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.

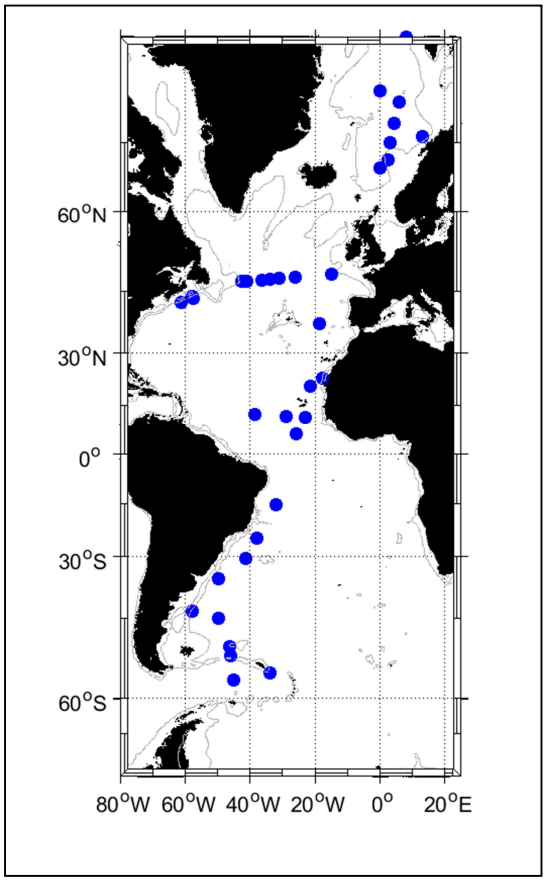


Fig. 1: Deployment positions for floats operated by BSH in 2017in the Atlantic Ocean.

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.

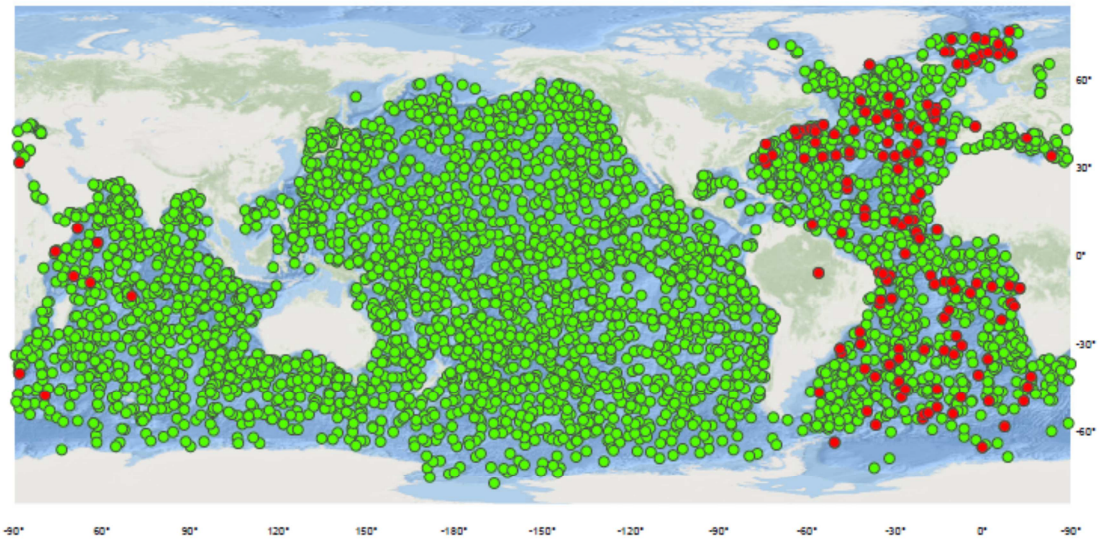


Fig. 2: Locations of active German floats (red) and active international floats (green) (Argo Information Centre, February 2018).

- 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.

