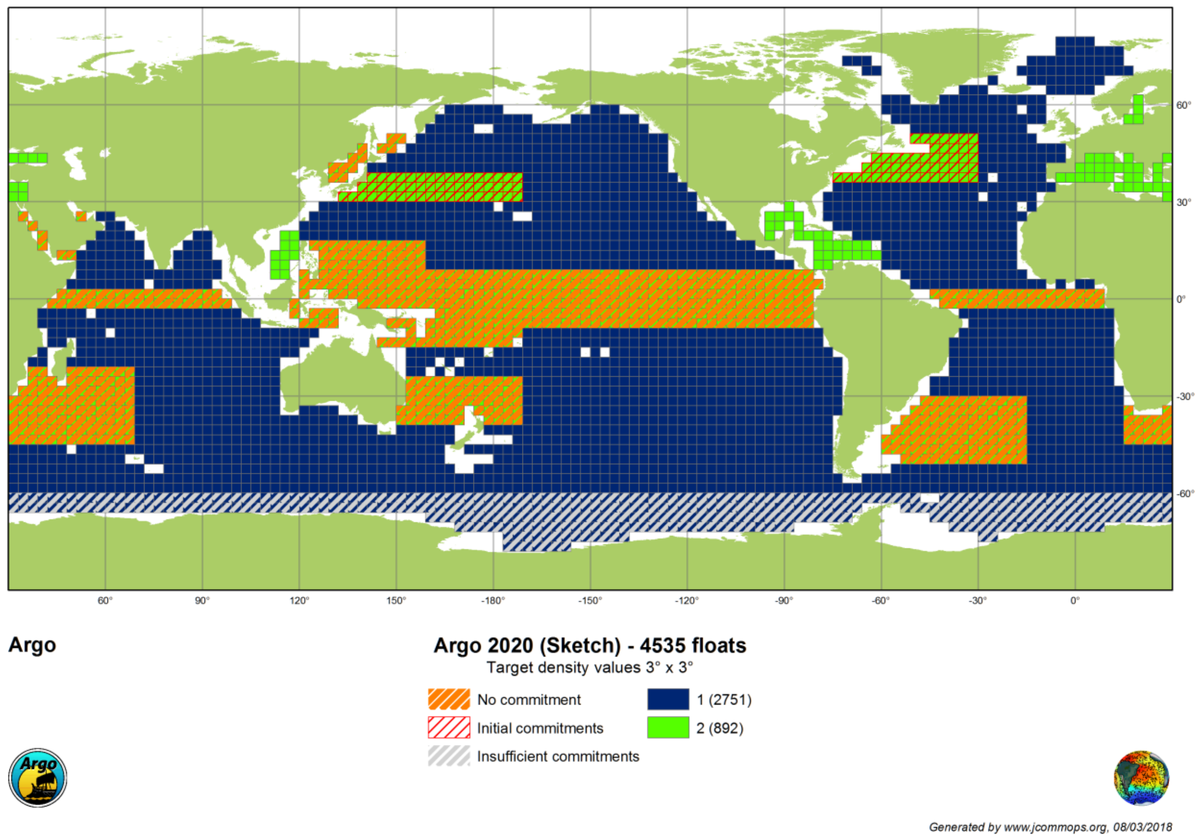
Gregory C. Johnson presented on the "Jump Starting Deep Argo Project", on which NOAA/PMEL is funded by, and working in partnership with, Paul G. Allen Philanthropies (PGAP). The goal of the project is to establish a Deep Argo regional pilot array in the Brazil Basin (western South Atlantic) at the Deep Argo target density of 5° lat x 5° long. The plan is to deploy 25–28 Deep SOLO floats in waters deeper than 4000 m within this basin. The floats will be manufactured by MRV Systems and deployed from Mr. Allen's ship the R/V Petrel. Deployment of additional floats and drifters will be possible during the deployment cruise. A memorandum of understanding for this three-year project was signed in April 2017. A purchasing contract was put into place in between MRV Systems and PGAP in September 2017. The first five floats will be delivered in late spring 2018. The remaining floats will be purchased subsequent to successful field testing of the first five.

9.4 Status of Argo extensions

M. Belbéoch introduced the different indicators used to monitor the Argo2020 expansions status.

The Argo2020 sketch design was reviewed according to the Global Design update and TPOS2020 requirements discussed last year.
Considering this design is a draft and used mainly for communication for now, it was proposed to harmonize all increased target densities to x2 where they were before x1.5 or x2.25, based on different requirements normalized on a 3x3 grid.
The equatorial extensions target in Atlantic/Indian could be aligned on the Pacific one and extended to the tropical band -10°/10°.



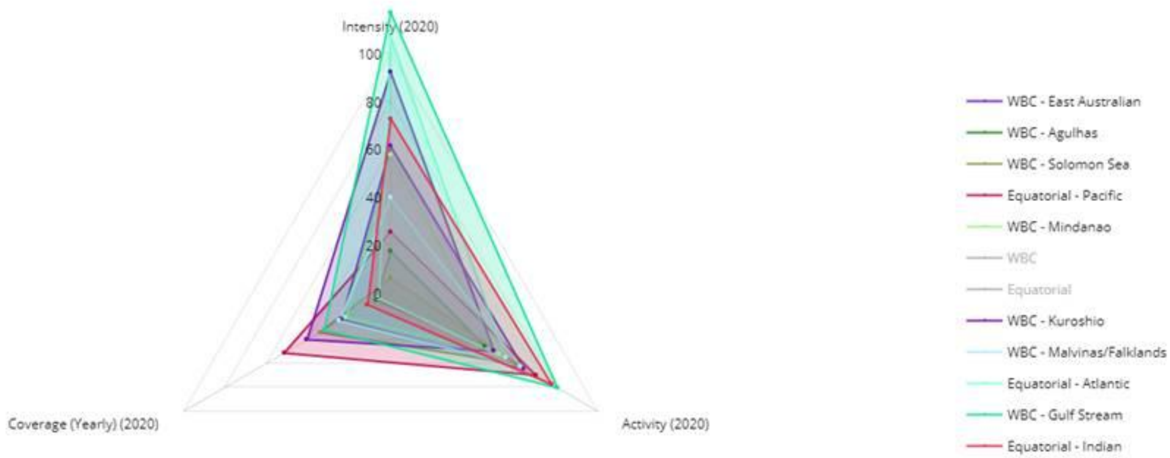


A first representation of the commitments on these extensions was drafted and should be improved for clarity.

	Targets Argo		Targets Argo 2020		Extra cost/year
	Activity	Intensity	Activity2020	Intensity2020	
Equatorial	**168**	**41**	**336**	**82**	**41**
Eq. Atlantic Ocean	35	8	70	16	8
Eq. Indian Ocean	36	9	72	18	9
Eq. Pacific Ocean	97	24	194	48	24
WBC	**459**	**112**	**918**	**224**	**112**
WBC – Agulhas	113	27	226	54	27
WBC – East Australian	59	14	118	28	14
WBC – Gulf Stream	49	12	98	24	12
WBC – Kuroshio	51	12	102	24	12
WBC – Malvinas/Falklands	93	23	186	46	23
WBC – Mindanao	56	14	112	28	14
WBC – Solomon Sea	38	9	76	18	19
TPOS [-30°;30°]	**894**	**218**	**1259**	**307**	**89**

<u>Targets and extra float requirements for equatorial and WBC extensions.</u>

The TPOS extension includes a double density in the [9°;9°] as calculated ion the base 3°x3° grid.
If the Atlantic and Indian oceans are extended on the same way, they will need each about 30 more floats per year.
A number of expansions areas, such as Marginal Seas, can't be implemented without an expanded international support of coastal states.
There are political issues with regard to EEZ access but moreover, there is a low interest from existing Argo partners to implement these areas.
The Gulf Stream is the only WBC with almost appropriate activity and intensity.
The Kuroshio activity (50%) keeps on decreasing (since 2012) but recent deployments show an appropriate intensity that should improve the situation.



Action item 23: Add WBC and Equatorial Region columns to Commitments Table. M. Belbéoch

Action item 24: Modify Future Argo /Argo 2020 map and tables to highlight how many more floats are needed to satisfy the extensions. M. Belbéoch, AST co-chairs.

BGC-Argo

Ken Johnson provided an update on activities of Biogeochemical-Argo. The program website (biogeochemical-argo.org) provides regular updates on activities through a periodic newsletter. Planning is underway for a Biogeochemical-Argo workshop at the University of Washington, 9 to 13 July 2018. Steve Riser, Ken Johnson and Lynne Talley are organizers and the US Ocean Carbon and Biogeochemistry program is providing funding. An abstract for the Ocean Obs19 meeting has been submitted. A best practices paper is in preparation for Frontiers in Marine Science. Henry Bittig will be lead author. A bibliography of peer-reviewed publications is maintained on the program web site. The number of papers/year is increasing rapidly. The number of BGC profiles/year has stabilized in the past 3 years and the next challenge for BGC-Argo will be to extend funding sources from small research projects to sustained observing. It should be noted that the number of BGC profiles for oxygen, nitrate, and pH now greatly exceed those collected by ships and the recent assessments demonstrate that the adjusted data is of high quality. Monthly reviews of the BGC-Argo data at the GDACs shows great improvements in the amount of adjusted or delayed mode data that is available. Efforts are underway to ensure that all DACs have access to the computer code used to produce adjusted data. Commitment tables show that the number of multi-parameter floats (4 or more of the 6 BGC parameters) is increasing. Well over 120 floats are anticipated for deployment in 2018 with increasing efforts by many nations, particularly China. Poland is a new contributor to the BGC array.

Action item 25: Work with UK Met Office to develop BUFR format for irradiance. F. Carse, J. Turton, K. Johnson, H. Claustre

TPOS2020

W. Kessler made a presentation via Skype on TPOS 2020 work that has been done to review and redesign the Tropical Pacific Observing System. The idea was to define requirements and then look for new science and technology to meet the requirements. The goals of TPOS include observing ENSO and advancing understanding of its causes, finding the most efficient and effective observational solutions to support prediction systems for ocean, weather and climate services and advancing understanding of tropical Pacific physical and biogeochemical variability and predictability. The first report was published in late 2016 and it included 22 recommendations and 15 actions. There is an integrated vision where Argo would resolve fine vertical structure, provide salinity and maps of subsurface temperature and salinity. Satellites and moorings would make up the rest of the backbone technologies. The recommendation is for a doubling of Argo coverage within 10 degrees of the equator. So far, there has been much endorsement of the report which makes a strong basis for partnerships.

10. Demonstrating Argo's value

10.1 Argo bibliography

M. Scanderbeg presented on the current status of the Argo bibliography and some of the statistics she tracks as well as a report by IFREMER with many more statistics. The bibliography now includes over 3100 papers and has similar numbers of papers in the past couple years. She believes this is due to more papers being published using Argo as a secondary data source without the mention of 'Argo' in the paper. Therefore, additional search methods should be deployed to find these secondary source papers. GODAE OceanView may be able to help provide a list of papers published by its various models. P. Oke agreed to help identify some authors in the modeling community who publish regularly as well.

In the past year, M. Scanderbeg has received requests to make the BGC extension papers more visible on the website. Therefore, she proposed to make all extension papers visible by using a unique symbol to be placed by each extension paper. Secondary source papers could also be identified in a similar manner. There was a big increase in the number of papers citing an Argo DOI and in officially acknowledging Argo. Journals appear to be asking for citations for the data in papers and that is showing.

M. Scanderbeg requested an analysis from IFREMER on the Argo bibliography as has been done occasionally in the past. This time, they analyzed papers published in 2014 – 2016. Starting from the list of Argo papers created by M. Scanderbeg, IFREMER makes figures showing key concepts and key words in those papers and can compile a list of the highly cited papers. She suggested making this a yearly request and hopes that some of the material can be made publicly available on the website to enhance the value of the bibliography.

Action item 26: Make extension papers and secondary source papers more visible on the Bibliography page. M. Scanderbeg

Action item 27: Request a yearly analysis of the bibliography from IFREMER. Create a summary for inclusion/distribution on the Bibliography page. M. Scanderbeg, IFREMER

10.2 Argo Steering Team Website Updates and Argovis website

M. Scanderberg reported on the AST website traffic, updates to the webpage and requested help on featuring some ocean heat content plots. The website traffic was actually down a bit in the past year, but there are still close to 40,000 users with 118,000 page views. She noted that the 'Global Change Analysis' page was changed to be called 'Global research' and it got much fewer views. The FAQ and data FAQ pages were visited more frequently and more questions came in on the email addresses about data.

The Future Argo, Polar, BGC and Deep Argo pages were presented at the meeting. These are all ready to go and will be posted following the meeting. The other extensions (Marginal Seas, Equatorial Regions and Western Boundary Currents) will appear on the Future Argo page, but will not have links until the pages are developed. The content of the extension pages could include the design, technical challenges, pilot arrays, links to related pages and task team leads.

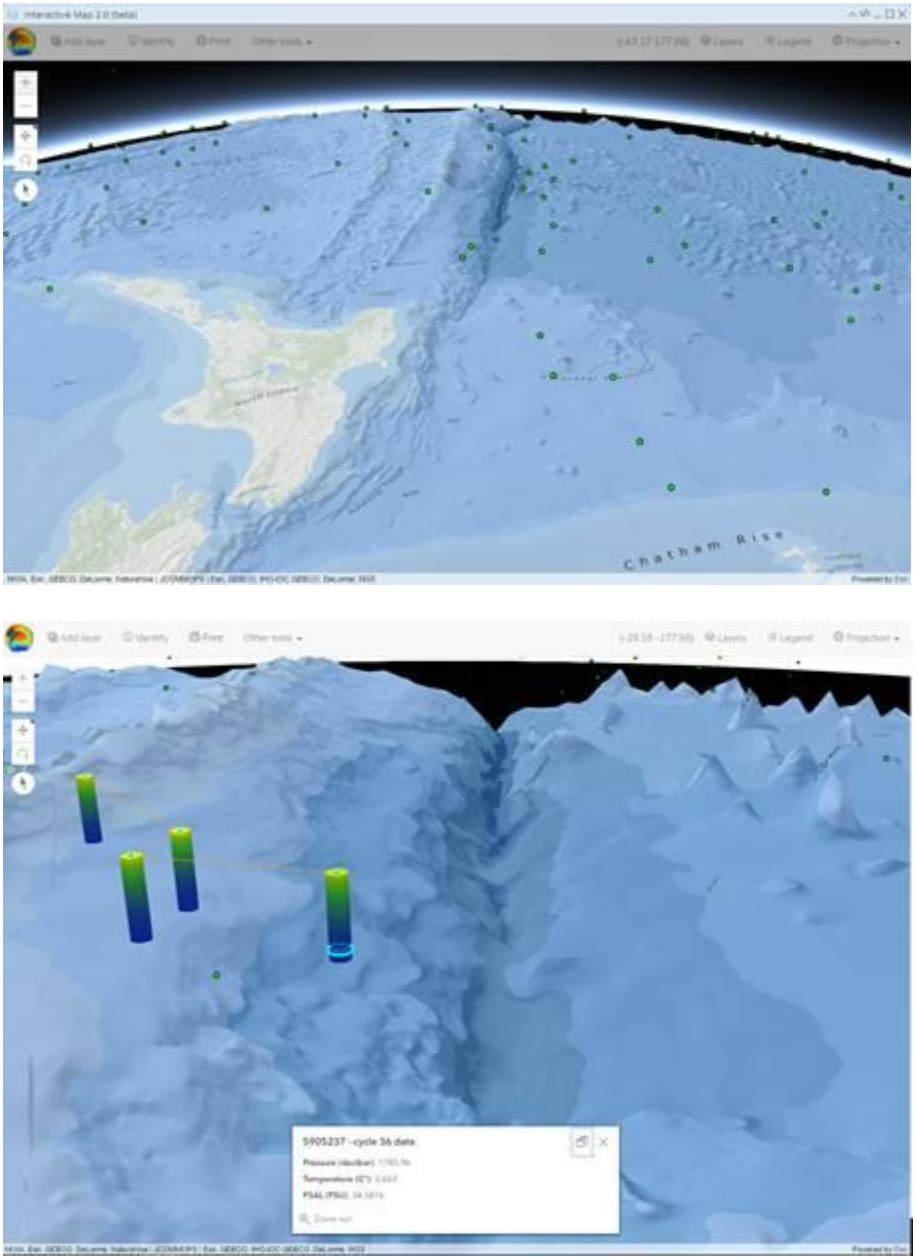
A series of ocean heat content anomaly plots were shown. The thought here is that Argo only gridded products could be used to regularly update an ocean heat content plot and/or panel. S. Wijffels has made a start at this and a small working group was formed to decide how to move forward with this without adding a large burden to produce it given how many other such products will be released yearly.

Finally, M. Scanderbeg presented Argovis which is a modern web app tool which allows for easy navigation of temperature and salinity profiles from the Argo GDACs. It provides a simple interface for both scientists and the general public to select profiles by region, date and pressure range by drawing polygons on an interactive map. Users can also query by platform and view platform history. The Argovis database is available via a customizable API and there is a way to compare gridded Argo products. The website is: http://www.argovis.com Suggestions and collaboration from the community are welcome.

Action item 28: Work with G. Maze and B. Owens to finalize ocean heat content page. Decide on which Argo grids to include, which plot(s) and how to caption it. M. Scanderberg, G. Maze, B. Owens and M. Belbéoch.

10.3 argo.jcommops.org news

M. Belbéoch made a live demonstration of the website capabilities focusing on the GIS 3D interface.



3D view on floats and profiles (Real-time data).
[http://www.jcommops.org/maps/interactive_new/?theme=Argo&projection=3D&ptfStatuses=[6]](http://www.jcommops.org/maps/interactive_new/?theme=Argo&projection=3D&ptfStatuses=[6])
The AST encouraged the team to keep on developing outreach tools for Argo data/metadata access. A specific development project will be included in 2018-2019 JCOMMOPS workplan. JCOMMOPS will seek ESRI experts feedback on these developments to further exploit the engine capacities and continue the collaboration with Ifremer colleagues (such as G. Maze).

10.4 Assessment of the Global Argo Array Enhancements Using Observing System Simulation Experiments

P.Y. Le Traon gave an overview of observing system simulation experiments carried out at Mercator Ocean. The ocean analysis and forecasting systems have a high dependency on observations availability and quality. A dedicated team is working at Mercator Ocean on observation impact assessment and analysis of the contributions of future observations in global and regional data assimilation systems. Observation impact studies are needed to support the evolution of global ocean observing system but also to refine data assimilation schemes and prepare the uptake of future data sets. As part of the Atlantos EU H2020 research project, Mercator Ocean is, in particular, carrying out a series of OSSEs to assess the global Argo Array enhancements. These OSSEs allow quantifying the impact of Argo data together with the other elements of the global ocean observing system (e.g. satellite observations). The extension of Argo into the deep ocean brings a very significant improvement in the capability of the models to reproduce the mean and variability of the deep ocean. Doubling Argo in WBC regions and in the tropics shows a positive but smaller impact. These results are preliminary and more investigations are needed. Results will also be compared with those obtained by other groups involved in Atlantos (e.g. Met Office/CLS/CMMC). As a final message, P.Y. Le Traon emphasized the need to develop further OSSE activities at international level (e.g. GODAE OceanView OseVal Task Team) to assess the contribution of the observing system evolutions taking into account the complementary nature of in-situ, satellite observations and models.

10.5 Machine Learning of Argo Quality Control

Quality Control (QC) of Argo data is based on complex sequences of both automatic and manual tests with human inspection of the test results and the data. At a time where about 400 profiles are produced by the global array each single day, the QC of Argo data has become critically dependant on the performances of the tests and on human resources dedicated to QC. Most of the human expertise is "encoded" within the design of the tests and in the final quality if the Argo Delayed Mode dataset. So, we address the question of whether machine learning of this expertise can be conducted and used to improve the performance of the QC process, or not. Using standard supervised classification methods, we show two use cases for wish a prediction model give 89 and 97% of accuracy on QC flag changes and alarms status decided by a human operator. These encouraging results pave the way for more developments into incorporating machine learning methods into the Argo data flow. But building a training dataset for machine learning is complicated. Propositions are made to the ADMT and AST to improve how the history variables of the Argo dataset are filled and documented.

Action item 29: Support ADMT work on improving history section profile files to help with machine learning.

10.6 Upcoming science conferences and technical workshops –

6th Argo Science Workshop

Toshio Suga reported on a preparation status of the 6th Argo Science Workshop (ASW-6). JAMSTEC will host ASW-6 to be co-sponsored by Japan Meteorological Agency (JMA) and Japan Argo Promotion Committee and to be supported by Ministry of Education, Culture, Sports, Science and technology, Fisheries Agency, Japan Coast Guard and Ministry of Foreign Affairs. Hitotsubashi Hall in central Tokyo has been booked for October 22-24, 2018 as a venue, which accommodates 500 people at most and 200 people comfortably and poster presentations for up to 200. While the original objective of ASW-6 was to prepare for OceanObs'19 white papers, the due date of the OceanObs'19 white papers was set to September 30, 2018. Accordingly the objective of ASW-6 should be to prepare for Oceanbs'19, focusing on sharing ideas presented in a series of Argo white papers among the Argo community and connecting them to other observing networks and user communities including research/operational and other application areas. The science organize committee is to be formed from AST executives and other volunteers. Suggested timeline is as follows:

Early April:	1st announcement
May:	Web site to be opened
	Plenary Speakers posted
Early June:	2nd announcement
Early August:	Abstract deadline
Late August:	Program to be posted

Action item 30: Move forward with planning of 6th Argo Science Workshop in Japan. Both a Science and Program committee need to be set up and speakers need to be invited. Argo Japan, D. Roemmich, B. Owens, K. Johnson, AST Executive Committee.

EuroArgo DMQC Workshop, 17 – 18 April at IFREMER

Attendees have been invited to the Workshop from around Europe. The goals include training new delayed mode operators, analyzing consistency across operators among others.

DMQC Workshop ahead of ADMT-19, 2 – 3 December at Scripps

Conveners: Annie Wong, Brian King

Rationale

It has been 10 years since a multi-day Argo DMQC Workshop was held (Seattle, September 2008). Since then, several veteran delayed-mode operators and scientists have departed, and new operators and scientists have joined the group. The Argo data system has become more complex, and new tools are needed to interact with the V3.1 netCDF files. More importantly, recent analyses indicate that a significant portion of SBE CTD data show conductivity sensor drifts that are towards high of correct. Some of these salty drifts appear rapidly early on in a float's life, but others exhibit themselves slowly, and often take 5+ years to manifest in the data. The detection of these slow salty drifts therefore is complicated by ocean variability as the floats traverse multiple water masses over the course of several years.

The 6th Argo Delayed-mode QC Workshop is therefore being planned for 2018 to address these issues. The goals of the workshop are to provide an opportunity for anyone currently involved in the Argo CTD delayed-mode process to meet and exchange knowledge and tools, to discuss common difficulties, and to establish a means of communication heading into the future.

Agenda

Agenda of the workshop will include, but not limited to, the following topics:

- Review characteristics of conductivity sensor drifts
- Review experience of OW software and other variations
- Review regional oceanography in the context of detecting conductivity sensor drifts
- Review reference databases: CTD_for_DMQC, Argo_for_DMQC, other regional databases

- Review tools for interacting with V3.1 netCDF files, GUIs, code-sharing, etc
- Miscellaneous: frequency of DMQC salinity adjustments; salinity error estimation; interaction with the real-time data stream; difficulties with D-files in V3.1; etc.

OceanObs 19

- Abstract submission due March 15
- White paper due September 2018

10.7 data.scripps.earth

10.8 Other Argo outreach activities

G. Maze presented an app that is in development at IFREMER that asks users to predict float positions. The positions can be either missing/ interpolated positions or upcoming/ extrapolated positions. To support classroom use, teachers can set up and monitor each student's predictions. When the app is finalized, it will be released in both French and English, collaboration for translation into English will be welcome.

11. Revision of Argo's sustainability Document

M. Baringer reported that there was little feedback received on the Argo sustainability document. Many in the room said they had read it and had no additional comments. The paper can serve as material to incorporate into the OceanObs19 global Argo paper.

12. Future meetings

12.1 ADMT-19 December 2 - 7, 2018 at Scripps Institution of Oceanography
12.2 AST-20

13. AST Membership and leadership

As a reminder, D. Roemmich is stepping down as AST co-chair, but will remain on the AST. T. Suga will be taking on the role of AST co-chair. The AST asked Greg C. Johnson to join the team and he accepted. M. Belbéoch noted that a couple new European countries may be joining Argo and should be invited to nominate an AST member when this becomes official.

14. Other business: reaching 2 million profiles

H. Freeland predicts that Argo will reach 2 million profiles in early December 2018 and suggested Argo celebrate the occasion.

Action item 31: Create a press release celebrating the two millionth profile for late in 2018. Include images. M. Belbéoch, E. Rusciano, M. Scanderbeg

15. Agenda

Argo Steering Team Meeting (AST-19)
Sidney, British Columbia, Canada, March 13-15, 2018
Host: IOS

AST Exec meeting: 12 March 13h00

AST-19: 13 March 9h00 – 15 March 16h00

Location: Stewart Auditorium

1. 9h00 Welcome (Carmel Lowe, Director of Science at IOS)
2. 9h10 Local arrangements (Tetjana Ross)
3. 9h20 Objectives of the meeting/adoption of the agenda

   Argo's Future Challenges

   - Sustainability
   - IOC and EEZs
   - Finalizing and implementing design changes
4. 9h40 Status of action items from AST-18 (M. Scanderbeg)

5. Implementation issues

   5.1 9h50 Update commitments table including global Argo, extensions and equivalent floats (M. Scanderbeg)

10h00 – 10h30 break

   5.2 10h30 AIC Report on the Status of Argo (M. Belbéoch)

   5.3 10h50 JCOMM Observing Program Support Centre (M. Belbéoch)

   5.4 11h05 AIC Funding (B. Owens)

   5.5 11h15 BGC-Argo and the IOC (S. Wijffels/K. Johnson)

   5.6 11h35 Canadian Argo (B. Greenan)

   5.7 11h50 Discussion items from National Reports and a quick oral round table of highlights or key issues

12h30 lunch

   5.8 13h30 Argo Data Paper and Argo Best Practices papers (S. Wijffels)
   Discussion on OceanObs19 abstracts

6. Data Management and related issues

   6.1 14h00 Feedback from ADMT-18 (M. Scanderbeg)

   6.2 14h20 Update on meta and tech tables (J. Gilson, B. Klein)

   6.3 14h35 DAC Trajectory Workshop Report (M. Scanderbeg)

6.4 14h50 Positioning for under-ice floats (B. Klein)

15h00 – 15h30 break

6.5 15h30 CTD Reference data & how to describe the quality of each station (S. Diggs)

6.6 15h45 BUFR format for BGC floats (F. Carse)

Welcome reception at Shaw Center from 18h00 – 19h30

Move to Agenda Item 8 if there is time before End of day one

7. Regional science, education and outreach

7.1 9h00: Roberta Hamme – "Oxygen saturation surrounding deep-water formation events in the Labrador Sea from Argo-O2 data"

7.2 9h20: Fraser Davidson – "Canadian Operational Network for Coupled Environmental PredicTion Systems (CONCEPTS)"

7.3 9h40: Tetjana Ross - "Changes in stratification in the North Pacific and implications for primary productivity" + Patrick Cummins – "Upper ocean variability over the Alaska Gyre from Argo"

10h00 – 10h30 break

8. Technical issues

8.1 10h30 Reports from Argo Platform and Sensor Technical Workshop (S. Riser)

Key issues for AST:

1. CTD testing activities
2. Corrosion in APEX (D. Swift's work)
3. The pathway for new sensors entering Argo and how we distribute and label pilot data (B. Owens)
4. Batteries and energy budgets (L. Gordon's work by B. Owens)

8.2 11h30 EuroArgo in-situ monitoring system (B. Klein)

8.3 11h45 Recent float performance evaluation of array (M. Belbéoch)

12h30 lunch

8.4 Sensor progress:

13h30 RBR (B. Owens)

13h45 Preliminary evaluation of the RBR Argo6000 during the RREX17 cruise (G. Maze)

14h00 SBE61 (N. Zilberman)

14h15 Increasing occurrences of fast salinity drifts in SBE41 (S. Wijffels)

8.5 14h30 Documenting pressure sensor performance (S. Riser)

15h00 – 15h30 break

9. Completing the global mission and exploring extensions

9.1 Technical updates on Deep Argo floats:

15h30 Deep SOLO – D. Roemmich

15h45 Deep APEX – S. Hosoda

16h00 Deep NINJA – T. Suga

16h15 Deep Arvor

9.2 Early results from Deep Pilot Arrays

16h30 N. Atlantic (G. Maze)

16h45 SW Pacific Basin (N. Zilberman)

9.3 17h00 Deep Argo partnership with Paul G. Allen Foundation (G. Johnson)

End of day two

9.4 9h00 Status of Argo extensions (M. Belbéoch)

9h15 BGC-Argo (K. Johnson, H. Claustre)

10h00 – 10h30 break

10h30 TPOS2020 (W. Kessler via Skype)

10. Demonstrating Argo's value

10.1 10h50 Argo bibliography (M. Scanderbeg)

10.2 11h10 Argo Steering Team Website Updates and Argovis website (M. Scanderbeg)

10.3 11h30 argo.jcommops.org news (M. Belbéoch)

10.4 11h45 Assessment of the Global Argo Array Enhancements Using Observing System Simulation Experiments (P-Y LeTraon)

10.5 12h05 Machine Learning of Argo Quality Control (G. Maze)

12h30 lunch

10.6 13h30 Upcoming science conferences and technical workshops –

ASW

EuroArgo DMQC Workshop

DMQC Workshop ahead of ADMT-19

OceanObs 19

- Abstract submission due March 15
- White paper due September 2018

10.7 data.scripps.earth (S. Diggs)

10.8 13h50 Other Argo outreach activities – G. Maze

11. 14h00 Revision of Argo's sustainability Document

12. Future meetings

12.1 14h30 ADMT-19 December 2 - 7, 2018

12.2 14h40 AST-20

13. AST Membership and leadership

14. Other business: reaching 2 million profiles

15. Review of action items

Meeting adjourns Thursday 15 March, 4 p.m.

Manufacturers day on Friday 16 March, 9am start.

Manufacturer's Reception at Victoria Distillers 17h00 – 18h30

Public lecture by G. Johnson at Shaw Center 19h00

16. Attendees

First Name	Last Name	Institution	Email
Molly	Baringer	AOML	molly.baringer@noaa.gov
Mathieu	Belbéoch	AIC/JCOMMOPS	mbelbeoch@jcommops.org
MINJIE	CAO	Second Institute of Oceanography, State Oceanic Administration	caominjie@sio.org.cn
Fiona	Carse	UK Met Office	fiona.carse@metoffice.gov.uk
Justin	Del Bel Belluz	Hakai	justin.belluz@hakai.org
Steve	Diggs	Scripps Institution of Oceanography	sdiggs@ucsd.edu
Mingmei	Dong	National Marine Data & Information Service	yupoyunhun@163.com
Howard	Freeland	Institute of Ocean Sciences	howard.freeland@dfo-mpo.gc.ca
Alison	Gray	University of Washington	argray@uw.edu
Blair	Greenan	Fisheries and Oceans Canada	blair.greenan@dfo-mpo.gc.ca
Shigeki	Hosoda	JAMSTEC	hosodas@jamstec.go.jp
Jennifer	Jackson	Hakai	jennifer.jackson@hakai.org
Steven	Jayne	Woods Hole Oceanographic Institute	sjayne@whoi.edu
Kenneth	Johnson	Monterey Bay Aquarium Research Institute	johnson@mbari.org
Gregory	Johnson	NOAA/PMEL	gregory.c.johnson@gmail.com
KiRyong	Kang	National Institute Meteorological Sciences / KMA	krkang@kma.go.kr
Birgit	Klein	BSH	birgit.klein@bsh.de

Atsushi	Kojima	JAMSTEC	kojima-ats@met.kishou.go.jp
Pierre-Yves	Le Traon	Mercator Ocean	pierre-yves.letraon@mercator-ocean.fr
Zenghong	Liu	Second Institute of Oceanography	liuzenghong@139.com
Guillaume	Maze	IFREMER	gmaze@ifremer.fr
Qingsheng	Miao	National Marine Data & Information Service	yupoyunhun@163.com
Peter	Oke	CSIRO	peter.oke@csiro.au
Breck	Owens	Woods Hole Oceanographic Institute	bowens@whoi.edu
Jong Sook	Park	National Institute Meteorological Sciences / KMA	jspark98@gmail.com
Eluri	Pattabhi Rama Rao	INCOIS	pattabhi@incois.gov.in
Stephen	Piotrowicz	NOAA	steve.piotrowicz@noaa.gov
Pierre	Poulain	OGS	ppoulain@inogs.it
Stephen	Riser	University of Washington	riser@ocean.washington.edu
Dean	Roemmich	Scripps Institution of Oceanography	droemmich@ucsd.edu
Tetjana	Ross	Institute of Ocean Sciences	tetjana.ross@dfo-mpo.gc.ca
Megan	Scanderbeg	Scripps Institution of Oceanography	mscanderbeg@gmail.com
Toshio	Suga	Tohoku University/ JAMSTEC	suga@pol.gp.tohoku.ac.jp
Chaohui	Sun	Second Institute of Oceanography, State Oceanic Administration	siosun@163.com
Phil	Sutton	NIWA	p.sutton@niwa.co.nz
Waldemar	Walczowski	Institute of Oceanology Polish Academy of Sciences	walczows@iopan.pl
Susan	Wijffels	Woods Hole Oceanographic Institute	swijffels@whoi.edu
Nathalie	Zilberman	Scripps Institution of Oceanography	nzilberman@ucsd.edu

Argo Australia National Report 2017

(Report prepared for the AST-19, by Peter Oke, for the Argo Australia team: Rebecca Cowley, Esmee Van Wijk, Craig Hanstein, Pat McMahon, Catriona Johnson, Tatiana Rykova, Jenny Lovell, Beatrice Pena Monilo, Lisa Krummel, Joel Cabrie, Susan Wijffels)

7 March 2018

Goal

The goal of Argo Australia is to maintain 50% of the core Argo array around Australia – and contribute significantly to the maintenance of the core array in the Indian Ocean and Pacific Ocean sectors of the Southern Hemisphere.

Organisation

Argo Australia are undergoing a transition period, with key leaders moving on. Susan Wijffels established Argo Australia and has led the Australian efforts since the beginning of the Argo Program. Susan has moved to WHOI, joining the US Argo effort – but still engaged in supporting Argo Australia. Ann Thresher has managed Argo Australia's real-time (RT) operations since Argo Australia was established. Ann has retired. Peter Oke has taken over as leader of Australian Argo. Peter's background is in ocean data assimilation, forecasting, and reanalysis. Rebecca Cowley has taken over management of RT operations. Rebecca has long been involved in RT activities – both for Argo and Australia's XBT program.

The Delayed Mode Quality Control (DMQC) operations of Argo Australia has been reviewed, with a new approach adopted. The DMQC operations is now led by a senior DMQC operator with oversight over throughput and decision-making (checking for consistency), and the throughput is now undertaken by a team of DM operators (working no more than 2-days a week on DMQC).

Argo Australia currently fund a total of 3.45 FTEs, including: Oke (Leadership, Science: 0.5 FTE), Cowley (RT operations: 0.5 FTE), Van Wijk (DM operations: 0.55 FTE), fractional allocations of individuals for DM throughout (Johnson, Lovell, Rykova, Doyle: 1.4 FTE), and fractional allocations for software support (Wallace, Scott, Slawinski: 0.5 FTE).

Status

Argo Australia currently manage 361 operational Argo floats. The distribution of floats is indicated in Figure 1. This indicates that profiles from Argo Australia comprise about 34% of the global array in the 90^{o}-sector around Australia in the Southern Hemisphere. Recall the target for Argo Australia is 50%. US floats comprise over 50% of the profiles in this region.

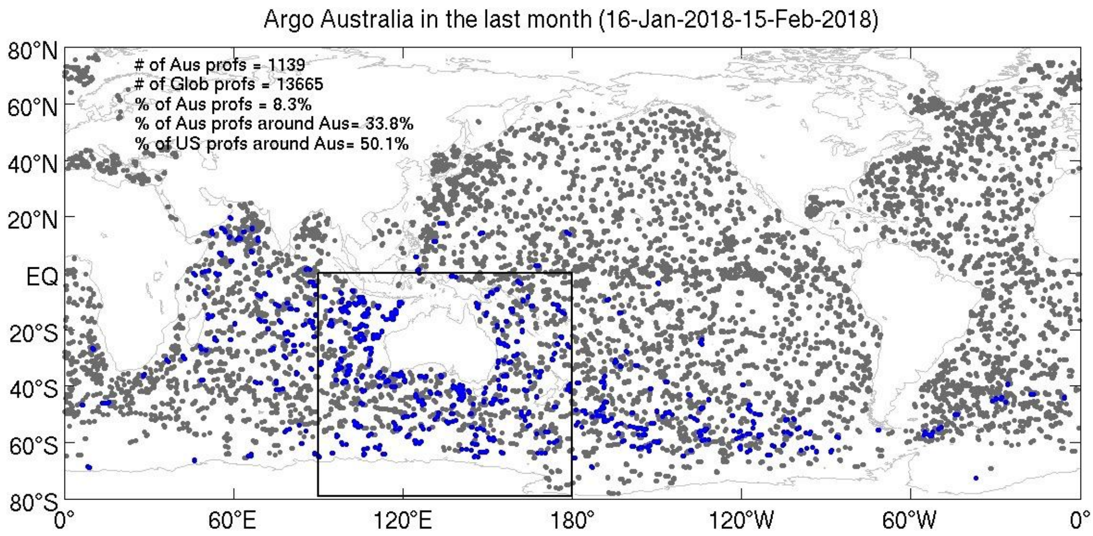


Figure 1: Location of all Argo profiles in the 30-day period between 16 January and 15 February 2018, showing the location of profiles from the global array (grey dots) and from Australian floats (blue dots).

In 2016-17, Australia deployed 51 floats, including 4 BGC floats.

Over 95% of data from Australian core Argo floats are published on the Global Telecommunications System (GTS) and the Argo Global Data Acquisition Centres (GDACs) within 24 hours of observation. The software for the Australia RT system has recently been rewritten (in Python). Two systems are currently operating in parallel to allow the new system to be tested. Subject to equivalent performance, the new code will soon be adopted for Australia's RT system.

The Argo Australia team undertook a detailed analysis of the failure modes of all Australian-deployed floats, together with an Intern, Benjiamin Briat. Results were presented at the Argo technical workshop in Seattle in September 2017, and can be found at http://www.argo.ucsd.edu/float_workshop_2017/Day_1/D1_Briat_fail_anal_csiro.pdf. Key findings included an understanding of the characteristics of engineering data that may give a hint of a pending failure of an Argo float. Diagnostics from all Argo floats are now derived routinely for all operational floats and monitored in RT and used in DM operations to support decision making. Another finding was recognition of the impact of deployment modes of floats, with floats deployed by vessels without scientific oversight, returning a greater number of floats that were dead-on-deployment.

DMQC throughput for Argo Australia is good, with about 95% of eligible floats processed through our DMQC system. The DMQC code that underpins Argo Australia's DM operations is now stable, and adequately serving DM purposes.

The Argo array around Australia is aging, with many floats older than 4.5 years located north-east of Australia (Figure 2Figure 3), indicating that a gap in the core array may soon emerge off north-eastern Australia in the absence of targeted deployments. It is expected that this emerging gap should be somewhat filled by upcoming deployments off the RV Kaharoa (with a mix of Australian and UW floats).

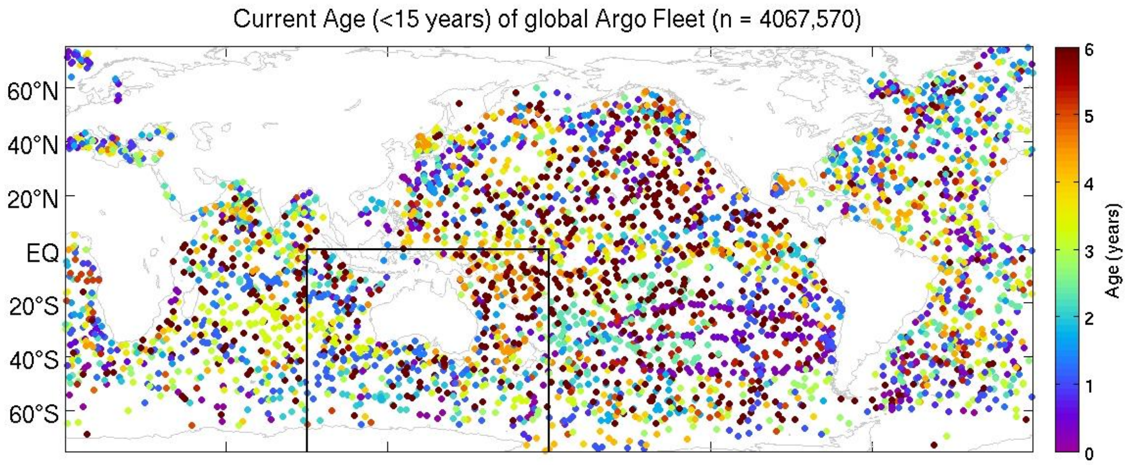


Figure 2: Location of Argo floats, colour-coded by age (time since deployment).

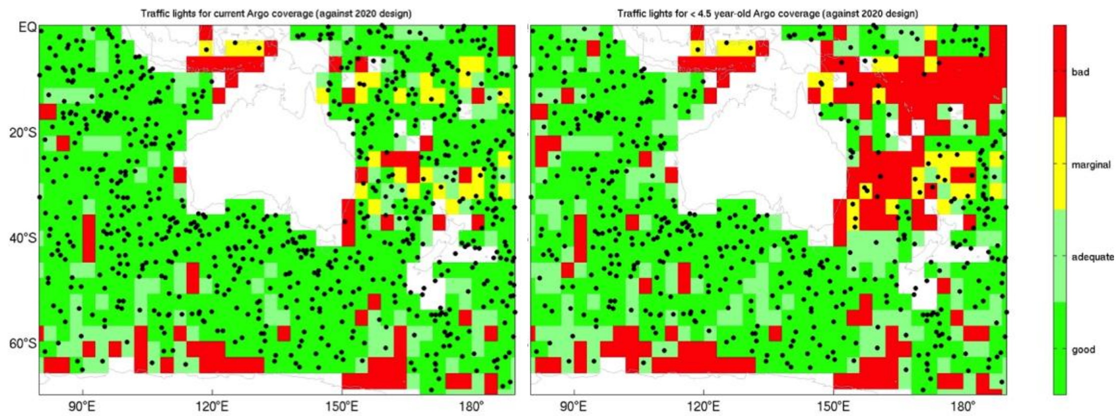


*Figure 3: Traffic lights for the current Argo array for the sector around Australia – using the Argo 2020 design as the target - for all current floats (left) and all current floats younger than 4.5 years (right). Maps are similar to the JCOMM-OPS "heat maps" – but assume a "footprint" for each float of 1^o. Coverage is considered **good**, **adequate**, or **marginal**, if the number of floats in each 3x3^o box exceeds, matches, or is within one float of the target Argo 2020 design. Coverage is considered **bad** if the number of flats is less than 2 floats of the target.*

Plans

Argo Australia are committed to deploy 59 floats in the next year – but are hoping to secure funding for an additional 70-80 core floats over the next two years. Funding for additional floats is expected to be confirmed in April 2018.

Approximate deployment locations are shown in Figure 4. We will utilise ships from the Australian Navy, commercial ships of opportunity, the RV Kaharoa charter, RV Tangaroa, the RV Investigator, Aurora Australis, the Thompson and other opportunities that become available.

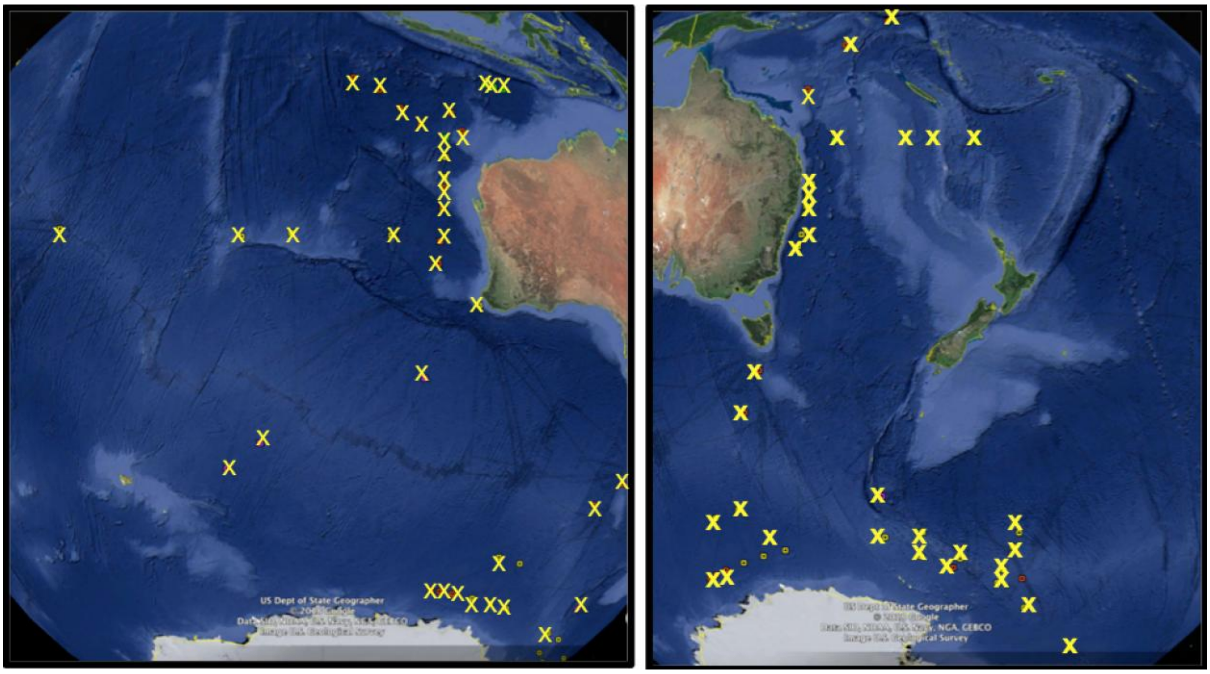


Figure 4: Approximate locations of planned deployments.

Argo Australia has funding for human resources secured until June 2019 – and expects funding at current levels to be maintained.

Argo Australia is exploring the feasibility of developing an online portal for DM operations – akin to a community DM system.

Argo Australia are conducting a field experiment to compare the performance of Seabird and RBR CTDs on the RV Investigator in April 2018.

Argo Australia are currently developing a suite of new analysis tools that are intended to routinely produce global maps of ocean properties, exploiting data assimilation tools developed under the Bluelink (ocean forecasting) project.

Data uptake

Argo data are used to underpin Australia's operational ocean forecast system (OceanMAPS: http://www.bom.gov.au/oceanography/forecasts/index.shtml) and seasonal prediction system (POAMA/ACCESS-S: http://poama.bom.gov.au).

Contributions to Argo Bibliography

Benthuysen, J. A., E. C. J. Oliver, M. Feng, A. G. Marshall, 2018: Extreme Marine Warming Across Tropical Australia During Austral Summer 2015–2016

Gao, L, S. R. Rintoul, W. Yu: 2018: Recent wind-driven change in Subantarctic Mode Water and its impact on ocean heat storage, Nature Climate Change, 8, 1, 58.

Griffin, D.; Oke, P.; Jones, E.. The search for MH370 and ocean surface drift - Part II. Australia: CSIRO; 2017. csiro:EP172633. https://doi.org/10.4225/08/58fba83e73f2b.

Griffin, D.; Oke, P.; Jones, E.. The search for MH370 and ocean surface drift. Canberra: CSIRO; 2016. csiro:EP167888. https://doi.org/10.4225/08/5892224dec08c.

Griffiths, G. P., P. G. Strutton, J. M. Semmens, 2017: Climate change alters stability and species potential interactions in a large marine ecosystem. Global Change Biology, DOI: 10.1111/gcb.13891.

Groeskamp, S., B.M. Sloyan, J.D. Zika, and T.J. McDougall, 2017: Mixing Inferred from an Ocean Climatology and Surface Fluxes. *J. Phys. Oceanogr.,* **47**, 667–687,https://doi.org/10.1175/JPO-D-16-0125.1 .

Langlais, C. E., A. Lenton, R. Matear, D. Monselesan, B. Legresy, E. Cougon, S. R. Rintoul, 2017: Stationary Rossby waves dominate subduction of anthropogenic carbon in the Southern Ocean, Scientific Reports, 7, 1, 17076.

Oliver, E. C. J., V. Lago, A. Hobday, N. J. Holbrook, S. D. Ling, 2018: Marine heatwaves off eastern Tasmania: Trends, interannual variability, and predictability, Progress in Oceanography, in press.

Pilo, G. S., P. R. Oke, R. Coleman, T. Rykova, K. Ridgway, K., Patterns of eddy vertical velocity induced by eddy distortion in an ocean model, Journal of Geophysical research, in press.

Roxana, V., K. Hartmann, A. J. Hobday, E. Oliver, 2018: *Evaluation of hydrodynamic ocean models as a first step in larval dispersal modelling,* Continental Shelf Research, 152, 38-49.

Rykova, T., P. R. Oke, D. A. Griffin: A comparison of the structure, properties, and water mass composition of quasi-isotropic eddies in western boundary currents in an eddy-resolving ocean model. *Ocean Modelling.* in press, 2017.

Sandery, P. A, P. Sakov, 2017: Ocean forecasting of mesoscale features can deteriorate by increasing model resolution towards the submesoscale, Nature Communications, 8, 1, 1566.

Zhang, Y., Y. Du, M. Feng, 2018: Multiple Time Scale Variability of the Sea Surface Salinity Dipole Mode in the Tropical Indian Ocean. Hournal of Climate, in press.

Zhang, L., Y. Dan, W. Cai, 2017: Low-frequency variability and the unusual Indian Ocean dipole events in 2015 and 2016. Geophysical Research Letters, in press.

2017 Argo Canada report of activities

(submitted by Blair Greenan, Fisheries and Oceans Canada)

19th meeting of the Argo Steering Team (AST-19)
Sidney, British Columbia, Canada
13-15 March 2018

1. Status of implementation (major achievements and problems in 2017)

- *floats deployed and their performance*

From January 2017 to December 2017, Argo Canada deployed 30 MetOcean (NOVA and DOVA) floats (12 in the northeast Pacific, and 18 in the northwest Atlantic). Of these 30 floats, 2 died prematurely. The 28 remaining floats are still active and functioning properly, except for one which is only profiling down to 500 m. “Active” assumes that less than 4 of the last 4 profiles have been missed. Of the 30 floats, 9 were replacements. Of the 2 that died prematurely, both were or are being replaced under warranty and one was a replacement. The warranty replacement has yet to be deployed. The Government of Canada Standing Offer with MetOcean requires that if a float fails to complete 18 profiles the manufacturer must provide a replacement float. As of 19 January 2018, Argo Canada has 90 active floats in the Argo array.

In addition, 2 BGC floats were deployed by NAOS-Canada in Baffin Bay, and 1 Argo-equivalent float was deployed by Argo Canada eq. on the Labrador Shelf.

As of 10 January 2018, the Government of Canada signed a new standing offer with NKE Instrumentation for a 3-year period (10 January 2021) for suppling core Argo float. This contract has the option of two additional years.

- *technical problems encountered and solved*

Of the two floats that failed, one sent did not transmit any profiles and the other stayed at the surface, transmitting every 8 hours. Another float showed similar behaviour, but then partially recovered, profiling only down to 500 m.

- *Status of contributions to Argo data management* *(including status of conversion to V3 file formats, pressure corrections, etc)*

MEDS, part of DFO Ocean Science Branch, continues to acquire data from 94 Argo floats, 4 of which have not reported data for at least 1 month. Data are issued to the GTS and GDACs hourly in TESAC, BUFR TM315003 and netCDF formats. The data of all Canadian floats together with some graphics are posted on a website and updated daily:

http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/argo/index-eng.html. On average, 97% and 95% of data from January 2017 to December 2017 data were issued to the GTS within 24 hours of the float reporting in TESAC and BUFR format, respectively.

Since AST-18, we have worked on the following:

- Converting existing netCDF profiles to version 3.1. A total of 230 netCDF profiles remain to be converted to version 3.1 due to failure of GDAC format checkers. We will continue our conversion process based on each individual case.
- Developing and implementing software to extract all of the Iridium positions contained in the email attachments sent by Iridium SBD floats in order to calculate the weighted average Iridium positions when a profile does not report GPS location. MetOcean is unable provide this information in their decoded files.
- Reprocessing and replacing Iridium positions with calculated weight average Iridium positions for approximately 1000 profiles which didn't have GPS location. The netCDF files were resubmitted to GDACs.
- Providing ADMT with quarterly reports on the performance of Argo data on the GTS in TESAC and BUFR formats and assist DACs that have difficulty with BUFR transmission.

- *Status of delayed mode quality control process*

As of February 2018, 44% of all eligible floats, active and inactive, had their profiles QCed visually and adjusted for pressure according to the latest delayed-mode procedures at least once. The salinity component of DMQC had been performed at least once on 67% of eligible cycles. In addition to DMQC of new profiles, 22 previously-processed floats received either updates to the visual QC or new adjustments in response to feedbacks (e.g., reports of density inversions) since May 2017. Routines were developed to visually QC dissolved oxygen profiles and, in the case of Aanderaa dissolved oxygen sensors, apply calibration factors. As of November 2017, 14% of B-files had been visually QC'd, and 4% were fully DMQC'd.

2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.

Financial resources

Argo Canada has ongoing funding for the O&M expenditures related to the International Argo program. Shared Services Canada (SSC) is responsible for the costs related to Iridium telecommunications as part of an initiative to centralize these services with the Federal government and will cover the costs for up to 85 core Argo floats. If Argo Canada has more than 85 active Argo floats, DFO is responsible for the additional telemetry charges. Ongoing capital for float purchases has not been identified and, therefore, it remains necessary to request capital resources on an annual basis to obtain the funding required to purchase new floats. Fisheries and Oceans Canada (DFO) committed $449k for purchases of core Argo floats in 2017. Department of National Defence (Canada) purchased of 5 MetOcean NOVA floats core Argo. Funding is expected to remain stable at approximately this level for the next few years. The development of close links between the Argo Canada program and both the operational meteorology and operational oceanography R&D activities at the Canadian Meteorological Centre (Dorval, Québec) has been beneficial. An inter-departmental (Environment and Climate Change Canada, Department of National Defence, Fisheries and Oceans) Memorandum of Understanding entitled CONCEPTS (Canadian Operation Network of Coupled Environmental PredicTion Systems) has provided strong advocacy for the Argo program.

Human resources
Since 1 April 2015, Blair Greenan of the Bedford Institute of Oceanography (BIO) has acted as national leader of the Argo Canada program. The logistics related to float deployments and satellite data transmission has been handled by Ingrid Peterson, also at BIO. On the west coast, Tetjana Ross has been hired by DFO at the Institute of Ocean Sciences and has taken over responsibility for Pacific deployments for Argo Canada.

In terms of FTE (Full-Time Equivalent) units, the following persons contribute to Argo Canada:

Anh Tran (MEDS, Ottawa, 0.7 FTE)
Mathieu Ouellet (MEDS, Ottawa, 0.1 FTE)
Isabelle Gaboury (MEDS, Ottawa, 0.4 FTE)
Blair Greenan (BIO, Halifax, 0.2 FTE)
Ingrid Peterson (BIO, Halifax, 0.7 FTE)
Igor Yashayaev (BIO, Halifax, 0.2 FTE)
Tetjana Ross (IOS, Sidney, 0.2 FTE)
Doug Yelland (IOS, Sidney, 0.1 FTE)
Denis Gilbert (IML, Mont-Joli, 0.1 FTE)

Denis Gilbert (DFO) and Roberta Hamme (University of Victoria) are assisting Argo Canada with issues related to dissolved oxygen. In particular, they have been providing expert advice and support on quality control and data processing of DO data from the DOVA floats deployed in the Labrador Sea.

In addition to the above persons, we benefit from the technical support of sea-going staff that follow pre-deployment protocols and perform the float deployments.

3. Summary of deployment plans (level of commitment, areas of float Deployment, low or high resolution profiles, Argo extensions) and other commitments to Argo (data management) for the upcoming year and beyond where possible..

In 2018 and early 2019, Argo Canada plans to deploy 37 floats (firm commitment), all of which have already been purchased or are replacements: 14 will be deployed in the North

Pacific (NOVA), 8 in the Labrador Sea (6 NOVA, 1 DOVA, 1ARVOR-I), 8 in the Gulf Stream's northern recirculation gyre (NOVA), and 7 in the Newfoundland Basin.
In addition, NAOS-Canada may deploy 2 BGC floats, and Argo Canada eq. plans to deploy 7 Argo-equivalent floats in the Beaufort Sea and Hudson Bay.

4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers. Please also include any links to national program Argo web pages to update links on the AST and AIC websites.

The Canadian CONCEPTS Global Ice Ocean Prediction System (GIOPS) assimilates Argo data on a weekly basis. The GIOPS assimilation system has been updated in 2015 to use a smoother increment update called IAU. In this process the results of the assimilation are progressively added to the model solution over a model period of 1 day. This ensures that the ocean model is more receptive to Argo data. The new version of GIOPS operational since Jun 2016, now uses the IAU update in it assimilation scheme. Inter-comparisons with observations (profiles, drifters), demonstrate increased forecast precision as a result of the updated assimilation scheme in GIOPS V2. Daily validations with Argo on GIOPS are also compared with four other international groups under the GODAE OceanView Intercomparison Validation Task team using class4 metrics. In addition to the operational GIOPS v2 system, CONCEPTS has implemented a Regional Ice Ocean Prediction System (RIOPS) covering the Arctic and Atlantic Oceans. This system is operational, there is no data assimilation, but RIOPS is spectrally nudged to GIOPS which assimilated Argo data. Future updates of CONCEPTS RIOPS systems will include its own assimilation scheme. The GIOPS output is being used by "MEDS" for Argo QC purposes.

All CONCEPTS systems run operationally at Environment and Climate Change Canada's Canadian Meteorological Center (Dorval, Quebec). CONCEPTS is an MOU for a collaboration between National Defence, Environment and Climate Change Canada and Fisheries and Oceans Canada.

The Department of National Defence Navy scientists routinely use real time Argo vertical profiles of temperature into their Ocean Work Station to aid in the computation of sound velocity profiles for support of at-sea operations.

Argo floats deployed in the Labrador Sea are an important element of an NSERC Climate Change and Atmospheric Research project entitled VITALS (Ventilation, Interactions and Transports Across the Labrador Sea). This research network is attempting answer fundamental questions about how the deep ocean exchanges carbon dioxide, oxygen, and heat with the atmosphere through the Labrador Sea. New observations and modelling will determine what controls these exchanges and how they interact with varying climate, in order to resolve the role of deep convection regions in the Carbon Cycle and Earth System. VITALs is a pan-Canadian initiative involving scientists from 11 Canadian universities as well as multiple federal government laboratories (Fisheries and Oceans Canada, as well as Environment Canada), industrial and foreign partners. http://knossos.eas.ualberta.ca/vitals/

The Argo Canada web site is maintained by Fisheries and Oceans Canada at http://www.isdm.gc.ca/isdm-gdsi/argo/index-eng.html.

In January 2017, MEOPAR (meopar.ca) and DFO co-sponsored a BGC-Argo Canada workshop which brought together scientists and managers from both DFO and the university community. A report summarizing the outcome of the workshop is available at:
http://archimer.ifremer.fr/doc/00413/52451/53335.pdf

5. Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo. These might include tasks performed by the AIC, the coordination of activities at an international level and the performance of the Argo data system. If you have specific comments, please include them in your national report.

Nothing to report this year.

6. To continue improving the quality and quantity of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include any CTD station data that was taken at the time of float deployments this year. Additionally, please list CTD data (calibrated with bottle data) taken by your country in the past year that may be added to the reference database. These cruises could be ones designated for Argo calibration purposes only or could be cruises that are open to the public. To help CCHDO track down this data, please list the dates of the cruise and the PI to contact about the data.

Most of the recent CTD data collected by DFO researchers are transferred to MEDS and then to NODC and CCHDO. Mathieu Ouellet (DFO, Ottawa) is responsible for dissemination of Canadian CTD data. Steve Diggs sometimes obtains data directly from Canadian PI's at DFO labs.

7. Keeping the Argo bibliography (http://www.argo.ucsd.edu/Bibliography.html) up to date and accurate is an important part of the Argo website. This document helps demonstrate the value of Argo and can possibly help countries when applying for continued Argo funding. To help me with this effort, please include a list of all papers published by scientists within your country in the past year using Argo data, including non-English publications.
There is also the thesis citation list (http://www.argo.ucsd.edu/argo_thesis.html). If you know of any doctorate theses published in your country that are missing from the list, please let me know.
Finally, if you haven't already sent me a list of Argo PIs in your country, please do so to help improve the statistics on how many papers are published including an Argo PI vs no Argo PIs.

Courtois, P., X Hu, C Pennelly, P Spence, PG Myers 2017. Mixed layer depth calculation in deep convection regions in ocean numerical models. Ocean Modelling 120, 60-78.

Danabasoglu, G., Yeager, S.G., Kim, W.M., Behrens, E., Bentsen, M., Bi, D., Biastoch, A., Bleck, R., Böning, C., Bozec, A., Canuto, V.M., Cassou, C., Chassignet, E., Coward, A.C., Danilov, S., Diansky, N., Drange, H., Farneti, R., Fernandez, E., Fogli, P.G., Forget, G., Fujii, Y., Griffies, S.M., Gusev, A., Heimbach, P., Howard, A., Ilicak, M., Jung, T., Karspeck, A.R., Kelley, M., Large, W.G., Leboissetier, A., Lu, J., Madec, G., Marsland, S.J., Masina, S., Navarra, A., Nurser, A.J.G., Pirani, A., Romanou, A., Salas y Mélia, D., Samuels, B.L., Scheinert, M., Sidorenko, D., Sun, S., Treguier, A.-M., Tsujino, H., Uotila, P., Valcke, S., Voldoire, A., Wang, Q., Yashayaev, I., 2016. North Atlantic simulations in Coordinated Ocean-ice Reference Experiments phase II (CORE-II). Part II: Inter-annual to decadal variability. Ocean Modelling 97, 65–90. https://doi.org/10.1016/j.ocemod.2015.11.007

Fröb, F., Olsen, A., Vage, K., Moore, G. W. K., Yashayaev, I., Jeansson, E., Rajasakaren, B., 2016. Irminger Sea deep convection injects oxygen and anthropogenic carbon to the ocean interior. Nature Communications, 7, 13244. https://doi.org/10.1038/ncomms13244

Lozier, M.S., S Bacon, AS Bower, SA Cunningham, M Femke de Jong, ...2017. Overturning in the Subpolar North Atlantic Program: a new international ocean observing system. Bulletin of the American Meteorological Society 98 (4), 737-752.

Katavouta, A., and K. R. Thompson, (2016). Downscaling ocean conditions with application to the Gulf of Maine, Scotian Shelf and adjacent deep ocean, Ocean Modelling, 104, 54-72, doi:10.1016/j.ocemod.2016.05.007

Kenchington, E., Yashayaev, I., Tendal, O. S., Jorgensbye, H., 2017. Water mass characteristics and associated fauna of a recently discovered Lophelia pertusa (Scleractinia: Anthozoa) reef in Greenlandic waters. Polar Biology, 40(2), 321–337. https://doi.org/10.1007/s00300-016-1957-3

Le Bras, I. A., Yashayaev, I., Toole, J. M., 2017. Tracking Labrador Sea Water property signals along the Deep Western Boundary Current. Journal of Geophysical Research-Oceans, 122(7), 5348–5366. https://doi.org/10.1002/2017JC012921

Palter, J. B., Caron, C.-A., Law, K. L., Willis, J. K., Trossman, D. S., Yashayaev, I. M., Gilbert, D., 2016. Variability of the directly observed, mid-depth subpolar North Atlantic circulation. Geophysical Research Letters, 43(6), 2700–2708. https://doi.org/10.1002/2015GL067235

Peterson, I., Greenan, B., Gilbert, D., Hebert, D., 2017. Variability and wind forcing of ocean temperature and thermal fronts in the Slope Water region of the Northwest Atlantic. Journal of Geophysical Research-Oceans, 122(9), 7325–7343. https://doi.org/10.1002/2017JC012788

Rhein, M., Steinfeldt, R., Kieke, D., Stendardo, I., Yashayaev, I., 2017. Ventilation variability of Labrador Sea Water and its impact on oxygen and anthropogenic carbon: a review. Philos Transact A Math Phys Eng Sci 375. https://doi.org/10.1098/rsta.2016.0321

Wang, Z., Brickman, D., Greenan, B. J. W., & Yashayaev, I., 2016. An abrupt shift in the Labrador Current System in relation to winter NAO events. Journal of Geophysical Research-Oceans, 121(7), 5338–5349. https://doi.org/10.1002/2016JC011721

Yashayaev, I., Loder, J. W., 2016. Recurrent replenishment of Labrador Sea Water and associated decadal-scale variability. Journal of Geophysical Research-Oceans, 121(11), 8095–8114. https://doi.org/10.1002/2016JC012046

Yashayaev, I., Loder, J. W., 2017. Further intensification of deep convection in the Labrador Sea in 2016. Geophysical Research Letters, 44(3), 1429–1438. https://doi.org/10.1002/2016GL071668

Ph.D./M.Sc. Thesis

Wolf, M. K. (2017), Oxygen saturation surrounding deep-water formation events in the Labrador Sea from Argo-O2 data, (Master's Thesis). Retrieved from [UVicSpace] (https://dspace.library.uvic.ca//handle/1828/8401). Victoria, BC: University of Victoria

The 19th Argo Steering Team Meeting, Sidney, B.C., Canada, March 12-16, 2018

Argo Chinese National Report 2017

(Jianping Xu & Zenghong Liu, The Second Institute of Oceanography, SOA)

1. The status of implementation

- floats deployed and their performance

From the last AST meeting, China deployed 21 floats (13 HM2000, 3 APEX, 3 ARVOR_D and 2 NAVIS floats) in the South China Sea (SCS), the northwestern Pacific, Indian Oceans and the Southern Ocean via 5 cruises (Fig.1). These floats were deployed by 2 PIs from the Second Institute of Oceanography, SOA (CSIO) and Shanghai Ocean University (SHOU). It is worth noting that it is the first time for China to deploy BGC-float with ECO Triplet sensors (1 NAVIS BGCi) and deep Argo float. Since 2002, China Argo has deployed 403 floats, and approximately 104 floats are still operational.

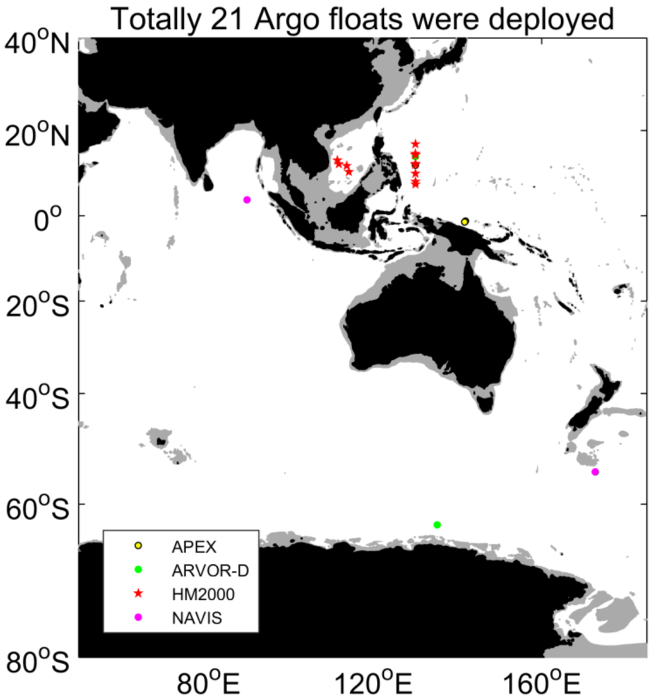


Fig.1 Launch positions of the floats from Mar. 2017 to Feb. 2018.

- technical problems encountered and solved

As the development of float and sensor technology, the performance of the battery used in profiling floats has become more and more important for the maintenance of the Argo array. It has been found that the HM2000 float has an average lifetime of ~ 1 yr based on the performance of the 10 floats deployed in 2016. We have recommended the manufacturer (HSOE) to change the battery model even if the cost probably increases. For APEX float, we have decided each float to be installed EI lithium battery packs by ourselves.

-status of contributions to Argo data management (including status of pressure corrections, technical files, etc)

From the last AST meeting, CSIO received data from 140 active floats (45 APEX, 68 PROVOR, 22 HM2000, 3 ARVOR and 2 NAVIS) and submitted 3743 TS and 7 BGC profiles to GDACs. Noted that the PI from Ocean University of China agreed to share data that from the 6 APEX floats (with oxygen sensors) with Argo community. These floats were deployed in the Southern Ocean in Nov. 2015, and observed about 309 profiles. All the profile data are converted into BUFR bulletin and send to the GTS via Chinese Meteorological Agency (Beijing). Unfortunately, there was a breakdown during May-October 2017, owing to a technical problem at CMA. The submission of BUFR bulletins was restored in the mid of last October. Now CSIO has been submitting meta, technical, trajectory and profile files in V3.1. A correction for the trajectory files is ongoing after the ADMT-18 meeting.

- status of delayed mode quality control process

There is a severe backlog for delayed QC. The situation is not changed from the last AST meeting owing to the lack of human resource. This year, a new staff will be employed to eliminate the backlog.

2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.

China Argo is still waiting for a chance to improve the situation. Some special programs and major infrastructure construction projects will include a batch of Argo floats deployment. But we do not know when the corresponding funds will be secured. The proposal about the maintenance of 400 Argo floats mentioned during the AST-18 meeting is still waiting for approval. If the proposal is granted this year, we hope more than 100 floats to be deployed in the second half of this year. However, the funds for 60 floats' purchasing and deployment will be secured in the mid of this year.

Currently there are 6 staffs working for float deployment, data processing and data applications, as well as the operational running of the Beidou profiling float data service center (Hangzhou, CHINA).

3. Summary of deployment plans (level of commitment, areas of float Deployment, low or high resolution profiles) and other commitments to Argo (data management) for the upcoming year and beyond where possible.

As of Feb. 2018 CSIO has 32 floats (including 12 BGC-floats) in storage. Two cruises have been confirmed to deploy about 10 APEX and 6 BGC-floats during April-July in the northwestern Pacific Ocean. To decode the BGC data from the different types of the BGC-float (including DOXY, FLBBCD and SUNA), CSIO is preparing decoding software.

4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers. Please also include any links to national program Argo web pages to update links on the AST and AIC websites.

Argo data has become an important data source in basic research and operational application. CSIO maintains a monthly global Argo gridded dataset (BOA_Argo) and updates once a year at present. CSIO has collected all the data from GDAC and carried out a post quality control for each float. Statistically, the good temperature and salinity data are account for 81.7% and 80.7% of the totals (floats in the grey list are also eliminated).

There are two websites maintained by China. One is maintained by CSIO (http://www.argo.org.cn) at Hangzhou (China Argo Real-time data center), where the implementation status of China Argo, real-time data display including T/S/O2/CHLA/CDOM/BBP profiles, float trajectory, profile data, the derived products and status of global Argo are provided. Another is maintained by NMDIS (China Argo Data Centre, http://www.argo.gov.cn), however, as the CMOC/China was established in NMDIS in 2015, the Argo data and products are aslo delivered on CMOC/China website (http://www.cmoc-china.cn).

5. Problems encountered during the operation of international Argo and suggestions

No.

6. To continue improving the number of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include the number and location of CTD cruise data uploaded by PIs within your country to the CCHDO website in the past year.

No CTD data were submitted.

7. Host the AST meeting

At the AST-18 meeting in Hobart, China Argo group expressed the desire to host the AST-20 meeting in Hangzhou, China. Of course, the final meeting place will be decided by the AST. We are still glad to host the following AST meeting.

8. Keeping the Argo bibliography

The following articles are not listed in Argo Bibliography:

Zhang, X., C. Sun, C. Liu, L. Zhang, C. Shao, X. Zhang, and Y. Zhao, 2017: Evaluation of the Impact of Argo Data on Ocean Reanalysis in the Pacific Region. Advances in Meteorology, https://doi.org/10.1155/2017/7314106.

Zhou, C., X. Ding, J. Zhang, J. Yang, Q. Ma, 2017: An objective algorithm for reconstructing the three-dimensional ocean temperature field based on Argo profiles and SST data. Ocean Dyn., 67(2), doi 10.1007/s10236-017-1104-x.

Wang, G., L. Cheng, T. Boyer, and C. Li, 2017: Halosteric Sea Level Changes during the Argo Era. Water, 9, 484, doi:10.3390/w9070484.

ARGO National Report 2018 – The Netherlands

1) **Status of implementation**
The Dutch Argo program started in 2004 and is run by the Royal Netherlands Meteorological Institute (KNMI).
The Netherlands are a founding member of the Euro Argo ERIC.
Contribution to the Argo array:
- 87 floats have been purchased
- 2 await deployment
- 25 are working

In 2017 four floats have been purchased. Two of them have already been deployed. The other ten are currently on board of a ship and will be deployed until April.

2) **Present level of (and future prospects for) national funding for Argo including summary of human resources devoted to Argo**.
In their observation strategy adopted in 2006 KNMI has expressed the intention to deploy about 7 floats per year, but due to budget constraints only four floats could be purchased in 2017, and none will be bought in 2018.
One person (Andreas Sterl) is working on ARGO. He does so besides his other duties.

3) **Summary of deployment plans** (level of commitment, areas of float deployment) and for other commitments to Argo for the coming year (and beyond where possible).
Four floats are to be deployed in the Southern Atlantic Ocean (including the Southern Ocean) in the austral summer 2017/18. Two have already been deployed. Four floats from the Euro Argo MOCCA project are carried on the same cruise.

4) **Summary of national research and operational uses of Argo data**
Argo data and/or products derived from Argo data are used to initialize climate models by groups at KNMI and Utrecht University.
Process studies using Argo data are performed at the Netherlands Institute for Sea Research (NIOZ).

5) **Issues that your country wishes to be considered (and resolved) by AST regarding the international operation of Argo**
Nothing.

6) **CTD data uploaded to CCHDO**
Yes.

7) **Bibliography**

French National Report on Argo - 2017

G. Maze, C. Cabanes, T. Carval, H. Claustre, C. Coatanoan, F. D'Ortenzio, N. Kolodziejczyk, N. Lebreton, A. Poteau, S. Le Reste, C. Schmechtig, P.Y. Le Traon, N. Poffa, S. Pouliquen and V. Thierry

http://www.argo-france.fr

Background, organization and funding of the French Argo activities

Organization

Argo France (http://www.argo-france.fr) gathers all the French activities related to Argo and its extension toward deep and biogeochemical measurements. Argo France is the French contribution to the Euro-Argo[i] European research infrastructure (ERIC) that organizes and federates European contribution to Argo.

Argo-France is coordinated by a steering team with: a national coordinator (G. Maze), scientific coordinators for the physical and bio-geochemical missions (N. Kolodziejczyk, F. D'Ortenzio, H. Claustre), technical coordinators for the physical and bio-geochemical missions (S. Pouliquen, F. D'Ortenzio), head of the data center (T. Carval), data center officer for BGC (C. Schmechtig) and heads of operational and infrastructure activities (N. Lebreton, N. Poffa, A. Poteau).

Euro-Argo and its french component (Argo France) is part of the Ministry of Research national roadmap on large research infrastructure (TGIR). Argo France operational activities are organized through the Coriolis[ii] partnership (IFREMER, SHOM, INSU, IRD, Météo France, CNES and IPEV) and its governance bodies. Two research laboratories are leading the Argo France scientific activities: the "Laboratoire d'Océanographie Physique et Spatiale[iii]" (LOPS, Brest, France) and the "Laboratoire d'Océanographie de Villefranche[iv]" (LOV, Villefranche, France). Coriolis and Argo France have strong links with Mercator Ocean[v] (the French ocean forecasting center).

Funding

Argo France is mainly funded by the ministry of Research through Ifremer as part of national roadmap on large scale infrastructures and contribution to Euro-Argo (TGIR). This is a long term commitment. Argo France is also funded through Ifremer, SHOM (Ministry of Defense), CNRS/INSU and other French institutes involved in oceanography (CNES, IRD, Météo-France). At regional scale, Argo France is supported by the IUEM OSU[i] and funded by the Brittany and Provence Alpes-Cote d'Azures regions (through CPER).

The French contribution to the Argo global array is at the level of 60 to 65 floats per year with funding from Ifremer (50 floats/year) and SHOM (about 10 to 15 floats/year).

Since 2000, around 1160 French floats have been deployed in a number of different geographic areas. Deployments have been focused on meeting specific French requirements while also contributing to the global array.
To complement Argo-France, the NAOS[ii] project (Novel Argo Ocean observing System, 2011-2019) has been funded by the Ministry of Research to consolidate and improve the French contribution to Argo and to prepare the next scientific challenges for Argo. The project provides an additional funding of 10 to 15 floats per year from 2012 to 2019, which allows Ifremer to increase its long-term contribution to Argo from 50 to 60-65 floats/year. NAOS also develops the new generation of French Argo floats and set up pilot experiments for biogeochemical floats (Mediterranean Sea, Arctic) and deep floats (North Atlantic).

The level of support, additional to float purchase, is as indicated in Tableau 1 (man power for coordination activities, float preparation, deployment and data management activities).

Year	Funding	**Man/Year**	***French floats***	***Co-funded EU floats***	***Total***
2000	300k€		*11*		*11*
2001	633k€	3	*12*		*12*
2002	980k€	6	*7*	*4*	*11*
2003	900k€	9	*34*	*20*	*54*
2004	1400k€	15	*85*	*18*	*103*
2005	450k€	15	*89*	*11*	*100*
2006	900k€	12	*51*	*14*	*65*
2007	900k€	12	*36*		*36*
2008	1200k€	12	*90*		*90*
2009	1200k€	12	*35*	*8*	*43*
2010	1400k€	12	*55*		*55*
2011	1400k€		*53*		*53*
2012	1400k€	12	*82*		*82*
2013	1400k€	12	*81*		*81*
2014	1400k€	12	*96*		*96*
2015	1400k€	14	*101*		*101*
2016	1400k€	14	58		*58*
2017	1400k€	14	65		65
Total (2000-2017)			*1041*		*1116*
2018	**1400k€**	**14**	88		88

Tableau 1: (*Man/year* column) Man power dedicated to Argo for coordination activities, float preparation, deployment and data management activities (GDAC, DAC, NAARC, DMQC) within Argo-France. (*French floats* column) French floats contributing to Argo deployed by year. (*Co-funded EU floats* column) EU floats are the additional floats co-funded by European Union within the Gyroscope, Mersea and MFSTEP projects. Estimated value is given for 2018.

Long term evolution of Argo

At the national level, the proposal for Argo-France is in two phases:

- 2011-2016: Core Argo mission (temperature and salinity – 0 to 2000m) and pilot experiments on the new phase of Argo (notably via the NAOS project).
- 2017-2020: Continuation of the core Argo mission with the addition of an extended mission.

For the upcoming phase 2017-2020, France will conduct an over-fitting strategy of a 66 floats/year sustained fleet with:

- 15 deep floats
- 7 with biogeochemical sensors including O2 sensors for 4 of them
- 11 with oxygen sensors
- 33 core T/S.

Core T/S, deep floats and oxygen sensors are fully funded until 2020 (CPER Brittany region), the biogeochemical mission is partially funded (CPER PACA and Brittany regions until 2020) and thus requires new sources of funding that are being requested for the 2018-2023 period as part of the Research Infrastructure second phase.
France strategy will be adjusted according to international recommendations with regard to the deep and Bio-Argo extensions. Euro-Argo has published a long term roadmap for the next phase of Argo and as part of the ERIC Euro-Argo countries will work on the implementation of a new sustained phase for Argo in Europe.

Float development

Since 2011, Ifremer together with NKE and CNRS has been working on PROVOR/ARVOR floats improvement in order to develop, validate and deploy the next generation of French Argo profiling floats. The new float capabilities include: longer life-time, more efficient design of the vehicle, improved transmission rates, integration of biogeochemical sensors, deeper measurements and under ice operations in the polar seas. In 2016, prototype designs were industrialised by NKE and some deployed by Operational Center. More informations on technological float developments can be found in the NAOS project webpage (http://www.naos-equipex.fr/) and its last newsletter (Feb 2018, French version.pdf).

The developed Arvor float behaves quite well at sea. 212 Arvor floats have been deployed in 2017 (48, about 25%, by France) and 198 are still active (93%).

Deep Arvor floats have been deployed since 2015 (36 in total). The general behaviour of the float is satisfactory and performances are improving. The Deep-Arvor technology was described in Le Reste et al (JAOT, 2016, http://dx.doi.org/10.1175/JTECH-D-15-0214.1

Development of a Deep-Arvor equipped with the SBE41CP, SBE61 and deep RBRconcerto is on going. This float should be deployed in summer 2018. Such an experiment will contribute to determine which CTD is the best suited for the 0-4000db profiling Deep-Arvor.

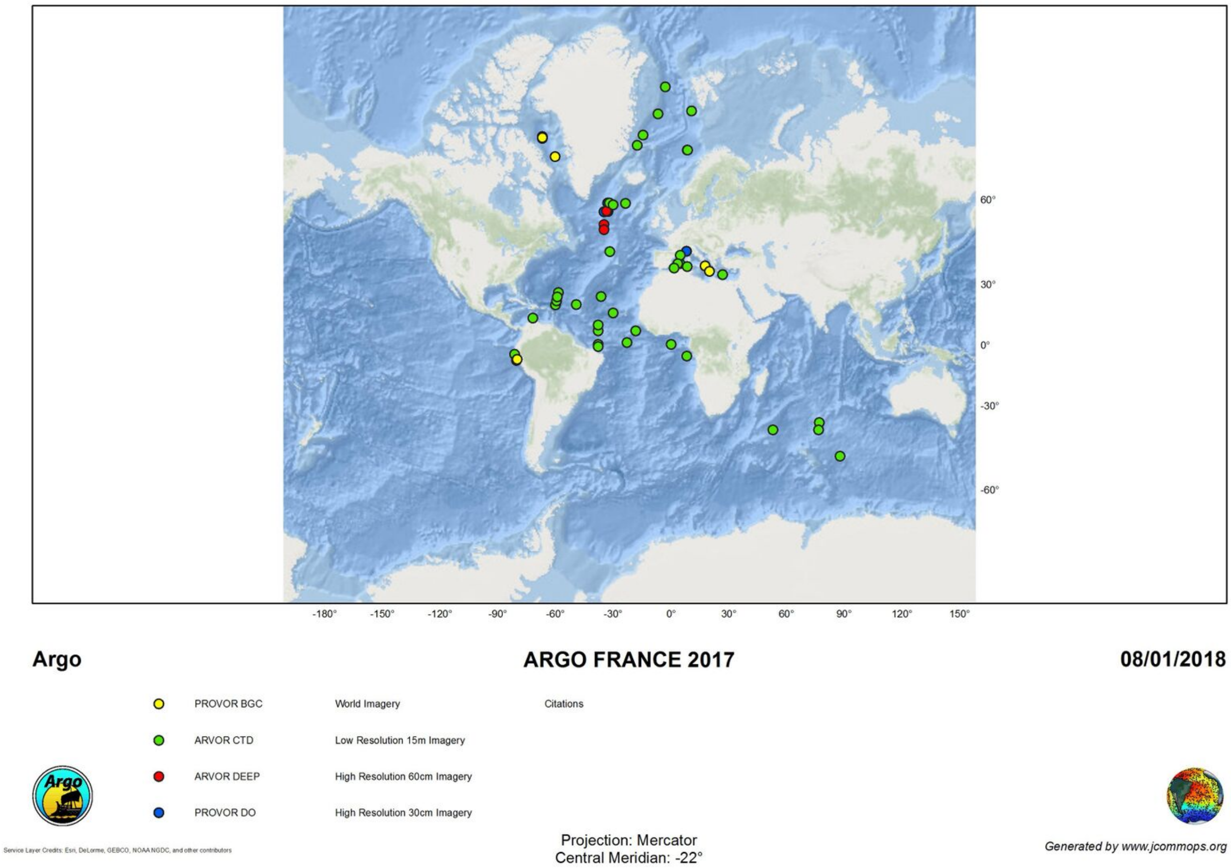
In 2017, the deep RBRconcerto was tested during 120 stations of the RREX2017 cruise in the North-Atlantic. Preliminary analysis of the data are encouraging for the ability of the RBRconcerto to meet the core Argo mission accuracy. Even though differences against bottles and SBE911 measurements were found out of specs, biais look systematic and pressure dependant in a correctable way. So, clearly more work is still needed to meet the Deep-Argo expectations. The deep RBRconcerto preliminary evaluation will be reported on at the AST19.

Setting on the LOPS-Ifremer rosette for the test of the deep RBRconcerto CTD (equiped with 2 RBRcoda ODO oxygen sensors). The RBR ctd is mounted near the SBE911.

The status of implementation

Floats deployed and their performance

65 T/S floats (3 BGC) have been deployed by France in 2017. The deployment areas are chosen to meet French requirements in terms of research and operational activities but also to contribute to establishing the global array (especially in the Southern Ocean) using AIC tools/map.



2017 Argo-France 65 deployments

Technical problems encountered and solved

No particular technical problems were encountered in 2017 with regard to operational T/S floats.

Status of contributions to Argo data management

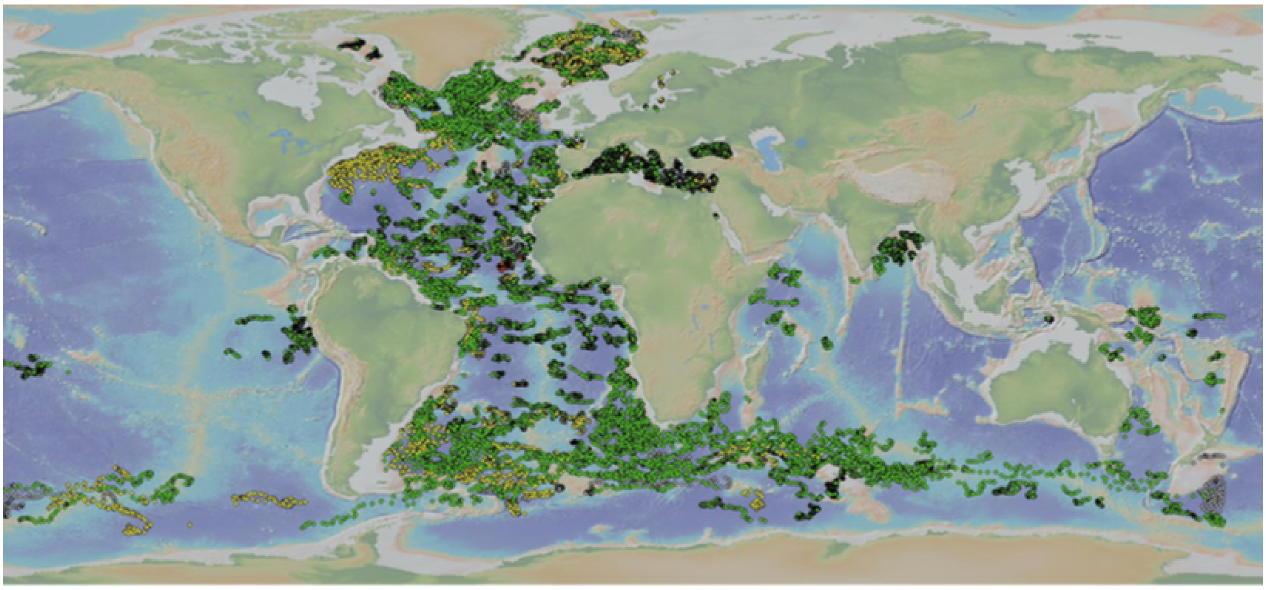
Within Argo-France, data management is undertaken by Coriolis, which play three roles: Data Assembly Centre, Global Data Centre, and leader of the North Atlantic Argo Regional Centre. Coriolis is located within Ifremer-Brest and is operated by Ifremer with support of SHOM. Since 2016, the BGC floats processing chain have been fully operational and integrated within the Coriolis data management stream.

All Argo data management details are in the Coriolis DAC and GDAC 2017 annual report (english) : http://archimer.ifremer.fr/doc/00411/52199/

Data Assembly Center

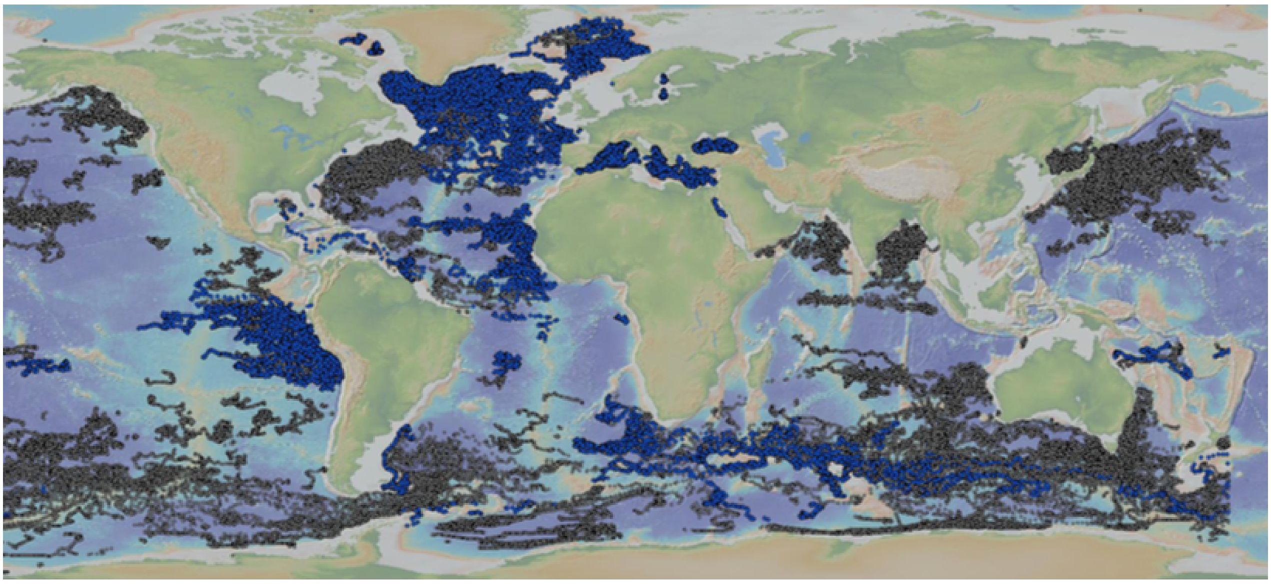
Coriolis processes in Real Time and Delayed Mode float data deployed by France and 7 European countries (Germany, Spain, Netherlands, Norway, Italy, Greece, Bulgaria). Details information can be found the 2017 Coriolis DAC / GDAC data management report (http://archimer.ifremer.fr/doc/00411/52199/).