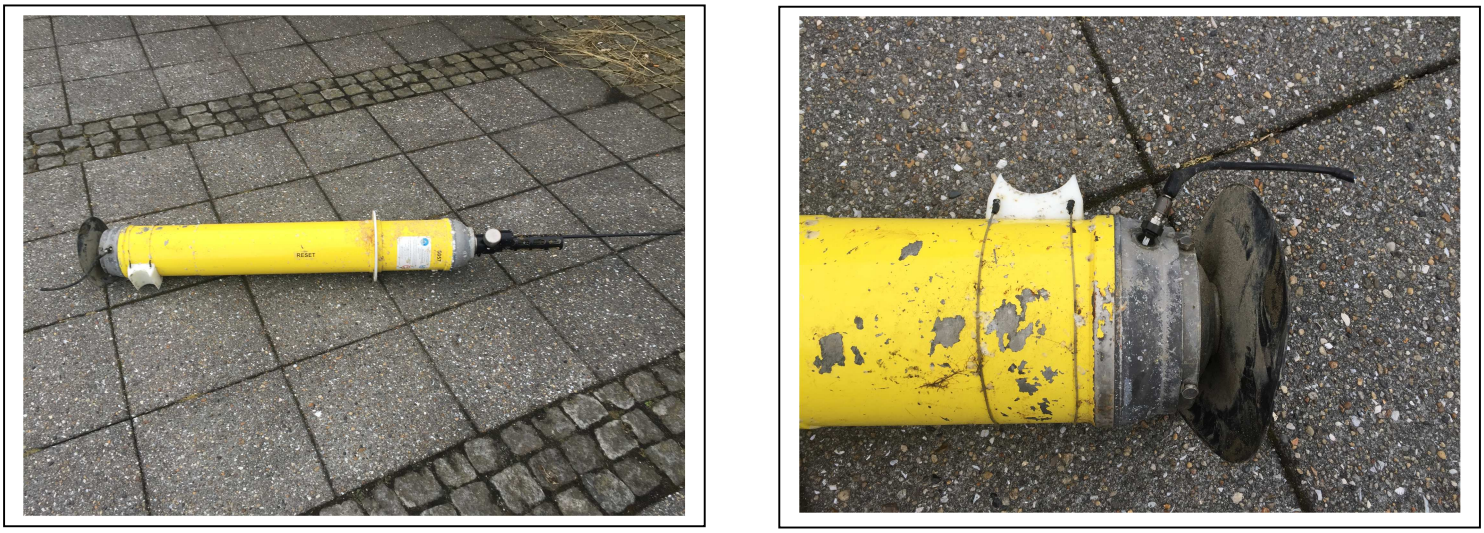


Fig. 3: Photos of beached float 6900876.

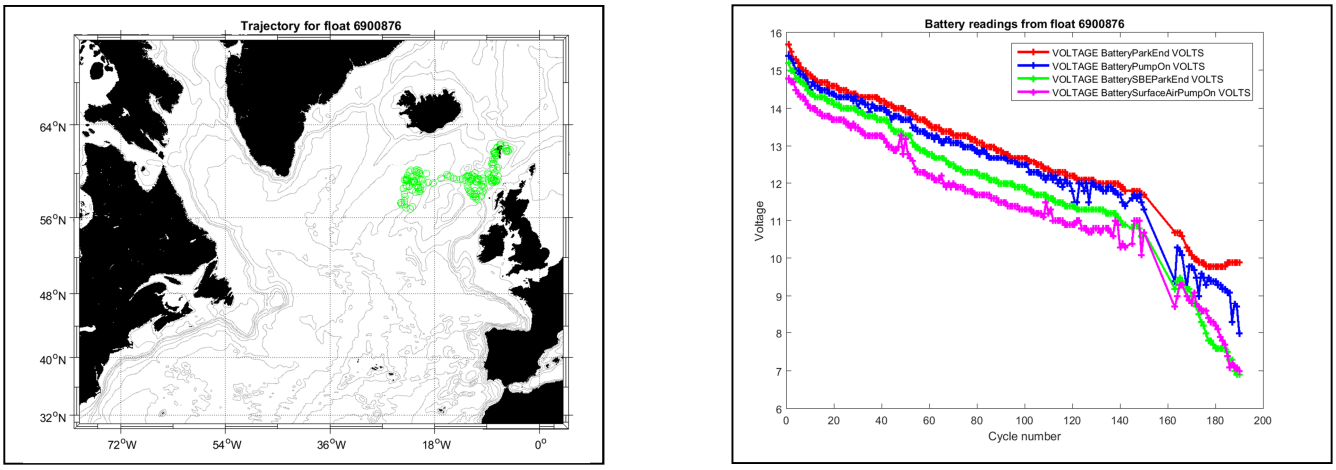


Fig. 4: Drift trajectory of float 6900876 (left) and battery readings (right).