These last 12 months (sep16-aug17), 30 367 profiles from 788 active floats were collected, controlled and distributed. Compared to 2016, the number of profiles increased by 1%, the number of floats increased by 2%. These figures show a fair stability in Coriolis DAC activity. The 788 floats managed during that period had 56 versions of data formats. Coriolis DAC provides data for 357 BGC-Argo floats from 5 families and 51 instrument versions. They performed 46 460 cycles.



Map of the 30.367 profiles from 788 active floats decoded by Coriolis DAC this current year

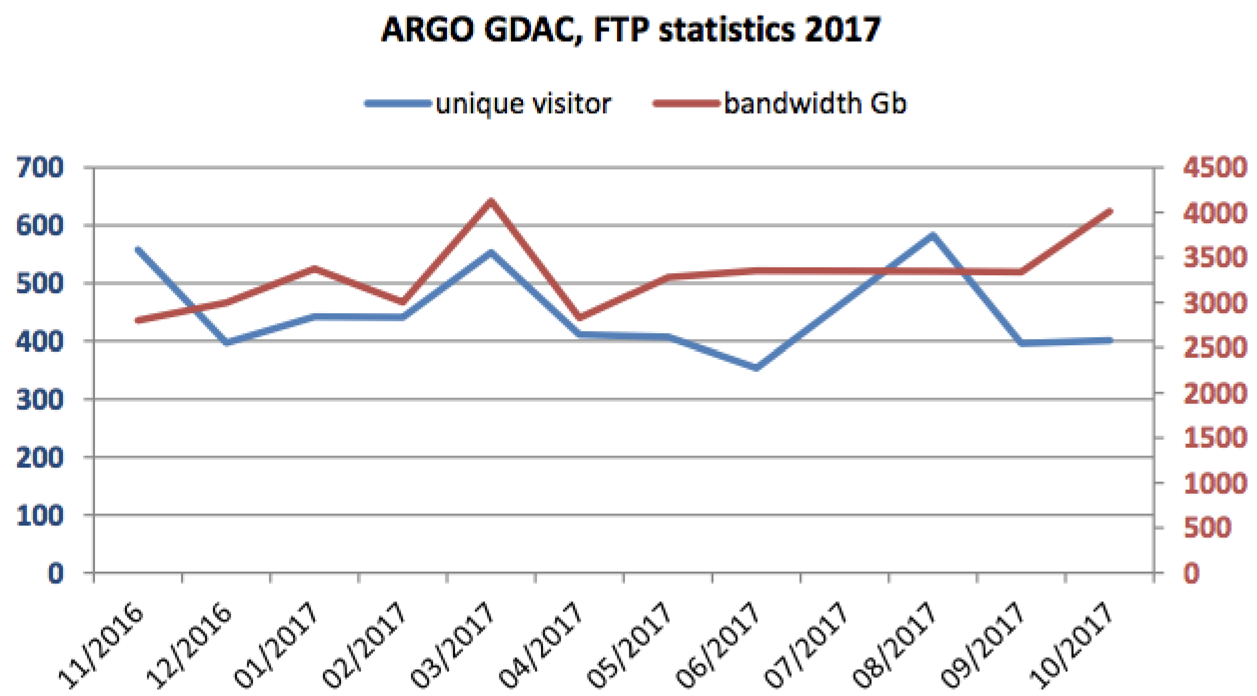
Apex Navis Nemo Nova Provor



Map of the 357 bio-Argo floats managed by Coriolis DAC (grey dots: the others DACs bio-Argo floats). They measure parameters such as chlorophyll, turbidity, CDOM, back-scattering, UV, nitrate, bisulfide, pH, radiance, irradiance, PAR.

Global Argo Data Centre

Coriolis hosts one of the two global data assembly centres (GDAC) for Argo that contains the whole official Argo dataset. The Argo GDAC ftp server is actively monitored by a Nagios agent (see http://en.wikipedia.org/wiki/Nagios). Every 5 minutes, a download test is performed. The success/failure of the test and the response time are recorded (see Figure). There is a monthly average of 449 unique visitors, performing 4552 sessions and downloading 3.3To of data files.



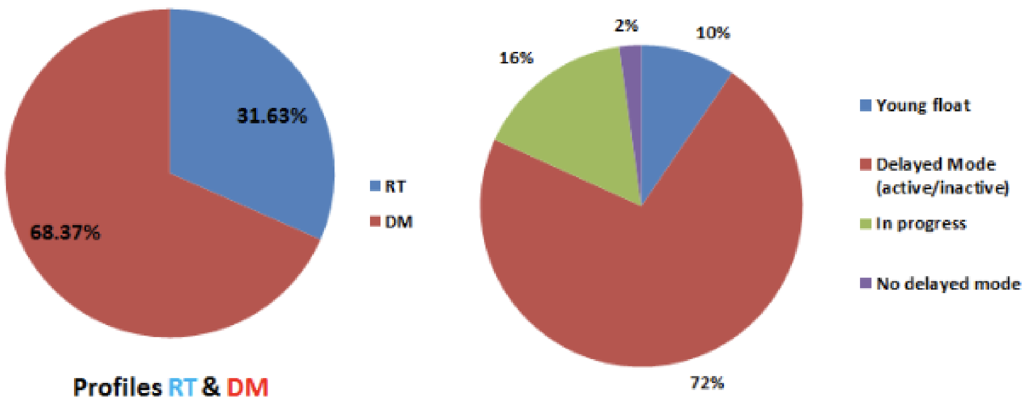
In November 2017, 131 308 BGC Argo profiles from 863 floats were available on Argo GDAC. This is a strong increase compared to 2016 : +65% more profiles and +54% more floats.

North Atlantic Argo Regional Centre

See section 5.4

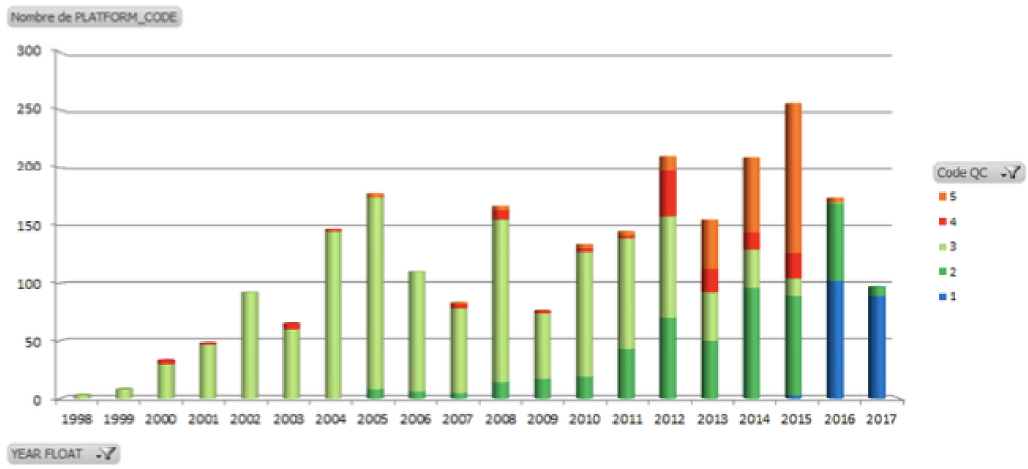
Status of delayed mode quality control process

During the last year (from Oct. 2016 to Nov. 2017), 49 125 new delayed mode profiles where produced and validated by PIs. A total of 178 763 delayed mode profiles where produced and validated since 2005. In February 2018, 72% of the floats and 68.37% of the profiles processed by the Coriolis DAC were in delayed mode (see Figure below).



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 two last years (2016-2017), 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.



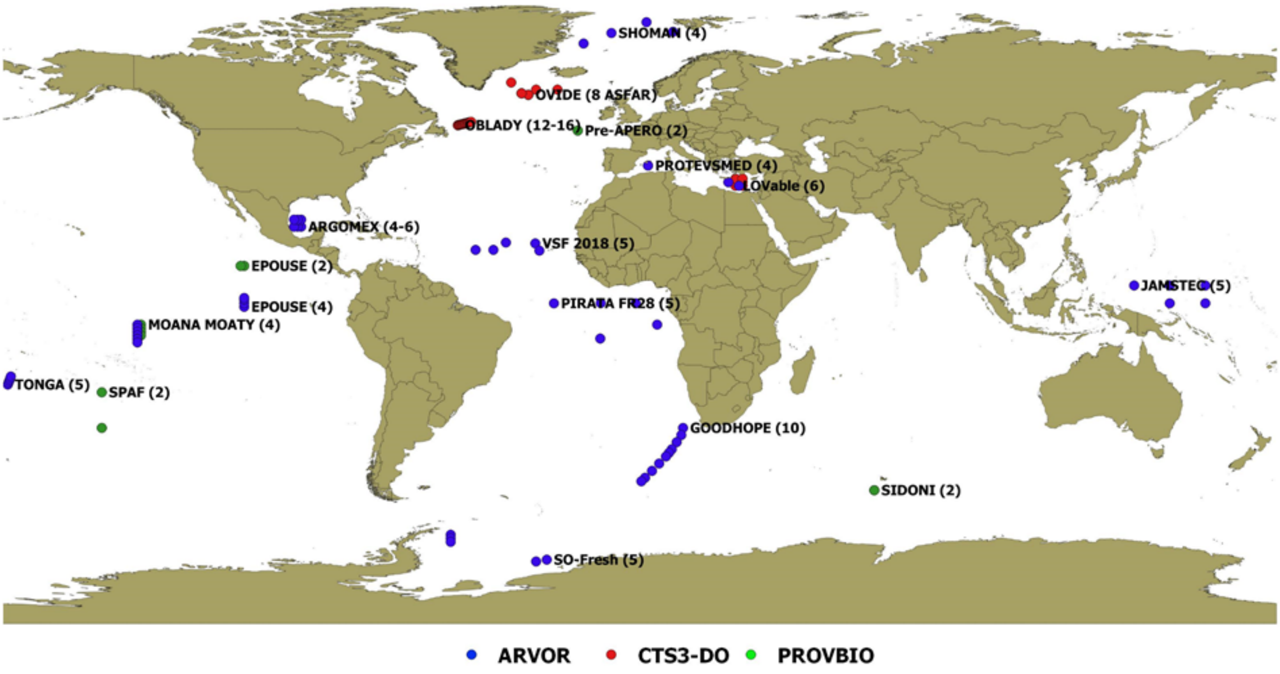
Status of the quality control done on profiles sorted by launch's year, code 1: young float, code 2: active float, DM done, code 3 : dead float, DM done; code 4 : DM in progress, code 5 : waiting for DM, code 6 : problems with float.

Summary of deployment plans and other commitments to Argo for the upcoming year and beyond where possible

According to the current deployment plan, 88 floats are scheduled to be deployed in 2018 (with 11 DO, 21 BGC and 7 DEEP), see map below.

Coriolis will continue to run the Coriolis DAC and the European GDAC as well as coordinating the North Atlantic ARC activities. Within the Euro-Argo project, development will be carried out to improve anomalies detection at GDAC both in RT and DM, to monitor in real time the behaviour of the European fleet and to improve data consistency check within NA-ARC.

France also contributes to the funding of the AIC.



2018 Argo-France planned deployments

Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers

Operational ocean forecasting

All Argo data (alongside with other in-situ and remotely sensed ocean data) are routinely assimilated into the MERCATOR operational ocean forecasting system run by the MERCATOR-Ocean structure. MERCATOR also operates the Global component of the European Copernicus Marine Environment Monitoring Service (CMEMS).

Support to the Mercator and Coriolis scientific activities

Coriolis has developed together with MERCATOR (The French operational oceanography forecast center) a strong connection with the French research community via the Mercator-Coriolis Mission Group (GMMC). It consists of about one hundred researchers (with some turnover each year) following a scientific announcement of opportunities and call for tender. Its task is to support the Mercator and Coriolis scientific activities and to participate in product validation. The call for tender proposes to the community "standard" Argo floats as well as floats equipped with oxygen and biogeochemical sensors. These new opportunities strengthen ties between the French scientific community and Coriolis with regard to the development of qualification procedures for "Argo extensions" floats.

National Research

Argo data are being used by many researchers in France to improve the understanding of ocean properties (e.g. circulation, heat storage and budget, and mixing), climate monitoring and on how they are applied in ocean models (e.g. improved salinity assimilation, ...).

In 2017, an update of the ISAS product, an objective analysis of delayed mode Argo data, has been published. The new interpolated 3D fields now cover the periods 2002-2015, as monthly means. A version based only on Argo data and another version also using MEMO (Marine Mammals), ITP (Arctic) and moorings from TAO-TRITON-PIRATA-RAMA are available. All fields and standardized data are freely available to the community: Kolodziejczyk Nicolas, Prigent-Mazella Annaig, Gaillard Fabienne (2017). ISAS-15 temperature and salinity gridded fields. SEANOE. http://doi.org/10.17882/52367.

Argo-Regional Center: North Atlantic

France leads the NA-ARC, which is a collaborative effort between Germany (IFM-HH, BSH), Spain (IEO), Italy (OGS), Netherlands (KNMI), UK (NOCS, UKHO), Ireland (IMR), Norway (IMR), Canada (DFO), and USA (AOML), Greece (HCMR) and Bulgaria (IOBAS). Coriolis coordinates the North-Atlantic ARC activities and in particular the float deployment in Atlantic.

The NA-ARC website provides information about float data and status in the North-Atlantic Ocean. NA-ARC also provides a web API to access metadata about Argo profiles in the North Atlantic region (http://api.ifremer.fr/naarc/v1).

All the floats that have been processed in delayed time in the North Atlantic ARC, north of 30°S, were checked again using a modified OW method that has been published by Cabanes et al (http://dx.doi.org/10.1016/j.dsr.2016.05.007). Among the 1682 floats checked, we found 10 floats for which it may be necessary to revise the original DM correction. Reports have been send to the Pis.

Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo.

These might include tasks performed by the AIC, the coordination of activities at an international level and the performance of the Argo data system. If you have specific comments, please include them in your national report.

-

CTD cruise data in the reference database

To continue improving the number of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include the number and location of CTD cruise data uploaded by PIs within your country to the CCHDO website in the past year. These cruises could be used for Argo calibration purposes only or could be cruises that are open to the public as well.

The last version CTD_for_DMQC_2017V01 has been provided in January 2017, this is an updated version (correction of bugs in some boxes) of the CTD_for_DMQC_2016V01 dataset provided in September 2016 which takes into account new CTD provided by the CCHDO API (following figure), CTD from scientists as well as feedbacks from users on quality of some profiles. Concerning the CCHDO API, all cruises have been imported but only 30% have been kept after duplicates check with data in Coriolis database. A new version should be published in early 2018.

Bibliography

List of publications in which a scientist from a french laboratory is involved

In 2017, at least 75 articles with a scientist affiliated in France as a coauthor have been published in peer reviewed journals. The list is reported hereafter. Note that the list of all publications in which a scientist from a French laboratory is involved is available on the Argo France website and on the Argo Bibliography webpage. To date, around 360 articles have been listed.

Ablain, M., J. F. Legeais, P. Prandi, M. Marcos, L. Fenoglio-Marc, H. B. Dieng, J. Benveniste, and A. Cazenave, 2017: Satellite Altimetry-Based Sea Level at Global and Regional Scales. Surveys in Geophysics, 38, 7-31, http://dx.doi.org/10.1007/s10712-016-9389-8

Alberty, M. S., J. Sprintall, J. MacKinnon, A. Ganachaud, S. Cravatte, G. Eldin, C. Germineaud, and A. Melet, 2017: Spatial patterns of mixing in the Solomon Sea. Journal of Geophysical Research: Oceans, 122, 4021-4039, http://dx.doi.org/10.1002/2016JC012666

Bellenger, H., K. Drushka, W. Asher, G. Reverdin, M. Katsumata, and M. Watanabe, 2017: Extension of the prognostic model of sea surface temperature to rain-induced cool and fresh lenses. Journal of Geophysical Research: Oceans, 122, 484-507, http://dx.doi.org/10.1002/2016JC012429

Bittig, H. C. and A. Körtzinger, 2017: Technical note: Update on response times, in-air measurements, and in situ drift for oxygen optodes on profiling platforms. Ocean Science, 13, 1-11, http://dx.doi.org/10.5194/os-13-1-2017

Bittig, H., Körtzinger, A, Neill, C., van Ooijen4, E., Plant, J. N., Hahn, J., Johnson, K. J., Yang, B., Emerson, S. (2017) Oxygen Optode Sensors: Principle, Characterization, Calibration and Application in the Ocean.. Frontiers in Marine Science | DOI: 10.3389/fmars.2017.00429

Buongiorno Nardelli, B., S. Guinehut, N. Verbrugge, Y. Cotroneo, E. Zambianchi, and D. Iudicone, 2017: Southern Ocean Mixed-Layer Seasonal and Interannual Variations From Combined Satellite and In Situ Data. Journal of Geophysical Research: Oceans, 122, 10042-10060, http://dx.doi.org/10.1002/2017JC013314

Caniaux, G., L. Prieur, H. Giordani, and J. L. Redelsperger, 2017: An inverse method to derive surface fluxes from the closure of oceanic heat and water budgets: Application to the north-western Mediterranean Sea. Journal of Geophysical Research: Oceans, 122, 2884-2908, http://dx.doi.org/10.1002/2016JC012167

Carret, A., J. A. Johannessen, O. B. Andersen, M. Ablain, P. Prandi, A. Blazquez, and A. Cazenave, 2017: Arctic Sea Level During the Satellite Altimetry Era. Surveys in Geophysics, 38, 251-275, http://dx.doi.org/10.1007/s10712-016-9390-2

Chambers, D. P., A. Cazenave, N. Champollion, H. Dieng, W. Llovel, R. Forsberg, K. von Schuckmann, and Y. Wada, 2017: Evaluation of the Global Mean Sea Level Budget between 1993 and 2014. Surveys in Geophysics, 38, 309-327, http://dx.doi.org/10.1007/s10712-016-9381-3

Chapman, C. and A. A. Charantonis, 2017: Reconstruction of Subsurface Velocities From Satellite Observations Using Iterative Self-Organizing Maps. IEEE Geoscience and Remote Sensing Letters, 14, 617-620, http://dx.doi.org/10.1109/LGRS.2017.2665603

Chapman, C. and J.-B. Sallée, 2017: Isopycnal Mixing Suppression by the Antarctic Circumpolar Current and the Southern Ocean Meridional Overturning Circulation. Journal of Physical Oceanography, 47, 2023-2045, https://doi.org/10.1175/JPO-D-16-0263.1

Chapman, C. and J.-B. Sallée, 2017: Can we reconstruct mean and eddy fluxes from Argo floats? Ocean Modelling, 120, 83-100, http://www.sciencedirect.com/science/article/pii/S1463500317301488

Charria, G., S. Theetten, F. Vandermeirsch, Ö. Yelekçi, and N. Audiffren, 2017: Interannual evolution of (sub)mesoscale dynamics in the Bay of Biscay. Ocean Sci., 13, 777-797, https://doi.org/10.5194/os-13-777-2017

Chen, J. L., C. R. Wilson, B. D. Tapley, H. Save, and J.-F. Cretaux, 2017: Long-term and seasonal Caspian Sea level change from satellite gravity and altimeter measurements. Journal of Geophysical Research: Solid Earth, 122, 2274-2290, http://dx.doi.org/10.1002/2016JB013595

Coppola, L., L. Prieur, I. Taupier-Letage, C. Estournel, P. Testor, D. Lefevre, S. Belamari, S. LeReste, and V. Taillandier, 2017: Observation of oxygen ventilation into deep waters through targeted deployment of multiple Argo-O2 floats in the north-western Mediterranean Sea in 2013. Journal of Geophysical Research: Oceans, 122, 6325-6341, http://dx.doi.org/10.1002/2016JC012594

Cravatte, S., E. Kestenare, F. Marin, P. Dutrieux, and E. Firing, 2017: Subthermocline and Intermediate Zonal Currents in the Tropical Pacific Ocean: Paths and Vertical Structure. Journal of Physical Oceanography, 47, 2305-2324, https://doi.org/10.1175/JPO-D-17-0043.1

de Boisséson, E., M. A. Balmaseda, and M. Mayer, 2017: Ocean heat content variability in an ensemble of twentieth century ocean reanalyses. Climate Dynamics, https://doi.org/10.1007/s00382-017-3845-0

Desbruyères, D., E. L. McDonagh, B. A. King, and V. Thierry, 2017: Global and Full-Depth Ocean Temperature Trends during the Early Twenty-First Century from Argo and Repeat Hydrography. Journal of Climate, 30, 1985-1997, http://dx.doi.org/10.1175/jcli-d-16-0396.1

Dieng, H. B., A. Cazenave, B. Meyssignac, and M. Ablain, 2017: New estimate of the current rate of sea level rise from a sea level budget approach. Geophysical Research Letters, 44, 3744-3751, http://dx.doi.org/10.1002/2017GL073308

Dieng, H. B., A. Cazenave, B. Meyssignac, K. von Schuckmann, and H. Palanisamy, 2017: Sea and land surface temperatures, ocean heat content, Earth's energy imbalance and net radiative forcing over the recent years. International Journal of Climatology, 37, 218-229, http://dx.doi.org/10.1002/joc.4996
Dunphy, M., A. L. Ponte, P. Klein, and S. L. Gentil, 2017: Low-Mode Internal Tide Propagation in a Turbulent Eddy Field. Journal of Physical Oceanography, 47, 649-665, http://dx.doi.org/10.1175/jpo-d-16-0099.1
Fournier, S., J. Vialard, M. Lengaigne, T. Lee, M. M. Gierach, and A. V. S. Chaitanya, 2017: Modulation of the Ganges-Brahmaputra River Plume by the Indian Ocean Dipole and Eddies Inferred From Satellite Observations. Journal of Geophysical Research: Oceans, 122, 9591-9604, http://dx.doi.org/10.1002/2017JC013333
Friedman, A. R., G. Reverdin, M. Khodri, and G. Gastineau, 2017: A new record of Atlantic sea surface salinity from 1896 to 2013 reveals the signatures of climate variability and long-term trends. Geophysical Research Letters, 44, 1866-1876, http://dx.doi.org/10.1002/2017GL072582
Germe, A., F. Sévellec, J. Mignot, D. Swingedouw, and S. Nguyen, 2017: On the robustness of near term climate predictability regarding initial state uncertainties. Climate Dynamics, 48, 353-366, http://dx.doi.org/10.1007/s00382-016-3078-7
Grodsky, S. A., N. Reul, B. Chapron, J. A. Carton, and F. O. Bryan, 2017: Interannual surface salinity on Northwest Atlantic shelf. Journal of Geophysical Research: Oceans, 122, 3638-3659, http://dx.doi.org/10.1002/2016JC012580
Guimbard, S., N. Reul, B. Chapron, M. Umbert, and C. Maes, 2017: Seasonal and interannual variability of the Eastern Tropical Pacific Fresh Pool. Journal of Geophysical Research: Oceans, 122, 1749-1771, http://dx.doi.org/10.1002/2016JC012130
Houssard, P., A. Lorrain, L. Tremblay-Boyer, V. Allain, B. S. Graham, C. E. Menkes, H. Pethybridge, L. I. E. Couturier, D. Point, B. Leroy, A. Receveur, B. P. V. Hunt, E. Vourey, S. Bonnet, M. Rodier, P. Raimbault, E. Feunteun, P. M. Kuhnert, J.-M. Munaron, B. Lebreton, T. Otake, and Y. Letourneur, 2017: Trophic position increases with thermocline depth in yellowfin and bigeye tuna across the Western and Central Pacific Ocean. Progress in Oceanography, 154, 49-63, http://dx.doi.org/10.1016/j.pocean.2017.04.008
Jordà, G., K. Von Schuckmann, S. A. Josey, G. Caniaux, J. García-Lafuente, S. Sammartino, E. Özsoy, J. Polcher, G. Notarstefano, P. M. Poulain, F. Adloff, J. Salat, C. Naranjo, K. Schroeder, J. Chiggiato, G. Sannino, and D. Macías, 2017: The Mediterranean Sea heat and mass budgets: Estimates, uncertainties and perspectives. Progress in Oceanography, 156, 174-208, https://doi.org/10.1016/j.pocean.2017.07.001
Karstensen, J., F. Schütte, A. Pietri, G. Krahmann, B. Fiedler, D. Grundle, H. Hauss, A. Körtzinger, C. R. Löscher, P. Testor, N. Vieira, and M. Visbeck, 2017: Upwelling and isolation in oxygen-depleted anticyclonic modewater eddies and implications for nitrate cycling. Biogeosciences, 14, 2167-2181, https://doi.org/10.5194/bg-14-2167-2017
Keerthi, M. G., M. Lengaigne, M. Levy, J. Vialard, V. Parvathi, C. de Boyer Montégut, C. Ethé, O. Aumont, I. Suresh, and P.M. Muraleedharan (2017), Physical control of the interannual variations of the winter chlorophyll bloom in the northern Arabian Sea, Biogeosciences, 14, 3615-3632. [doi:10.5194/bg-14-3615-2017]
Kessouri, F., C. Ulses, C. Estournel, P. Marsaleix, T. Severin, M. Pujo-Pay, J. Caparros, P. Raimbault, O. Pasqueron de Fommervault, F. D'Ortenzio, V. Taillandier, P. Testor, and P. Conan, 2017: Nitrogen and Phosphorus Budgets in the Northwestern Mediterranean Deep Convection Region. Journal of Geophysical Research: Oceans, 122, 9429-9454, http://dx.doi.org/10.1002/2016JC012665
Lacour, L., M. Ardyna, K. F. Stec, H. Claustre, L. Prieur, A. Poteau, M. R. D'Alcala, and D. Iudicone, 2017: Unexpected winter phytoplankton blooms in the North Atlantic subpolar gyre. Nature Geoscience, 10, 836, http://dx.doi.org/10.1038/ngeo3035
Lebeaupin Brossier, C., F. Léger, H. Giordani, J. Beuvier, M.-N. Bouin, V. Ducrocq, and N. Fourrié, 2017: Dense water formation in the north-western Mediterranean area during HyMeX-SOP2 in 1/36° ocean

simulations: Ocean-atmosphere coupling impact. Journal of Geophysical Research: Oceans, 122, 5749-5773, http://dx.doi.org/10.1002/2016JC012526
Lecomte, O., H. Goosse, T. Fichefet, C. de Lavergne, A. Barthélemy, and V. Zunz, 2017: Vertical ocean heat redistribution sustaining sea-ice concentration trends in the Ross Sea. Nature Communications, 8, 258, https://doi.org/10.1038/s41467-017-00347-4
Legendre, L. Rivkin, R. B. and Jiao, N. Advanced experimental approaches to marine water-column biogeochemical processes. – ICES Journal of Marine Science, doi:10.1093/icesjms/fsx146.
Lehahn, Y., I. Koren, S. Sharoni, F. d'Ovidio, A. Vardi, and E. Boss, 2017: Dispersion/dilution enhances phytoplankton blooms in low-nutrient waters. Nature Communications, 8, 14868, http://dx.doi.org/10.1038/ncomms14868
Lozier, M. S., S. Bacon, A. S. Bower, S. A. Cunningham, M. F. d. Jong, L. d. Steur, B. deYoung, J. Fischer, S. F. Gary, B. J. W. Greenan, P. Heimbach, N. P. Holliday, L. Houpert, M. E. Inall, W. E. Johns, H. L. Johnson, J. Karstensen, F. Li, X. Lin, N. Mackay, D. P. Marshall, H. Mercier, P. G. Myers, R. S. Pickart, H. R. Pillar, F. Straneo, V. Thierry, R. A. Weller, R. G. Williams, C. Wilson, J. Yang, J. Zhao, and J. D. Zika, 2017: Overturning in the Subpolar North Atlantic Program: A New International Ocean Observing System. Bulletin of the American Meteorological Society, 98, 737-752, http://dx.doi.org/10.1175/bams-d-16-0057.1
MacIntosh, C. R., C. J. Merchant, and K. von Schuckmann, 2017: Uncertainties in Steric Sea Level Change Estimation During the Satellite Altimeter Era: Concepts and Practices. Surveys in Geophysics, 38, 59-87, http://dx.doi.org/10.1007/s10712-016-9387-x
Mayot, N., F. D'Ortenzio, V. Taillandier, L. Prieur, O. P. de Fommervault, H. Claustre, A. Bosse, P. Testor, and P. Conan, 2017: Physical and Biogeochemical Controls of the Phytoplankton Blooms in North Western Mediterranean Sea: A Multiplatform Approach Over a Complete Annual Cycle (2012–2013 DEWEX Experiment). Journal of Geophysical Research: Oceans, 122, 9999-10019, http://dx.doi.org/10.1002/2016JC012052
Mayot, N., F. D'Ortenzio, J. Uitz, B. Gentili, J. Ras, V. Vellucci, M. Golbol, D. Antoine, and H. Claustre, 2017: Influence of the Phytoplankton Community Structure on the Spring and Annual Primary Production in the Northwestern Mediterranean Sea. Journal of Geophysical Research: Oceans, 122, 9918-9936, http://dx.doi.org/10.1002/2016JC012668
Maze, G., H. Mercier, R. Fablet, P. Tandeo, M. Lopez Radcenco, P. Lenca, C. Feucher, and C. Le Goff, 2017: Coherent heat patterns revealed by unsupervised classification of Argo temperature profiles in the North Atlantic Ocean. Progress in Oceanography, 151, 275-292, http://doi.org/10.1016/j.pocean.2016.12.008
Meyssignac, B., C. G. Piecuch, C. J. Merchant, M.-F. Racault, H. Palanisamy, C. MacIntosh, S. Sathyendranath, and R. Brewin, 2017: Causes of the Regional Variability in Observed Sea Level, Sea Surface Temperature and Ocean Colour Over the Period 1993–2011. Surveys in Geophysics, 38, 187-215, http://dx.doi.org/10.1007/s10712-016-9383-1
Monerie, P.-A., L. Coquart, É. Maisonnave, M.-P. Moine, L. Terray, and S. Valcke, 2017: Decadal prediction skill using a high-resolution climate model. Climate Dynamics, 49, 3527-3550, https://doi.org/10.1007/s00382-017-3528-x
Morris, T., J. Hermes, L. Beal, M. du Plessis, C. Duncombe Rae, M. Gulekana, T. Lamont, S. Speich, M. Roberts, and I. ansorge, 2017: The importance of monitoring the Greater Agulhas Current and its inter-ocean exchanges using large mooring arrays. South African Journal of Science, 113, http://dx.doi.org/10.17159/sajs.2017/20160330
Morrow, R. and E. Kestenare, 2017: 22-year surface salinity changes in the Seasonal Ice Zone near 140°E off Antarctica. Journal of Marine Systems, 175, 46-62, https://doi.org/10.1016/j.jmarsys.2017.07.003
Organelli, E., M. Barbieux, H. Claustre, C. Schmechtig, A. Poteau, A. Bricaud, E. Boss, N. Briggs, G. Dall'Olmo, F. D'Ortenzio, E. Leymarie, A. Mangin, G. Obolensky, C. Penkerc'h, L. Prieur, C. Roesler, R. Serra, J. Uitz, and X. Xing, 2017: Two databases derived from BGC-Argo float measurements for marine

biogeochemical and bio-optical applications. Earth Syst. Sci. Data, 9, 861-880, https://doi.org/10.5194/essd-9-861-2017
Organelli, E., H. Claustre, A. Bricaud, M. Barbieux, J. Uitz, F. D'Ortenzio, and G. Dall'Olmo, 2017: Bio-optical anomalies in the world's oceans: An investigation on the diffuse attenuation coefficients for downward irradiance derived from Biogeochemical Argo float measurements. Journal of Geophysical Research: Oceans, 122, 3543-3564, http://dx.doi.org/10.1002/2016JC012629
Ortega, P., E. Guilyardi, D. Swingedouw, J. Mignot, and S. Nguyen, 2017: Reconstructing extreme AMOC events through nudging of the ocean surface: a perfect model approach. Climate Dynamics, 49, 3425-3441, https://doi.org/10.1007/s00382-017-3521-4
Palmer, M. D., C. D. Roberts, M. Balmaseda, Y.-S. Chang, G. Chepurin, N. Ferry, Y. Fujii, S. A. Good, S. Guinehut, K. Haines, F. Hernandez, A. Köhl, T. Lee, M. J. Martin, S. Masina, S. Masuda, K. A. Peterson, A. Storto, T. Toyoda, M. Valdivieso, G. Vernieres, O. Wang, and Y. Xue, 2017: Ocean heat content variability and change in an ensemble of ocean reanalyses. Climate Dynamics, 49, 909-930, https://doi.org/10.1007/s00382-015-2801-0
Pauthenet, E., F. Roquet, G. Madec, and D. Nerini, 2017: A Linear Decomposition of the Southern Ocean Thermohaline Structure. Journal of Physical Oceanography, 47, 29-47, http://dx.doi.org/10.1175/JPO-D-16-0083.1
Pellichero, V., J.-B. Sallée, S. Schmidtko, F. Roquet, and J.-B. Charrassin, 2017: The ocean mixed layer under Southern Ocean sea-ice: Seasonal cycle and forcing. Journal of Geophysical Research: Oceans, 122, 1608-1633, http://dx.doi.org/10.1002/2016JC011970
Piron, A., V. Thierry, H. Mercier, and G. Caniaux, 2017: Gyre-scale deep convection in the subpolar North Atlantic Ocean during winter 2014–2015. Geophysical Research Letters, 44, 1439-1447, http://dx.doi.org/10.1002/2016GL071895
Planton, Y., A. Voldoire, H. Giordani, and G. Caniaux, 2017: Main processes of the Atlantic cold tongue interannual variability. Climate Dynamics, https://doi.org/10.1007/s00382-017-3701-2
Poteau, A., E. Boss, and H. Claustre, 2017: Particulate concentration and seasonal dynamics in the mesopelagic ocean based on the backscattering coefficient measured with Biogeochemical-Argo floats. Geophysical Research Letters, 44, 6933-6939, http://dx.doi.org/10.1002/2017GL073949
Raapoto, H., Martinez, E., Petrenko, A., Doglioli, A. M., & Maes, C. (2018). Modeling the wake of the Marquesas archipelago. Journal of Geophysical Research: Oceans, 123. https://doi.org/10.1002/2017JC013285
Rembauville, M., N. Briggs, M. Ardyna, J. Uitz, P. Catala, C. Penkerc'h, A. Poteau, H. Claustre, and S. Blain, 2017: Plankton Assemblage Estimated with BGC-Argo Floats in the Southern Ocean: Implications for Seasonal Successions and Particle Export. Journal of Geophysical Research: Oceans, 122, 8278-8292, http://dx.doi.org/10.1002/2017JC013067
Roesler, C., Uitz, J., Claustre, H., Boss, E., Xing, X. G., Organelli, E., Briggs, N., Bricaud, A., Schmechtig, C., Poteau, A., D'Ortenzio, F., Ras, J., Drapeau, S., Haentjens, N., Barbieux, M. (2017)Recommendations for obtaining unbiased chlorophyll estimates from in situ chlorophyll fluorometers: A global analysis of WET Labs ECO sensors. Limnology and Oceanography-Methods15: 572-585 | DOI: 10.1002/lom3.10185
Rossby, T., G. Reverdin, L. Chafik, and H. Søiland, 2017: A direct estimate of poleward volume, heat, and freshwater fluxes at 59.5°N between Greenland and Scotland. Journal of Geophysical Research: Oceans, 122, 5870-5887, http://dx.doi.org/10.1002/2017JC012835
Sánchez-Román, A., S. Ruiz, A. Pascual, B. Mourre, and S. Guinehut, 2017: On the mesoscale monitoring capability of Argo floats in the Mediterranean Sea. Ocean Science, 13, 223-234, http://dx.doi.org/10.5194/os-13-223-2017
Sérazin, G., A. Jaymond, S. Leroux, T. Penduff, L. Bessières, W. Llovel, B. Barnier, J.-M. Molines, and L. Terray, 2017: A global probabilistic study of the ocean heat content low-frequency variability: Atmospheric forcing versus oceanic chaos. Geophysical Research Letters, 44, 5580-5589, http://dx.doi.org/10.1002/2017GL073026

Sévellec, F. and A. V. Fedorov, 2017: Predictability and Decadal Variability of the North Atlantic Ocean State Evaluated from a Realistic Ocean Model. Journal of Climate, 30, 477-498, http://dx.doi.org/10.1175/JCLI-D-16-0323.1

Sévellec, F., A. C. d. Verdiére, and M. Ollitrault, 2017: Evolution of Intermediate Water Masses Based on Argo Float Displacements. Journal of Physical Oceanography, 47, 1569-1586, http://dx.doi.org/10.1175/jpo-d-16-0182.

Seyfried, L., P. Marsaleix, E. Richard, and C. Estournel, 2017: Modelling deep-water formation in the north-west Mediterranean Sea with a new air–sea coupled model: sensitivity to turbulent flux parameterizations. Ocean Sci., 13, 1093-1112, https://doi.org/10.5194/os-13-1093-2017

Sgubin, G., D. Swingedouw, S. Drijfhout, Y. Mary, and A. Bennabi, 2017: Abrupt cooling over the North Atlantic in modern climate models, 8, http://dx.doi.org/10.1038/ncomms14375

Shi, L., O. Alves, R. Wedd, M. A. Balmaseda, Y. Chang, G. Chepurin, N. Ferry, Y. Fujii, F. Gaillard, S. A. Good, S. Guinehut, K. Haines, F. Hernandez, T. Lee, M. Palmer, K. A. Peterson, S. Masuda, A. Storto, T. Toyoda, M. Valdivieso, G. Vernieres, X. Wang, and Y. Yin, 2017: An assessment of upper ocean salinity content from the Ocean Reanalyses Inter-comparison Project (ORA-IP). Climate Dynamics, 49, 1009-1029, https://doi.org/10.1007/s00382-015-2868-7

Slangen, A. B. A., B. Meyssignac, C. Agosta, N. Champollion, J. A. Church, X. Fettweis, S. R. M. Ligtenberg, B. Marzeion, A. Melet, M. D. Palmer, K. Richter, C. D. Roberts, and G. Spada, 2017: Evaluating Model Simulations of Twentieth-Century Sea Level Rise. Part I: Global Mean Sea Level Change. Journal of Climate, 30, 8539-8563, https://doi.org/10.1175/JCLI-D-17-0110.1

Stanev, E. V., S. Grayek, H. Claustre, C. Schmechtig, and A. Poteau, 2017: Water intrusions and particle signatures in the Black Sea: a Biogeochemical-Argo float investigation. Ocean Dynamics, 67, 119-1136, https://doi.org/10.1007/s10236-017-1077-9

Storto, A., S. Masina, M. Balmaseda, S. Guinehut, Y. Xue, T. Szekely, I. Fukumori, G. Forget, Y.-S. Chang, S. A. Good, A. Köhl, G. Vernieres, N. Ferry, K. A. Peterson, D. Behringer, M. Ishii, S. Masuda, Y. Fujii, T. Toyoda, Y. Yin, M. Valdivieso, B. Barnier, T. Boyer, T. Lee, J. Gourrion, O. Wang, P. Heimback, A. Rosati, R. Kovach, F. Hernandez, M. J. Martin, M. Kamachi, T. Kuragano, K. Mogensen, O. Alves, K. Haines, and X. Wang, 2017: Steric sea level variability (1993–2010) in an ensemble of ocean reanalyses and objective analyses. Climate Dynamics, 49, 709-729, https://doi.org/10.1007/s00382-015-2554-9

Toyoda, T., Y. Fujii, T. Kuragano, M. Kamachi, Y. Ishikawa, S. Masuda, K. Sato, T. Awaji, F. Hernandez, N. Ferry, S. Guinehut, M. J. Martin, K. A. Peterson, S. A. Good, M. Valdivieso, K. Haines, A. Storto, S. Masina, A. Köhl, H. Zuo, M. Balmaseda, Y. Yin, L. Shi, O. Alves, G. Smith, Y.-S. Chang, G. Vernieres, X. Wang, G. Forget, P. Heimbach, O. Wang, I. Fukumori, and T. Lee, 2017: Intercomparison and validation of the mixed layer depth fields of global ocean syntheses. Climate Dynamics, 49, 753-773, https://doi.org/10.1007/s00382-015-2637-7

Toyoda, T., Y. Fujii, T. Kuragano, N. Kosugi, D. Sasano, M. Kamachi, Y. Ishikawa, S. Masuda, K. Sato, T. Awaji, F. Hernandez, N. Ferry, S. Guinehut, M. Martin, K. Andrew Peterson, S. A. Good, M. Valdivieso, K. Haines, A. Storto, S. Masina, A. Köhl, Y. Yin, L. Shi, O. Alves, G. Smith, Y.-S. Chang, G. Vernieres, X. Wang, G. Forget, P. Heimbach, O. Wang, I. Fukumori, T. Lee, H. Zuo, and M. Balmaseda, 2017: Interannual-decadal variability of wintertime mixed layer depths in the North Pacific detected by an ensemble of ocean syntheses. Climate Dynamics, 49, 891-907, https://doi.org/10.1007/s00382-015-2762-3

Verrier, S., P. Y. Le Traon, and E. Remy, 2017: Assessing the impact of multiple altimeter missions and Argo in a global eddy-permitting data assimilation system. Ocean Sci., 13, 1077-1092, https://doi.org/10.5194/os-13-1077-2017

Waldman, R., M. Herrmann, S. Somot, T. Arsouze, R. Benshila, A. Bosse, J. Chanut, H. Giordani, F. Sevault, and P. Testor, 2017: Impact of the Mesoscale Dynamics on Ocean Deep Convection: The 2012–2013 Case Study in the Northwestern Mediterranean Sea. Journal of Geophysical Research: Oceans, 122, 8813-8840, http://dx.doi.org/10.1002/2016JC012587

Waldman, R., S. Somot, M. Herrmann, A. Bosse, G. Caniaux, C. Estournel, L. Houpert, L. Prieur, F. Sevault, and P. Testor, 2017: Modeling the intense 2012–2013 dense water formation event in the northwestern Mediterranean Sea: Evaluation with an ensemble simulation approach. Journal of Geophysical Research: Oceans, 122, 1297-1324, http://dx.doiorg/10.1002/2016JC012437
Xing, X., H. Claustre, E. Boss, C. Roesler, E. Organelli, A. Poteau, M. Barbieux, and F. D'Ortenzio, 2017: Correction of profiles of in-situ chlorophyll fluorometry for the contribution of fluorescence originating from non-algal matter. Limnology and Oceanography: Methods, 15, 80-93, http://dx.doi.org/10.1002/lom3.10144
Zunino, P., Lherminier, P., Mercier, H., Daniault, N., García-Ibáñez, M. I., and Pérez, F. F.: The GEOVIDE cruise in May–June 2014 reveals an intense Meridional Overturning Circulation over a cold and fresh subpolar North Atlantic, Biogeosciences, 14, 5323-5342, https://doi.org/10.5194/bg-14-5323-2017, 2017

Argo-France: http://www.argo-france.fr
French bibliography: *http://www.argo-france.fr/publications*
Argo PhD list: http://www.argo.ucsd.edu/argo_thesis.html
NA-ARC data mining website: http://www.ifremer.fr/lpo/naarc
Coriolis FTP: http://www.coriolis.eu.org/Data-Services-Products/View-Download/Download-via-FTP

Coriolis DAC: http://www.coriolis.eu.org/Observing-the-ocean/Observing-system-networks/Argo
IUEM OSU: http://www-iuem.univ-brest.fr/observatoire
NAOS project: http://www.naos-equipex.fr
Euro-Argo: http://www.euro-argo.eu
Coriolis: http://www.coriolis.eu.org
Laboratoire d'Océanographie Physique et Spatiale: http://www.umr-lops.fr/
Laboratoire d’Océanographie de Villefranche: http://www.obs-vlfr.fr/LOV
Mercator: http://www.mercator-ocean.fr

1. The status of implementation (major achievements and problems in 2017)

- floats deployed and their performance

All of the floats deployed by Germany in 2017 are operated by BSH, but in other years additional funding had been acquired by various research institutes. BSH has deployed 38 floats (12 APEX, 26 ARVOR) by the end of 2017, 11 floats purchased in 2017 will used for deployment cruises early 2018 together with 7 warranty floats from Teledyne Webb and 5 warranty floats from Metocean. No floats have been deployed by GEOMAR and AWI in 2017. All of the German floats deployed in 2017 were standard TS floats. Deployment was carried out on research vessels which comprised Canadian, German and UK ships. The deployment locations for 2017 are shown in Fig. 1.

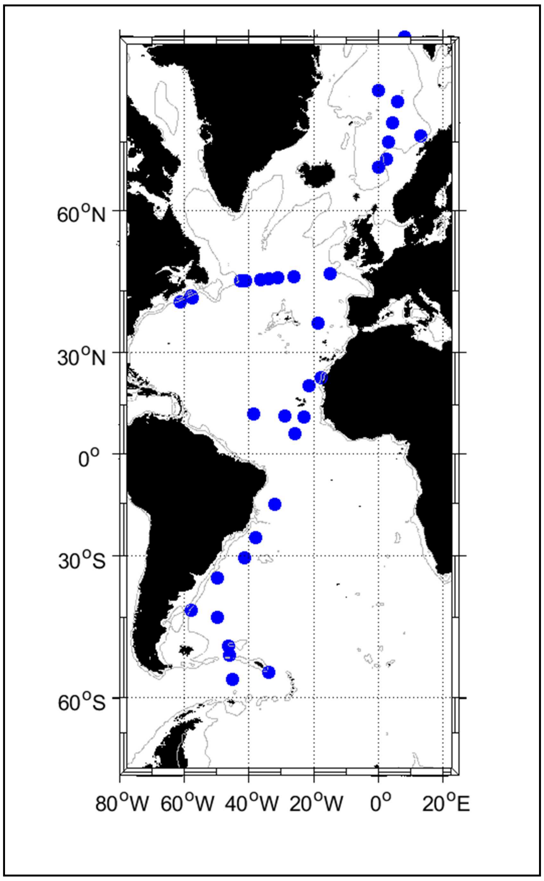


Fig. 1: Deployment positions for floats operated by BSH in 2017in the Atlantic Ocean.

Currently (February 12th, 2018) 155 German floats are active (Fig.2) and the total number of German floats deployed within the Argo program increased to 860. The number of German floats in the network is stiller lower than anticipated due to the loss rate of APEX floats in the previous years. TWR has provided 13 more floats during 2017 from the warranty agreement for lost floats. In total 47 floats were provided by TWR between 2014 and 2017 to replace floats suffering from battery flue. Some of the under-ice floats deployed by AWI in the previous years are assumed to be still active under the ice and could resurface again in the next austral summer and deliver their stored data.

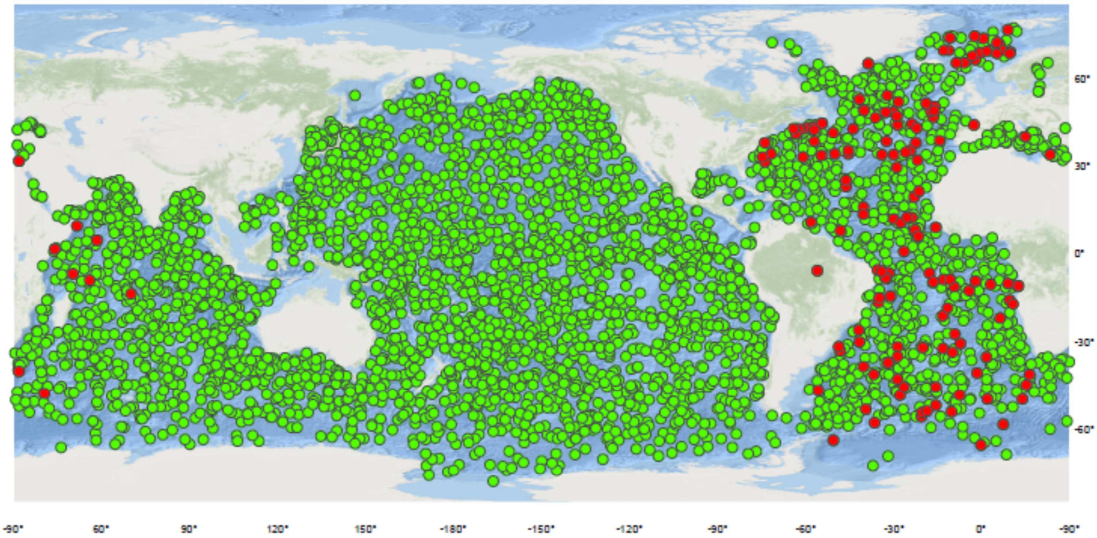


Fig. 2: Locations of active German floats (red) and active international floats (green) (Argo Information Centre, February 2018).

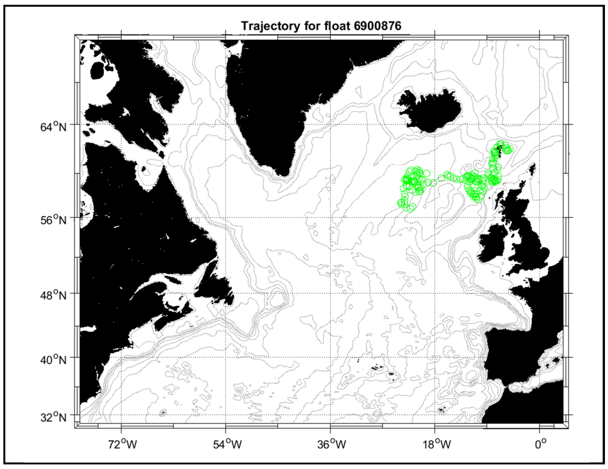
- technical problems encountered and solved

The major technical problem with the alkaline batteries in our APEX floats deployed between 2010-2014 has faded out. Until February 2018 more than 82 floats, deployed between 2010 and 2014, expired early, mostly with life cycles of about 700-800 days. The technical data send back from the floats indicated a sudden loss of battery voltage to values of around 7 volt during the last profile and increased battery consumption during the previous cycles due to 'energy flue'. WEBB/TELEDYNE has replaced 47 floats in four batches (14 floats in 2014, 11 floats in 2015 and 9 floats in 2016, 13 floats in 2017/2018).

As has been reported in last year's national report the Canadian NOVA floats appear to have an extremely high early death rate. According to the analysis of the entire NOVA fleet in the Argo program the survival rate after 6 months was only 81%, i.e. 19% were lost in the first 6 months. In the smaller sample of 22 German NOVA floats 11 have died within the first year (<40 cycles) and 4 more before reaching 100 cycles. Additional to the high early failure rate the floats also show very noisy salinity profiles which have abundant spikes and inversion which are unstable in salinity.

One of our floats (6900876) has been found on a beach on the Faroe Islands (Fig.3). The photos show that the backscatter sensor (FLBB) is missing and the through-hull connector is broken. Water intrusion through the broken FLBB connector could have caused internal damage and additionally the hull shows damage to the yellow paint. The float was deployed in the eastern subpolar North Atlantic and drifted northward towards the Nordic Seas (Fig. 4). It crossed the shallow Wyville-Thompson Ridge into the Nordic Seas between cycles 140-150, which drained the alkaline batteries severely. But it survived for 40 more cycles and transmitted its last profile at cycle 190. The float is waiting for transport back to Germany and then to TWR which has agreed to perform a post-mortem.

Fig. 3: Photos of beached float 6900876.



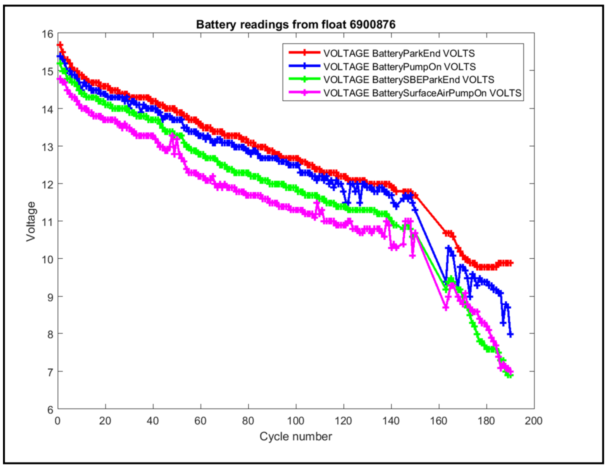


Fig. 4: Drift trajectory of float 6900876 (left) and battery readings (right).

- status of contributions to Argo data management (including status of conversion to V3 file formats, pressure corrections, etc.)

Germany has continued to work in the new European Research Infrastructure Consortium EURO-ARGO-ERIC which was established in July 2014 in Brussel by 9 founding countries (France, Germany, United Kingdom, Italy, Netherlands, Norway, Greece, Poland and Finland). GEOMAR and AWI are members of the EU-funded ATLANTOS project and will deploy deep-floats and bio-Argo floats within this project. Germany will be responsible in the framework of the MOCCA project (coordinated by the ERIC) for the delayed-mode quality control of the MOCCA floats in the Nordic Seas and subpolar gyre and contribute to the at-sea monitoring of the fleet. Within MOCCA an ice-algorithm will be developed for the Arctic ocean from a combination of quality controlled hydrographic data and ice-edge information. BSH is also looking at improvements of the real-time test for density inversion.

Germany has adopted a few (9) of the orphaned US Navy floats and has provided quality control for these floats. Germany is also acting as delayed mode quality control for European contributions from Denmark, Finland, Norway, the Netherlands and Poland.

Birgit Klein has taken on duties from Ann Thresher on the standardization of the technical files. This is an ongoing issue as more names will be required for new float models and sensors. This work is carried out in cooperation with John Gilson and Esmee van Wijk to ensure consistency to the meta-files.

- status of delayed mode quality control process

The delayed mode processing is distributed between the various German institutions contributing to Argo, depending on their area of expertise. The Alfred-Wegener Institute is responsible for the Southern Ocean and GEOMAR is processing floats with oxygen data. BSH is also processing the German/Finnish/Norwegian floats in the Nordic Sea, and is covering the tropical, subtropical and subpolar Atlantic. German floats in the Mediterranean on the other hand are processed by MEDARGO. The sharing of delayed-mode data processing will be continued in the coming years, but BSH will cover all German floats which have not been assigned to a PI.

All German institutions have been working in close collaboration with Coriolis and delayed mode data have been provided on a regular basis. Delays in delayed-mode data processing are still occurring at AWI due to changes in personal. The processing of the RAFOS information on the under ice floats needs reformatting of the files to file format 3.1 which is still underway and is coordinated between AWI and Coriolis. The intermediary RAFOS amplitudes and time-of-arrival will be stored in the in the aux-files directory until permanent solutions are found by ADMT. AWI has enhanced their decoders for the remaining NEMO floats to solve issues with the dating of under-ice profiles and has resubmitted these data to Coriolis. These files will then be transformed to file format 3.1.

The process of updating existing D-files to format 3.1 from reprocessed float files at Coriolis is ongoing for APEX floats and new decoders for NEMO and NOVA floats will hopefully be finished in 2018.

The DMQC process for German floats is continuing, and the frequency of delayed-mode visits has increased during 2017. The total number of available profiles from German floats is 66394 (February 12th, 2018), the number of DM profiles is 53225. The percentage of DM profiles with respect to the total number of profiles has increased from 81 % last year to about 87% in 2017. The main delays remain with the floats in the Southern Ocean processed by AWI, for the other float programmes managed by BSH the delayed mode is up to 93%. All delayed mode profiles have been sent to the Coriolis GDAC node.

2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.

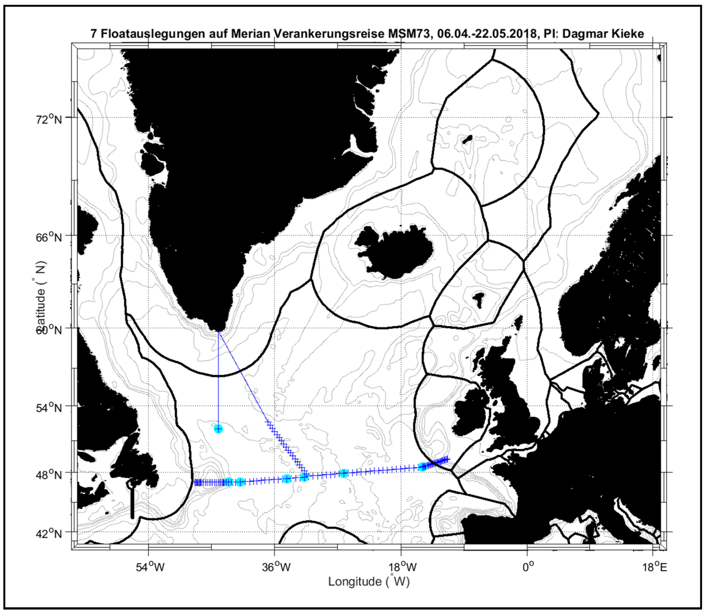
The present level of national funding for Argo has remained at flat levels during the last years, but we hope for an increase in funding in 2019 which would allow us to increase the number of floats purchased per year from ~35 back to 50 as originally envisioned. Negotiations with the ministry have been conducted during the last year and we have been asked to provide updated budget numbers for 2019 for the national budget negotiations.

Funding for complementary oxygen and ph-sensors has been provided by the science ministry (BMBF) and three floats equipped with these sensors will be deployed in the Labrador Sea in 2018.

At BSH staff connected to Argo (Birgit Klein, Jan-Hinrich Reissmann and Anja Schneehorst) has been increased in 2017 by an additional engineer (Simon Tewes) and cover now all activity areas from purchase, technical inspection, deployment, data quality control and representation in national and international teams. As part of our Euro-Argo activities Birgit Klein and Bernd Brügge are involved as management board and council members. Birgit Klein is until now also a member of the Scientific and Technical Advisory Group.

3. Summary of deployment plans (level of commitment, areas of float Deployment, low or high resolution profiles, Argo extensions) and other commitments to Argo (data management) for the upcoming year and beyond where possible.

Purpose is gapping filling in the Atlantic, main focus areas are southern ocean and gaps in the subtropical/subpolar areas from the priority list of the ERIC (see maps below). A maximum deployment of 60 floats is planned (Figs. 5-7), 23 from these have purchased in 2017 or are replacements from warranty settlements. The AWI is planning to deploy 15 ice-floats in the Weddell Gyre from a Polarstern cruise from 2018/2019. But all deployments in the Weddell Gyre will be performed in 2019 and are not part of this year's national report.



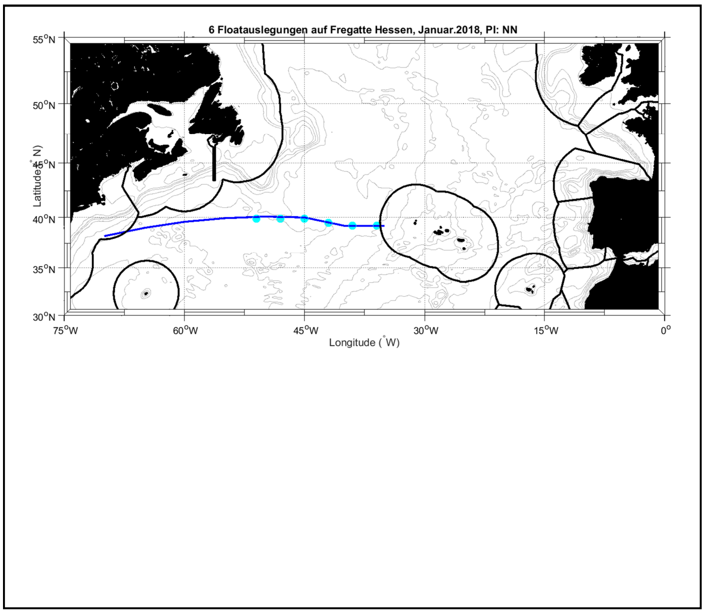


Fig.5: Planned deployments in the North Atlantic in 2018

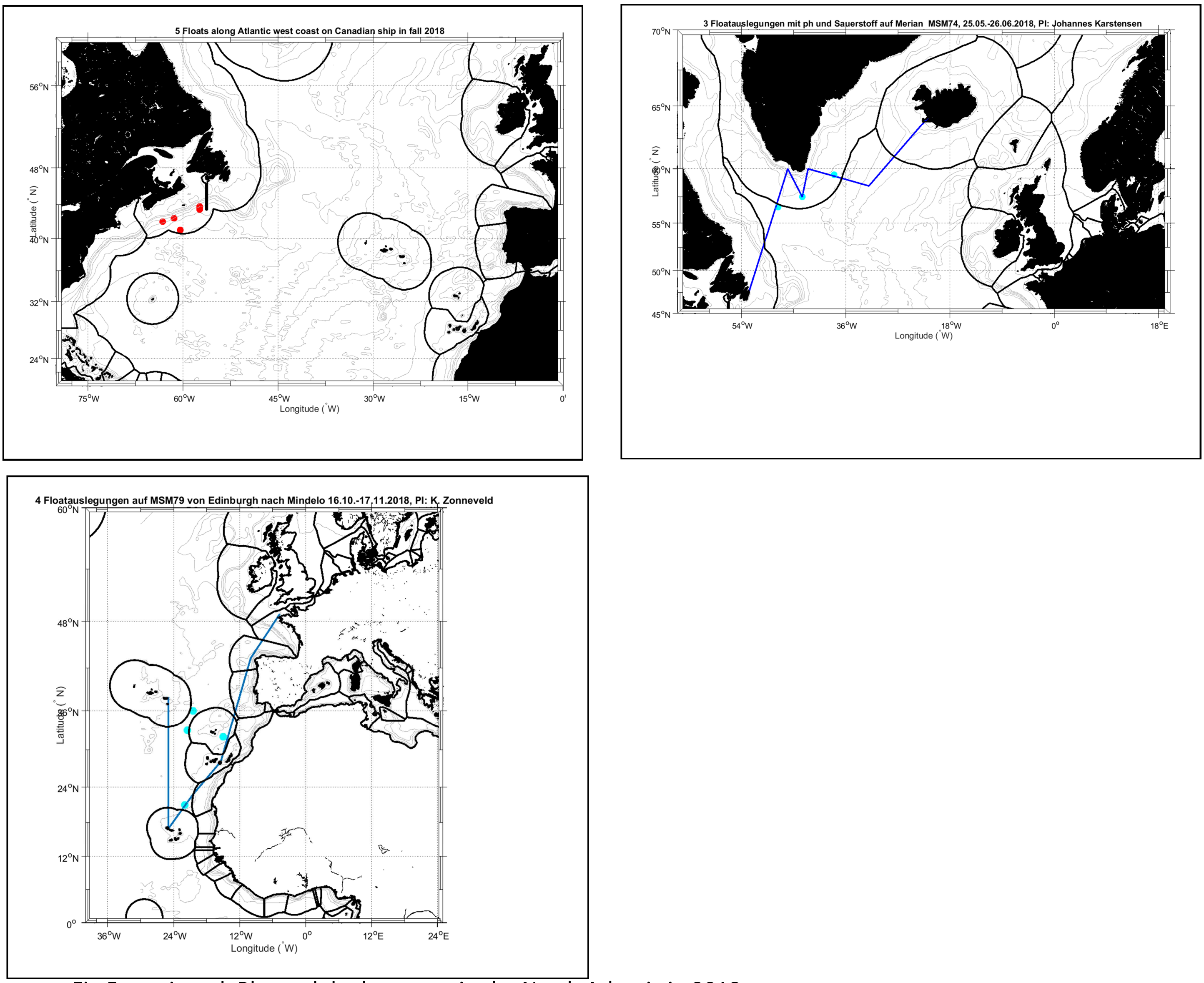


Fig.5 continued: Planned deployments in the North Atlantic in 2018

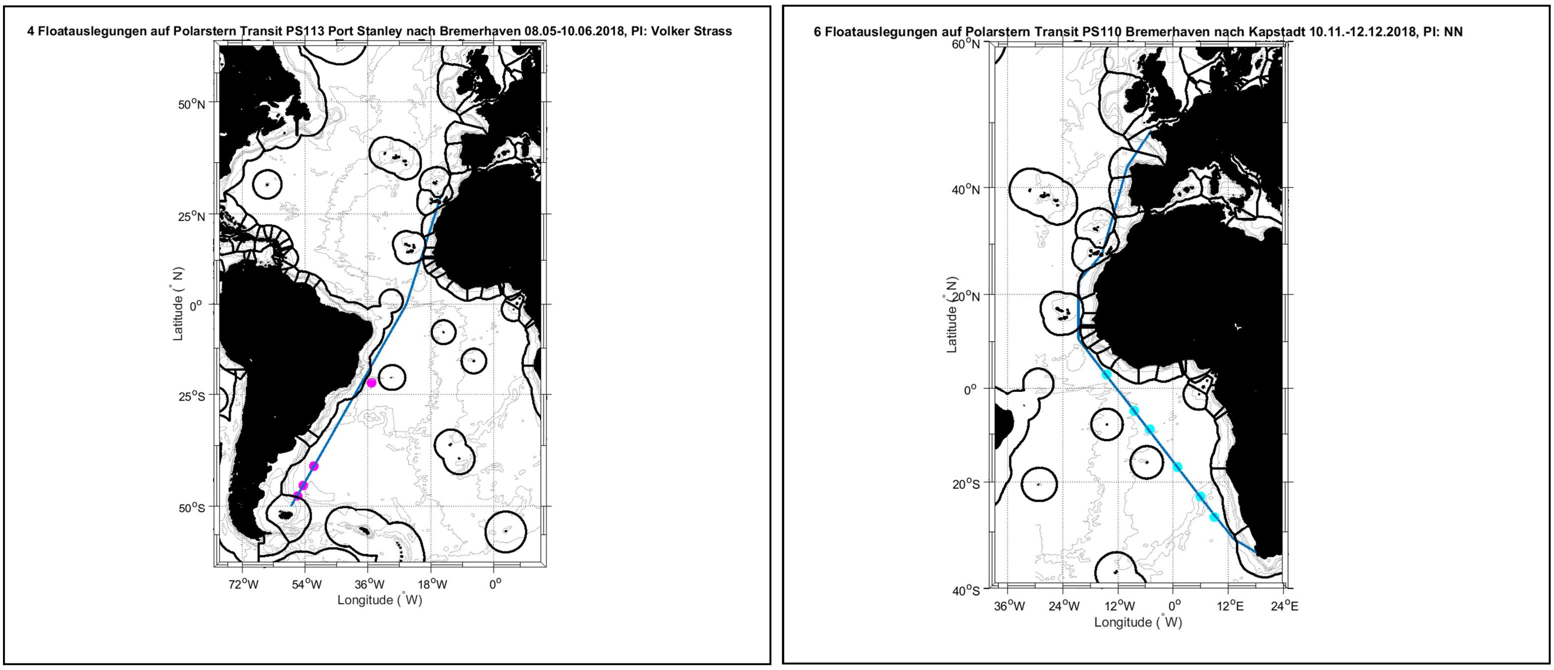
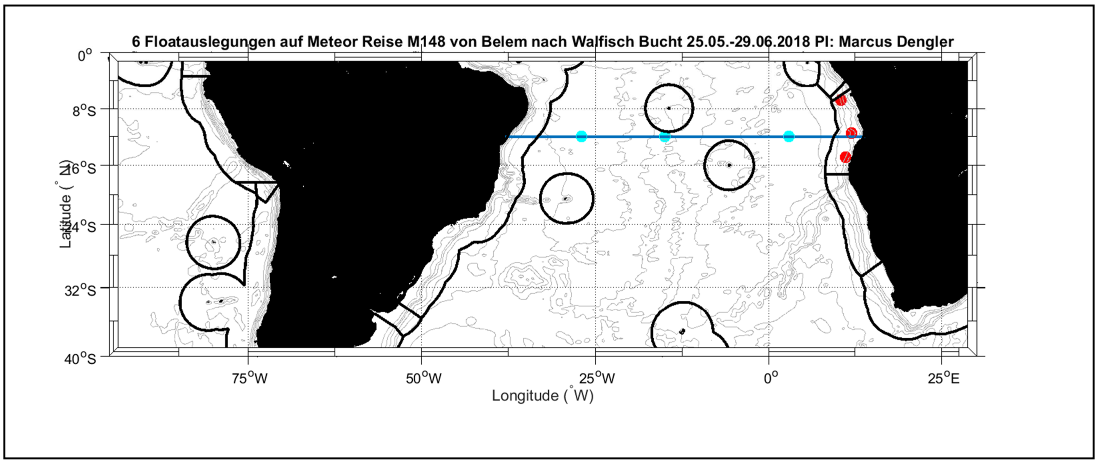


Fig. 6: Planned deployments in the South Atlantic in 2018



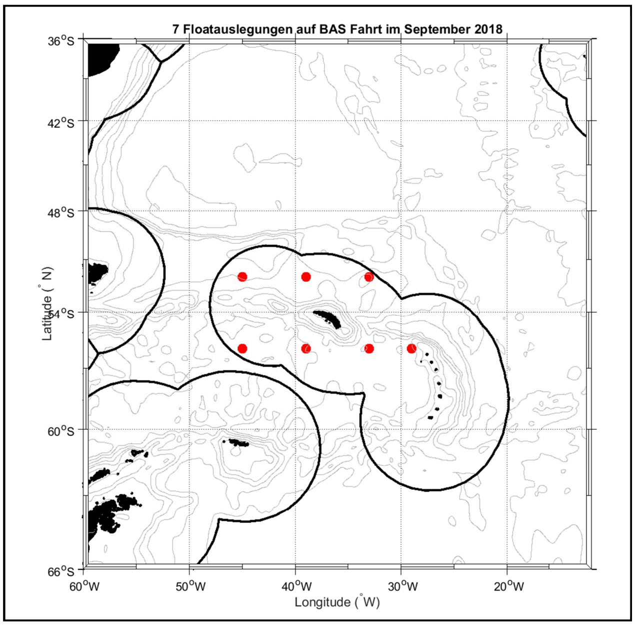
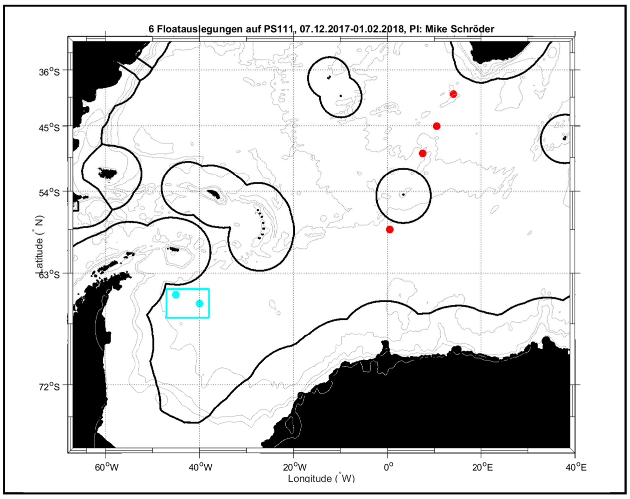


Fig. 6 continued: Planned deployments in the South Atlantic in 2018



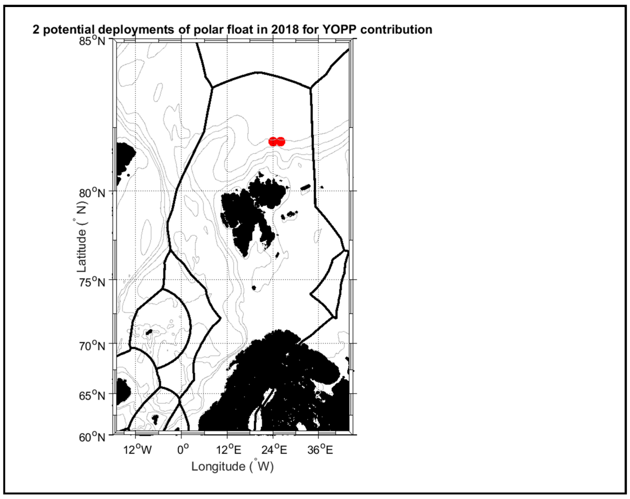


Fig. 7: Planned deployments in the ice covered areas

Summary of deployment plans by area and float type and sensor additions

Germany	2018							
Area	Total	T/S Core	T/S Ice	T/S/O2	BGC	Bio	Deep (4000m)	Abyssal (6000m)
Nordic Seas								
Mediterranean Sea								
Black Sea								
Baltic Sea								
Southern Ocean except Weddell								
Weddell Sea	2		2					
Arctic Ocean	2		2					
Global Ocean	52	49			3			
Unknown Area	4	4						
Total	60	53	4		3			

4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers. Please also include any links to national program Argo web pages to update links on the AST and AIC websites.

BSH is maintaining the Argo Germany Web site. The URL for the Argo Germany is:

http://www.german-argo.de/

It provides information about the international Argo Program, German contribution to Argo, Argo array status, data access and deployment plans. It also provides links to the original sources of information.

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. Argo data are routinely assimilated in the GECCO reanalysis, which is used for the initialisation the decadal prediction system MiKlip. At BSH the data are used within several projects such as KLIWAS, RACE, MiKlip, ICDC and Expertennetzwerk BMVI.

The user workshop held on 22.06.2016 at BSH and a follow-up is planned for June 2018.

A key aspect of the use of Argo data at BSH is to develop a data base for climate analysis, to provide operational products for interpretation of local changes and to provide data for research applications for BSH related projects (KLIWAS, RACE, MiKlip, ICDC and Expertennetzwerk BMVI).

Argo data are being used by many researchers in Germany to improve the understanding of ocean variability (e.g. circulation, heat storage and budget, and convection), climate monitoring and application in ocean models.

Germany contributes to the NAARC and also recently joined the SOARC. Researchers from German institutions have continued to contribute recent CTD data to the Argo climatology.

5. Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo. These might include tasks performed by the AIC, the coordination of activities at an international level and the performance of the Argo data system. If you have specific comments, please include them in your national report.

6. To continue improving the quality and quantity of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include any CTD station data that was taken at the time of float deployments this year. Additionally, please list CTD data (calibrated with bottle data) taken by your country in the past year that may be added to the reference database. These cruises could be ones designated for Argo calibration purposes only or could be cruises that are open to the public. To help CCHDO track down this data, please list the dates of the cruise and the PI to contact about the data.

A variety of CTD data sets from recent research groups were provided to Coriolis:

Merian cruises MSM 64 were provided by Uni Bremen and data from GEOMAR cruise M133.

7. Keeping the Argo bibliography (http://www.argo.ucsd.edu/Bibliography.html) up to date and accurate is an important part of the Argo website. This document helps demonstrate the value of Argo and can possibly help countries when applying for continued Argo funding. To help me with this effort, please include a list of all papers published by scientists within your country in the past year using Argo data, including non-English publications.

Breckenfelder, T., M. Rhein, A. Roessler, C. W. Böning, A. Biastoch, E. Behrens und C. Mertens (2017), Flow paths and variability of the North Atlantic Current: A comparison of observations and a high-resolution model. J. Geophys. Res., 122, 2686-2708, doi:10.1002/2016JC012444.

Müller, V., D. Kieke, P. G. Myers, C. Penelly und C. Mertens (2017), Temperature flux carried by individual eddies across 47°N in the Atlantic Ocean, J. Geophys. Res., 122, 2441-2464, doi:10.1002/2016JC012175.

Rhein, M., R. Steinfeldt, D. Kieke, I. Stendardo und I. Yashayaev (2017), Ventilation variability of Labrador Sea Water and its impact on oxygen and anthropogenic carbon, Phil. Trans. R. Soc. A, 375(2102), doi:10.1098/rsta.2016.0321.

Müller, M. (2017),Temperature and Freshwater Fluxes by Individual Eddies in the North Atlantic Ocean, PHD-thesis, Fachbereich für Physik und Elektrotechnik der Universität Bremen, 136 pages, 2017

Sanguineti, L. (2017), Labrador Sea Water exported through Flemish Pass: Hydrographic trends and transport variability inducing process, PHD-thesis, Fachbereich für Physik und Elektrotechnik der Universität Bremen, 164 pages

Breckenfelder, T.M. (2017), North Atlantic Current in model and observations: Transport variability, flow paths and hydrography, PHD-thesis, Fachbereich für Physik und Elektrotechnik der Universität Bremen 176 pages.

Reeve, K. , Boebel, O. , Kanzow, T. , Strass, V. , Rohardt, G. and Fahrbach, E. (2016), A gridded data set of upper-ocean hydrographic properties in the Weddell Gyre obtained by objective mapping of Argo float measurements, Earth System Science Data, 8 (1), pp. 15-40 , doi:10.5194/essd-8-15-2016

Ohde, T., Fiedler, B. und Körtzinger, A. (2015), Spatio-temporal distribution and transport of particulate matter in the eastern tropical North Atlantic observed by Argo floats. Deep-Sea Research Part I-Oceanographic Research Papers, 102 . pp. 26-42. DOI 10.1016/j.dsr.2015.04.007.

GREEK ARGO PROGRAMME

PRESENT STATUS AND FUTURE PLANS

G. Korres and D. Kassis
HCMR
March, 2018

1. Background and organization of GREEK ARGO activities

Greece established national contribution to the ARGO project through national funding to the Greek Argo programme (2012-2015). The programme was co-financed by Greece and the European Union.

1.1 Deployed floats

During 2017, 4 Argo floats were successfully deployed in the Greek Seas under the framework of the Greek Argo Programme and MOCCA projects. Three (3) of the floats were NOVA type and were purchased by the Greek Argo RI whilst, one (1) Arvor type float was deployed under the framework of MOCCA project. The floats were deployed by the Greek-Argo team in the North, Central and South Aegean basin. All floats integrate Iridium satellite telemetry system which provides a dual telecommunication capability allowing modification of the configuration in real-time. The first (WMO number: 6903278) was deployed on the 2nd of April 2017 at the Northern Aegean, near Athos Peninsula. Two days later, the second float (WMO: 3901890) was deployed 20 miles approximately towards south. On the 5th of April a third float (WMO: 6903279) was deployed in the Central Aegean, west of the Chios Island. On the next day (6/4/2017) the 4th float was deployed in the Cretan Sea. During 2017, 9 floats had been active however, 6 were still active by the end of the year since 3 terminated their operation. The deployments during 2017 are presented in Table 1:

Table 1. Deployments performed from Greek Argo team during 2017

A/A	Type	WMO	IMEI NUMBER	S/N	Deployment date	Deployment time	Latitude	Longitude	Acquired profiles by the end of 2017	Current Status
6	NOVA	6903278	300234063608400	273	2/4/2017	12:25	39,93	24,32	54	Active
7	ARVOR	3901890	300234063609200		4/4/2017	1:15	39,16	24,93	54	Active
8	NOVA	6903279	300234063606420	275	5/4/2017	0:10	38,33	25,00	54	Active
9	NOVA	6903280	300234063602410	272	6/4/2017	1:10	35,98	24,75	45	Inactive

All floats have been integrated in the MedArgo project. Taking into account the proposed sampling strategy for the Mediterranean Sea and the bathymetry of the deployment site and the adjacent areas, the mission parameters of the floats were set as follows: The parking depth of the floats was set to 350 m, its profiling depth to 1000 m and the cycle period to 5 days. The raw data of the Greek float are delivered at the Coriolis data Centre where the real time quality control takes place while the delayed mode quality control of the data will be processed by the MedArgo Centre at OGS. The 3901890 Arvor float is configured to alternate its profile depth between 700 and 1000 m.

1.2 Float Development

In 2013, HCMR has constructed an Argo float's detection system after the process of locating a float has been described and the various approaches have been indicated. A prototype active locator unit has been developed, and the principle of operation has been demonstrated. The unit has been tested successfully in land and at sea at the SIDERI workshop at 17-18 September 2013 that took place at Heraklion, Greece. The deck unit communicates via Bluetooth with any mobile phone which is used for interface and control. Future work includes the study of a pressure housing and antenna design. This activity was under the task of proposing and testing simple methods of tracking and recovery Argo floats in short time and range scales in the framework of SIDERI FP7 project.

1.3 Data management

HCMR has run an extended network of buoys within the Aegean and Ionian Seas including the multi-parametric M3A observatory of the Cretan Sea and a deep sea (2000 m) bottom platform deployed in the Ionian Sea (POSEIDON & POSEIDON-II monitoring, forecasting and information systems). HCMR also operates the Hellenic National Oceanographic Data Centre (HNODC) established in 1986, as part of the National Centre for Marine Research (NCMR). HNODC operates as a National Agency and is responsible for processing, archiving and distributing marine data. HNODC is also developing techniques for oceanographic data processing and data base maintenance. Furthermore it promotes the International Exchange of Data in the frame of its cooperation with the "Intergovernmental Oceanographic Commission IOC) of UNESCO as it is responsible for the coordination of International Data Exchange (IODE) in Greece. The HNODC manages a variety of oceanographic data and information collected by several Hellenic Marine Research Laboratories and in particular from the Institute of Oceanography of the Hellenic Centre for Marine Research-HCMR as well as from HNODC's participation in international projects (MTP-II MATER, MEDAR/MEDATLAS II, HUMBOLDT, SEADATANET). Moreover within the My Ocean project (GMES MCS) HCMR will consolidate and improve its in-situ data services for the Eastern Mediterranean region building on the capacity developed under POSEIDON, MFSTEP (coordination of M3A time-series network, analysis and provision of basin scale data), and MERSEA projects (coordination of Mediterranean in situ observations).

Delayed-mode data processing. HCMR has not developed yet a delayed-mode quality control capability for the Greek Argo data. The delayed mode quality control of the data delivered from the Greek Argo float will be processed by the MedArgo data centre. HCMR considers the possibility of developing delayed-mode data processing for ARGO profiles collected within the Eastern Mediterranean region. HCMR may also contribute to the improvement of the delayed mode quality control processing conceding CTD data collected through several HCMR research cruises. HCMR operates the Med Sea data portal that was set up for the needs of Copernicus CMEMS services. Within this framework HCMR is in charge of validating biochemical data from Argo floats that are operating in the Mediterranean.

1.4. Operational and scientific use of Argo data

A very important activity, in the frame of the Greek Euro-Argo programme (which will demonstrate the Argo value) is the development of the capabilities in order to exploit Argo data for operational forecasting as well as for research applications. Along this direction, HCMR established a network of relevant Greek scientific groups mainly from Universities and Research Institutes which constitute the Greek Argo Users group/network. These different groups are already using or will be using ARGO data in ocean/atmospheric forecasting, climate studies and for educational purposes. It is expected that the Greek Argo Users Group will further grow and expand its activities concerning the scientific exploitation of Argo data and the cooperation among Greek scientists. The next step will be the expansion of the Greek Argo network in more members. The network is already in contact with many organizations / agencies / institutions and it is foreseen that the establishment of the E-A ERIC will increase the interaction of the Greek Argo Users Group with the European and international ARGO scientific community in the near future.

Operational ocean forecasting:

Med-Argo data have been already used as independent data in order to assess the impact of remote sensed and Ferry-box SSS data assimilation into the Aegean Sea hydrodynamic model component of the POSEIDON system running operationally at HCMR within the framework of POSEIDON system.

Med-Argo data are routinely assimilated (using localized Singular Evolutive Extended Kalman filtering techniques) on a weekly basis in three different modelling forecasting components (Mediterranean $1/10^{o}$ resolution, Aegean Sea $1/130^{o}$ resolution and Ionian – Adriatic Sea at $1/50^{o}$ resolution) of the POSEIDON operational system.

Some of the results of the works described above are included in the following scientific publications:

Korres, G., K. Nittis, I. Hoteit, and G. Triantafyllou, 2009: A high resolution data assimilation system for the Aegean Sea hydrodynamics. *Journal of Marine Systems*, 77, 325-340.

Korres, G., K. Nittis, L. Perivoliotis, K. Tsiaras, A. Papadopoulos, I. Hoteit and G. Triantafyllou, 2010. Forecasting the Aegean Sea hydrodynamics within the POSEIDON-II operational system. *Journal of Operational Oceanography*, Vol. 3, nu. 1, 37-49,

Korres, G., K. Nittis, L. Perivoliotis, G. Triantafyllou and M. Chatzinaki, 2009. The Aegean Sea –Poseidon model. Hellenic Centre For Marine Research, Greece.

Korres, G., M. Ntoumas, M. Potiris and G. Petihakis, 2014. Assimilating Ferry Box data into the Aegean Sea model. Journal of Marine Systems, 140 (2014) 59–72

Ocean science

Med-Argo data are currently used by a small group of researchers in Greece for studies of water mass characteristics of the different deep basins of the Mediterranean Sea and as a continuous record of T/S characteristics providing insight in the seasonal and inter-annual variability of the Mediterranean Sea and its sub-basins. A number of publications and scientific results have been released regarding the Greek Argo acquired data during the last 4 years.

Publications in scientific journals and conferences proceedings:

Kassis, D., Korres, G., Konstantinidou, A., Perivoliotis, L., 2017. Comparison of high-resolution hydrodynamic model outputs with in situ Argo profiles in the Ionian Sea. Mediterranean Marine Science, 0, 22-37. doi:10.12681/mms.1753

Kassis, D., Korres, G., Perivoliotis, L., 2016. Sub-mesoscale features of the Eastern Ionian Sea as derived from Argo floats operating during 2014-2015, in: Submesoscale Processes: Mechanisms, Implications and New Frontiers. Presented at the 48th Liege Colloquium, University of Liege, Liege, Belgium.

Kassis, D., Krasakopoulou, E., Korres, G., Petihakis, G., Triantafyllou, G.S., 2016. Hydrodynamic features of the South Aegean Sea as derived from Argo T/S and dissolved oxygen profiles in the area. Ocean Dyn. 1–18. doi:10.1007/s10236-016-0987-2

Kassis, D., Korres, G., Petihakis, G., Perivoliotis, L., 2015. : Hydrodynamic variability of the Cretan Sea derived from Argo float profiles and multi-parametric buoy measurements during 2010–2012. Ocean Dynamics, 15-00058. doi: 10.1007/s10236-015-0892-0

Kassis, D., Konstantinidou, A., Perivoliotis, L., Korres, G., 2015. Inter-comparing numerical model simulations in the Ionian Sea with Argo T/S profiles for the period 2008-2012. In proceedings of the 11th Panhellenic Symposium on Oceanography and Fisheries, p.945-948, ISBN 978-960-9798-08-2

Kassis D., Perivoliotis L. & G. Korres, 2014. Greek Argo: Towards monitoring the Eastern Mediterranean - First deployments preliminary results and future planning. In proceedings of the 7th International Conference on EuroGOOS, Lisbon – Portugal, 28-30 October 2014

Scientific Sheets in Greek Argo web page:

"Use of Lagrangian methods in optimizing Argo float deployment locations in the Mediterranean Sea" Summary of the scientific report of the University of Aegean in the framework of the Greek Argo Project.

"The integration of Argo floats in numerical weather prediction" Summary of the scientific report of the Harokopio University in the framework of the Greek Argo Project.

"Use of Argo data in ocean numerical simulations" Summary of the scientific report of the Aristotle University of Thessaloniki in the framework of the Greek Argo Project.

"Evaluation of climate and biochemical models using Argo data" Summary of the scientific report of the University of Crete in the framework of the Greek Argo Project.

Scientific Sheets in Euro-Argo web page:

Kassis D., Konstantinidou A., Perivoliotis L. and Korres G., 2014: Comparison of Argo profiles observations against numerical model simulations in Ionian Sea. Euro Argo RI web page http://www.euro-argo.eu/Main-Achievements/European-Contributions/Science/Regional-Seas/Med-Black-Seas/

Kassis D. and Korres G., 2014: Hydrological variability derived from the first Argo mission in the Cretan Sea basin. Euro Argo RI web page http://www.euro-argo.eu/Main-Achievements/European-Contributions/Science/Regional-Seas/Med-Black-Seas/

Presentations in the EURO ARGO users meeting:

Kassis D., Von Schuckmann K., Korres G., 2013: Hydrographic properties of Cretan Sea derived from Argo float's profiles and buoy data measurements during 2010-2012. In proceedings of the 4th Euro-Argo Science Meeting and Workshop, June 2013, Southampton, UK http://www.euro-argo.eu/News-Meetings/Meetings/Users-Meetings/4th-Users-meeting-June-2013

Kassis, D., Perivoliotis, L., Korres, G., 2015: Hydrological variability of the Eastern Ionian and Adriatic Seas derived from two new Argo missions in 2014. In proceedings of the 5th Euro-Argo User Workshop - Brest, March 16-17 2015 http://www.euro-argo.eu/News-Meetings/Meetings/Users-Meetings/5th-User-Workshop-March-2015/Workshop-Programme

Additionally, Argo data are used for educational purposes in some Greek University Departments. Due to HCMR initiatives within Euro Argo, Greek Argo and SIDERI programmes to contact potentially interested Greek and other scientists from the eastern Mediterranean region and inform them about the benefits of Argo programme. An increasing demand for Argo data along the Aegean and Ionian Sea for both scientific and educational purposes has been registered. Furthermore, a presentation of Greek Argo and Euro-Argo activities was made at the University of Aegean (Marine Sciences department) in November 2016.

2. Funding

2.1 Existing funding for Greek Argo

Currently there is no existing funding for the Greek Argo. The procurement, deployment and operation costs of the first Greek float launched in 2010/2011 were covered by HCMR internal funds. During 2012, Greece established national funding to the Greek Argo programme through the General Secretariat of Research and Technology (GSRT), Ministry of Education, Lifelong Learning and Religious Affairs (funding agency). A major achievement is that Greece participates to the European infrastructure E-A ERIC as a full member.