- 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.

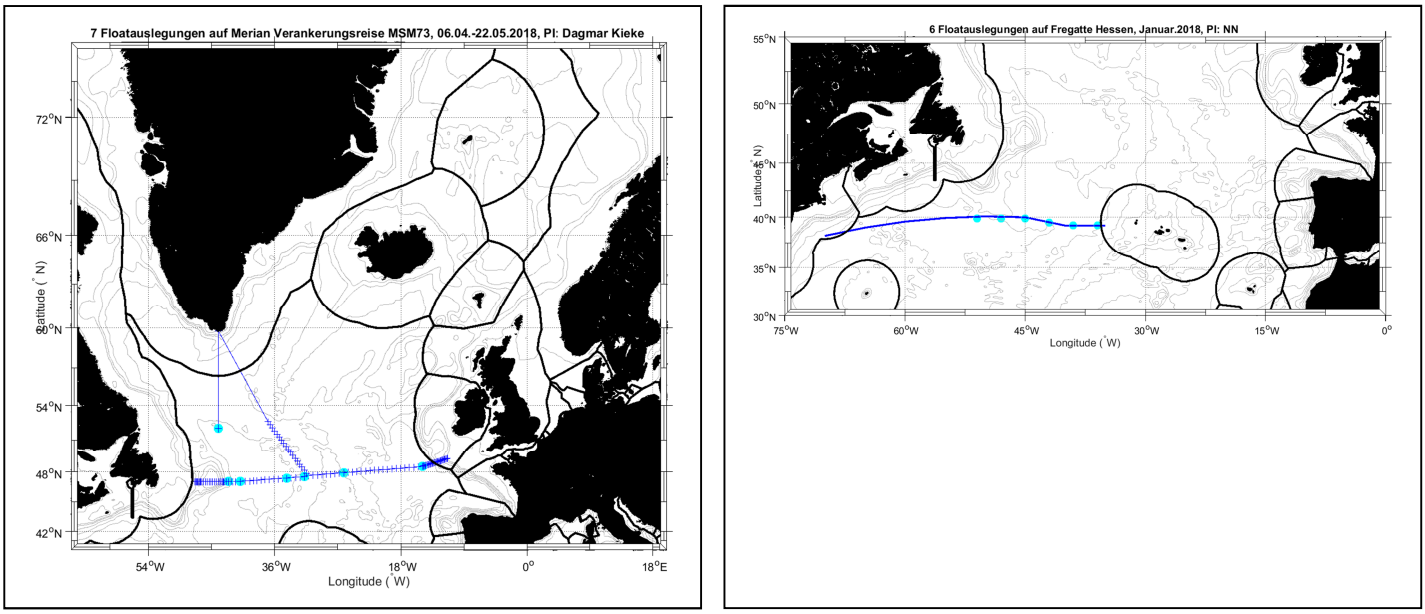
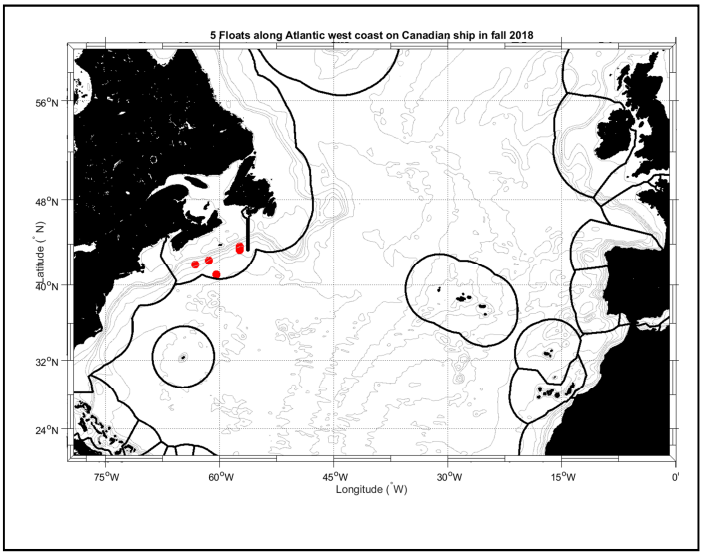
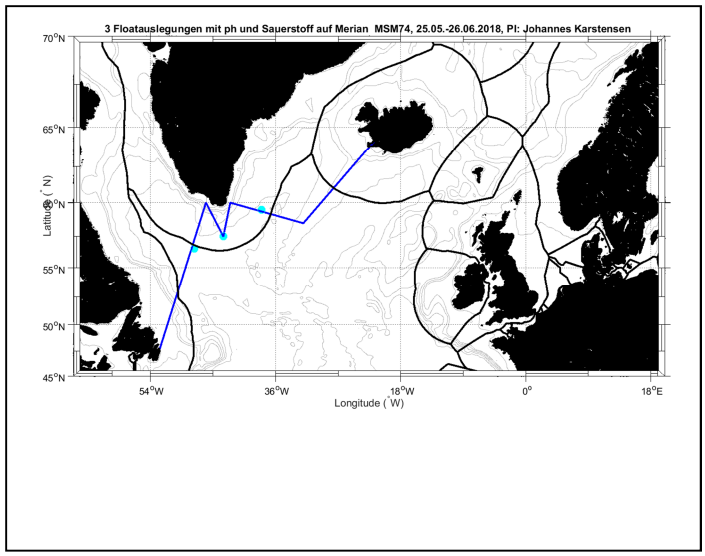