2.2 On the future funding, organization and planning for Greek Argo

As part of the Euro-Argo, HCMR has undertaken all necessary efforts and managed to establish long term national funding for the E-A ERIC infrastructure and to meet the standards of a full member. Regarding the Greek Argo RI annual contribution to Euro-Argo RI an indicative estimation is the following:

Personnel committed/dedicated to Euro-Argo activities (man months/year):

- National representation, member commitments: 2.5
- Float preparation, deployment, procurement: 1

Personnel committed/dedicated to Greek-Argo activities (man months/year):

- Greek Argo coordination and management: 3
- Float preparation, deployment, procurement, fleet operation and data monitoring: 4.5

Greece has deployment capabilities for the Aegean, the Ionian Sea and the central Levantine basin. Float deployments in 2018 will be performed according to the plans of the Greek-Argo research infrastructure. The main goal within 2018 is to continue the development of the Greek-Argo infrastructure array in accordance with the Euro-Argo infrastructure. Future deployments are a function of the operational needs of the Greek Argo network and the current coverage of areas of interest. Although the final decisions for the areas that floats will be deployed may change, the plan for 2018 generally includes:

- 1 float deployment in the South Aegean (where Myrtoan and Cretan Sea meet)-one of which will concern a DOVA Argo float (equipped with dissolved oxygen sensor)
- 1 float deployment in the North Aegean
- 1 float deployment in the Ionian Sea
- 1 float deployment in the Levantine Sea

3. Dissemination activities of the Greek Argo– links with Euro-Argo infrastructure

Within 2017 several dissemination activities were carried out by the Greek Argo RI. Under the framework of the 1st Ocean Observers Meeting (June 2017) Greek Argo presented its educational and outreach activities whilst, during the 6th Euro-Argo Users Workshop (July 2017) the Greek Argo Infrastructure activities and achievements were presented.
By the end of 2013 Greek Argo has launched its web page: www.greekargo.gr that demonstrates and promotes Greek-Argo and Euro-Argo activities. At the end of 2014 Greek-Argo web portal was upgraded providing information and data access from all floats operating in the Mediterranean and presenting all Greek Argo activities, news and data from Greek Argo floats. A continuous upgrade is ongoing integrating more images and videos from Greek Argo deployment activities. Furthermore, new education material has been released and a school visit programme has been established since 2015.
The Euro-Argo infrastructure is also demonstrated on the POSEIDON updated web page, http://www.poseidon.hcmr.gr/article_view.php?id=57&cid=28&bc=28. The POSEIDON system is the operational monitoring and forecasting system for the Greek Seas and many of its forecasting components use T/S Argo profiles for data assimilation purposes. The POSEIDON web page is also hosting the links to the EuroArgo educational web site as well as to the floats from each European country. The above links along with other informative material (Euro Argo leaflet, focused questionnaire) were forwarded directly to all active and potential users of Argo data in Greece. Many research groups filled and sent back the questionnaire providing valuable feedback to HCMR team. Furthermore, the EuroArgo poster and leaflet translated in Greek and they are hosted in the POSEIDON website.

National report of India (2017)

(Submitted by E. Pattabhi Rama Rao)

1. The status of implementation

1.1a Floats deployment

During the year 2017, 32 floats were deployed in the Indian Ocean, taking the total to 438. The new deployment includes 9 Bio-Argo floats with additional sensors like Doxy, FLBB, Chl-a and 1 EM Float.

1.1b Performance Analysis of Floats deployed

Out of 438 floats deployed so far 147 floats are active. Out of these 147 active floats, the life of the floats are listed below:

6 Years	5 Years	4 Years	3 Years	2 Years	1 Year	< 1 Year	TOTAL
31	3	2	33	22	30	26	147

1.2 Technical problems encountered and solved

None

1.3 Status of contributions to Argo data management

- **Data acquired from floats**

  India had deployed 438 floats so far. Out of these 147 floats are active. All the active floats data are processed and sent to GDAC.

- **Data issued to GTS**

  TESAC and BUFR format messages from these floats are being sent to GTS via New Delhi RTH.

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

  All the active floats (147) data are subject to real time quality control and are being sent to GDAC.

- **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.

- **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. The demand for Bio-Argo data is increasing and the same is being supplied for research interest by various research institutes and universities. These data is also used for validation of Biogeochemical model outputs like ROMS with Fennel module.

INCOIS Argo web page statistics during the year 2017 are as shown below:

Page	Number
Argo Web Page Vies	53070
Visitors	2871

Products generated from Argo data

- 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.
- Version 2.2 of DVD on "Argo data and products for the Indian Ocean" is released to public for use with data corresponding to August 2017 updated. This DVD consists of ~ 3,00,000 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.
- 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.

1.4 Status of Delayed Mode Quality Control process

- INCOIS started generating and uploading D files to GDAC from July 2006, and as of today, profiles belonging to all eligible floats have been subjected to DMQC.
- Advanced Delayed Mode Quality Control s/w developed by CSIRO is being put to use successfully. Using this s/w all the eligible floats are reprocessed to tackle pressure sensor offset problems, salinity hooks, thermal lag corrections, salinity drifts.
- 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 51% 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.

1.5 Trajectory files status:

A total of 408 trajectory netcdf files were processed and uploaded to the GDAC. The process of generation of trajectory netcdf files undergoes quality checks like position, time, cycle number, etc., and corresponding quality status is assigned to each parameter. Trajectory files in Ver 3.1 format for all APEX floats is being uploaded to GDAC and trajectories wrt to PROVOR floats need to generated.

2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.

Indian Argo Project is fully funded by Ministry of Earth Sciences, (MoES), Govt. of India. Funding is secured for the deployment of 50 Argo floats per year including (3:2 Normal and

Bio), Data management activities, Data analysis, etc. for the period 2017-2020. India plans to deploy 50 floats/per (40 tropical Indian Ocean and 10 in the Southern ocean).

Three Permanent and one temporary scientific/technical personnel are working under Indian Argo project, which include personal for deployment of Argo floats, Data system, Analysis of Data, etc.

3. Summary of deployment plans (level of commitment, areas of float deployment) and other commitments to Argo (data management) for the upcoming year and beyond where possible.

India is committed to deploy floats in the Indian Ocean wherever gap exists. India has committed 50 floats per year during 2017-2020 (40 in the Tropical Indian Ocean and 10 in the Southern ocean). Out of 50 floats, 20 floats will be bio-argo floats. After ascertaining the gap region and cruise plan of MoES research vessels, these floats will be deployed. The existing data management resources will continue until 2020.

4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers.

Operational: All Argo data are being routinely assimilated in Ocean Model for providing Global ocean analysis. This analysis is being used by Indian MET department for initialization of coupled ocean-atmosphere forecast of the Monsoon. From the year 2011, India is providing seasonal forecast of monsoon using dynamical model wherein Ocean analysis (with assimilation of Argo) is an important contribution. The analysis products are being made available through INCOIS live access server (las.incois.gov.in).

Research: Argo data are being widely used for many applications to understand the Indian Ocean dynamics, cyclone and monsoon system in relation to heat content, thermostericcomponent of sea level and validation of OGCM by various Indian institutions and university students.

Argo Regional Centre (ARC) - Indian Ocean

(http://www.incois.gov.in/argo/ARDCenter.jsp)

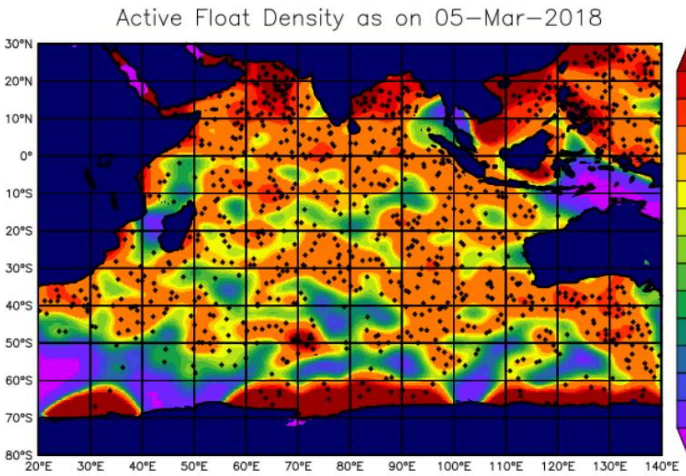
- Acquisition of Argo data from GDAC corresponding to floats other than deployed by India and made them available on INCOIS web site.
- All these data sets are made available to the user through a s/w developed with all GUI facilities. This s/w is made available through FTP at INCOIS and UCSC web sites.
- 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.
- Efforts are underway to setup ERDDAP for the data and data products 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

2. Regional Co-ordination for Argo floats deployment plan for Indian Ocean. The float density in Indian Ocean as on 05 Mar 2018 is shown below.



5. Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo. These might include tasks performed by the AIC, the coordination of activities at an international level and the performance of the Argo data system. If you have specific comments, please include them in your national report.

None

6. To continue improving the quality and quantity of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include any CTD station data that was taken at the time of float deployments this year. Additionally, please list CTD data (calibrated with bottle data) taken by your country in the past year that may be added to the reference database. These cruises could be ones designated for Argo calibration purposes only or could be cruises that are open to the public. To help CCHDO track down this data, please list the dates of the cruise and the PI to contact about the data.

All the CTD data (1832 Profiles) outside EEZ were submitted to CCHDO for adding to the reference database.

7. Argo bibliography

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. Quality control of oceanographic in situ data from Argo floats using climatological convex hulls, TVS Udaya Bhaskar, R Venkat Shesu, Timothy P Boyer, E Pattabhi Rama Rao, MethodX, Vol 4, 469 - 479, doi: 10.1016/j.mex.2017.11.007

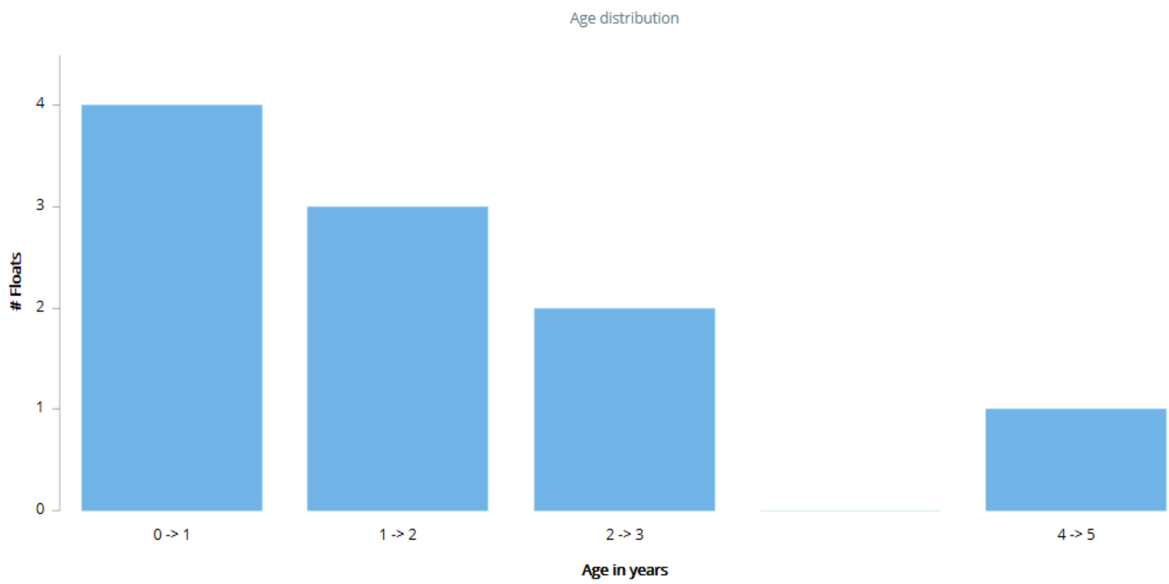
2. Chacko, N., 2017: Chlorophyll bloom in response to tropical cyclone Hudhud in the Bay of Bengal: Bio-Argo subsurface observations. Deep Sea Research Part I: Oceanographic Research Papers, 124, 66-72, http://dx.doi.org/10.1016/j.dsr.2017.04.010.
3. Chakraborty, K., N. Kumar, and G. V. M. Gupta, 2017: Getting the right wind-forcing for an ecosystem model: A case study from the eastern Arabian Sea. Journal of Operational Oceanography, 10, 176-190, http://dx.doi.org/10.1080/1755876X.2017.1354686
4. Chand, C. P., M. V. Rao, B. Prasad Kumar, and K. H. Rao, 2017: Influence of cyclone Phailin on the Upper Ocean over Bay of Bengal. International Journal of Applied Environmental Sciences, 12, 717-729, http://www.ripublication.com/ijaes17/ijaesv12n5_01.pdf
5. Ghosh, S., S. Hazra, S. Nandy, P. P. Mondal, T. Watham, and S. P. S. Kushwaha, 2017: Trends of sea level in the Bay of Bengal using altimetry and other complementary techniques. Journal of Spatial Science, 1-14, http://dx.doi.org/10.1080/14498596.2017.1348309.
6. Gordon, A. L., E. Shroyer, and V. S. N. Murty, 2017: An Intrathermocline Eddy and a tropical cyclone in the Bay of Bengal. Scientific Reports, 7, 46218, http://dx.doi.org/10.1038/srep46218
7. Jain, V., D. Shankar, P. N. Vinayachandran, A. Kankonkar, A. Chatterjee, P. Amol, A. M. Almeida, G. S. Michael, A. Mukherjee, M. Chatterjee, R. Fernandes, R. Luis, A. Kamble, A. K. Hegde, S. Chatterjee, U. Das, and C. P. Neema, 2017: Evidence for the existence of Persian Gulf Water and Red Sea Water in the Bay of Bengal. Climate Dynamics, 48, 3207-3226, https://doi.org/10.1007/s00382-016-3259-4.
8. Narvekar, J., J. R. D'Mello, S. Prasanna Kumar, P. Banerjee, V. Sharma, and P. Shenai-Tirodkar, 2017: Winter-time variability of the eastern Arabian Sea: A comparison between 2003 and 2013. Geophysical Research Letters, 44, 6269-6277, http://dx.doi.org/10.1002/2017GL072965.

Argo National Report 2017: Ireland

1) The status of implementation (major achievements and any issues in 2017):

   a) Irish Argo float Overview

   2017 has seen Ireland deploy 3 core T&S Argo profiling floats as well as the procurement of Ireland's first biogeochemical (BGC) profiling float. Throughout 2017 the Marine Institute has seen 3 floats (deployed in 2011 and 2012) return a status of 'inactive' however, considering the lifespan of these floats was 5-6 years they demonstrated considerable longevity while sampling at sea. 2017 also seen the procurement of floats via a Euro-Argo ERIC centralised tender which proved significantly useful, both in terms of time and value for money.



***Above**: Age distribution of all operational and registered Irish Argo profiling floats in 2017 (including registered floats for 2018 deployment)*

2018 should see the Irish fleet increase to a total of 13-14 floats (depending on deployment weather windows, vessel accessibility etc.) which would be an all-time high number of profiling floats within the Irish fleet. The planned deployment of a BGC float in 2018 will also add considerably to the amount of data as well as research capabilities within the Irish Argo fleet.

ARGO: Marine Institute Operational & Stock ARGO Floats (as of: 30/01/2018)					
Deployed / Operational ARGO Floats (as of: 30/01/2018)					
# of Floats	WMO (Global Identifier) #	Float Identifier #	Make/Model	Deployed	Status
1	6900444		NKE/AVOR	08/03/2011	Inactive 2017
2	6900658		NKE/AVOR	07/03/2011	Inactive 2017
3	6901913		NKE/AVOR	06/09/2012	Inactive 2017
4	6901914		NKE/AVOR	26/03/2013	Operational
5	6901919	7244	Teledyne/Apex	22/03/2015	Operational
6	6901920	7245	Teledyne/Apex	22/04/2015	Operational
7	6901921	7243	Teledyne/Apex	23/03/2016	Operational
8	6901922	7242	Teledyne/Apex	14/04/2016	Operational
9	6901923	7241	Teledyne/Apex	09/04/2016	Operational
10	6901924	7240	Teledyne/Apex	10/02/2017	Operational
11	6901925	7841	Teledyne/Apex	11/02/2017	Operational
12	6901926	7842	Teledyne/Apex	20/05/2017	Operational
Argo floats to be deployed in 2018					
# of Floats	WMO (Global Identifier) #	Float Identifier #	Make/Model	Deployed	
1	6901927	7843	Teledyne/Apex	TBC ~February 2018	
2	6901928	7844	Teledyne/Apex	TBC ~February 2018	
3	6901929	300234065961200	NKE/ARVOR	TBC ~February 2018	
4	6901930	300234065968220	NKE/ARVOR	TBC ~February 2018	
ARGO Floats Awaiting Deployment (in stock)					
# of Floats	WMO (Global Identifier) #	Float Identifier (IMEI) #	Make/Model	Deployed	
1	TBC	300234065967210	NKE/ARVOR	TBC throughout 2019	
2	TBC	300234065151700	NKE/ARVOR	TBC throughout 2019	
3*	TBC*		TWR Apex BGC	TBC throughout 2018	

**Designates the procurement of Ireland's first biogeochemical Argo profiling float*

b) Irish floats deployed in 2017 and their performance

WMO (Global Identifier) #	Float Identifier #	Make/Model	Deployed
6901924	7240	Teledyne/Apex	10/02/2017
6901925	7841	Teledyne/Apex	11/02/2017
6901926	7842	Teledyne/Apex	20/05/2017

All floats are reporting their data and performing to specification. No problems to report from floats deployed during 2017.

c) Technical problems encountered and solved
None

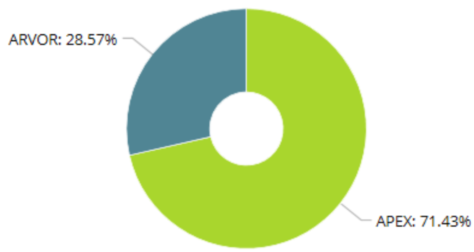
d) Status of contributions to Argo data management (including status of conversion to V3 file formats, pressure corrections, etc.)

Carried out by BODC for the Marine Institute (Ireland).

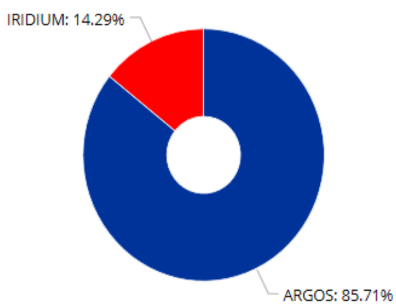
e) **Status of delayed mode quality control process**
Carried out by BODC for the Marine Institute (Ireland).

2) **Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.**
Ireland is now an established member of the Euro-Argo ERIC and will comply with the minimum requirement of deploying 3 floats per annum. Ireland via the Marine Institute will deploy additional floats where funding allows and will also assist the ERIC in deploying project specific floats where appropriate e.g. The MI deployed an additional float in 2016 via the EU funded MOCCA project.

3) **Summary of deployment plans (level of commitment, areas of float Deployment, low or high resolution profiles, extra sensors, Deep Argo) and other commitments to Argo (data management) for the upcoming year and beyond where possible.**
It is our goal to ensure a minimum of three core T&S floats will be deployed during 2018 in alignment with the requirements of the Euro Argo ERIC. Multi-annual funding for the programme remains elusive but efforts continue towards that end on the national level. Float procurement via the Euro-Argo ERIC may allow for an increased number of floats to be procured.



Right (Top): Illustrating the breakdown of Irish floats via the manufacturer (type) of float deployed (this includes 2018 registered floats (2 x NKE and 2 x Teledyne Webb). With NKE being the Euro-Argo ERIC tender winning bid, Ireland should see the number of NKE deployed floats increase over the coming years.



***Right (Bottom):** Graph showing the number if Irish floats using ARGOS or Iridium communications (including floats registered for deployment in 2018). With floats procured via Euro-Argo ERIC having Iridium communication systems the number of Irish floats with iridium communications will increase over the coming years.*

4) **Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centres. Please also include any links to national program Argo web pages to update links on the AST and AIC websites.**
Argo data is primarily used to validate ROMS models in the Oceanographic Services section of the Marine Institute. Argo data will also be utilised by a number of PhD students within the Marine Institute and 3rd level institutes across Ireland. Irish deployed Argo float data may also be used by researchers on an international level as all data is open and freely available.

Irish Argo National Webpage (hosted by the Marine Institute):
https://www.marine.ie/Home/site-area/areas-activity/oceanography/euro-argo

Irish Argo Float Data*:
https://www.digitalocean.ie/
*May not visualise correctly via Internet Explorer web browser

5) **Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo. These might include tasks performed by the AIC, the coordination of activities at an international level and the performance of the Argo data system. If you have specific comments, please include them in your national report.**
N/A. Any issues can be dealt with via the Euro-Argo ERIC office.

6) **To continue improving the quality and quantity of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include any CTD station data that was taken at the time of float deployments this year. Additionally, please list CTD data (calibrated with bottle data) taken by your country in the past year that may be added to the reference database. These cruises could be ones designated for Argo calibration purposes only or could be cruises that are open to the public. To help CCHDO track down this data, please list the dates of the cruise and the PI to contact about the data.**
No CTD data are uploaded to the CCHDO website. However, all CTD data are emailed to Else Juul Green (else@ices.dk) who checks the data before it is uploaded to the ICES Oceanographic data portal annually:
http://ocean.ices.dk/HydChem/HydChem.aspx?plot=yes

7) **Keeping the Argo bibliography (http://www.argo.ucsd.edu/Bibliography.html) up to date and accurate is an important part of the Argo website. This document helps demonstrate the value of Argo and can possibly help countries when applying for continued Argo funding. We reached more than 2000 papers published using Argo data! To help me with this effort, please include a list of all papers published by scientists within your country in the past year using Argo data, including non-English publications.**
N/A although anticipated during 2018.

Report on the Italian Argo Program for 2017

1. The status of implementation (major achievements and problems in 2017).

- floats deployed and their performance:

In total, **27 Italian floats** were deployed in 2017 (see Tables 1 and 2 for details). These floats were Arvor-L, Arvor-I and Arvor-Ice designs manufactured by NKE (France), Apex floats produced by Teledyne Webb Research (USA) and Nova/Dova profilers manufactured by MetOcean (Canada). The majority of the floats transmit data via Iridium telemetry (Arvor-I, Arvor-Ice, Nova/Dova) and some have Argos telemetry (Apex and Arvor-L).

Mediterranean and Black Sea deployments

Two floats were deployed in the Black Sea and 8 units were released in the Mediterranean (Table 1). In the Mediterranean, all floats have a parking depth at 350 dbar and maximal profiling depths alternating at 700 and 2000 dbar. In the Black Sea, the parking depth was set to 200 dbar. They all have cycles of 5 days.

Most floats were deployed from research vessels of opportunity (i.e., R/V Beautemps-Beaupré, R/V Minerva I, R/V Medexplorer for the Mediterranean and R/V Akademic for the Black Sea) with the help of colleagues from France, Italy, Israel and Bulgaria. In the framework of the International Seakeepers Society (http://www.seakeepers.org/), two floats were deployed in the Tyrrhenian and Ionian seas from the maxi-yatch Exuma.

Model	WMO	Argos	Deploy Date	Lat	Lon	Cycles	Last TX Date	Lat	Lon	Status*	Cycle**
Arvor-I	3901907		21/01/2017 13:53	37,49	6,48	70	08/01/2018 03:14	39,22	6,38	A	5
Arvor-I	3901908		25/01/2017 15:51	34,50	20,25	69	07/01/2018 21:10	32,68	24,01	A	5
Nova	6903221		07/02/2017 10:20	32,34	34,23	69	12/11/2017 03:32	34,20	35,34	D	5
Dova	6903222		07/02/2017 13:32	32,51	33,68	75	27/12/2017 02:50	32,06	34,21	A	5
Apex	6903202	133511	30/03/2017 12:56	42,20	10,83	10	16/05/2017 04:18	42,26	11,05	D	5
Dova	6903225		23/05/2017 18:25	39,42	14,63	47	08/01/2018 04:14	39,80	15,10	A	5
Arvor-L	6903224	114256	10/06/2017 11:15	38,52	20,16	74	08/01/2018 14:21	38,62	18,27	A	5
Dova	**6903226**		**11/10/2017 07:50**	**43,16**	**29,00**	**0**	**14/11/2017 18:41**	**42,83**	**31,88**	**AS**	**5**
Nova	**6903228**		**20/10/2017 18:49**	**43,41**	**29,52**	**9**	**04/12/2017 03:12**	**41,81**	**28,74**	**A**	**5**
Arvor-I	6903227		19/11/2017 07:09	40,59	11,76	10	04/01/2018 23:49	40,90	11,03	A	5

**Status in early January 2018: A = active, D = dead; AS = active but drifting at surface.*
***Cycle: Length of cycle in days.*

Table 1. Status information for the 10 Italian floats deployed in the Mediterranean and Black Sea (bold) during 2017.

South Atlantic, South Pacific and Southern Ocean

Ten Italian floats were deployed in the South Pacific Ocean and the Pacific sector of the Southern Ocean (Table 2) with the help of Italian colleagues onboard the R/V Italica while sailing from New Zealand to the Ross Sea. These floats included 7 Nova and 3 Arvor-Ice floats. The Arvor-Ice uses an Ice Sensing Algorithm (ISA) based on temperature readings to abort surfacing when sea ice is present at the sea surface (Pacciaroni et al., 2017). All the floats were programmed to cycle between the surface and 2000 dbar every 10 days and to drift at the parking depth of 1000 dbar. Nine of these 10 floats were still active in early 2018.

Five Italian floats were also deployed in the South Atlantic Ocean (Table 2) with the help of Italian colleagues onboard the R/V Agulhas II. These floats were all Nova instruments. All the floats were programmed to cycle between the surface and 2000 dbar every 10 days and to drift at the parking depth of 1000 dbar. They were all still active in early 2018.

Two Arvor-Ice were also deployed from R/V OGS Explora south of Tasmania (WMO 6903214 & 6903215) in January 2017.

Some of the Arvor-Ice floats (WMO 6903211, 6903212 and 6903213) drifted in areas with a weak presence of surface ice in August. However it appears that the ISA did not prevent the float to perform their usual surfacing (Pacciaroni et al., 2017).

Model	WMO	Deploy Date	Lat	Lon	Cycles	Last Date	Lat	Lon	Status*	Cycle**
Nova	6903208	02/01/2017 03:57	-55,03	175,50	39	07/01/2018 04:53	-51,78	-169,58	A	10
Nova	6903209	02/01/2017 10:05	-56,04	175,77	39	07/01/2018 04:50	-52,00	-174,41	A	10
Nova	6903207	02/01/2017 15:38	-57,02	176,11	38	07/01/2018 04:46	-52,00	-157,99	A	10
Nova	6903206	02/01/2017 21:20	-58,04	176,40	8	03/03/2017 04:50	-58,19	179,14	D	10
Nova	6903210	03/01/2017 02:05	-59,02	176,75	39	08/01/2018 04:51	-57,95	-163,22	A	10
Nova	6903205	03/01/2017 07:12	-60,03	177,07	39	08/01/2018 04:51	-58,53	-167,02	A	10
Arvor-ICE	6903213	03/01/2017 11:52	-61,03	177,26	39	10/01/2018 05:48	-61,98	-172,13	A	10
Arvor-ICE	6903211	03/01/2017 16:41	-62,04	177,58	38	04/01/2018 05:45	-59,83	-171,51	A	10
Arvor-ICE	6903212	03/01/2017 21:35	-63,05	177,93	38	10/01/2018 05:55	-63,25	-173,19	A	10
Arvor-ICE	6903214	22/01/2017 06:22	-48,01	149,23	37	09/01/2018 05:15	-46,65	138,35	A	10
Arvor-ICE	6903215	23/01/2017 07:04	-52,37	148,95	37	10/01/2018 05:35	-48,30	157,80	A	10
Nova	6903216	28/01/2017 07:36	-54,00	-30,99	36	03/01/2018 04:49	-55,91	-16,80	A	10
Nova	6903217	30/01/2017 14:33	-54,00	-9,00	36	05/01/2018 04:59	-53,26	-8,68	A	10
Nova	6903218	31/01/2017 10:08	-54,00	-9,00	35	06/01/2018 04:39	-54,89	-0,56	A	10
Nova	6903220	31/01/2017 19:06	-52,00	0,01	35	06/01/2018 04:50	-51,84	30,78	A	10
Nova	6903219	01/02/2017 05:20	-50,00	1,54	36	07/01/2018 05:04	-49,36	26,50	A	10
Nova	6903223	19/02/2017 04:27	-54,01	173,00	33	05/01/2018 04:51	-53,90	-178,40	A	10

**Status in early January 2017: A = active, D = dead.*
***Cycle: Length of cycle in days.*

Table 2. Status information for the 17 Italian floats deployed in the Southern Ocean, South Atlantic and South Pacific during 2017.

Overall status at the end of 2017

In summary, at the end of 2017, the Italian Argo program had a total of 68 active floats, including 32 instruments in the Mediterranean Sea, 7 in the Black Sea (Figure 1) and 29 in the South Pacific, South Atlantic and Southern Ocean (south of 60˚S) (Figure 2).

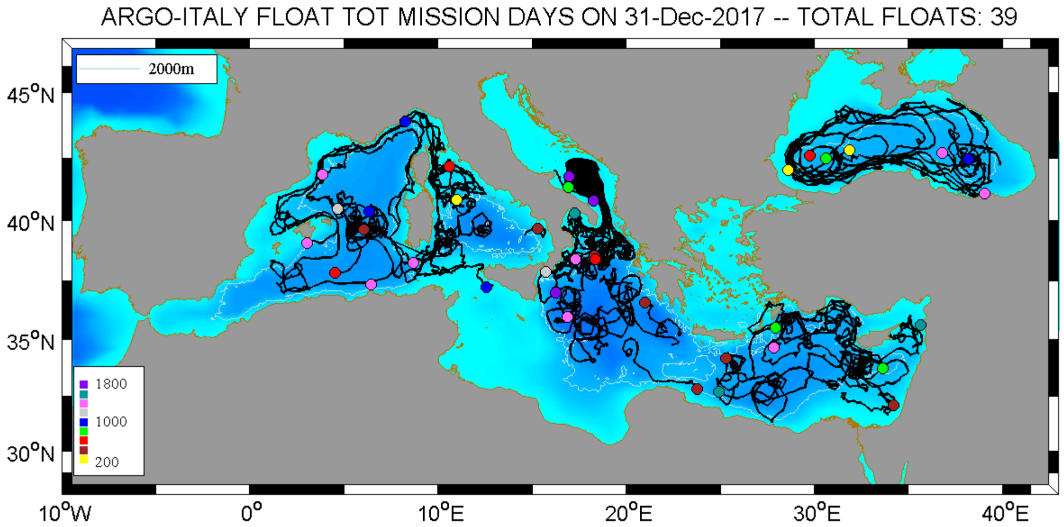


Figure 1. Trajectories and positions (circle symbols) on 31 December 2017 of the 39 Italian floats active in the Mediterranean and Black Sea at the end of 2017. The circle symbols are color-coded as a function of float age in days.

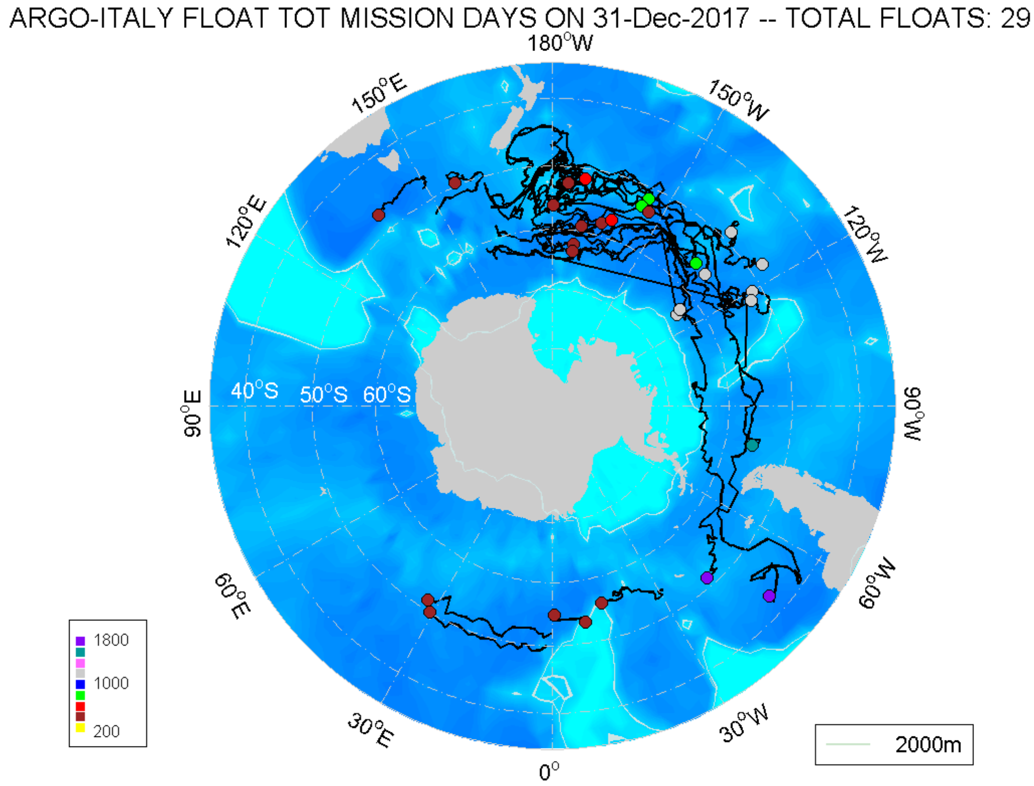


Figure 2. Trajectories and positions (circle symbols) on 31 December 2017 of the 29 Italian floats in the South Pacific, South Atlantic and Southern Oceans. The circle symbols are color-coded as a function of float age in days.

The temporal evolution of the number of active floats is shown in Figure 3 with weekly resolution, along with the annual numbers of float deployments and float deaths for the period 2012-2017. The float population in 2012-2017 is essentially increasing and reaching 70-80 active instruments in 2017. In 2015 and 2016 the annual numbers of deployments (26 and 28, respectively) were related to annual losses of 13 in 2015 and 14 in 2016. In 2017, the number of floats which stopped transmitted was rather high (22) probably due to the natural aging of the Italian Argo network and also due to the short operating life of some float types.

Since 18 February 2012, a total of **136 ARGO-ITALY floats** have been deployed, 82 in the Mediterranean and Black seas, and 54 in the oceans of the Southern Hemisphere. In less than 6 years, they have provided about **15000 CTD profiles**. In total, 13 floats (~10 %) have failed just after deployment.

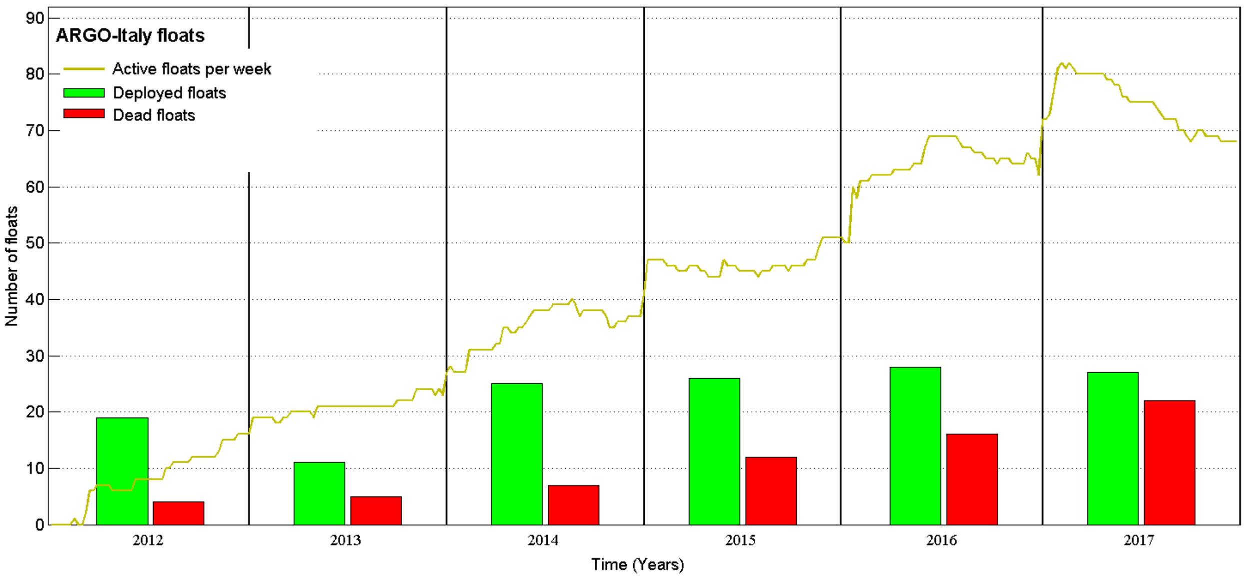


Figure 3. Temporal evolution of the number of active Italian floats with weekly resolution and histogram of the annual float deployments and losses.

- <u>technical problems encountered and solved</u>

Mediterranean and Black Sea

In total, 5 floats (out of 10 deployed in 2017) stopped functioning before the end of the year 2017. Nova (WMO 6903221) and Dova (WMO 6903222) floats deployed in the Eastern Levantine stopped transmitting data after 69 and 75 cycles, respectively. The Apex float (WMO 6903202) deployed in the north Tyrrhenian had a very short operational life (10 cycles). Dova float (WMO 6903226) did not work upon deployment in the Black Sea and drifted at the surface. It was not possible to reset it using the Iridium downlink. Nova float (6903228) stopped functioning after only 9 cycles in the Black Sea.

Southern Hemisphere

Nova float WMO 6903206 stopped transmitting after only 8 cycles in March 2017.

Nova/Dova floats

In general, the Nova and Dova floats have low survival rates. After a little more than 2 years since their first deployments in October 2015, only 18 floats (out of 39 units, i.e., about 46%) were still fully operational (some of them collecting weird data!) in early 2018. We are still trying to investigate the causes of the premature malfunctioning in collaboration with MetOcean.

- status of contributions to Argo data management (including status of pressure corrections, technical files, etc)

The data management for the Italian float is mostly done by the Coriolis GDAC. Metadata and data are available through the Coriolis web site in near real-time.

- status of delayed mode quality control process

The delayed mode quality control (DMQC) of the physical data (pressure, temperature and salinity) provided by the Italian floats in the Mediterranean and Black seas was done for 43 floats (all information and statistics to create the D-files sent to Coriolis). The temperature and salinity data of those floats were quality controlled following the standard Argo procedure, covering the period 2010-2016. The float salinity calibration needs an accurate reference dataset and these data have to be quite close in time and space to the float measurements. The latter is necessary, in order to reduce the effects both of the inter-annual and the seasonal variability of the Mediterranean Sea, mostly in the upper and intermediate layers of the water column. The standard statistical method adopted by the Argo community for the salinity correction is strictly affected by the natural changes in the water column of the Mediterranean Sea and hence a careful interpretation of the method results is necessary. For this reason we adopt other qualitative checks (i.e., the comparison between nearby floats and analysis of the deepest portion of the temperature-salinity diagram) in order to increase the reliability of the analysis. The DMQC of the Italian floats deployed in the Southern Ocean, the South Pacific and South Atlantic will be done by OGS in early 2018.

References

Pacciaroni, M., Poulain P.-M., Notarstefano G. and Bussani A. (2017) Arvor-I with ice detection deployments in the Southern Ocean, Rel. 2017/90 Sez. OCE 27 MAOS, 32 pp.

2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.

The Italian Ministry of Research has provided funding to buy 21 floats in 2017, including 3 instruments with dissolved oxygen sensors and 3 BGC floats. In addition, the Italian human resources per year devoted to Argo-Italy was about 50 man-months for technical, administrative and scientific personnel involved in the project in 2017. It is expected that the same level will be maintained in 2018, including the procurement of 20 additional standard floats and 3 deep floats. The Italian Ministry of Research is committed to provide funding in order to sustain the Italian contribution to Argo beyond 2018 as founding member of the Euro-Argo Research Infrastructure Consortium. In addition to the Italian national funding, OGS has funding from EC (CMEMS, MOCCA) and the Italian Ministry of Foreign Affairs (MELMAS) projects for several activities related to Argo.

3. Summary of deployment plans (level of commitment, areas of float Deployment, low or high resolution profiles) and other commitments to Argo (data management) for the upcoming year and beyond where possible.

The Italian deployment plans for 2018 and 2019 are detailed in Table 3. The main areas of interest are the Mediterranean and Black seas and the oceans of the South Hemisphere.

Year	T/S floats (some of them with DO)		BGC floats		Deep floats		Total
	Quantity	Area	Quantity	Area	Quantity	Area	
2018	12 1 8	Mediterranean Black Sea South Hemisphere	3 1	Mediterranean Black Sea	2	Mediterranean	**27**
2019	13 2 10	Mediterranean Black Sea South Hemisphere	1	Mediterranean Black Sea	1	Mediterranean	**27**

Table 3. Italian float deployment plans for 2016-2017.

On the longer time frame, Italy is interest to maintain contributions to the Argo Core mission and the BGC and Deep Argo extensions with numbers similar to those listed in Table 3. OGS is committed to carry out the DMQC for all the Argo floats of the Mediterranean and Black seas and for some floats in the World Ocean as part of the CMEMS and MOCCA projects over the next years.

The website for the Italian contribution to Argo (Argo-Italy) was improved and upgraded (http://argoitaly.ogs.trieste.it/). The link to the Mediterranean & Black Sea Argo Centre (MedArgo) is http://nettuno.ogs.trieste.it/sire/medargo/. A completely new web site for Argo-Italy is in development and will be operational in spring 2018.

4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers.

Operational ocean forecasting.

All Argo temperature and salinity data in the Mediterranean (along with other in-situ and remotely sensed data) are routinely assimilated into the Mediterranean Forecasting System (MFS) operational forecasting system run by the Italian Istituto Nazionale di Geofisica e Vulcanologia (INGV) and which is a component of the Copernicus Marine Environment Monitoring Service (CMEMS). Assessments have clearly demonstrated the positive impact of Argo data on ocean analyses and predictions. In particular, studies on the optimization of float sampling and cycling characteristics for the Mediterranean have been performed, as well as the development of methodology for the assimilation of Argo float sub-surface velocities into numerical models.

Ocean science.

Argo data are being used by several researchers in Italy to improve the understanding of marine properties (e.g. circulation, heat storage and budget, and mixing) in both the Mediterranean Sea and the Southern Ocean (see bibliography below).

5. Issues that your country wishes to be considered and resolved by the AST.

N/A

6. Number of CTD cruise data added to the Argo reference database by Italian PIs in 2017.

N/A

7. Italian contribution to Argo bibliography in 2017.

Buongiorno Nardelli, B., S. Guinehut, N. Verbrugge, Y. Cotroneo, E. Zambianchi, and D. Iudicone, 2017: Southern Ocean Mixed-Layer Seasonal and Interannual Variations From Combined Satellite and In Situ Data. Journal of Geophysical Research: Oceans, 122, 10042-10060, http://dx.doi.org/10.1002/2017JC013314

Cipollone, A., S. Masina, A. Storto, and D. Iovino, 2017: Benchmarking the mesoscale variability in global ocean eddy-permitting numerical systems. Ocean Dynamics, 67, 1313-1333, https://doi.org/10.1007/s10236-017-1089-5

Clementi, E., P. Oddo, M. Drudi, N. Pinardi, G. Korres, and A. Grandi, 2017: Coupling hydrodynamic and wave models: first step and sensitivity experiments in the Mediterranean Sea. Ocean Dynamics, 67, 1293-1312, https://doi.org/10.1007/s10236-017-1087-7

Jordà, G., K. Von Schuckmann, S. A. Josey, G. Caniaux, J. García-Lafuente, S. Sammartino, E. Özsoy, J. Polcher, G. Notarstefano, P. M. Poulain, F. Adloff, J. Salat, C. Naranjo, K. Schroeder, J. Chiggiato, G. Sannino, and D. Macías, 2017: The Mediterranean Sea heat and mass budgets: Estimates, uncertainties and perspectives. Progress in Oceanography, 156**,** 174-208, https://doi.org/10.1016/j.pocean.2017.07.001

Kokkini Z., Gerin R., Poulain P.-M., Mauri E., Pasarić Z., Janeković I., Pasarić M., Mihanović H. and Vilibić I., 2017: A multiplatform investigation of Istrian Front dynamics (north Adriatic Sea) in winter 2015. Mediterranean Marine Science, 18(2), 344-354.

Mancero-Mosquera I., Poulain P.-M., Gerin R., Mauri E., Hayes D., Testor P. and Mortier L., 2017: Analysis of frequency content of temperature glider data via Fourier and wavelet transforms. Bollettino di Geofisica Teorica ed Applicata, 58(2), 137-156.

Masina, S., A. Storto, N. Ferry, M. Valdivieso, K. Haines, M. Balmaseda, H. Zuo, M. Drevillon, and L. Parent, 2017: An ensemble of eddy-permitting global ocean reanalyses from the MyOcean project. Climate Dynamics, 49, 813-841, https://doi.org/10.1007/s00382-015-2728-5

Olita, A., A. Capet, M. Claret, A. Mahadevan, P. M. Poulain, A. Ribotti, S. Ruiz, J. Tintoré, A. Tovar-Sánchez, and A. Pascual, 2017: Frontal dynamics boost primary production in the summer stratified Mediterranean sea. Ocean Dynamics, 67, 767-782, https://doi.org/10.1007/s10236-017-1058-z

Pascual, A., S. Ruiz, A. Olita, C. Troupin, M. Claret, B. Casas, B. Mourre, P.-M. Poulain, A. Tovar-Sanchez, A. Capet, E. Mason, J. T. Allen, A. Mahadevan, and J. Tintoré, 2017: A Multiplatform Experiment to Unravel Meso- and Submesoscale Processes in an Intense Front (AlborEx). Frontiers in Marine Science, 4, http://dx.doi.org/10.3389/fmars.2017.00039

Reale, M., S. Salon, A. Crise, R. Farneti, R. Mosetti, and G. Sannino, 2017: Unexpected Covariant Behavior of the Aegean and Ionian Seas in the Period 1987–2008 by Means of a Nondimensional Sea Surface Height Index. Journal of Geophysical Research: Oceans, 122**,** 8020-8033, http://dx.doi.org/10.1002/2017JC012983

Storto, A. and S. Masina, 2017: Objectively estimating the temporal evolution of accuracy and skill in a global ocean reanalysis. Meteorological Applications, 24, 101-113, http://dx.doi.org/10.1002/met.1609

Storto, A., S. Masina, M. Balmaseda, S. Guinehut, Y. Xue, T. Szekely, I. Fukumori, G. Forget, Y.-S. Chang, S. A. Good, A. Köhl, G. Vernieres, N. Ferry, K. A. Peterson, D. Behringer, M. Ishii, S. Masuda, Y. Fujii, T. Toyoda, Y. Yin, M. Valdivieso, B. Barnier, T. Boyer, T. Lee, J. Gourrion, O. Wang, P. Heimback, A. Rosati, R. Kovach, F. Hernandez, M. J. Martin, M. Kamachi, T. Kuragano, K. Mogensen, O. Alves, K. Haines, and X. Wang, 2017: Steric sea level variability (1993–2010) in an ensemble of ocean reanalyses and objective analyses. Climate Dynamics, 49, 709-729, https://doi.org/10.1007/s00382-015-2554-9

Storto, A., C. Yang, and S. Masina, 2017: Constraining the Global Ocean Heat Content Through Assimilation of CERES-Derived TOA Energy Imbalance Estimates. Geophysical Research Letters, 44, 10,520-10,529, http://dx.doi.org/10.1002/2017GL075396

Verri, G., N. Pinardi, P. Oddo, S. A. Ciliberti, and G. Coppini, 2017: River runoff influences on the Central Mediterranean overturning circulation. Climate Dynamics, https://doi.org/10.1007/s00382-017-3715-9

Japan National Report

(Submitted by Toshio Suga)

1. The Status of implementation (major achievements and problems in 2017)

1.1 Floats deployed and their performance

The current positions of all the active Japanese Argo floats are shown in Fig.1.

Japan Agency for Marine-Earth Science and Technology (JAMSTEC) deployed 35 Argo and Argo equivalent floats from January to December 2017: 11 ARVOR, 10 NAVIS, 7 APEX, 2 Deep APEX, 1 Biogeochemical (BGC) APEX, 3 Deep NINJA, and 1 RINKO-Deep NINJA floats. All the floats except one described below were deployed with the aid of R/Vs of 8 domestic organizations.

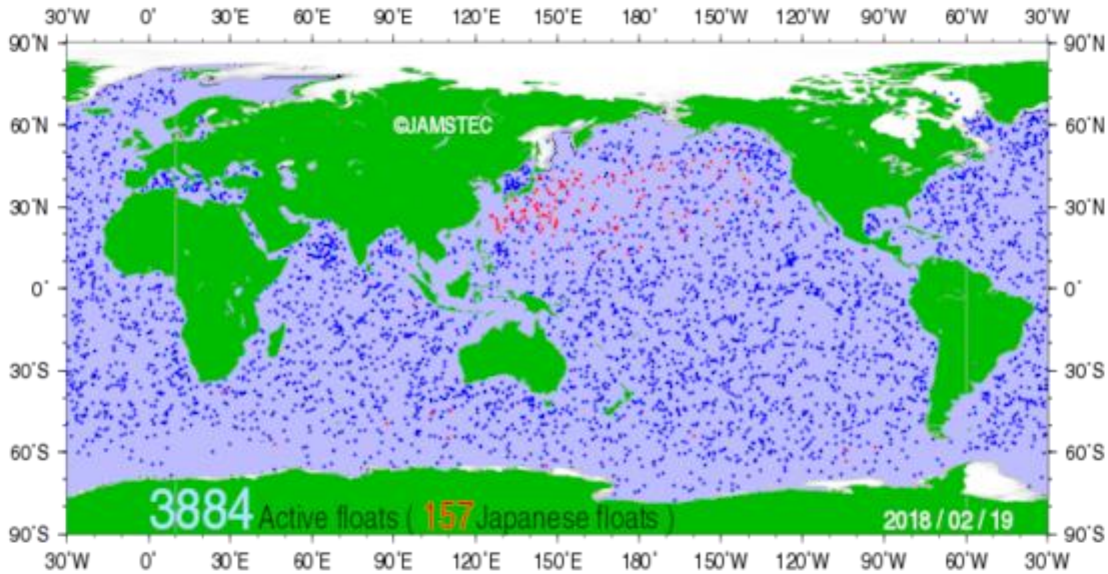


Figure 1: The distribution of active Argo floats. The red dots represent active Japanese floats.

One Navis float of JAMSTEC was deployed by a voluntary cargo ship owned by a Japanese merchant ship company, NYK Line, in July 2017. The arrangement of the semi-regular float deployment by cargo ships was made under the cooperative relationship between JAMSTEC and NYK line, which was established in 2011 to increase float deployment opportunity.

From 1999 to the end of December 2017, JAMSTEC deployed 1227 Argo and Argo equivalent floats in the Pacific (1026), Indian (107) and Southern Oceans (94; South of 50°S). As of the end of December 2017, 123 floats are active and additionally 5 floats (including Deep, BGC floats) are planned to be deployed until March 2018.

The Japan Meteorological Agency (JMA) deployed 36 Argo equivalent and WBC floats (36 ARVOR floats) in the seas around Japan from January to December 2017. All the floats get 2,000 dbar T/S profiles every 5 days for operational ocean analysis and forecast.

Among 262 floats (16 PROVOR, 167 APEX and 79 ARVOR floats) which JMA has deployed from 2005 to 2017, 50 floats (50 ARVOR floats) are active as of the end of December 2017, while 29 floats (26 APEX and 3 ARVOR floats) terminated the transmission in 2017. JMA deployed 4 ARVOR floats from January to February 2018.

A profiling float for deep ocean observation, Deep NINJA, was developed by JAMSTEC and Tsurumi Seiki Co. Ltd. and has been available for public since April 2013. In February 2017, one Deep NINJA floats were operated in the Indian Ocean. From February 2017 to February 2018, 7 Deep NINJA floats (including two prototypes with RINKO DO sensor, to be mentioned below) were deployed; one in the South Pacific in February 2017, two in the North Pacific in July 2017, three off the Adelie Coast, Antarctica in January/February 2018 (by R/V Investigator, CSRIO), and one in the tropical Indian Ocean in December 2017. Unfortunately, three of them had lost contact. The data measured by these Deep NINJA floats were transferred to GDAC in accordance with the AST consensus on the data observed by Deep Argo floats.

Okinawa Institute of Science and Technology Graduate University (OIST) deployed 21 Argo equivalent floats from 2011 to 2017, including 4 deployed in 2017 to investigate mid-depth ocean circulation. Four Argo equivalent floats (NEMO floats) are active as of end of December 2017.

1.1.1 Float deployment for synchronous array observation

JAMSTEC has been conducting a small synchronized float array observation since 2014 to investigate formation and dissipation process of the North Pacific central mode water (CMW) in detail, aiming for quantification of temporal variations of surface and subsurface vertical mixing process forced by wind and surface cooling. The observation array was arranged at 6 latitude grids (30-42.5N) along 170W, measuring daily temperature and salinity every 2dbar. Through a 4-year array observation, active internal waves below subsurface layer were identified, related to wind energy from atmospheric disturbances. The internal wave enhances vertical diffusivities in fall to winter, which makes the CMW diffused effectively (Inoue et al., 2017). The result of this synchronized Argo array gives us a new application for ocean observation using Argo floats.

1.1.2 Float deployment for the research project "Optimization of tropical Pacific Ocean observation system"

Three NAVIS floats were deployed as Argo equivalent floats in the western tropical Pacific to investigate interior ocean disturbances and their source region related to ENSO. The purpose of this project is to make suggestion on effective design of tropical Pacific Observation System (TPOS) for the ENSO prediction, contributing to TPOS2020. The NAVIS floats were deployed among TRITON moorings along 137E line in February; they make measurement down to 2000m every 2 days. Unfortunately the last float of the three stopped to communicate in 2017, all data are available from GDACs as well as through an objective analyses dataset.

1.2 Technical problems encountered and solved

1.2.1 Float hardware troubles on NAVIS float

NAVIS floats, which were purchased in 2013-2015, suffered hardware troubles, which were possibly caused by pump, bulb or bladder system failure, and are still operating without proper measurement. The symptom of these troubled NAVIS floats were drifting at the sea surface or not being able to control their drifting or profiling depth. Following the warranty policy, JAMSTEC has received 9 warranty floats in 2017 and 4 floats are still on the watch list.

1.2.2 Deep Ninja with RINKO sensor

In 2016, JAMSTEC began to develop a new model of Deep NINJA with RINKO DO sensor in cooperation with JFE Advantech Co. Ltd. and Tsurumi Seiki Co. Ltd. We made two prototypes in June 2017. One was deployed at K2 station in the western subarctic North Pacific in July 2017 from R/V Mirai. It had halted its operation due to a mechanical failure after the measurement of the 9-th profile. The other was deployed in the Southern Ocean in January 2018 from R/V Investigator, CSIRO. The RINKO DO sensor for deep float (AROD-FT) is already available at JFE Advantech.

1.2.3 Deep APEX

In February 2017, JAMSTEC deployed one Deep APEX float in the Southern Ocean as its first deployment of 6000m deep Argo float. Unfortunately, the float drifted at sea surface after a few cycles without acquiring proper data because of going into emergency mission due to internal hydraulic oil leaks, seawater leaks through connecting component. Based on analyses by the manufacturer (Teledyne Webb Research), it was found that the problem was caused by factory fault and they decided that warranty float will be delivered in 2018.

In November, 2017, JAMSTEC deployed one Deep APEX float with Aanderaa Optode4835 oxygen sensor (S/N:29, WMOID:2903212) in the western North Pacific region. The Deep APEX float makes measurement from sea bottom every 2 days (then changed to 15 days later), setting the parking pressure at 4000 dbar. In comparison with shipboard CTDO measurement at the deployment point, clear negative salinity bias (>0.1 psu) and unstable oxygen measurement were appeared and the situation is still continued after 15 cycles in February 2018. Further analyses and improvement by the manufacturer are required. Relevant information, data and experiences will be shared with other users.

1.3 Status of contributions to Argo data management

The Japan DAC, JMA has operationally processed data from all the Japanese Argo and Argo-equivalent floats including 157 active floats as of February 14, 2018. Ten Japanese PIs agree to provide data to the international Argo. All the profiles from those floats are transmitted to GDACs in the netCDF format and are also issued to GTS using the TESAC and BUFR codes after real-time QC on an operational basis. Argo BUFR messages have been put on GTS since May 2007.

JMA and JAMSTEC have converted the almost all of Japanese meta-files, except a few Iridium floats, 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 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.

1.4 Status of delayed mode quality control process

JAMSTEC has submitted the delayed-mode QCed Core data (P, T, and S) of 115,054 profiles to GDACs as of December 2017. JAMSTEC had submitted D-Core files of 6,177 profiles in 2017 and will accelerate the submission of D-Core files in 2018..

2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.

Japan Argo had been conducted in a 5-year program from FY1999 to FY2004, as a part of Millennium Project implemented under cooperation among the Ministry of Education, Culture, Sports, Science and Technology (operation: by JAMSTEC), the Ministry of Land, Infrastructure and Transport, JMA and Japan Coast Guard. After the Millennium Project terminated in March 2005, JAMSTEC has continued the operation until FY2013 nearly in the same scale (about 80 floats to be deployed every year and associated delayed-mode data management) under its two consecutive mid-term programs for FY2004-2008 and FY2009-2013. JAMSTEC continues the float deployment and delayed mode data management but in the scale somewhat lower than ever before under its new mid-term program FY2014-2018. Because of budget cuts in FY2014-2015, the number of technical staff devoted to delayed mode QC and PARC activities has been decreased from 5 to 4 since FY 2015 and also the number of purchased floats had been reduced to about 12-15.

In FY2016, owing to ocean monitoring enhancement recommended by G7 Ise-Shima Summit, especially its Science and Technology Ministers' Meeting in Tsukuba, additional fund for Core Argo and Argo extensions (Deep and BGC Argo) was allocated for aiming to sustain Core Argo array and to enhance Deep and BGC Argo. Furthermore, following its communique and our original research plans, JAMSTEC had got extra research fund to purchase 50 Core, 25 Deep and 10 BGC Argo floats in FY2017, and will be deployed in the Pacific, Indian and Southern Ocean in FY2018-19. JMA allocates operational budget for 27 floats in FY2018.

3. Summary of deployment plans (level of commitment, areas of float deployment, low or high resolution profiles, Argo extensions) and other commitments to Argo (data management) for the upcoming year and beyond where possible.

Based on the additional fund, larger number of Core/Deep/BGC Argo floats will be deployed in 2018. To maintain Core Argo array, JAMSTEC will deploy 34 floats mainly in the North Pacific, where the index of deployment intensity is not good and the age of floats tend to be higher than the other area, based on the information from Argo Information Center. Those deployment will help to improve North Pacific Core Argo array. Regarding Deep Argo, 3 Deep NINJA, 4 RINKO (DO) Deep NINJA, 10 Deep APEX, 3 DO(RINKO or Optode)-Deep APEX floats will be deployed in the Pacific and Indian Oceans, especially focusing on the Southern Ocean. In Australian Antarctic Basin, freshening and warming signal of AABW had been detected from shipboard observations; however, its spatial and temporal changes are still unclear because of limited historical data. In cooperation with the Deep Argo observation campaign by Australia, France and Japan, which has been carried out in 2017-2018, JAMSTEC has a plan to deploy further Deep Argo floats (>10) in the region to investigate long-term change in AABW, enhancing Deep Argo array in the Southern Ocean. Regarding BGC Argo, one BGC float with oxygen, chlorophyll-a and BBP, and one BGC float with oxygen, chlorophyll-a, BBP and Nutrient will be deployed in the Pacific and Indian Oceans. Highlighted area is the subpolar region of the North Pacific Ocean, where oxygen minimum zone (OMZ) and ocean acidification tend to be strengthened and expanded. By deploying BGC floats with Nutrient and pH sensor, long term BGC data will be obtained to contribute to acquire more knowledge of OMZ and acidification. As a test mode, 2 APEX floats with RBR CTD sensor are deployed at the same point, evaluating RBR sensor with shipboard CTD cast. As non-Argo float, one EM APEX will be deployed in the Kuroshio Extension.

JMA plans to deploy 15 Argo equivalent floats and 12 Argo WBC floats around Japan in FY2018 and in the coming years. All the JMA floats are identical with the core Argo floats except that they are operated in a 5-day cycle, synchronized with JMA's real-time ocean data assimilation and forecast system.

JMA continues serving as the Japan DAC. JAMSTEC continues running the Pacific Argo Regional Center for the upcoming year.

4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers.

Many groups in JAMSTEC, JMA, FRA and Japanese universities are using Argo data for oceanographic researches on water mass formation and transport in the Pacific Ocean, the mid-depth circulation, the mixed layer variation, the barrier layer variation, and tropical atmosphere-ocean interaction in the Pacific and Indian Ocean and so on. Japanese fisheries research community is conducting their biogeochemical studies using Argo floats equipped with chlorophyll and/or oxygen sensors.

The global Argo TESAC and BUFR messages are used for operational ocean analysis and forecast by JMA. Daily and monthly products of subsurface temperatures and currents for the seas around Japan and western North Pacific, based on the output of the real-time ocean data assimilation system (MOVE/MRI.COM-WNP), are distributed through the JMA web site (in Japanese). Numerical outputs of the system are available from the NEAR-GOOS Regional Real Time Data Base (http://www.data.jma.go.jp/gmd/goos/data/database.html) operated by JMA. Monthly diagnosis and outlook of El Niño-Southern Oscillation based on the outputs of the Ocean Data Assimilation System and the El Niño Prediction System (an ocean-atmosphere coupled model) are also operationally distributed through the JMA web site (in Japanese) and the Tokyo Climate Center (TCC) web site (http://ds.data.jma.go.jp/tcc/tcc/products/elnino/). These systems were upgraded in June 2015 (for descriptions of the new systems, please refer to http://ds.data.jma.go.jp/tcc/tcc/products/elnino/move_mricom-g2_doc.html, and http://ds.data.jma.go.jp/tcc/tcc/products/model/outline/cps2_description.html). The ocean-atmosphere coupled model is also used for seasonal forecast of climate in Japan. The model products for seasonal forecast are available from the TCC web site (http://ds.data.jma.go.jp/tcc/tcc/products/model/).

JAMSTEC is providing a variety of products including objectively mapped temperature and salinity field data (Grid Point Value of the Monthly Objective Analysis using Argo float data: MOAA-GPV: http://www.jamstec.go.jp/ARGO/argo_web/MapQ/Mapdataset_e.html), objectively mapped velocity field data based on YoMaHa'07 (version September 2010) (http://www.jamstec.go.jp/ARGO/argo_web/G-YoMaHa/index_e.html), and gridded mixed layer depth with its related parameters (Mixed Layer data set of Argo, Grid Point Value: MILA-GPV http://www.jamstec.go.jp/ARGO/argo_web/MILAGPV/index_e.html). JAMSTEC have released Argo temperature and salinity profile data put through more advanced automatic checks than real-time quality controls (Advanced automatic QC Argo Data version 1.2) since October 2014. We add our own new flag to real time profile data which tells whether it passed each check or not. JAMSTEC has also provided scientifically quality controlled data of Deep NINJA for convenient use on scientific or educational purposes (http://www.jamstec.go.jp/ARGO/deepninja/). The QC is based on comparisons with high accurate shipboard CTD observations conducted nearby float observations.

JAMSTEC is also providing information about consistency check of float data related to delayed-mode QC for the Pacific Argo Regional Center (PARC) web site as a main contributor. JAMSTEC will support the activities of the Southern Ocean ARC (SOARC) in the Pacific sector.

ESTOC (Estimated state of ocean for climate research) is a JAMSTEC product; an integrated dataset of ocean observations including Argo data by using a four dimensional variational (4D-VAR) data assimilation approach. ESTOC is the open data that consists of not only physical but also biogeochemical parameters for 55 years during 1957-2011 (See the web site in JAMSTEC, http://www.godac.jamstec.go.jp/estoc/e/top/). The ESTOC continue being improved by introducing new observational elements (e.g., ocean mixing, a global sea level), and extended for 58 years for the period of 1957-2014. A new version plan to be released in spring 2018.

JCOPE2 (Japan Coastal Ocean Predictability Experiment 2) is the model for prediction of the oceanic variation around Japan which is operated by Application Laboratory of JAMSTEC. JCOPE2 is the second version of JCOPE1, developed with enhanced model and data assimilation schemes. The Argo data are used by way of GTSPP. The reanalysis data 25 years back (from 1993 to present) and the forecast data 2 months ahead are disclosed on the following web site: http://www.jamstec.go.jp/frcgc/jcope/. More information are shown in http://www.jamstec.go.jp/frcgc/jcope/htdocs/jcope_system_description.html.

FRA-ROMS is the nowcast and forecast system for the Western North Pacific Ocean developed by Fisheries Research Agency (FRA) based on the Regional Ocean Modeling System (ROMS). Instead of FRA-JCOPE, which was the previous system of providing the hydrographic forecast information around Japan, FRA started the FRA-ROMS operation in May 2012. Argo has been one of important sources of in-situ data for the FRA-ROMS data assimilation system. The forecast oceanographic fields are provided every week on the website http://fm.dc.affrc.go.jp/fra-roms/index.html/.

5. Issues that our country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo.

As reported in 2011, EEZ clearance procedure for Argo float deployed by Japanese PIs has been simplified following IOC Resolution XLI-4. This change reduced our time and effort for the process of EEZ clearance significantly. However, the traditional EEZ clearance is still needed for some key countries because Argo national focal points (NFPs) of those countries are not registered on the listed at AIC. Japan Argo hopes for more NFPs especially of nations in and around the Pacific Ocean to be registered to facilitate more timely and optimal deployment of Argo floats. This could be also helpful for smooth implementation of any future extension of Argo.

6. Summary of the number and location of CTD cruise data to the CCHDO website.

Data of 514 CTD casts conducted by JMA in the western North Pacific from October 2016 to September 2017 were uploaded to the CCHDO website.

7. Outreach activity.

In October, 2017, a domestic Argo symposium took place during annual fall meeting of the Oceanographic Society of Japan at Tohoku University. The purpose of the symposium was to inform Japanese research and operational communities about recent status of Core/Deep/BGC Argo and share experiences of those observations with scientists/technicians/manufacturers in Japan. Over 70 people participated and discussed lively about sustainability and expansion of Core/Deep/BGC Argo. All of the presentations are available on the JAMSTEC's web site and the documents of all talk will be summarized in a review paper.

8. Argo bibliography

(1) Articles

Inoue, R., M. Watanabe, and S. Osafune (2017), Wind-induced mixing in the North Pacific, J.

Phys. Oceanogr., 1587-1603, 47, 10.1175/JPO-D-16-0218.1.
Shimada, K., S. Aoki, Kay I. Ohshima (2017),Creation of a Gridded Dataset for the Southern Ocean with a Topographic Constraint Scheme, JOURNAL OF ATMOSPHERIC AND OCEANIC TECHNOLOGY, 511-532, 34[3], 10.1175/JTECH-D-16-0075.1.
Doi, T., A. Storto, S. K. Behera, A. Navarra, and T. Yamagata (2017),Improved prediction of the Indian Ocean Dipole Mode by use of subsurface ocean observations., J. Climate,, 3219-3235, 30.
Tozuka, T, M. F. Cronin, H. Tomita (2017), Surface frontogenesis by surface heat fluxes in the upstream Kuroshio Extension region, Scientific Reports, 10258, 7, 10.1038/s41598-017-10268-3.
K. Katsumata (2017), Eddies Observed by Argo Floats. Part II: Form Stress and Streamline Length in the Southern Ocean, J.Phys.Oceanogr., 2237--2250, 47[9], 10.1175/JPO-D-17-0072.1.
Masayoshi Ishii, Yoshikazu Fukuda, Shoji Hirahara, Soichiro Yasui, Toru Suzuki, Kanako Sato (2017), Accuracy of Global Upper Ocean Heat Content Estimation Expected from Present Observational Data Sets, SOLA, 163－167, 13, doi:10.2151/sola.2017-030.
Sugimoto, S., K. Hanawa, T. Watanabe, T. Suga, and S.-P. Xie (2017), Enhanced warming of the subtropical mode water in the North Pacific and North Atlantic, Nature Climate Change, 656-658, 7[9], 10.1038/nclimate3371.
Akira Nagano, Takuya Hasegawa, Iwao Ueki, Kentaro Ando (2017), El Niño-Southern Oscillation-time scale covariation of sea surface salinity and freshwater flux in the western tropical and northern subtropical Pacific, Geophysical Research Letters, 44, 10.1002/2017GL073573.
Ryo Furue, Kévin Guerreiro, Helen E. Phillips, Julian P. McCreary, Nathaniel L. Bindoff (2017), On the Leeuwin Current System and Its Linkage to Zonal Flows in the South Indian Ocean as Inferred from a Gridded Hydrography, Journal of Physical Oceanography, 583-602, 47[March], 10.1175/JPO-D-16-0170.1.
Oka, E., S. Katsura, H. Inoue, A. Kojima, M. Kitamoto, T. Nakano, and T. Suga (2017), Long-term change and variation of salinity in the western North Pacific subtropical gyre revealed by 50-year long observations along 137E, Journal of Oceanography, 73[in press], 10.1007/s10872-017-0416-2.

(2) Doctorate thesis

Katsura, S. (2016), Structure and Variability of Surface Layer Salinity in the Subtropical Pacific, Doctorate Thesis, Tokyo University.

Argo-KOREA Annual Report 2017

by National Inst. of Meteorological Sciences/KMA

19th Argo Steering Team Meeting (AST-19)
Victoria, British Columbia, Canada, 13-15 March 2018

1. Status of Implementation

The National Institute of Meteorological Sciences of Korea Meteorological Administration (NIMS/KMA) and Korea Institute of Ocean Science & Technology (former KORDI) have been involved in the International Argo Program since 2001. NIMS/KMA has deployed 230 Argo floats around Korea peninsula and North Pacific Ocean including 50 active floats as of February 2018. In 2017, total 13 floats were deployed in the East Sea (8 ea), Yellow Sea (2 ea) and southern part of Korea (3 ea) (Fig.1).

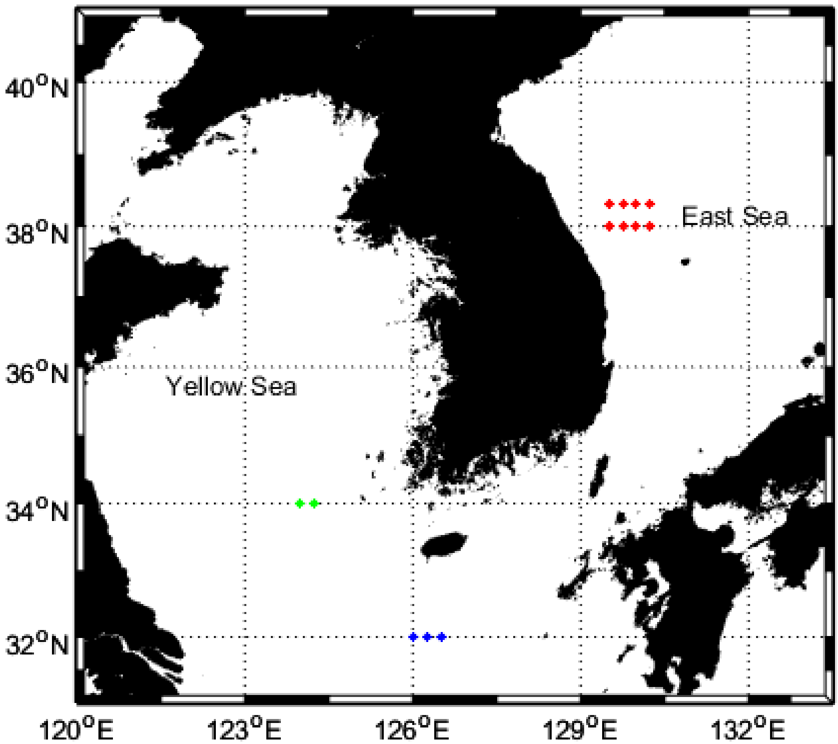


Fig. 1. Location map of Argo float deployment by NIMS/KMA in 2017

- Status of contributions to Argo data management

・Reproduction of NetCDF data of dead floats.
  - Meta, technical and trajectory files will send to GDAC (by Mar. 9)
・Transmission of converted NetCDF data to US-GDAC
  - solved the network issue (US-GDAC)
・Implementing the Argo data format check program (new version)

- ***Delayed Mode QC***

・During October 2016 - November 2017, we reprocessed most of previous D-files and has sent 7,208 of the revised D-files with NetCDF format (ver. 3.1) to the GDAC.

2. Present level of (and future prospects for) national funding for Argo including summary of human resources devoted to Argo.

KMA has tried to keep same level of deployment about 10~15 floats per year. However, the float number deployed around Korea this year will be 5 due to the budget decrease.

- ***Human resources***

・**Following persons contribute to the Argo-Korea program:**

- KiRyong KANG, JongSook PARK, Hyeong-jun JO (KMA)
- Sung-Dae KIM (KIOST)

3. Summary of deployment plans

NIMS/KMA has a deployment plan for 5 floats (ARVOR float) in 2018: 3 will be deployed at the East Sea for normal Argo program and 2 at the Yellow Sea for the new observation scheme in the regional ocean. Continuing the last year's program in the Yellow Sea, observation program using the Argo float will be preformed to investigate the ocean environment variation in west coast of Korea.

4. Summary of National Research and Operational Uses of Argo data as well as contributions to Argo Regional Centers.

NIMS/KMA operates the Global Ocean Data Assimilation and Prediction System (GODAPS), based on the NEMO-CICE coupled models and NEMOVAR assimilation. The global Argo profiles data obtained thru GTS network (TESAC and BUFR format data) are used to assimilate into the model using the 24-hour time-window. This operating system produces daily mean ocean, sea-ice analysis and 1-day forecast. And NIMS/KMA runs an Argo Regional Data Center in order to provide the profile data, float-track, and number of acting float, and etc, which can be found at the home page: http://argo.nims.go.kr.

5. Issues that your country wishes to be considered (and resolved) by AST regarding the international operation of Argo.

- Regional ocean observation using the Argo float

6. CTD data uploaded to CCHDO

- No

<The End>

New Zealand National Report March 2018

NIWA is the New Zealand participant in Argo. NIWA has purchased 2 floats per year since 2001, with no floats being purchased in 2003 because of float availability. We have also deployed floats for other providers and are collaborating on large deployments by contributing towards vessel costs.

New Zealand's floats

NIWA has purchased and deployed 22 floats to date. Purchases and deployments are likely to continue at the 2 floats/year level.

Information on the New Zealand floats, designated (WMO#): 2039 (5900106), 2042 (5900109), 2137 (5900205), 2138 (5900206), 2331 (5900631), 2332 (5900632), 2463 (5901028), 2547 (5901227), 2555 (5901239), 2585 (5901271), 2693 (5901763), 2659 (5901804), 2739 (5901843), 2750 (5901853), 2859 (5902224), 2860 (5902225), 2872 (5903332), 2873 (5903333), 8035 (5903756), 8064 (5903777), 8097 (5904062), 8116 (5904076), 8131 (5904332)*, 8179 (5904274)*, 8322 (5902383)*, 8323 (5902384)*, 8426 (5902439)*, 8427 (5902440)*, 8511 (5902502)*, 8513 (5902503)*, 8597, (5905265)*, 8599 (5905266)* can be found at: http://sio-argo.ucsd.edu/weqpac_web.html.

*=active

The data from the NZ floats are administered by Scripps Institution of Oceanography and are available on the Argo Global Data Assembly Centers (GDACS).

Providing deployment opportunities

NIWA has provided deployment opportunities for other nation's floats in the southwest Pacific and Southern Ocean. This is a very important contribution to Argo, given that these regions had poor float coverage and limited deployment opportunities from commercial vessels.

In an ongoing collaboration, NIWA is funding 15% of the vessel costs of R/V Kaharoa deploying floats for University of Washington (USA), Scripps Institution of Oceanography (USA) and CSIRO (Australia).

NIWA's larger research vessel, R/V Tangaroa has also deployed floats in the southern ocean, both as part of the same collaboration and opportunistically when other research takes place in the southern ocean. There is an Antarctic (Ross Sea) voyage planned for February 2019 with the opportunity to deploy floats.

An R/V Kaharoa deployment voyage from New Zealand to the tropical Pacific is planned for July 2018.

Finally, NIWA is also available to facilitate float deployments being mobilized out of New Zealand ports.

Vessel replacement

R/V Kaharoa is nearing replacement. Argo needs and requirements are being considered in the replacement process, but any input would be welcome.

National report of Norway (2017)

Kjell Arne Mork, Institute of Marine Research, Norway (06.03.2018)

1. The status of implementation

Argo Norway is the Norwegian contribution to the Euro-Argo European research infrastructure (ERIC) and to the global Argo programme. The main focus area for Argo Norway has been the Nordic Seas (Greenland, Iceland and Norwegian Sea).

Argo Norway has in total purchased and deployed 26 floats, and the floats were mainly deployed in the Norwegian Sea. All these floats have been APEX floats and the last years these had Iridium telemetry**. The lifetime time of these floats was in average 135 cycles.** At present Argo Norway have seven operative floats. In the Nordic Seas there are now about 50 operative Argo floats (Fig. 1).

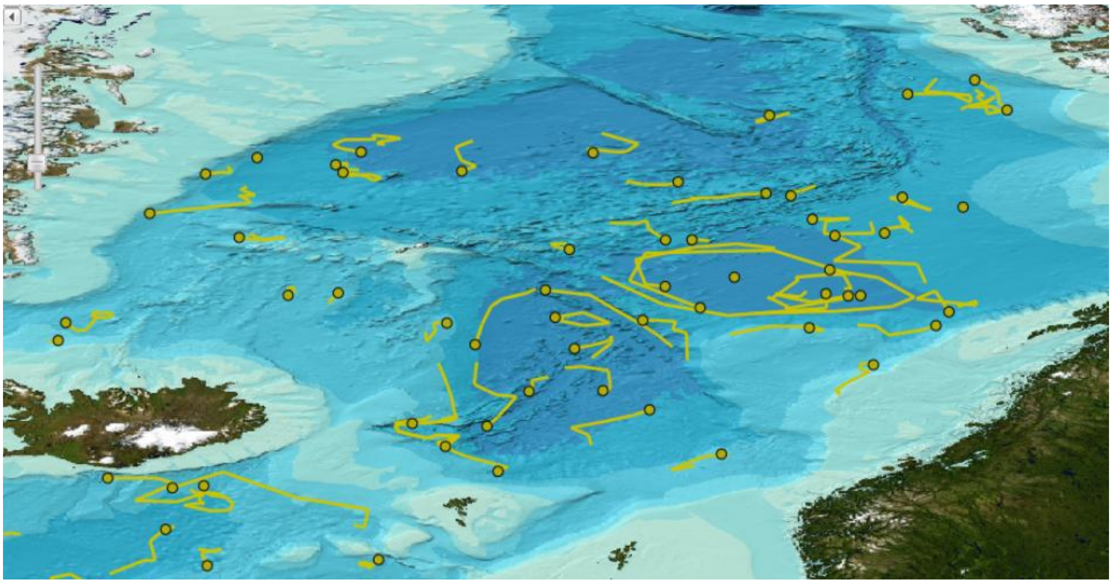


Figure 1. Operative Argo floats in the Nordic Seas (Updated 8. februar 2018).

Several countries have contributed to the deployment of Argo floats in the Nordic Seas. Figure 2 shows the number of Argo floats deployed in the Nordic Seas for the different years and countries. Numbers of profiles taken each year have been steady the last years (2014-2017), above 2000 profiles per year (Fig. 2). In total, from 2001 to 2018, about 19800 profiles have been taken.

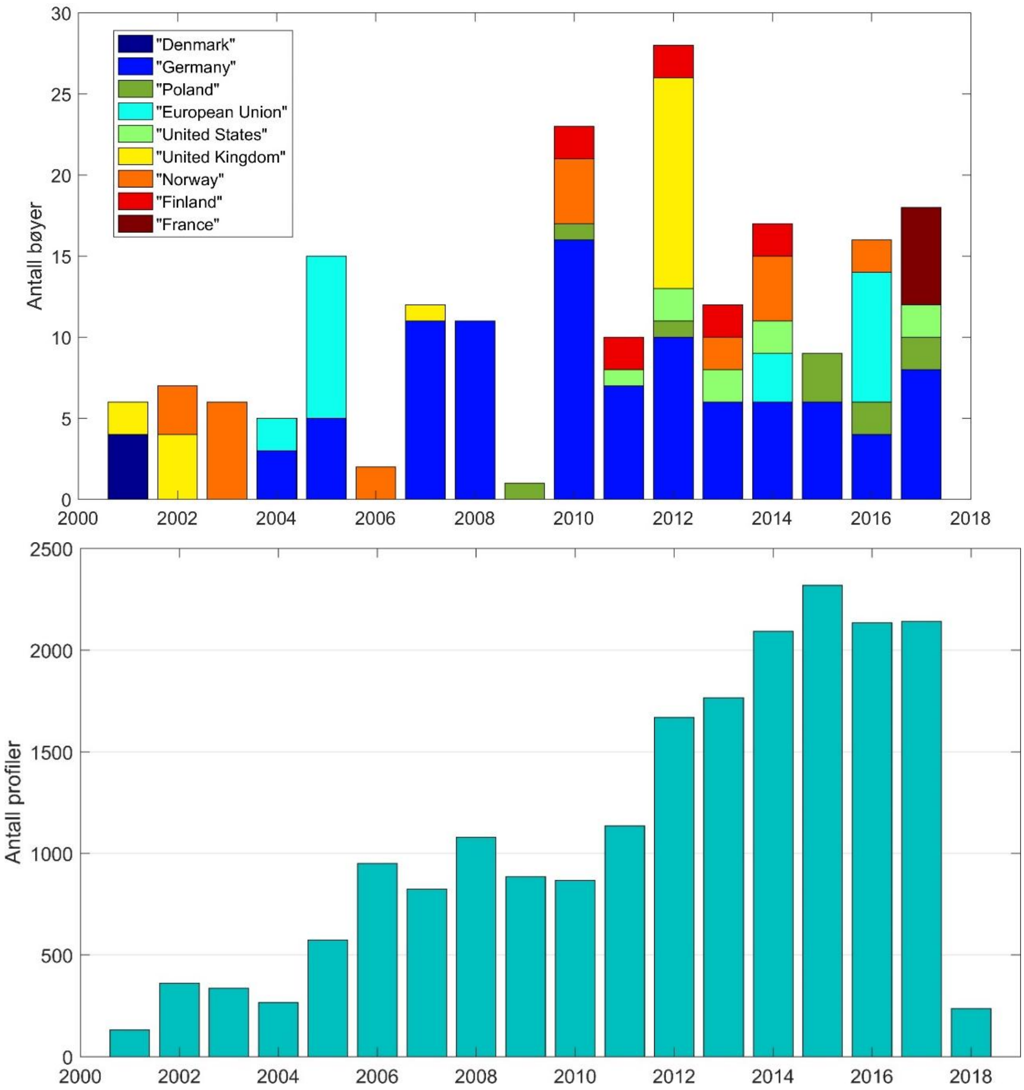


Figure 2. Top: Number of Argo floats deployed in the Nordic Seas per year and country. Bottom: Number of Argo profiles in the Nordic Seas (updated 8. February 2018).

Delayed mode quality control

Regarding the "Delayed mode" Argo Germany have done the delayed mode quality control for all floats in the Nordic Seas including our floats.

2. Present level of and future prospects for national funding

The funding has been a combination of self-financed (i.e. funded by Institute of Marine Research) and funding from the Norwegian Research Council (NRC, Ministry of Education and Research) during 2012-2015.

For 2018-2023 we have received funding from the NRC for a national Argo infrastructure project (NorArgo2). Within the project we will purchase and deploy approximately 13 floats per year which include core, bio, bgc and deep floats. The infrastructure will have approximately 36 person months per year.

3. Summary of deployment plans

In 2018 we plan to deploy 14 floats which include 6 core floats, 2 BGC-floats, 3 Deep floats, and 3 Bio floats (floats with some extra sensors). The floats will be deployed in the Nordic Seas and Arctic Ocean/Barents Sea.

In 2019 we plan to deploy 13 floats including 3 BGC floats, 2 Deep floats, and 3 bio floats. The floats will be deployed in the Nordic Seas and Arctic Ocean/Barents Sea.

For the years 2020-2022 the deployment plan will be (nearly) similar as in 2019.

4. Summary of national research and operational uses of Argo data

Argo Norway focuses on both research topics and marine climate monitoring of the Nordic Seas. There is an increasing interest in using Argo data in Norway, and two climate centres are now using the data operationally in climate models. For instance, the operational TOPAZ4 modeling system assimilates Argo data into the ocean models to provide forecast product for the Nordic Seas and Arctic Ocean under the EUs Copernicus Marine Environment Monitoring Services (CMEMS, http://marine.copernicus.eu/).

The present scientific topics are mainly within the Nordic Seas (Norwegian, Iceland and Greenland Seas) and include:

- Studies of the deep ocean circulation in the Nordic Seas. These studies have so far brought new insights in the circulation of the Nordic Seas.
- Water mass changes and also in relation with biological activities. This topic is also one of the reasons that we have included bio sensors on the Argo floats.
- Studies that involve changes in the mixed layer.

5. Issues we wish to be considered and resolved

At the moment we have no suggestion.

6. Improving the quality and quantity of CTD cruise data

All ship CTD-data are sent to the ICES and EUs CMEMS.

7. The Argo bibliography

Mastropole, D., R. S. Pickart, H. Valdimarsson, K. Våge, K. Jochumsen, and J. Girton (2017), On the hydrography of Denmark Strait, *J. Geophys. Res. Oceans*, 122, 306–321, doi:10.1002/2016JC012007.

Eide, M., A. Olsen, U. S. Ninnemann, *and* T. Eldevik *(*2017*)*, A global estimate of the full oceanic 13C Suess effect since the preindustrial, *Global Biogeochem. Cycles*, 31, 492–514, *doi:*10.1002/2016GB005472.

Rossby, T., G. Reverdin, L. Chafik, *and* H. Søiland *(*2017*)*, A direct estimate of poleward volume, heat, and freshwater fluxes at 59.5°N between Greenland and Scotland, J. Geophys. Res. Oceans, 122, 5870–5887, *doi:*10.1002/2017JC012835.

Jeansson, E., Olsen, A., & Jutterström, S. (2017). Arctic Intermediate Water in the Nordic Seas, 1991–2009. *Deep Sea Research Part I: Oceanographic Research Papers*, 128, 82-97.

Argo-Poland National Report 2017

Waldemar Walczowski, Małgorzata Merchel
IO PAS, Sopot, Poland, 31.12.2017 r.

1. The status of implementation

Since 2009 IOPAS has deployed sixteen Argo floats. Eleven of them were launched in the Nordic Seas from the board of *r/v Oceania* and three in the same region aboard *r/v Horyzont II*. Since November 2016, also aboard *r/v Oceania*, IOPAS has launched two floats in the Baltic Sea.

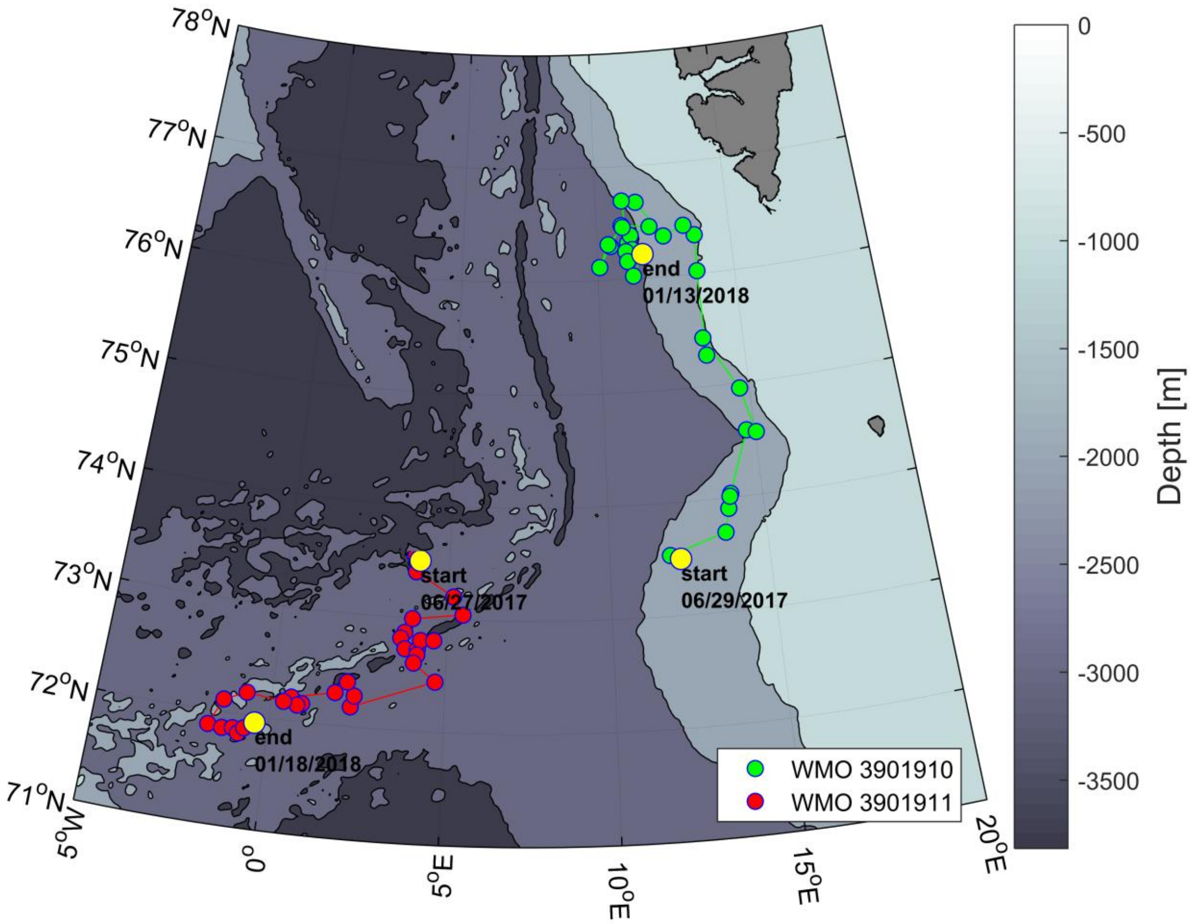


Figure 1. Surface position of two Argo floats deployed in the Norwegian and Greenland Seas in June 2017

Two Argo floats (WMO 3901910, 3901911) were deployed in the Norwegian and Greenland Seas from the board of *r/v Oceania* at the end of June 2017 (Fig.1). All instruments are the ARVOR-I floats with Iridium transmission system. Both floats were deployed under the EU MOCCA Project. The parking depth was set at 1000 dbars and profiling depth at 2000 dbars. They all have cycles of 7 days.

There were no technical problems with the two instruments. Every float was operated for the whole 2017 and has sent 27 complete sets of hydrographic data by the end of year.