Fig.5: Planned deployments in the North Atlantic in 2018





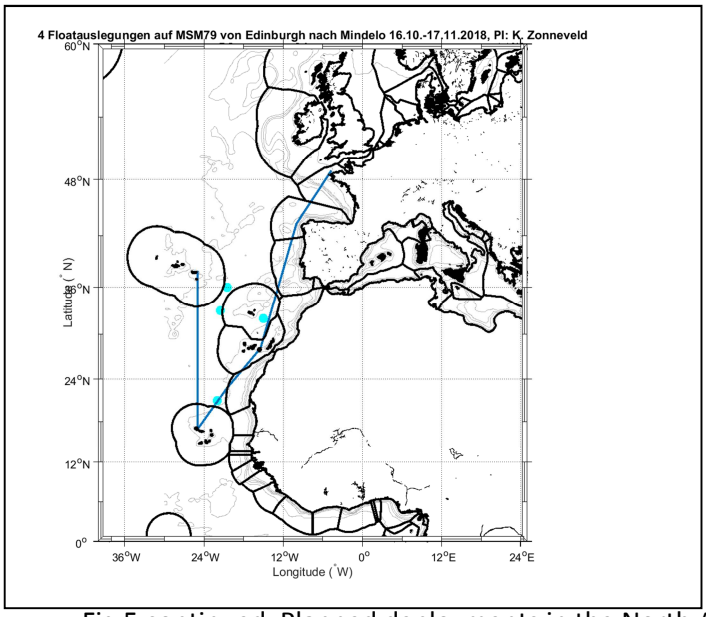
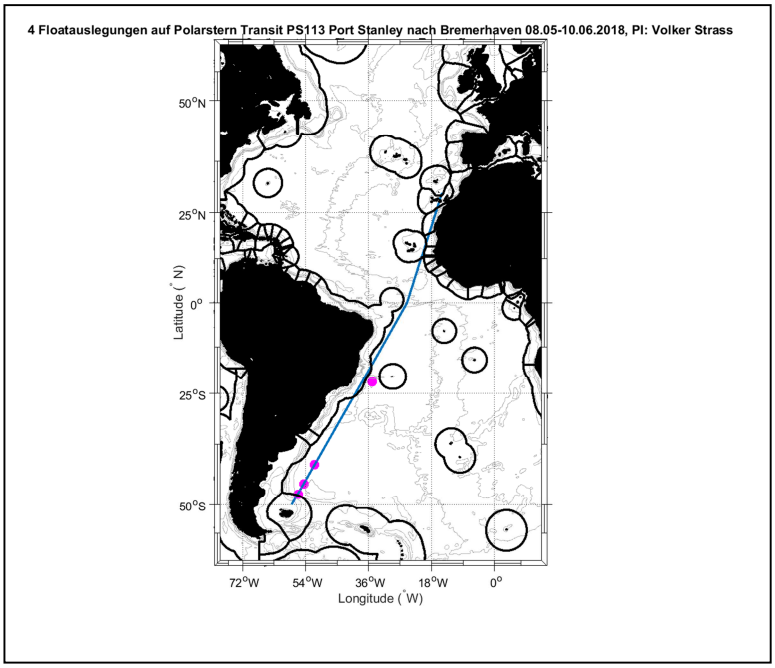


Fig.5 continued: Planned deployments in the North Atlantic in 2018



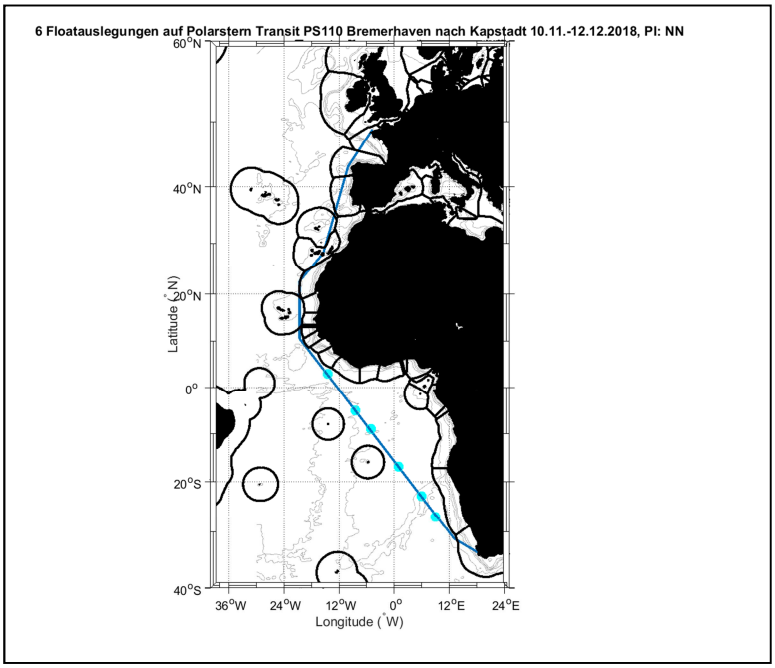
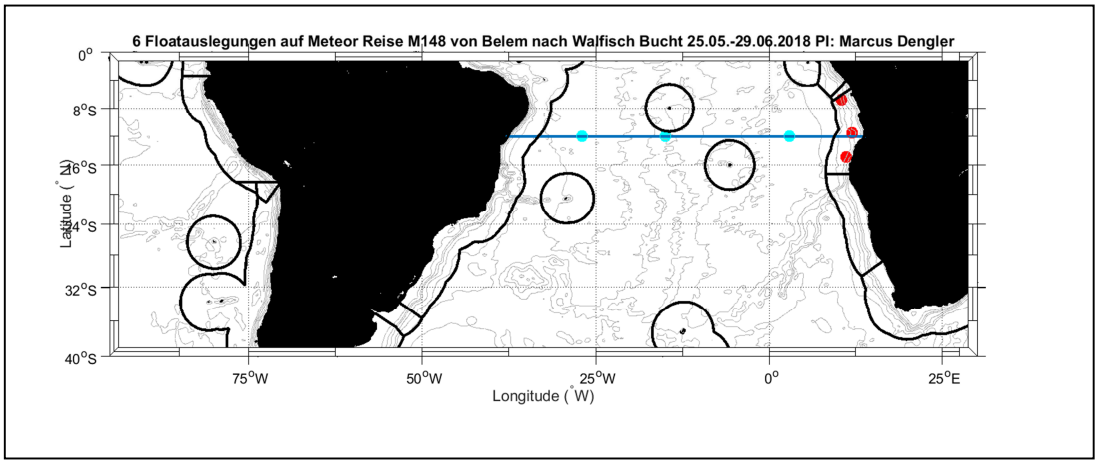