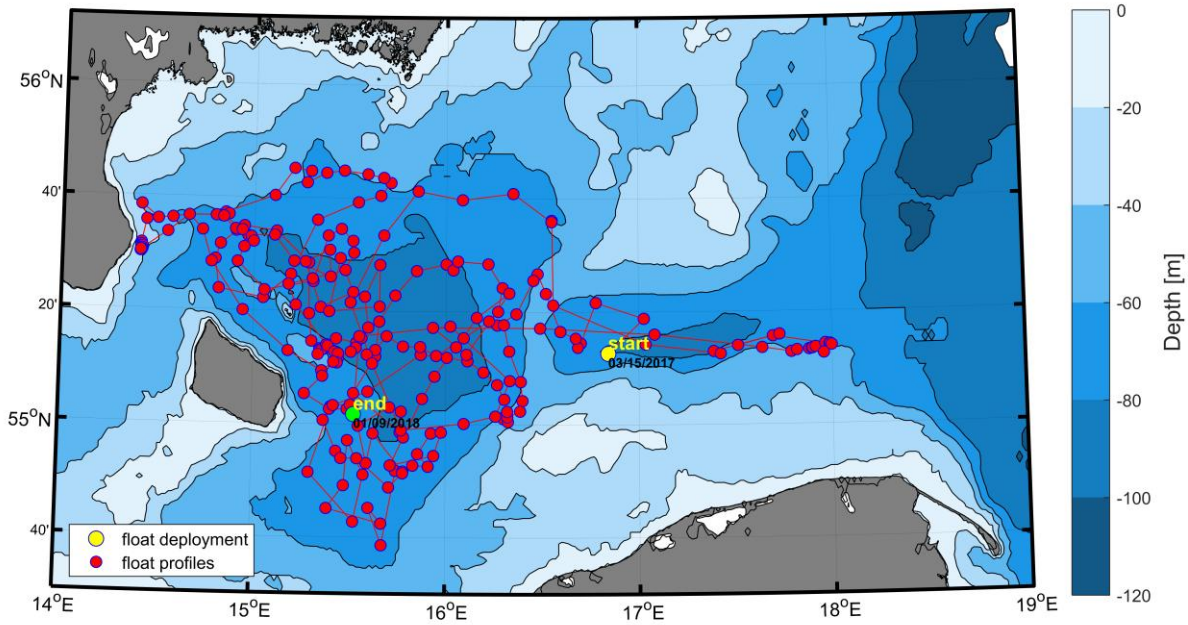


Figure 2. Surface position of Argo float deployed in the Baltic Sea in March 2017

The first Polish Argo float in the Baltic Sea (WMO 6902036) was redeployed from the board of *r/v Oceania* in the middle of March 2017 (WMO 3902100) (Fig. 2). The instrument is the APEX float with Iridium transmission system. The parking depth was set at 50 dbars and profiling depth at 85 dbars. It had cycles of 1-2 days. By the end of 2017 year the float has sent 230 sets of data.

Two floats deployed in June 2016 (WMO 3901850, 3901851) was also active during the 2017 year (Fig. 3). During their whole operating time, the floats have been sent 58 sets of hydrographic data.

Two floats deployed in September 2015 (WMO 6902038, 6902039) stopped transmission in February 2017. The floats have been sent respectively WMO 6902038 - 104, WMO 6902039 - 100 sets of hydrographic data.

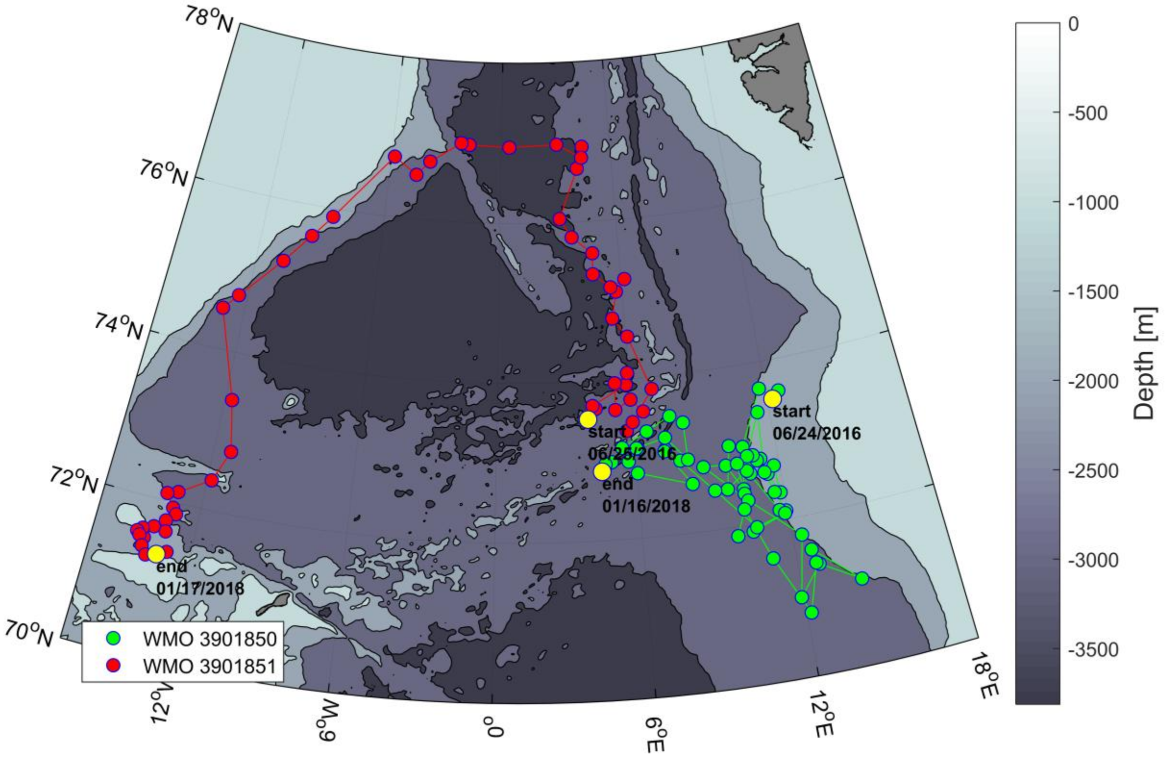


Figure 3. Surface position of two Argo floats deployed in the Nordic Seas in June 2016

2. Present level of and future prospects for national funding for Argo

The present level of the Polish national funding allow for purchase and deployment of two Arctic floats per year and one Baltic Sea float per one-two years (depending on price). There are some funds for coordination, technician works and PhD student. Travel, deployment, technical maintenance is covered. This level of funds is secured to 2020.

3. Summary of deployment plans

Poland committed to launching three Argo floats per year. In 2018 we plan to deploy 3 floats: two in the Nordic Seas region during the IOPAS Arctic cruise and one in the Baltic Sea during the IOPAS Baltic cruise. All of the floats will be launched from the board of *r/v Oceania*.

4. Summary of national research and operational uses of Argo data

IOPAS has been carried the scientific program aimed at investigation of the Atlantic Water inflow into the Arctic Ocean and climatic aspect of this process for over 20 years. Every summer expedition of IOPAS research vessel ‘Oceania’ to the Nordic Seas and Arctic Ocean is organized. Polish Argo floats are usually deployed during these cruises. The data obtained from the Argo floats support this research, in particular those concerning the advection of the warm Atlantic Water through the Nordic Seas and changes of Atlantic water properties. The Argo results are

compared with data from standard *in situ* measurements, used in calculation of the signal propagation velocities, currents pathways. The Argo measurements complement the lack of data in winter season.
We also use Argo floats to investigate hydrography and dynamics of the Baltic Sea.
The Argo Poland program's website is regularly updated by IO PAS:

http://www.iopan.gda.pl/hydrodynamics/po/Argo/argo.html

5. Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo.

We have no suggestion at the moment.

6. CTD data

In 2017 two Polish floats were deployed during IOPAS Arctic cruise AREX, when 237 CTD profiles have been done including the stations performed just before the floats deployment. IOPAS can provide this two stations CTD data to compare it with Argo floats. The Ago floats were deployed at section 'H', station H11, φ 73°30.610 N, λ 004°03.880 E, station H19, φ 73°30.050 N, λ 12°13.518 E.
Rest of the data (237 stations) from the Nordic Seas will be available via IOPAS database. Contact point: Waldemar Walczowski, walczows@iopan.pl.

7. The Argo bibliography

Goszczko, I., *Water mass transformation in the region influenced by the West Spitsbergen Current*, PhD thesis, defended on 22 June 2017.

Argo National Report – South Africa

Report to Argo Steering Team Meeting: March 2018

Compiled by: Tamaryn Morris – SAEON Egagasini Node.

For any queries or deployment requests, please email tammy@saeon.ac.za

The South African Argo Program presently is one of deployment opportunities and educational outreach as opposed to procuring of floats and seeding the global Argo array. However, we are striving to develop projects and funding opportunities in that direction. Given South Africa's unique position geographically of bordering three oceans – The Atlantic, Indian and Southern Oceans – we are able to provide numerous deployment opportunities for Argo floats to the global array. We are also working on dynamic research programs and experiments using Argo floats to a) study physical forcing dynamics and b) contribute to the development of biogeochemical floats particularly in the Southern Ocean. The research groups currently involved in the South African Argo program are: The South African Weather Services (SAWS) – who are the National Focal Point, University of Cape Town (UCT), the Department of Environmental Affairs (DEA), The Council for Scientific and Industrial Research (CSIR), The South African Environmental Observation Network (SAEON), and the Nansen-Tutu Centre for Marine Environmental Research.

1. Status of implementation (major achievements and problems in 2017):

Floats deployed and their performance (on behalf of UK MetOffice and Euro-Argo)

Southern Ocean:

SANAE Cruise (RV SA *Agulhas II*) – December 2017-February 2018

13 floats deployed for Euro-Argo (in collaboration with the Italian team), 3 x ice-monitoring capable floats, and 10 x Argos floats

Katharsis II yacht – December 2017

3 x ice-monitoring capable floats facilitated to the yacht for deployment on behalf of Euro-Argo

Indian Ocean:

Winter Cruise (RV *Algoa*) – July 2017

6 x Iridium floats deployed across the Agulhas Current on behalf of Euro-Argo

IIOE-2 Cruise (RV SA *Agulhas II*) – July 2017

4 x floats deployed on behalf of UK MetOffice off Tanzania and within the Mozambique Channel

Atlantic Ocean:

SAMBA (RV *Algoa*) – April 2017

4 x floats deployed on behalf of UK MetOffice along the SAMBA transect (Fig. 1 below)

SEAmester along the SAMBA transect (RV *Algoa*) – July 2017

> 4 x floats deployed on behalf of UK MetOffice along the SAMBA transect (Fig. 1 below), in addition to 2 x floats on behalf of Euro-Argo

Gough Island supply cruise (RV SA *Agulhas II*) – September 2017

> 4 x floats deployed on behalf of Euro-Argo along the Gough Island supply cruise transect

Technical issues encountered and solved:

None at this stage.

Status of contributions to Argo data management (including status of conversion to V3 file formats, pressure corrections, etc)

None

Status of delayed mode quality control processes:

Not applicable

2. **Present level of (and future prospects for) national funding for Argo including summary of human resources devoted to Argo:**

Dedicated Argo funding to procure new floats to seed the global array is currently being investigated through the South African Environmental Observation Network (SAEON). Individuals from organisations (listed above) work on different projects involving Argo floats and have come together under the auspices of the South African Argo program to share knowledge, resources, cruise time where applicable and information regarding Argo. We are working towards taking this forward now.

We have one Argo representative for the South African Marine Science community who is also looking to drive the Argo float procurements and data management plans in future endevours.

3. **Summary of deployment plans (level of commitment, areas of float deployment, low or high resolution profiles, extra sensors, Deep Argo) and other commitments to Argo (data management) for the upcoming year and beyond where possible:**

Southern Ocean:

Marion Island Cruise (RV SA *Agulhas II*) – April/May 2018.

This cruise follows the CrossRoads Transect on Figure 1.

> *available for Argo float deployments*

Gough Island Cruise (RV SA *Agulhas II*) – September 2018.

This cruise follows the SAMBA Transect on Figure 1.

> *available for Argo float deployments*

SANAE Cruise (RV SA *Agulhas II*) – December 2018 / January 2019.

This cruise follows the GoodHope Transect on Figure 1.

> *available for Argo float deployments*

Indian Ocean:

Agulhas System Climate Array (ASCA) mooring maintenance cruise – April 2018.

Refer to Figure 1 for positions.

9 x SOLO II floats will be deployed on behalf of US Argo team in to the Agulhas Current.

SEAmester Training Cruise (SA Agulhas II) – July 2018.

The cruise will undertake CTD stations along the ASCA transect. Refer to Figure 1 for positions.

available for Argo float deployments

International Indian Ocean Expedition (IIOE-2) Expeditions

Cruises are being developed for both the eastern and western Indian Ocean and these can be communicated for interested countries wanting to deploy Argo floats into the Indian Ocean. 2 APEX floats from the UK Met Office are available for a cruise in to the Mozambique Channel, most likely to take place in June / July 2018, however additional deployment opportunities are available.

Atlantic Ocean:

SAMBA Mooring Array (RV *Algoa*) – September / October 2018.

Refer to Figure 1 for positions.

available for Argo float deployments

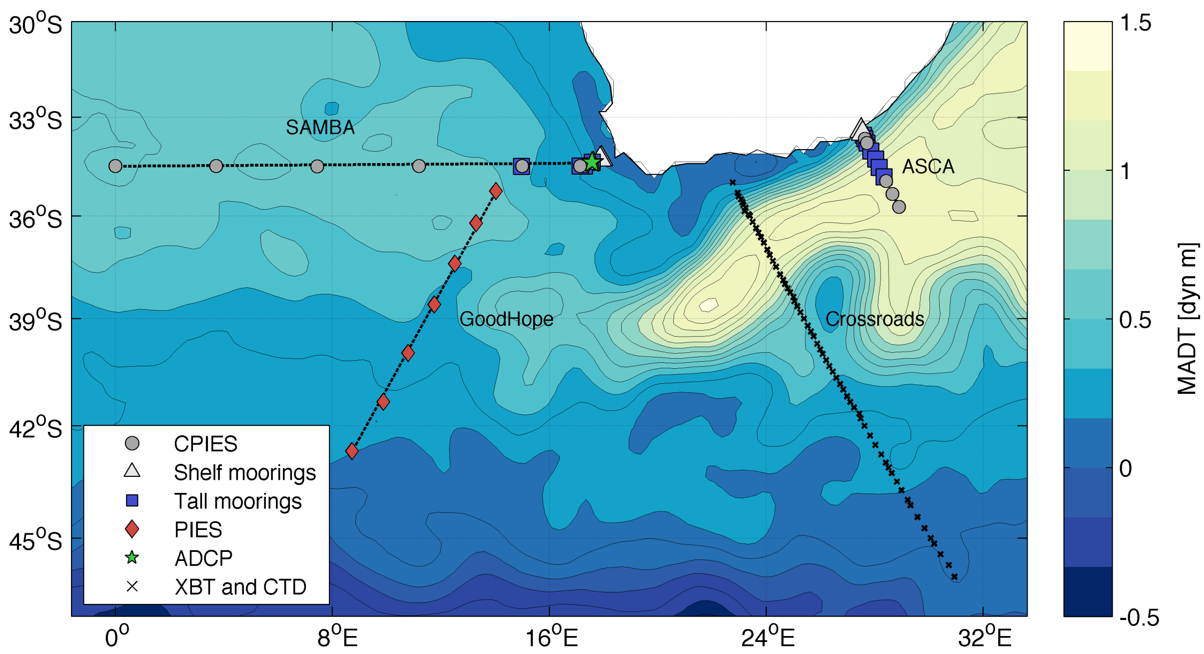


Figure 1: Large mooring array and CrossRoads transects around South Africa where floats could be deployed if available (Morris et al 2017).

4. **Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers. Please also include any links to national program Argo web pages to update links on the AST and AIC websites:**

   Projects and initiatives reported on in the AST report for South Africa from 2017 are ongoing. These will be reported on in more detail for the 2019 AST report, along with updated publications.

5. **Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo. These might include tasks performed by the AIC, the coordination of activities at an international level and the performance of the Argo data system. If you have specific comments, please include them in your national report.**

   None at this stage.

6. **To continue improving the quality and quantity of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include any CTD station data that was taken at the time of float deployments this year. Additionally, please list CTD data (calibrated with bottle data) taken by your country in the past year that may be added to the reference database. These cruises could be ones designated for Argo calibration purposes only or could be cruises that are open to the public. To help CCHDO track down this data, please list the dates of the cruise and the PI to contact about the data.**

   No data was loaded this year, but new data is available from the east coast of South Africa and will be loaded shortly.

7. **Keeping the Argo bibliography (http://www.argo.ucsd.edu/Bibliography.html) up to date and accurate is an important part of the Argo website. This document helps demonstrate the value of Argo and can possibly help countries when applying for continued Argo funding. We reached more than 2000 papers published using Argo data! To help me with this effort, please include a list of all papers published by scientists within your country in the past year using Argo data, including non-English publications. I've added a thesis citation list too (http://www.argo.ucsd.edu/argo_thesis.html). If you know of any doctorate theses published in your country that are missing from the list, please let me know**

   None at this stage.

Argo-Spain Annual Report 2017

Present status and future plans

Alberto González Santana, Pedro Vélez Belchí

Argo-España
Parte de la estrategia global de observación del océano

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

SOCIB Balearic Islands Coastal Observing and Forecasting System

1. Introduction

In 2002, Argo-Spain started the Argo program through a European project where a total of 80 Argo profilers were deployed in the North Atlantic. Since then, data have been collected in order to reach the scientific objectives scheduled:

- Oceanographic data is assimilated into operational models.
- Results of the models are used to redesign observation and measurement strategies.
- Information of subsurface water is used in ocean - atmosphere models, essential for medium and long-term predictions.
- Getting information of salinity and temperature fields at different depths, mixing layer, thermocline depth and its seasonal and spatial variability.
- Data will make strong the Argo ocean observing system, allowing optimal and accurate estimations of the fields and flows into the ocean in climate modeling and statistical analysis of variability.

Data from Argo floats is transmitted from the float and passed through processing and automatic quality control procedures. The target is to issue the data to the GTS and Global Data servers as quickly thereafter as possible. These are called real – time data (RT). The data are also issued to the Principle Investigators. These scientists apply other procedures to check data quality. The main target is to return the processed data to the global data centers within 6 to 12 months. These procedures are called the delayed mode (DM). The adjustments applied to delayed-data may also be applied to real – time data, to correct sensor drifts for real – time users. However, these real – time adjustments will be recalculated by the delayed mode quality control (DMQC).

The main working area covers the North Atlantic Ocean, Canary Islands region and Mediterranean Sea. This allows us to get a general perspective of completely different ocean dynamics.

In this document we briefly describe all the stages of the data management (data processing, data correction and generation of data products and figures) of the DMQC for Argo-Spain floats. It is designed to process data of the most widely used and commercially exploited Argo platforms (APEX, ARVOR and NAVIS).

2. The status of implementation

The Argo-Spain program started in 2002 and is currently coordinated by the IEO. Since then, 67 floats have been deployed, of which 7 are active at the end of 2017.

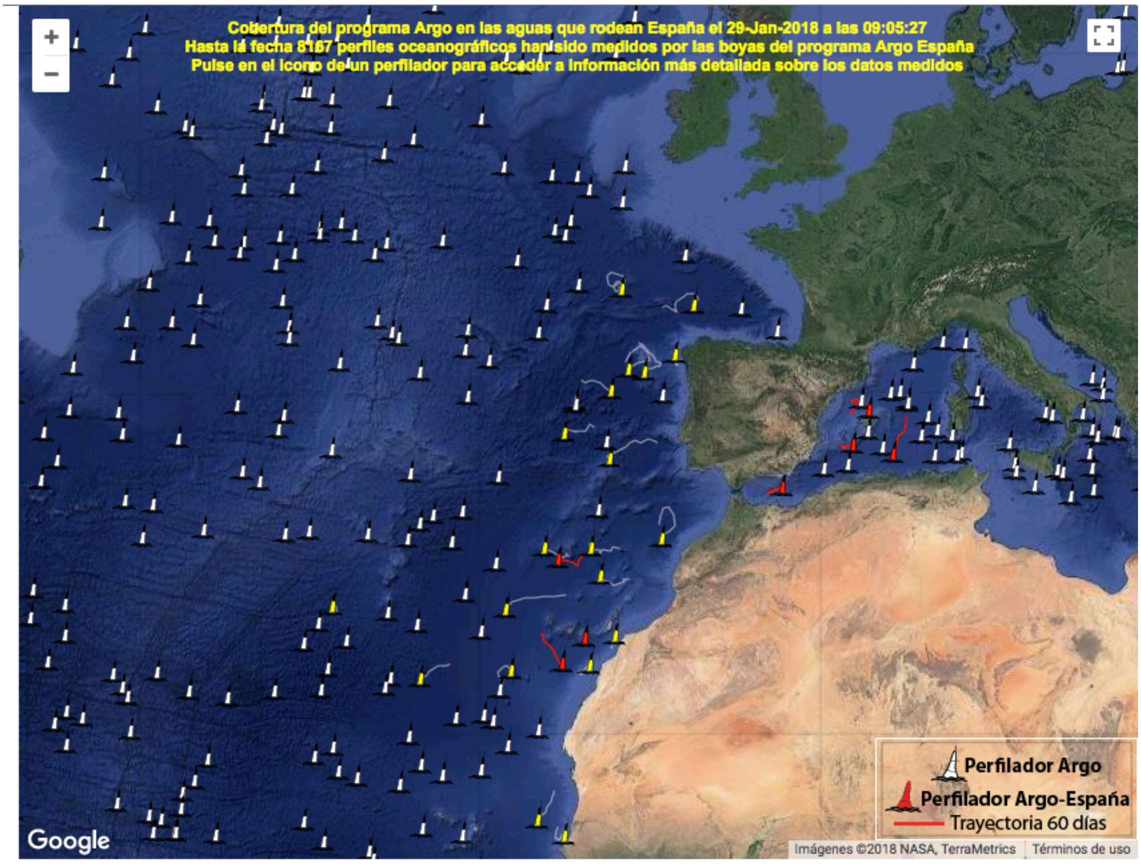


Figure 1. Status of the Argo Spain program on February 5th 2018. Altogether, 68 floats have been deployed.

The following table shows relevant information of each Argo-Spain float. It is a database that records information of some features from the deployment until the floats stop completely.

WMO ID	Status	PROJECT_NAME	FLOAT_OWNER	PLATFORM_TYPE	CONTROLLER_BOARD_TYPE_PRIMARY	Depl. Date (DD/MM/YYYY)
1900275	**EOWL**	Argo SPAIN	IEO	APEX	APF8C	21/09/2003
1900276	**EOWL**	Argo SPAIN	IEO	APEX	APF8C	22/09/2003
1900277	**EOWL**	Argo SPAIN	IEO	APEX	APF8C	24/09/2003
1900278	**EOWL**	Argo SPAIN	IEO	APEX	APF8C	19/09/2003
1900279	**EOWL**	Argo SPAIN	IEO	APEX	APF8C	27/09/2003
1900377	**EOWL**	Argo México	IEO	PROVOR		04/05/2005
1900378	**EOWL**	Argo Costa Rica	IEO	PROVOR		07/12/2005
1900379	**EOWL**	Argo Costa Rica	IEO	PROVOR		07/12/2005
4900556	**EOWL**	Argo SPAIN	IEO	PROVOR		05/03/2005
4900557	**EOWL**	Argo SPAIN	IEO	PROVOR		10/09/2004
4900558	**EOWL**	Argo SPAIN	IEO	PROVOR		10/09/2004
6900230	**EOWL**	Argo SPAIN	IEO	APEX	APF8C	13/09/2003
6900231	**EOWL**	Argo SPAIN	IEO	APEX	APF8C	18/12/2003
6900506	**EOWL**	Argo SPAIN	IEO	APEX		13/09/2006
6900633	**NW**	Argo SPAIN	ICM	APEX	APF8C	14/02/2012
6900634	**NW**	Argo SPAIN	ICM	APEX	APF8C	14/02/2012
6900635	**EOWL**	Argo SPAIN	ICM	APEX	APF8C	09/11/2011
6900636	**Active**	Argo SPAIN	ICM	APEX	APF8C	28/07/2012
6900659	**EOWL**	Argo SPAIN	SOCIB ICTS	APEX		12/01/2011
6900660	**EOWL**	Argo SPAIN	SOCIB ICTS	APEX	APF8C	08/09/2011
6900661	**EOWL**	Argo SPAIN	SOCIB ICTS	APEX	APF8C	22/06/2011
6900662	**EOWL**	Argo SPAIN	SOCIB ICTS	APEX	APF8C	10/06/2012
6900760	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	05/09/2010

6900761	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	06/09/2010
6900762	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	11/09/2010
6900763	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	10/09/2010
6900764	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	01/02/2011
6900765	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	03/02/2011
6900766	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	16/12/2010
6900767	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	24/12/2010
6900768	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	27/12/2010
6900769	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	04/02/2011
6900770	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	07/02/2011
6900771	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	07/02/2011
6900772	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	27/10/2010
6900773	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	15/02/2011
6900774	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	20/02/2011
6900775	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	23/02/2011
6900776	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	25/02/2011
6900777	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	26/02/2011
6900778	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	01/12/2010
6900779	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	01/12/2010
6900780	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	25/01/2011
6900781	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	26/01/2011
6900782	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	27/01/2011
6900783	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	01/12/2010
6900784	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	05/09/2010
6900785	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	06/09/2010
6900786	**EOWL**	Argo SPAIN	SOCIB ICTS	APEX	9I-8373	01/05/2012
6900787	**EOWL**	Argo SPAIN	SOCIB ICTS	APEX	9I-8500	15/07/2013

6900788	**EOWL**	Argo SPAIN	SOCIB ICTS	APEX	9I-8496	15/04/2013
6900789	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	13/12/2012
6901237	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	21/12/2012
6901238	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	17/09/2013
6901239	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	27/07/2015
6901240	**Active**	Argo SPAIN	IEO	APEX	APF9A	20/04/2014
6901241	**EOWL**	Argo SPAIN	IEO	APEX	APF9A	10/12/2012
6901242	**EOWL**	Argo SPAIN	SOCIB ICTS	APEX	APF 9i-9253	01/10/2014
6901243	**Active**	Argo SPAIN	SOCIB ICTS	APEX	9i-9271	22/11/2014
6901244	**EOWL**	Argo SPAIN	SOCIB ICTS	APEX	9i-9283	11/27/2015
6901245	**Active**	Argo SPAIN	SOCIB ICTS	ARVOR		21/11/2014
6901246	**Active**	Argo SPAIN	Euro Argo	ARVOR_D	70-10-444-000	03/02/2015
6901247	**Active**	Argo SPAIN	SOCIB ICTS	APEX	APF 9i-9253	01/10/2014
6901248	**Active**	Argo SPAIN	IEO	ARVOR_D	70-10-444-000	01/11/2016
6901249	**Active**	Argo SPAIN	SOCIB ICTS	ARVOR	70-10-596	19/02/2017
6901250	**Active**	Argo SPAIN	SOCIB ICTS	ARVOR	70-10-596	10/07/2017
6901251	**Active**	Argo SPAIN	SOCIB ICTS	ARVOR	70-10-596	19/12/2017

Floats deployed and their performance

During 2017, a total of 3 Argo floats were deployed by Argo-Spain:

- 3 ARVOR - I floats (Argo SPAIN) in the Mediterranean Sea.

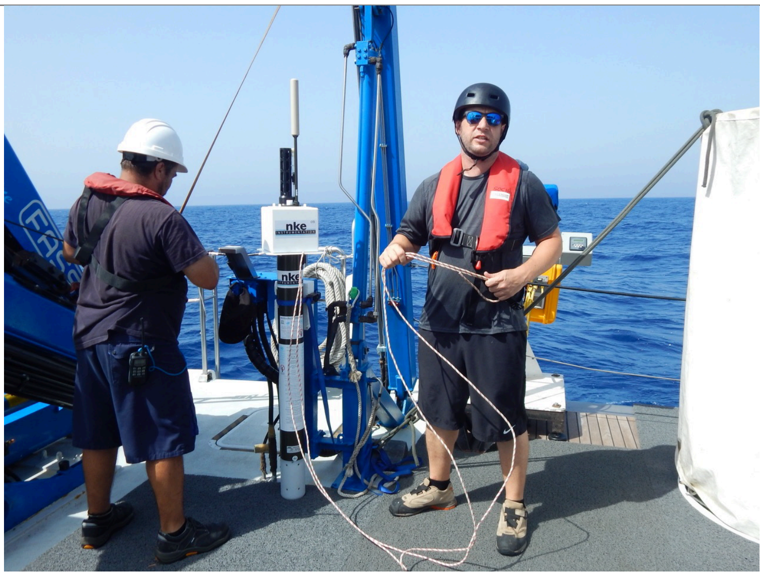


Figure 2. SOCIB staff moments before the deployment of WMO 6901251 under safety measures at *IRENE* survey.

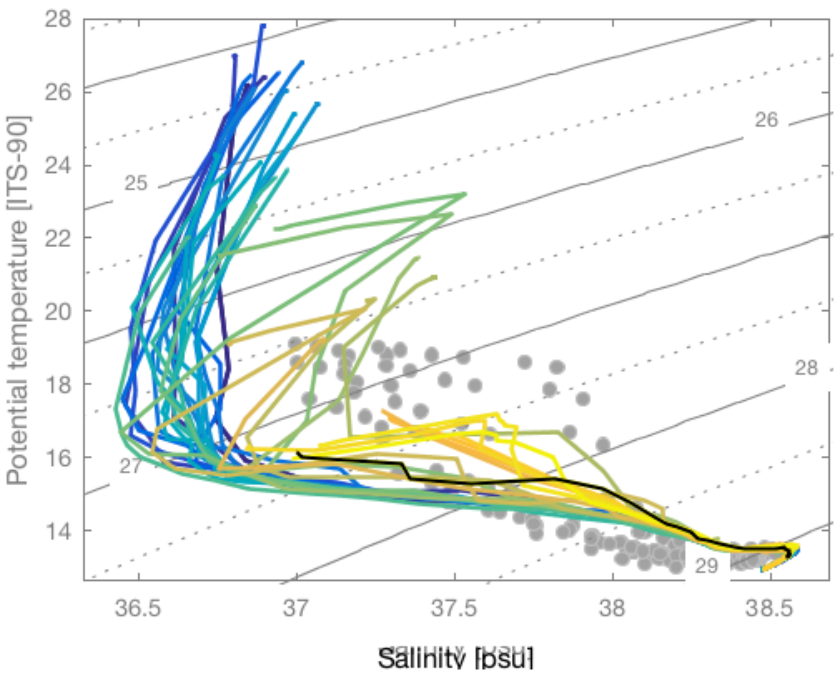


Figure 3. T-S diagram of WMO 6901251.

For instance, the ARVOR – I 6901251 is currently diving south of the Balearic Islands archipelago after 35 profiles developed (Fig. 3). The float was programmed to dive up to 2000m every 5 days measuring temperature and salinity during the ascending phase, developing a profile depth of 700m within a parking depth of 350m.

Technical problems encountered and solved

Float WMO 6901250 was deployed on July 10th, 2017 in the Mediterranean Sea. The float didn't dive up properly and drifted on surface under dangerous conditions (possible cruise crash and extra bio deposition) for almost a month. Location position was reported every hour but any profiles carried out since the deployment. After some checks, the trouble was identified: Float failed during autotest, because of internal vacuum issues that mostly happens when the float was tested after been exposed in high sunny conditions (boxes on the deck). Parameters were corrected and WMO 6901250 carried out its first profile on August 6th, so far, the float is in good conditions.

Status of contributions to Argo data management (including status of pressure corrections, technical files, etc)

After each deployment, the detailed technical information is provided to the DAC in charge of the floats (Coriolis) and to the AIC. The Argo-Spain program is aware of the changes in the technical and metadata data formats and is providing the necessary information. Some of the earlier floats deployed by Spain were affected by TNPD. Most of these floats were already corrected during 2017, but the total corrected files will be submitted during 2018.

Status of delayed mode quality control process

Argo-Spain mainly deploys floats in the Atlantic Ocean and Mediterranean Sea. In terms of DMQC, Argo-Spain manages its floats that operate in the Atlantic Ocean and the Instituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS) manages all the floats that operate in the Mediterranean Sea, including floats of Argo-Spain. The DMQC of the Argo Spain floats that operate in the Mediterranean Sea will be assumed by Argo Spain itself at some point, always subject to personnel availability.

Argo-Spain float fleet is comprised of 67 floats deployed so far. A total of 47 floats have been deployed in the Atlantic Ocean and 20 floats deployed in the Mediterranean Sea (fig. 4).

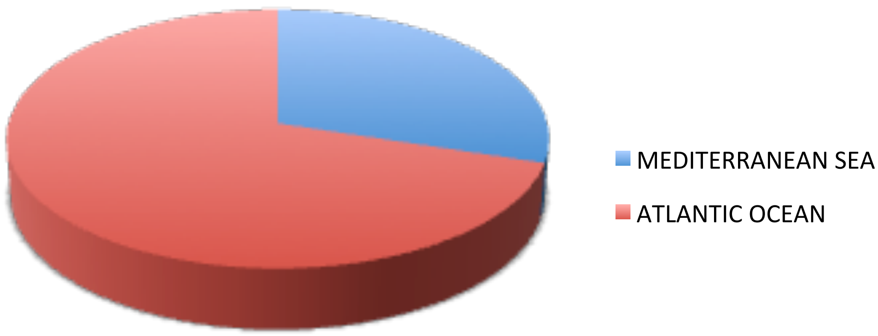


Figure 4. Argo-Spain floats fleet

DMQC have been carried out for 16 floats in 2016 (34%), for 19 floats (40,5%) in 2017. It is planned to carry DMQC for the remaining 9 floats (19%) during 2018 (fig. 5). All the Argo-Spain should have gone through the first round of DMQC during the first semester of 2018. Significant improvements have been made in the processing of the data in Argo-Spain.

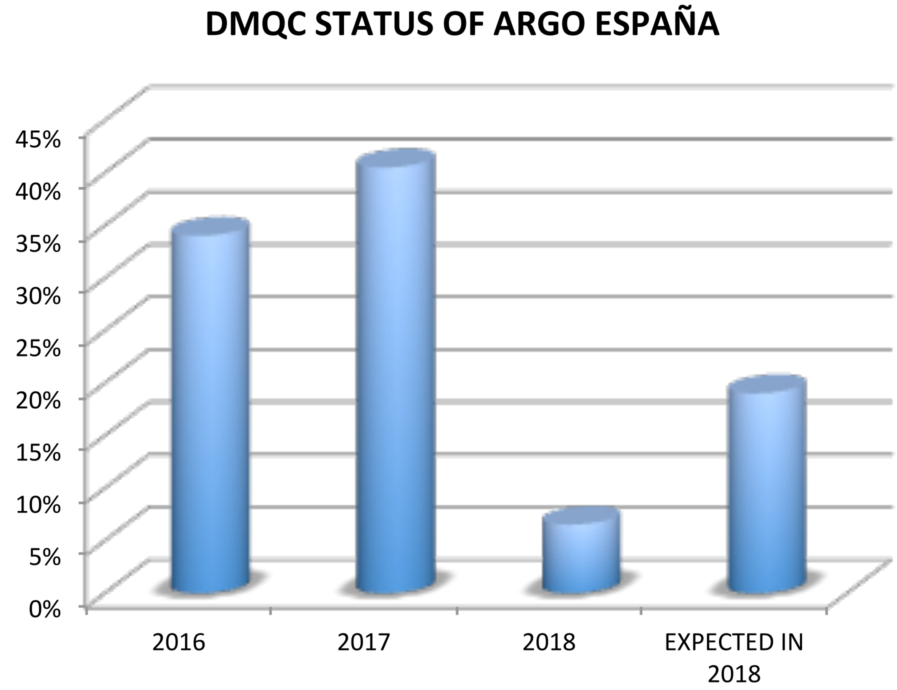


Figure 5. Argo-Spain floats fleet.

3. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.

Aware of the importance of the role that Spain should play and development opportunities, the *IEO* and the *Coastal and Prediction Observation System of the Balearic Islands* (SOCIB) have assumed the financial commitment that entails that Spain takes part as a full member of the Euro-Argo research infrastructure, thus the deployment of at least 3 Argo floats per year since 2015 has been ensured. On January 1, 2017, Spain joined definitively as a full member of the European infrastructure Euro- Argo.

The funding covers for 2018-2020 float procurement in the period 2018-2021 (5 argo floats per year), transmission costs and part-time personnel support. The *IEO* funds the scientific coordination (0.25 FTE). In addition, a specific budget from Ministry of Economy has been assigned to incorporate 1 FTE technician that expires in October, 2018. Besides the long-term support from the IEO, SOCIB will deploy 3 Argo floats per year in the Western Mediterranean until 2021.

4. Summary of deployment plans and other commitments to Argo for the upcoming year and beyond where possible.

The deployment plan has been submitted to the IAC. Although the ultimate deployments may change following feedback from the Spanish research community, the current plan is:

- 3 floats (ARVOR -I) to be deployed in the Mediterranean Sea in 2018, 2019, 2020 and 2021
- 5 floats (ARVOR -I) to be deployed in the Atlantic Sea in 2018, 2019, 2020, and 2021
- 1 float (DEEP ARVOR) to be deployed in the Eastern Atlantic in 2018

- 1 float (DEEP ARVOR) to be deployed in the Galician Bank in 2018

Point out that both Deep Arvor floats are part of the AtlantOS European project and are Euro-Argo floats.

5. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers.

Argo is used by many Spanish researches to improve the understanding of the climate and ocean variability. Ocean and weather forecast operational models also use Argo data. The web page of the Argo Spain program is: http://www.argoespana.es

6. Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo.

None.

7. To continue improving the quality and quantity of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include any CTD station data that was taken at the time of float deployments this year. Additionally, please list CTD data (calibrated with bottle data) taken by your country in the past year that may be added to the reference database. These cruises could be ones designated for Argo calibration purposes only or could be cruises that are open to the public. To help CCHDO track down this data, please list the dates of the cruise and the PI to contact about the data.

A CTD cast is performed after most of the Argo-Spain deployments. However, the data have not been submitted to the CCHDO website due to lack of personnel during 2017. This task will be undertaken throughout 2018.

8. List of all papers published by scientists within Spain in the past year using Argo data, including non-English publications.

- Olita, A., Capet, A., Claret, M. et al. Frontal dynamics boost primary production in the summer stratified Mediterranean Sea. Ocean Dynamics (2017) 67: 767. https://doi.org/10.1007/s10236-017-1058-z
- Sánchez-Román, A., Ruiz, S., Pascual, A., Mourre, B., and Guinehut, S. On the mesoscale monitoring capability of Argo floats in the Mediterranean Sea, Ocean Sci., 13, 223-234, https://doi.org/10.5194/os-13-223-2017, 2017.
- Fernandez, D., P. Sutton, and M. Bowen (2017), Variability of the subtropical mode water in the Southwest Pacific, J. Geophys. Res. Oceans, 122, 7163–7180, doi:10.1002/2017JC013011.
- Somavilla, R., C. González-Pola, and J. Fernández-Diaz (2017), The warmer the ocean surface, the shallower the mixed layer. How much of this is true? J. Geophys. Res. Oceans, 122, 7698–7716, doi:10.1002/2017JC013125.

UK ARGO PROGRAMME

REPORT FOR 19TH ARGO STEERING TEAM MEETING, MARCH 2018

1 Introduction

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

The most pressing issue for the UK programme remains on securing ongoing funding for UK Argo, in particular for core Argo floats, and ensuring that data is delivered (in real-time and delayed-mode) from both our core and non-core (e.g. floats with additional sensors) to the WMO GTS and GDACs.

Internationally, it is imperative to the UK that the core Argo array is complemented by the Argo extensions into deeper profiling, bio-geochemistry and high latitudes, such that these do not lead to a reduction in core Argo below its target density or its ability to deliver core data to users.

2 Status of implementation

2.1 Floats deployed and their performance

Figure 1 shows the number of UK floats procured and deployed each year since 2000. The number purchased each year has been somewhat variable as it has largely been reliant on the release of additional in-year or year-end (under-spend) funding. As a result, the number of deployments each year has also been variable, with 53 floats deployed in 2017 (a new UK record!), with over the last five years an average of 42 floats/year having been deployed. Since 2012, the number of non-core floats deployed has increased. In 2017, 18 of the 53 UK floats deployed were deep, bio or core floats deployed at high latitude (> 60S).

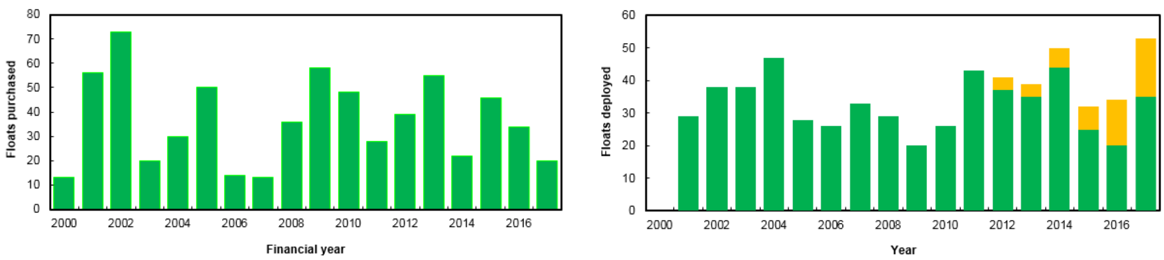


Figure 1. Showing (left) the number of floats procured each financial year (Apr-Mar) and (right) the number deployed in each calendar year. Yellow bars indicate non-core float deployments.

In 2017, float deployments have been made in the North Atlantic, South Atlantic, Southern Ocean, and Indian Ocean (Mozambique Channel and Bay of Bengal). The 53 floats deployed include: 33 core Argo floats, two core Argo floats (with RBR sensor), four deep floats, six T/S/O2 floats, and six T/S/O2/pH floats. Of these, three failed immediately (the core with RBR float deployed in Bay Of Bengal on 10/02/17; two Deep Apex in Drake Passage in December 2017). At present only data from the core floats are being processed by BODC and delivering data to the GTS and GDACs. Coriolis is presently processing our 11 PML-funded BGC Provor floats.

With the floats deployed the number of UK floats presently contributing data to Argo (including those provided to and deployed by Mauritius) is 164 (*as at 21/02/18, JCOMMOps query for UK & Mauritius 'operational' floats*), as shown in Figure 2, with their geographic distribution shown by Figure 3. Of the 164 operational floats, the majority are TWR Apex floats using Argos communications (139). The remaining 25 use Iridium communications and comprise: 7 Apex core floats, 11 PROVOR BGC floats and 7 NAVIS core floats.

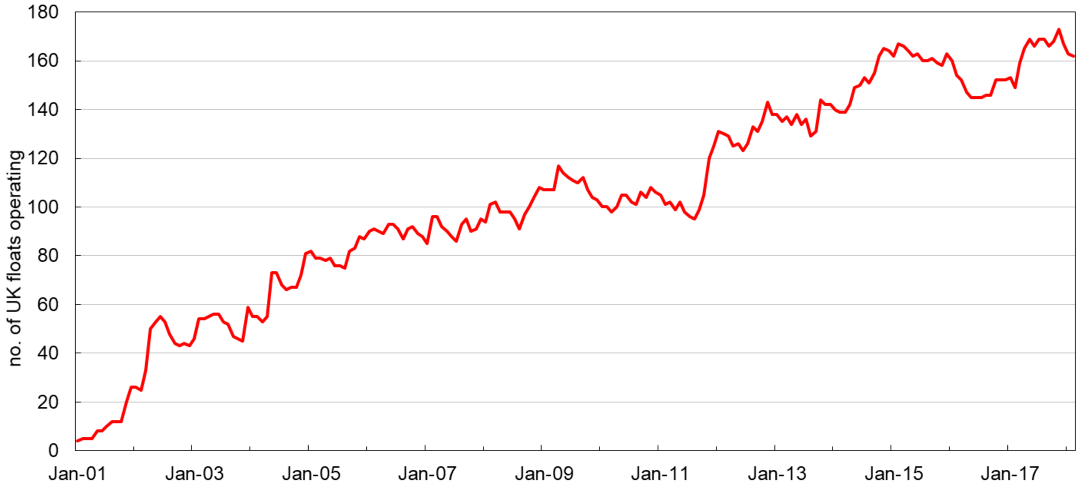


Figure 2. Number of UK (including Mauritius) floats with data on Coriolis GDAC by month (164).

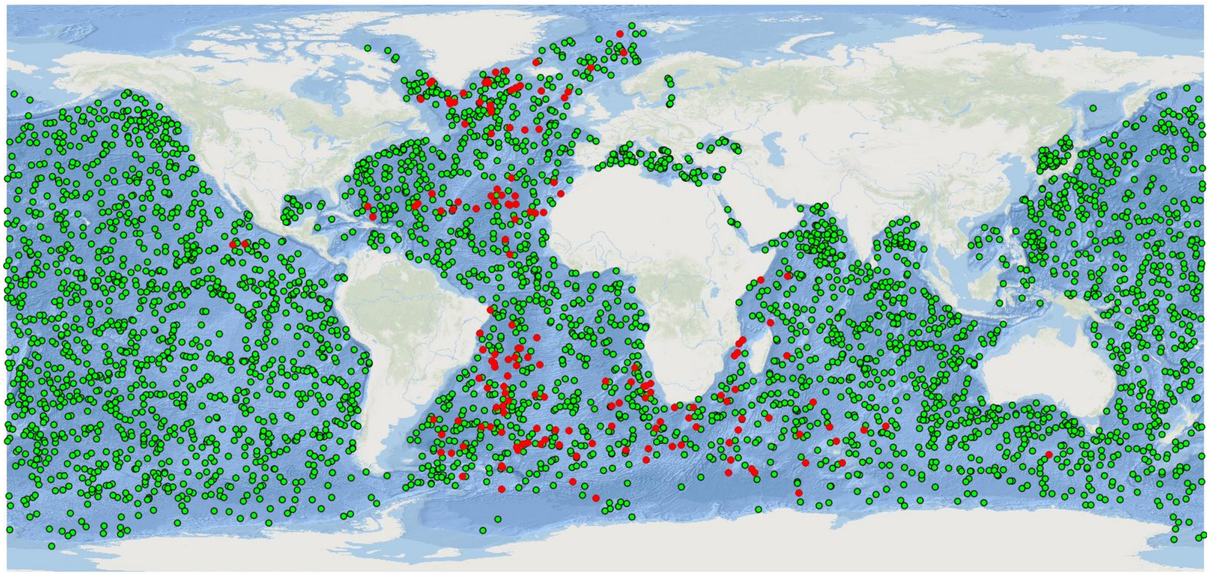


Figure 3. Showing the locations of reporting UK (and Mauritius) floats (in red) with the global network (in green), as at 21st February 2018 (164).

However, there are a number of active floats (additional sensors, deep, RBR CTD) deployed in recent years for which data processing has not yet been set up (so are not included in Figures 2 and 3). At 21 February 2018, we have a further 31 floats in operation for which the data are not yet being processed:

- 6 Apex with T/S/O2/pH (all deployed in South Atlantic near South Georgia, Nov 2017)

- 3 Apex with RBR (2 at 60N in Atlantic, Jun/Jul 2016; 1 at 28N in Atlantic, Oct 2017)
- 4 Apex with STS (all deployed in Bay of Bengal, Jun 2016)
- 6 Apex Deep (2 T/S at 24N in Atlantic, Dec 2015; 4 with T/S/O2 in Drake Passage, Dec 2017)
- 1 Arvor Deep (at 24N in Atlantic, Jan 2016)
- 3 Navis with radiometer (Bay Of Bengal, Jun 2016)
- 8 Navis T/S with Iridium (45S in Atlantic, Jul 2016; 34S in Atlantic, Jan 2017)

The UK's total number of floats in the water is 195, with 164 of these presently reporting data in real time. A priority for the coming year will be to ensure that the data (at least for T/S) are processed and delivered to the GTS and GDACs.

At this time, we have eight floats with NOAA for deployment during the IO7N section, plus the following floats in storage in the UK: 30 core floats, four deep T/S floats, four deep with T/S/O2, three bio-geochemical floats, two Apex oxygen floats, two Navis oxygen floats and one with the RBR CTD. We also have 20 core T/S floats on order, due to be delivered in March 2018. PML plan to buy a further 2 BGC floats for PICCOLO[1] during 2018. This will give a total 'stock' of 50 core and 18 non-core floats.

From these floats we plan to deploy 41 to 43 during 2018:

24 T/S Core:
- 8 Apex (IO7N, with NOAA, exact dates tbc, Apr-Jun 2018)
- 2 Apex (North Atlantic OSNAP moorings cruise, Stuart Cunningham, Jun 2018)
- 2 Apex (SW Indian / Mozambique Channel, Tammy Morris, Jun 2018)
- 2 Apex (SE Atlantic, Tristan da Cunha line, Tammy Morris, Sep 2018)
- 4 Apex (Atlantic, AMT28 cruise, Glen Tarran, Sep-Oct 2018)
- 4 Apex (26N RAPID cruise, David Smeed, Oct-Nov 2018)
- 2 Apex (Mauritius)

4 T/S core deployed at High Latitude:
- 4 Apex with Ice avoidance (PICCOLO cruise, Weddell Sea, Dec 2018)

4 T/S/O2:
- 2 Apex with O2
- 2 NAVIS with O2
- (all 4 on South Atlantic, 24S line, Brian King, March-April 2018)

4 deep with O2:
- Apex Deep (South Atlantic, 24S line, Brian King, March-April 2018).

5 BGC:
- 3 Seabird NAVIS.
- 2 type to be confirmed, awaiting outcome of UK Framework tendering process.
- (all 5 on PICCOLO cruise, Weddell Sea, December 2018)

Possible but not definite:
- 1 RBR paired with 1 Apex Iridium float (not yet purchased), in North Atlantic sub-tropical gyre.

This will leave around 26 core and 4-5 non-core 'in stock' going into 2019, plus around 20 core floats expected to be purchased in 2018, which should allow for continuity of deployments for around one year if there is a funding shortfall in future.

2.2 Technical problems encountered and solved

2.2.1 Non-core float technology

Bio-geochemical Argo. Eleven UK PROVOR BGC floats are being processed at Coriolis until BODC are able to take over the code.

[1] PICCOLO: Processes Influencing Carbon Cycling: Observations of the Lower limb of the Antarctic Overturning (

Oxygen & pH. Six Apex floats with T/S/O2/pH were deployed at one site near South Georgia during November 2017 (COMICS cruise). CTD stations were performed simultaneously, to aid calibration and QC.

Deep Argo. In December 2015 and January 2016 we deployed two Apex Deep and two Deep Arvor floats in the North Atlantic. The Deep Apexs performed 50 profiles and 127 profiles, lasting until June 2016 and April 2017 respectively. One of the Deep Arvors failed after one cycle, the other failed sometime before September 2017 (Fiona/Jon can't be more specific on the fail date, because we cannot look any further back than this in the CLS mydata application).

Three Deep Apexs with O2 (deployed and recovered during December 2016 after leaking at 2-7 cycles) were shipped back to Teledyne Webb for investigation, to find out the cause of the leak. These have been repaired and were deployed with one other Apex Deep in Drake Passage during December 2017. Of these four, one never transmitted, one transmitted on its day of deployment but never again, and two are transmitting well but the data has serious quality problems (Yvonne Firing, *pers. comm.* 8^{th} March 2018).

Apex floats with RBR CTD: Two RBR floats were meant to be deployed during the BoBBLE (Bay of Bengal Boundary Layer Experiment) cruise in June 2016. The first one failed immediately after deployment so the second was returned to India for a firmware upgrade. This float was subsequently deployed in February 2017 but failed (in spite of passing all pre-deployment checks). The two floats have not been recovered. The UK has three other RBR floats operating in the North Atlantic without problems in the network (see 2.1).

2.2.2 Core float performance

Float lifetime. At the 2016 Argo Steering Team meeting it was reported that float longevity had improved up to 2005, but since then there have been dips in longevity. There was also great diversity in performance across programs, some achieving long life (50% reaching 200 profiles) and others short lifetimes (50% only reaching 100 profiles). This behaviour is clearly evident in the UK's floats, the vast majority of which have been Webb Apex floats, as shown in Figure 4. For floats deployed 2004-2006 50% of floats exceeded 160 cycles, for 2007-2009 floats 48% reached 170 cycles but for floats deployed 2010-2012 only 47% of floats reached 160 cycles. Since 2007 we have fitted lithium batteries in over 50% of Apex floats deployed, so those floats deployed 2007-2009 are showing the greatest longevity.

For floats deployed 2013-2015, the statistics put them in 'second place' behind the 2007-2009 batch, with over 70% of floats performing 120 cycles. At the time of the 2017 AST meeting, it appeared the UK was experiencing a downturn in longevity of our core Apex floats. This year, the picture is more encouraging.

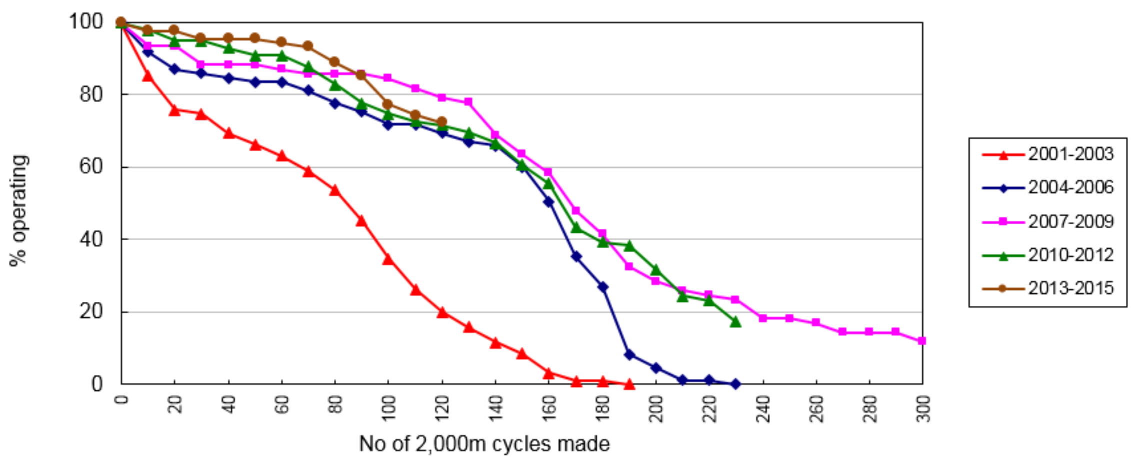


Figure 4. Number of (normalised to 2,000m) cycles made by UK standard Apex floats deployed in 2001-2003, 2004-2006, 2007-2009, 2010-2012 and 2013-2015 (updated 22 February 2018).

2.3 Status of contributions to Argo data management

2.3.1 DAC functions and real-time data processing

BODC retrieves data for all UK, Irish, Mauritius and EU MOCCA floats from a number of sources and archives these for further processing. Where possible, processing of arriving data is normally setup within one week of float deployment, and during the past year this has typically been achieved much more quickly.

During the past year, BODC has transitioned to retrieving all Iridium Rudics float data from the new CLS SFTP server, providing greater security and file integrity, and allowing us to terminate the FTP-push of data to our FTP by CLS. BODC has been working with CLS to address issues that arose during this migration and these have been resolved. BODC has also established a robust method for handling SBD Iridium messages received via email.

All core data received for currently processed floats are distributed to the GDACs within one hour of the data arriving at BODC, with the real-time quality control tests applied. Any file that fails to be transferred is queued for the next transfer attempt. BODC has not yet completed the conversion to v3.1 for all file types, although great improvement has been made (> 60% of core profiles are now delivered in v3 netCDF format as at November 2017, compared with ~ 30% at Nov 2016).

Processing of floats for the EU MOCCA project began at BODC in December 2016, increasing the total of core floats being processed by 46 at November 2017. This included the deployment of decoder software provided by Coriolis to augment the BODC Argo System. During 2017, BODC uprated automated data processing such that data are now submitted to the GTS four times a day, rather than twice a day as was previously the case. An issue identified with the application of the BODC greylist to a small subset of floats has now been resolved.

Distribution of all core data to the GTS from all BODC managed floats is a priority, including core data from floats with any type of Argo extension (deep, BGC or auxiliary data). BODC's current focus is to ensure all floats with an APF9I controller board are effectively managed within the BODC Argo System, and attention will then turn to floats with other controller boards such as the APF11. BODC is seeking to collaborate with other DACs in the development of APF11 decoders.

There remains further work to complete the conversion of the remaining core profile files, with the conversion to v3.1 for technical and trajectory files due after this work has been completed. We are not currently issuing any BGC-Argo files for UK floats due to the current focus on core profile data. The exception to this is the dozen PROVOR floats kindly hosted for BODC by Coriolis until such time as BODC can take over the real-time processing.

2.3.2 BUFR TM 3-15-003 for GTS data distribution

BODC has begun making all netCDFs available directly to the Met Office via SFTP and this is now occurring on a routine basis four times a day. Upon receipt of the netCDF files, the Met Office runs Python 2.7 software that converts netCDF to BUFR. The Met Office issues BUFR to the GTS four times per day. We are in the final stages of testing this system, and the intention is to switch off BODC's BUFR generating software very soon. After this switch-off, the Met Office will assume responsibility for the BUFR generation and distribution on the GTS. In the near future, the Met Office will make the BUFR converter freely available for use. The code has been designed to be extensible, where capability for secondary temperature/temperature and salinity, and oxygen profiles will be added plus other BGC variables when required. The Met Office plans to begin work to extend the Python code to include secondary T/S and oxygen profiles during 2018.

2.3.3 GDAC activity

The UK does not currently make a direct contribution to GDAC functions, although BODC has contributed to the development of the Argo DOI and has begun suppling some auxiliary data files to the new auxiliary directories at Ifremer for floats funded by the EU MOCCA project.

BODC-NOC and Ifremer won a small 15 k Euro grant to progress the Argo DOI from Research Data Alliance (RDA) Europe. Ifremer migrated the Argo snapshots to a single DOI (http://doi.org/10.17882/42182) in March 2016. A '#' key is used to identify the monthly snapshots within the archive on SEANOE, e.g. http://www.seanoe.org/data/00311/42182/#45420 . The '#' means that the identification of the snapshot is evaluated on the browser rather than the DOI resolving server making it possible to use a single DOI without a change to the DOI system.

2.4 Status of delayed mode quality control process

All delayed-mode QC on BODC hosted floats is performed within BODC, with the exception of some floats funded under the Euro-Argo MOCCA project. Currently BODC is only capable of providing data for delayed mode QC for core data, with work required to finish the delivery of biogeochemical parameters in v3.1. Again, the exception to this are a dozen PROVOR floats that Coriolis is kindly hosting on BODC's behalf.

During 2017, BODC has regenerated delayed mode QC capability though a software and procedural review, accompanied by knowledge transfer primarily from Justin Buck to Matt Donnelly. BODC use OW software for delayed mode quality control with the latest reference data available from Coriolis (CTD climatology and Argo profile climatology for guidance). Following advice from the wider UK Argo team, and particularly from Brian King, we are currently working to the following prioritisation:

- To facilitate increasing knowledge/experience of regional oceanography we are addressing DMQC on an ocean basin-by-ocean basin basis. DMQC has started with the Indian Ocean, and will move onto the South Atlantic next, followed by the Southern Ocean and North Atlantic.
- To facilitate increasing knowledge/experience of the use of the OW software and to avoid applying excessive corrections, we are tackling floats with simple pathologies first, then moving onto floats with increasingly complex pathologies as DMQC skills improve within BODC.

During October/November 2017 we have performed our first significant batch of DMQC since 2013, totalling c. 1700 profiles. At the time of writing, 49% of BODC hosted floats profiles eligible for delayed mode QC have been processed and submitted to the GDACs in delayed mode. BODC expects to continue improving this situation in the coming year, with an additional uplift in capacity expected from additional team members undertaking DMQC training in the coming months.

3 Funding and human resources

Over the last five years funding for the UK Argo Programme has been provided by DECC, NERC and (since 2012) the Met Office. The Met Office and DECC-funded element of the UK Argo Programme supports the Met Office's activities and includes: programme management and coordination, float procurement, preparation of floats for deployment, organisation of float deployments and representation in the international Argo Steering Team and Euro-Argo. Argo science and data management aspects are funded by NERC and led by NOCS and BODC respectively. NERC has also provided ad-hoc funding for floats, which has been directed through NOC, PML and other delivery partners.

During 2016 DECC advised that as a consequence of savings to be made under the Government's Comprehensive Spending Review their funding for Argo will cease from April 2018. Since then the majority of the activities previously delivered by DECC have been moved into the new Department for Business, Energy and Industrial Strategy (BEIS) which is also the owning department for the Met Office and NERC. The Met Office are actively pursuing the issue to see if there is a way to recover the position, as the DECC funding provided for the majority of our core Argo floats. As at 27 February 2018, we have received positive indications that funding for the Met Office management costs, plus funding for around 20 core floats, will be available for UK financial year 2018/9. However, we have not received written confirmation of this situation.

From April 2018 it is expected that NERC will continue to fund deep and bio-geochemical floats through projects (e.g. ORCHESTRA, BoBBLE, ACSIS, RoSES), but they are unlikely to fund many (if any) core Argo floats.

BODC NERC National Capability funding, which funds Argo data management, was reviewed during 2017 and for the coming year we expect funding to remain at the same cash amount as it has been for the previous few years, which, when inflation is taken into account, is a net reduction in real terms. In addition, it is expected that the NERC projects BoBBLE, ORCHESTRA, ACSIS and RoSES will provide some funding for data management. The European funded MOCCA project supports real time processing of 75 Euro-Argo ERIC floats and delayed mode quality control for 38 ERIC floats for 4 years (2017-2021). AtlantOS will support delayed-mode QC of bio-geochemical Argo data during the period 2017-2019.

Staff members working on UK Argo, their institution and an estimate of their fraction of full time equivalent time spent on Argo during FY2017/8 (April 2017 – March 2018) are listed below:

Jon Turton, Met Office (0.25)
Fiona Carse, Met Office (0.4)
Brian King, NOCS (0.25) *[estimated on BK's behalf]*
Giorgio Dall'Olmo, PML (0.2) *[estimated on GD's behalf]*
Matt Donnelly, BODC (0.56)
Clare Bellingham, BODC (0.52)
Katie Gowers, BODC (0.35)
Violetta Paba, BODC (0.36)
Paul McGarrigle, BODC (0.02)
Elizabeth Bradshaw, BODC (0.02)
Justin Buck, BODC (0.11)
Robin McCandliss, BODC (0.11)

Total: 3.15 FTE.

Projections for FY 2018/9 show an additional 1.0 FTE staff time at BODC.

4 Uses of Argo data in the UK

4.1 Research Uses

4.1.1 National Oceanography Centre

Argo data are used widely within NOC science with the following regional leads for float deployment and science:

- Alex Sanchez Franks (Indian Ocean)
- Yvonne Firing (Southern Ocean)
- Penny Holiday (Sub-polar N Atlantic)
- Brian King (everywhere else)

Elaine McDonagh is also engaged in using Argo data, bidding for float funds, planning strategies, leading analyses and mapped products.

The applications of Argo data at NOC 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).

4.1.2 Plymouth Marine Laboratory

Giorgio Dall'Olmo is the lead PI for BGC data in the UK. Bio-Argo data from 13 Provor floats are now available from the GDACs, thanks to processing courtesy of Coriolis. Core-Argo data are used at PML for:

- 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.

BGC-Argo data focuses on investigating new methods to:

- efficiently monitor the ocean biological carbon pump;
- quantify particle flux attenuation;
- vertically-resolve seasonal remineralisation rates;
- and to better understand the nitrogen cycle in oxygen minim zones.

4.2 Operational uses – Met Office

Argo data (received over the WMO GTS) are routinely assimilated into the Met Office's FOAM (Forecasting Ocean Assimilation Model) which is run daily. The FOAM suite runs daily in an early morning slot and produces 2 analysis days and a 7-day forecast. The 3-D temperature, salinity and current fields from the global model run are used as boundary conditions for the regional models. There are 4 different configurations: ¼ degree global, 1/12 degree North Atlantic, 1/12 degree Mediterranean, 1/12 degree Indian Ocean and ~6km European North West Shelf. More details are at: http://www.oceansci.net/12/217/2016/os-12-217-2016.pdf and http://www.geosci-modeldev.net/7/2613/2014/gmd-7-2613-2014.html . The global FOAM system is used to initialise the ocean component of coupled monthly-to-seasonal forecasts, and so the requirements for Argo for that application are the same as for FOAM.

A coupled ocean/atmosphere prediction system has been developed for weather forecasting timescales, including assimilating Argo data in a coupled data assimilation framework (Lea et al., 2015), and is now being run operationally, delivering ocean forecast information to the Copernicus Marine Environment Monitoring Service (CMEMS). The timeliness constraints on Argo for this application are more stringent (data need to be available within 24 hours of measurement, and preferably within 6 hours). The impact of Argo on this system was assessed as part of the E-AIMS EU project (King et al., 2015).

Near-surface Argo data are used to validate the output from the Met Office's OSTIA (Operational Sea Surface Temperature and Sea Ice Analysis) – the OSTIA fields are in turn used as a lower boundary condition in numerical weather prediction models run by both the Met Office and ECMWF.

Argo data are also used in the initialization of ocean conditions in models run to make decadal predictions, see: http://www.metoffice.gov.uk/research/modellingsystems/unified-model/climate-models .

4.3 Links to websites maintained by the UK Argo program

BODC 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). Work has also progressed to split the UK Argo website into separate UK Argo and SOARC websites – providing SOARC with a distinct web presence – and the new SOARC website is now available (www.soarc.aq).

5 Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo.

The UK has no specific issues to raise.

6 Cruise CTD data during float deployments (reference database)

Fiona Carse and Jon Turton always encourage the deployers of UK floats to tell us about CTD casts performed at the time the floats are deployed. We include any information supplied by staff on board deploying vessels in the “Description” (free text) section of the JCOMMOPS float registration form. Cruise information (PI, ship, dates) is also made available through the JCOMMOPS float registration form whenever possible (it is always possible for cruises on UK research vessels). Can CCHDO staff see this field? Do they monitor it and request data from national data centres such as BODC?

CTD data for which there is an agreed Data Management Plan (DMP) in place with BODC (e.g. as for data funded by NERC research projects) will be supplied to BODC for ingestion into the UK National Oceanographic Database (NODB). Data will be forwarded from BODC to relevant partners, such as CCHDO, were this is specified in the DMP. A review of CTD data pathways to the Argo reference database is likely needed. Pathways for CTD data availability from deploying cruises from projects that do not have a DMP with BODC in place are the responsibility of the relevant programme. Further consideration needs to be given to the content of DEPLOYMENT_REFERENCE_STATION_ID across the Argo data system to ensure accessibility and interoperability of CTD data.

7 Argo bibliography

7.1 Papers by UK authors.

Included below is a list of papers published during 2016 to 2018, with at least one author based at a UK institution. There are seven papers in 2016, eleven in 2017, and one in 2018.

Berry, D.I.; Corlett, G.K.; Embury, O.; Merchant, C.J..
Stability Assessment of the (A)ATSR Sea Surface Temperature Climate Dataset from the European Space Agency Climate Change Initiative.
Remote Sens. 2018, 10, 126. doi:10.3390/rs10010126

Xue, Yan; Wen, C.; Kumar, A.; et al.
A real-time ocean reanalyses intercomparison project in the context of tropical pacific observing system and ENSO monitoring.
CLIMATE DYNAMICS. 2017, 49, 11-12, 3647-3672 doi:10.1007/s00382-017-3535-y

Organelli, E., Barbieux, M., Claustre, H., Schmechtig, C., Poteau, A., Bricaud, A., Boss, E., Briggs, N., Dall'Olmo, G., D'Ortenzio, F., Leymarie, E., Mangin, A., Obolensky, G., Penkerc'h, C., Prieur, L., Roesler, C., Serra, R., Uitz, J., and Xing, X.:
Two databases derived from BGC-Argo float measurements for marine biogeochemical and bio-optical applications,
Earth Syst. Sci. Data, 2017, 9, 861-880. doi:10.5194/essd-9-861-2017

Tang, WQ ; Fore, A ; Yueh, S ; Lee, T ; Hayashi, A; Sanchez-Franks, A; Martinez, J; King, B ; Baranowski, D.
Validating SMAP SSS with in situ measurements.
REMOTE SENSING OF ENVIRONMENT, 2017, 200, 326-340 doi:10.1016/j.rse.2017.08.021

Palmer, M.D., Roberts, C.D., Balmaseda, M., Chang, YS; Chepurin, G; Ferry, N; Fujii, Y; Good, SA; Guinehut, S; Haines, K; Hernandez, F; Kohl, A; Lee, T; Martin, MJ; Masina, S; Masuda, S; Peterson, KA; Storto, A; Toyoda,T; Valdivieso, M; Vernieres, G; Wang, O; Xue, Y.
Ocean heat content variability and change in an ensemble of ocean reanalyses.
Clim Dyn (2017) 49: 909. https://doi.org/10.1007/s00382-015-2801-0 doi:10.1007/s00382-015-2801-0

Sevellec, F; Colin De Verdiere, A; Ollitrault, M.
Evolution of Intermediate Water Masses Based on Argo Float Displacements,
Journal of Physical Oceanography, 2017, 47, 7, 1569-1586 doi:10.1175/JPO-D-16-0182.1

Organelli, E., H. Claustre, A. Bricaud, M. Barbieux, J. Uitz, F. D’Ortenzio, G. Dall’Olmo,
Bio-optical anomalies in the world’s oceans: An investigation on the diffuse attenuation coefficients for downward irradiance derived from Biogeochemical Argo float measurements,
J. Geophys. Res. Oceans, 2017, 122, 3543–3564, doi:10.1002/2016JC012629

While, J; Mao, C; Martin, MJ; Roberts-Jones, J; Sykes, PA; Good, SA; McLaren, AJ.
An operational analysis system for the global diurnal cycle of sea surface temperature: implementation and validation,
QUARTERLY JOURNAL OF THE ROYAL METEOROLOGICAL SOCIETY, 2017, 143, 705, 1787-1803. doi:10.1002/qj.3036

F.M. Calafat; P. Cipollini; J. Bouffard; H. Snaith; P. Féménias.
Evaluation of new CryoSat-2 products over the ocean.
Remote Sensing Of Environment, 2017, 191, 131-144. doi:10.1016/j.rse.2017.01.009

Clarke, JS; Achterberg, EP; Connelly, DP; Schuster, U; Mowlem M.
Developments in marine pCO2 measurement technology; towards sustained in situ observations.
Trends in Analytical Chemistry 88 (2017) 53-61 doi:10.1016/j.trac.2016.12.008

Xing, XG; Claustre, H; Boss, E; Roesler, C; Organelli, E; Poteau, A; Barbieux, M; D'Ortenzio, F.
Correction of profiles of in-situ chlorophyll fluorometry for the contribution of fluorescence originating from non-algal matter,
LIMNOLOGY AND OCEANOGRAPHY-METHODS, 2017, 15, 1 , 80-93 doi:10.1002/lom3.10144

Hausfather, Z; Cowtan, K; Clarke, DC; Jacobs, P; Richardson, M; Rohde, R.
Assessing recent warming using instrumentally homogeneous sea surface temperature records.
Science Advances, 2017, 3: e1601207 doi:10.1126/sciadv.1601207

Dall’Olmo, G; Dingle, J, Polimene, L, Brewin, RJW; Claustre, H.
Substantial energy input to the mesopelagic ecosystem from the seasonal mixed-layer pump.
Nature Geoscience, 2016, 9(11), 820-823. doi:10.1038/ngeo2818

Organelli, E; Claustre, H; Bricaud, A; Schmechtig, C; Poteau, A ; Xing, XG; Prieur, L ; D'Ortenzio, F; Dall'Olmo, G; Vellucci, V.
A Novel Near-Real-Time Quality-Control Procedure for Radiometric Profiles Measured by Bio-Argo Floats: Protocols and Performances.
Journal of Atmospheric and Oceanic Technology, 2016, 33, 5, 937-951. doi:10.1175/JTECH-D-15-0193.1

Sauzede, R; Claustre, H; Uitz, J; Jamet, C; Dall'Olmo, G; D'Ortenzio, F; Gentili, B; Poteau, A;

Schmechtig, C.
A neural network-based method for merging ocean color and Argo data to extend surface bio-optical properties to depth: Retrieval of the particulate backscattering coefficient.
JGR-Oceans, 2016, 121, 4, 2552-2571. doi:10.1002/2015JC011408

Drushka, K; Asher, WE; Ward, B; Walesby, K.
Understanding the formation and evolution of rain-formed fresh lenses at the ocean surface.
JGR-Oceans, 2016, 121, 4, 2673-2689 doi:10.1002/2015JC011527

von Schuckmann, K; Palmer, MD; Trenberth, KE; Cazenave, A; Chambers, D; Champollion, N; Hansen, J; Josey, SA; Loeb, N; Mathieu, PP; Meyssignac, B ; Wild, M.
An imperative to monitor Earth's energy imbalance.
Nature Climate Change, 2016, 6, 2, 138-144. doi:10.1038/NCLIMATE2876

Riser, SC; Freeland, HJ; Roemmich, D; et al.
Fifteen years of ocean observations with the global Argo array.
Nature Climate Change, 2016, 6, 2, 145-153. doi:10.1038/NCLIMATE2872

Emberton, S; Chittka, L ; Cavallaro, A; Wang, MH.
Sensor Capability and Atmospheric Correction in Ocean Colour Remote Sensing.
Remote Sensing, 2016, 8, 1. doi:10.3390/rs8010001

7.2 UK PhD theses using Argo data

Fiona and Jon do not have access to this information at the present time.

7.3 Argo PIs

The UK does not have Argo PIs, except that, nominally, Jon Turton is the PI for core floats, Giorgio Dall'Olmo is the PI for BGC floats, and Brian King is PI for deep and all other non-core floats.

8 Talks and Outreach

BODC maintains UK Argo Facebook and Twitter accounts, the latter of which has been successfully used to highlight the contributions of various contributors to the Argo programme such as the British Antarctic Survey's role in deploying our longest operating float and the RRS James Clark Ross has deployed 171 floats during the course of the Argo programme.

As part of personal outreach activities, Matt Donnelly from BODC has undertaken outreach talks at All Saints High School in Liverpool and to Manchester and Salford University Royal Navy Unit which have included a significant Argo component.

Fiona has sent Megan a file containing some slides that Fiona and Jon use for general talks, for example for new starters at the Met Office [AST19_UK_Argo_slides_for_general_talks.pptx].

In general, I find the IPPC 5th report (Physical Science Basis, Chapter 3 http://www.ipcc.ch/report/ar5/wg1/) useful. Also Lea et al.'s 2014 OSE paper (http://onlinelibrary.wiley.com/doi/10.1002/qj.2281/full). And the Riser et al. (2016) paper (https://www.nature.com/articles/nclimate2872).

9 References

Atkinson, C. P., N. A. Rayner, J. J. Kennedy, and S. A. Good (2014), An integrated database of ocean temperature and salinity observations, J. Geophys. Res. Oceans, 119, 7139–7163, doi:10.1002/2014JC010053.

King, R.R., M. Martin, A. Stearl, 2015. Weather, seasonal and decadal forecasting: OSE/OSSE results and recommendations. E-AIMS deliverable report D3.323. http://www.euroargo.eu/content/download/88659/1093576/file/E-AIMS_D3.323-v2.pdf?version=1

Lea, D. J., I. Mirouze, M. J. Martin, R. R. King, A. Hines, D. Walters, and M. Thurlow, 2015: Assessing a New Coupled Data Assimilation System Based on the Met Office Coupled Atmosphere–Land–Ocean–Sea Ice Model. Monthly Weather Review, 143, 4678-4694, doi: 10.1175/MWR-D-15-0174.1.

U.S. Argo National Report to AST-19, March 2018

Organization of U.S. Argo:

The U.S. Argo Program is supported with major funding provided by the National Oceanic and Atmospheric Administration (NOAA), and additional participation of the U.S. Navy. It is implemented by a U.S. Float Consortium that includes principal investigators from six institutions: Scripps Institution of Oceanography (SIO), Woods Hole Oceanographic Institution (WHOI), the University of Washington (UW), the Atlantic Oceanographic and Meteorological Laboratory (AOML), the Pacific Marine Environmental Laboratory (PMEL), and the Naval Research Laboratory (NRL/Monterey). Float technology development, production, deployment, array monitoring, and data system functions are distributed among these institutions on a collaborative basis.

In addition to U.S. Argo floats, Argo-equivalent floats have been provided from a number of U.S. float groups, programs, and principal investigators. A notable U.S. Argo-equivalent program is Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM). SOCCOM is a regional pilot array for Biogeochemical Argo, with support from the National Science Foundation and NASA, and in partnership with U.S. Argo. SOCCOM has 91 operational floats at present (as tracked by the AIC) equipped with biogeochemical sensors, in the Southern Ocean, and has plans to increase the size of its array to 200 floats in the coming years. The contributions of all Argo-equivalent partners are gratefully acknowledged.

The present 5-year cycle of U.S. Argo implementation began in July 2015, and extends through June 2020.

Objectives:

During the present 5-year cycle, U.S. Argo will sustain its contribution of half of the Core Argo array, while enhancing coverage on a regional basis (high latitudes, western boundary and equatorial regions, marginal seas) as recommended through sustained ocean observing system community activities and endorsed by the AST. These coverage enhancements will only be implemented if sufficient resources are available to maintain the original Argo coverage and the data quality of the Argo array. Further improvements in data quality, timeliness, and resolution are planned, along with ongoing extensions to float lifetimes and cost-effectiveness.

A major enhancement to Argo is the implementation of Deep Argo to extend sampling to the ocean bottom (to pressures as high as 6000 dbar). As a key component of the Deep Ocean Observing Strategy (DOOS), Deep Argo is needed to close regional and global budgets of heat, freshwater, and steric sea level, and for exploration of deep ocean circulation. Deployment of several regional Deep Argo pilot arrays is being undertaken to test floats and sensors, to aid in global array design, and to demonstrate the capability to deploy on a regional basis. U.S. Deep Argo deployments are integrated with planned contributions of international partners.

Status:

The support level for U.S. Argo is determined on a year-to-year basis. Support levels for Core U.S. Argo have remained relatively flat since 2004, with some recent yearly augmentations. Inflationary losses have been offset by increases in float lifetime, so the number of operational U.S. floats remains approximately 2000, equal to the high levels achieved since 2008. Further increases in lifetime are expected through a changeover in SIO and WHOI Argo floats to hybrid lithium batteries to mitigate passivation losses. However, the present number of yearly deployments may not be sufficient to sustain the level of U.S. Argo floats.

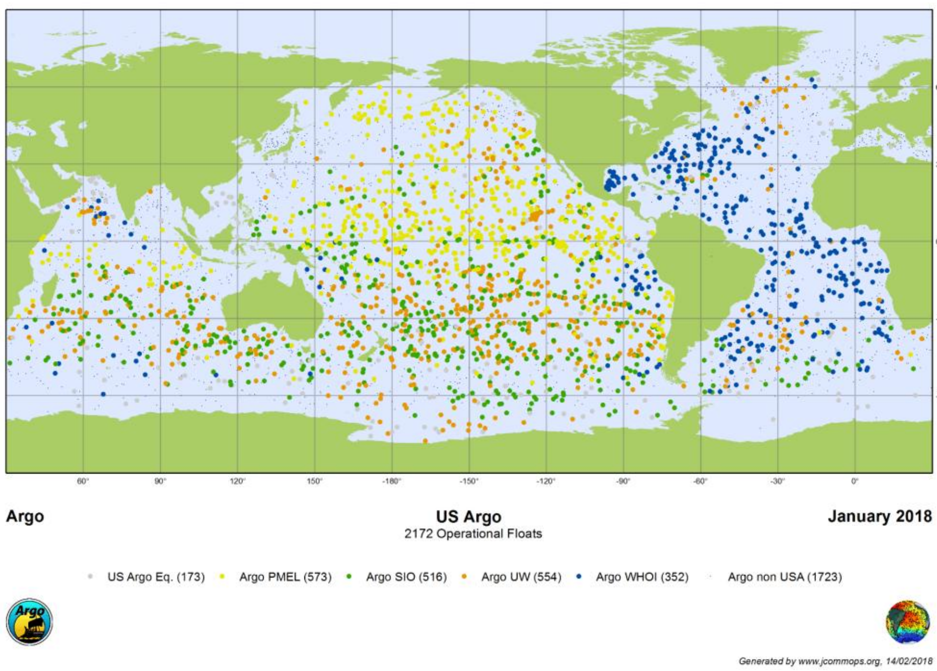


***Fig. 1**: Location of 2172 operational U.S. Argo Program and U.S. Argo Equivalent floats as of January 2018. (Source: AIC)*

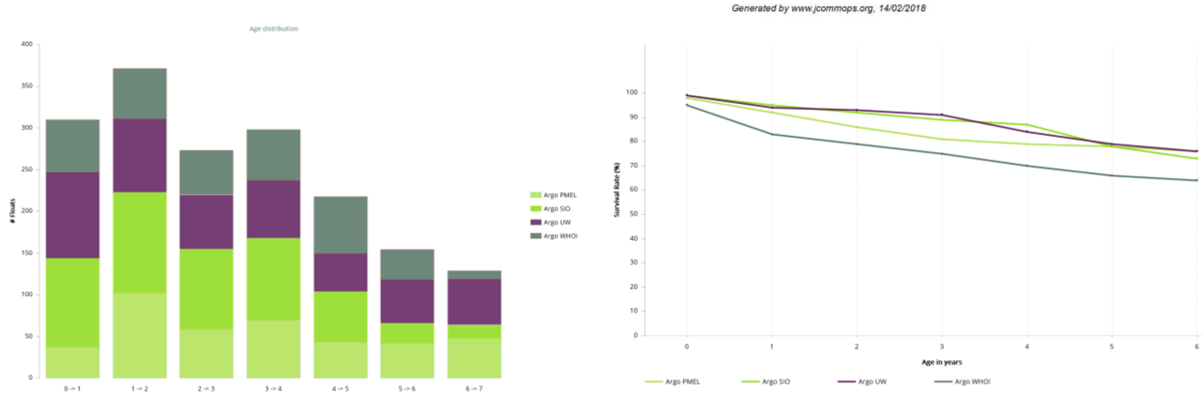


***Fig. 2:** Left panel – Age distribution of operational U.S. Argo Program floats deployed since 2011. Right panel: Survival rate of U.S. Argo Program floats deployed since 2011. (Source: AIC)*

There are presently 1995 operational U.S. Argo Program floats (Fig. 1) as of January 2018. The age distribution of operational floats deployed since 2011 is shown in Fig. 2, along with the AIC failure rate for that sample. Of the 329 U.S. Argo Program floats deployed in 2013, 229 (67%) remain operational (AIC). Table 1 indicates the number of U.S. Argo Program floats deployed and operational for each year since 2011 (Source: AIC).

Year deployed	Number deployed	Number active	% active (2/2018)
2011	329	116	34%
2012	341	133	39%
2013	329	221	67%
2014	376	292	78%
2015	356	303	85%
2016	348	334	96%
2017	344	332	97%

Support for U.S. Argo includes float production and deployment, technology improvement, communications, data system development and implementation for real-time and delayed-mode data streams, and participation in international Argo coordination, Regional Centers, and outreach activities.

Deep Argo:

In 2011-2015, U.S. Argo carried out development and testing of Deep Argo prototype floats. Successful prototype float deployments were made in 2013 – 2015. U.S. Deep Argo floats profile to pressures as great as 6000 dbar, and recent versions with hybrid lithium batteries are capable of more than 200 cycles. Deployment of U.S. Deep Argo regional pilot arrays began in the SW Pacific Basin in 2016 - 2017, in the South Australian Basin in late 2016, in the Australian Antarctic Basin in early 2018, and in the western North Atlantic in early 2017 (Fig 3).

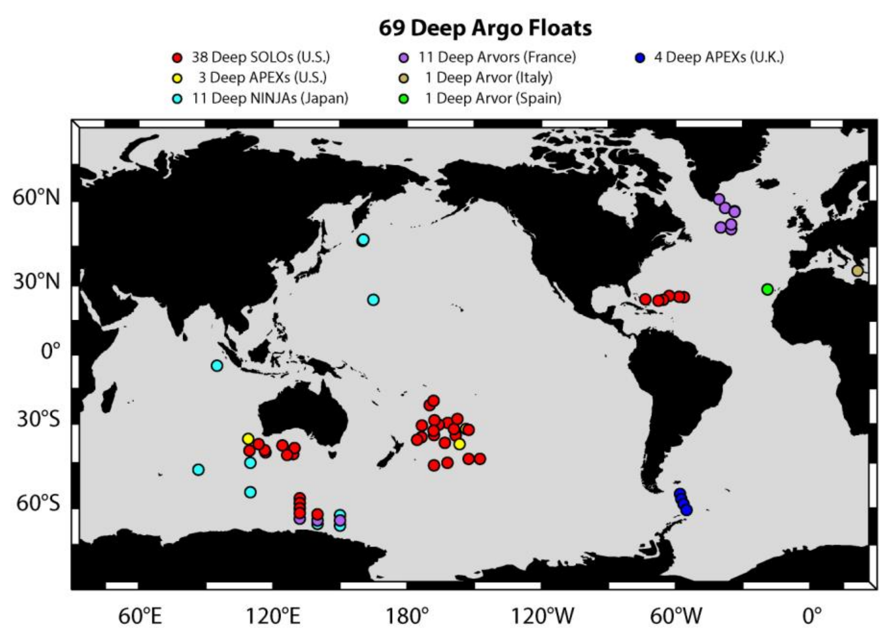


Fig. 3*: Location of all Deep Argo pilot floats, including 20 U.S. Deep Argo floats in the SW Pacific Basin, 9 in the South Australian Basin, 5 in the Australian Antarctic Basin, and 6 in the NW Atlantic. SIO Deep SOLO floats are indicated in red and UW Deep APEX floats in yellow.*

Testing of deep float models continues as well as testing of SBE-61 CTD accuracy and stability. The SBE-61 has not yet achieved its aspirational goals of (± .001C, ±.002 psu, and ± 3 dbar) but is progressing relative to those goals (Fig. 4).

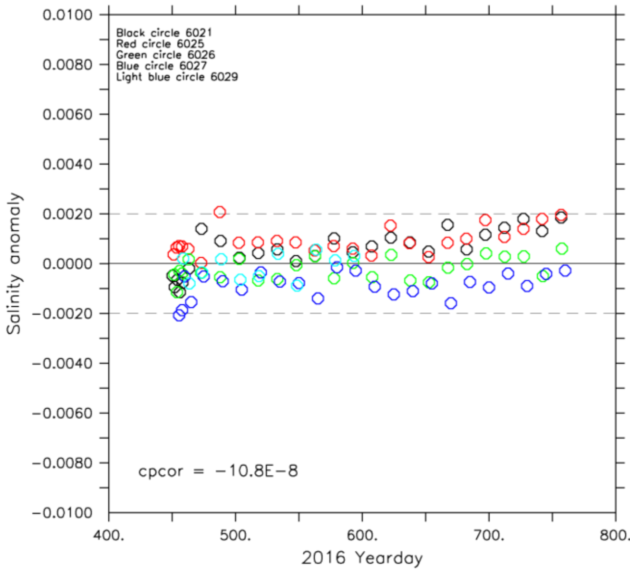


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Fig. 4: *Time-series of salinity anomaly at 1.6°C potential temperature from 5 Deep SOLO floats, with SBE-61 CTDs, in the NW Atlantic. A 6th float has a failed CTD. Salinity anomaly is relative to shipboard CTD casts at the place and time of each float deployment. The conductivity cell compressibility is estimated, to remove a fresh bias seen in all floats.*

Plans:

The highest priority for U.S. Argo is to sustain the Core Argo array. Specific plans for float deployments in 2018, as they evolve, are posted on the AIC deployment planning links. A major U.S./New Zealand/Australia Argo deployment cruise from New Zealand to Chile and back on RV Kaharoa was carried out in late 2017 (Fig. 5 yellow symbols). This voyage deployed 107 Core Argo floats in the South Pacific Ocean and 5 Deep Argo floats in the SW Pacific Basin, enlarging the regional pilot array there (Fig. 3). A deployment cruise on RV Kaharoa, from New Zealand to Tahiti, is planned in July 2018 to deploy 10 – 14 Deep Argo floats in the SW Pacific Basin, plus additional Core Argo floats in the South Pacific.

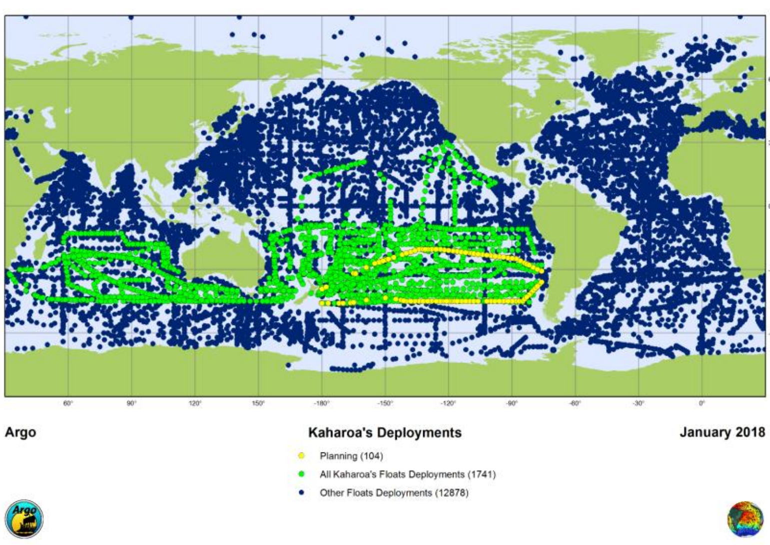

Fig. 5: All 1845 Argo float deployments by RV Kaharoa since 2004 (Green and yellow symbols). Deployment voyages are supported by U.S., New Zealand, and Australia Argo. Argo could not have achieved and cannot sustain global coverage without deployment voyages in the South Pacific and South Indian Ocean.

The U.S. Argo Data Assembly Center (DAC) is based at NOAA/AOML. Real-time data from all U.S. Argo floats are transmitted via the GTS. GTS transmission uses parallel systems developed at AOML and housed at AOML and at Collect Localisation Satellites (CLS), implementing internationally-agreed quality control tests. The AOML data center serves as the national focus for data management and is the conduit for delayed-mode data to pass between the PIs and the GDACs. During 2016, processing of delayed-mode files continued but was slowed somewhat by adoption of new file formats.

In addition to the national DAC, a Global Data Assembly Center (GDAC) is run as part of the GODAE server, located at the Naval Research Laboratory, Monterey. The two GDACs at NRL/Monterey and IFREMER/Brest are mirror images in their assemblies of Argo data from all international partners, and are responsible for dissemination of the data. Several U.S. institutions participate in Argo Regional Center activities, including AOML's role as focus for the South Atlantic ARC.