Fig. 6: Planned deployments in the South Atlantic in 2018



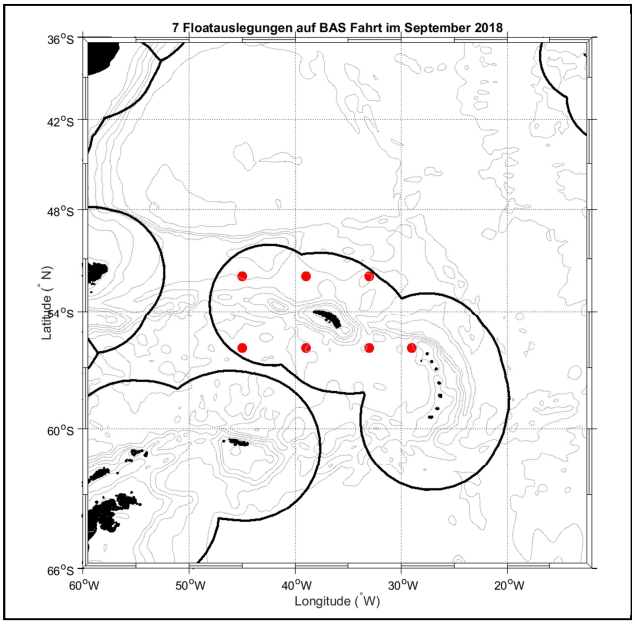
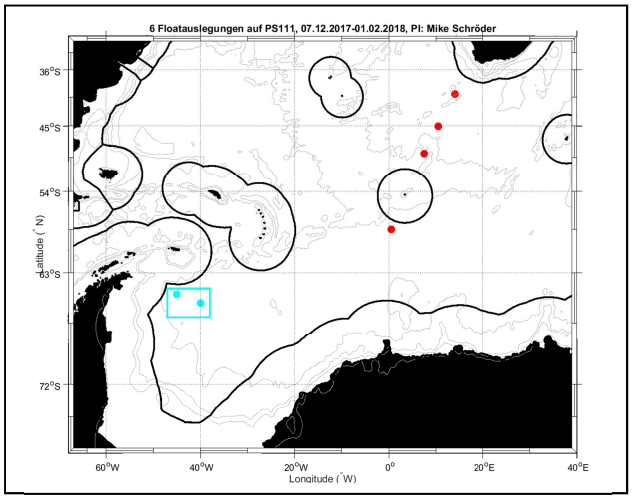


Fig. 6 continued: Planned deployments in the South Atlantic in 2018



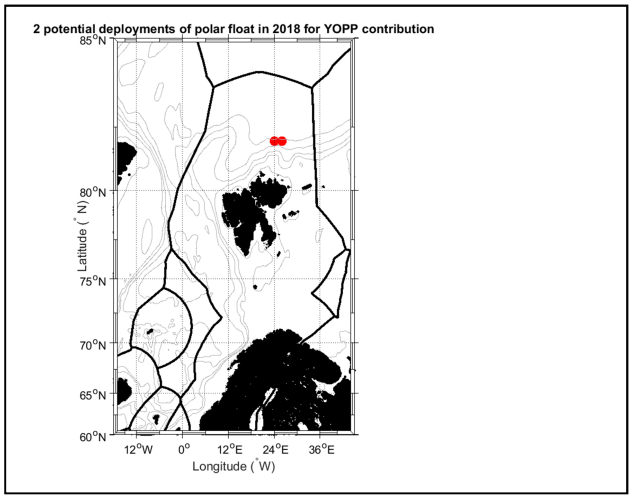


Fig. 7: Planned deployments in the ice covered areas

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.