1. The status of implementation (major achievements and problems in 2019)

- floats deployed and their performance

Most of the floats deployed by Germany in 2019 are operated by BSH, but in this year ICBM (Institute for Chemistry and Biology of the Marine Environment) had acquired additional funding. ICBM deployed 4 BGC APEX floats while BSH has deployed 36 floats (all ARVOR) by the end of 2019. GEOMAR and AWI have not deployed floats in 2019. 36 of the German floats deployed in 2019 were standard TS floats, 4 ICBM floats deployed in the Mediterranean carried a suite of BGC sensors. Deploymenta were carried out on research vessels, which comprised Canadian, German and UK ships. The BSH deployment locations for 2019 are shown in Fig. 1. Deployment of a few floats projected for 2019 has been delayed and will happen early 2020.

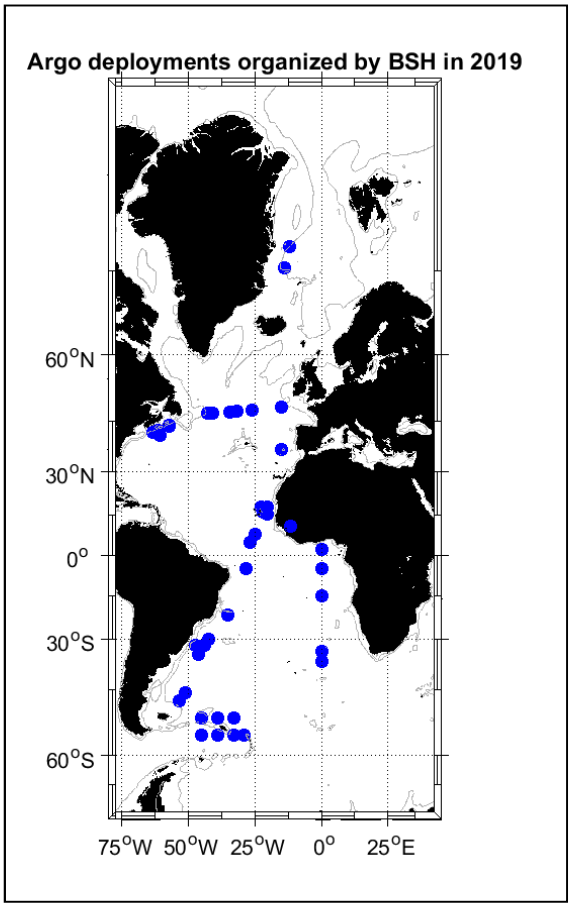


Fig. 1: Deployment positions for floats operated by BSH in 2019 in the Atlantic Ocean.

Currently (April 3rd, 2020) 162 German floats are active (Fig.2) and the total number of German floats deployed within the Argo program increased to 911. Two floats intended for deployment in the Arctic are stored in a bonded warehouse in Norway and will go on a Norwegian cruise with an icebreaker in summer 2020.

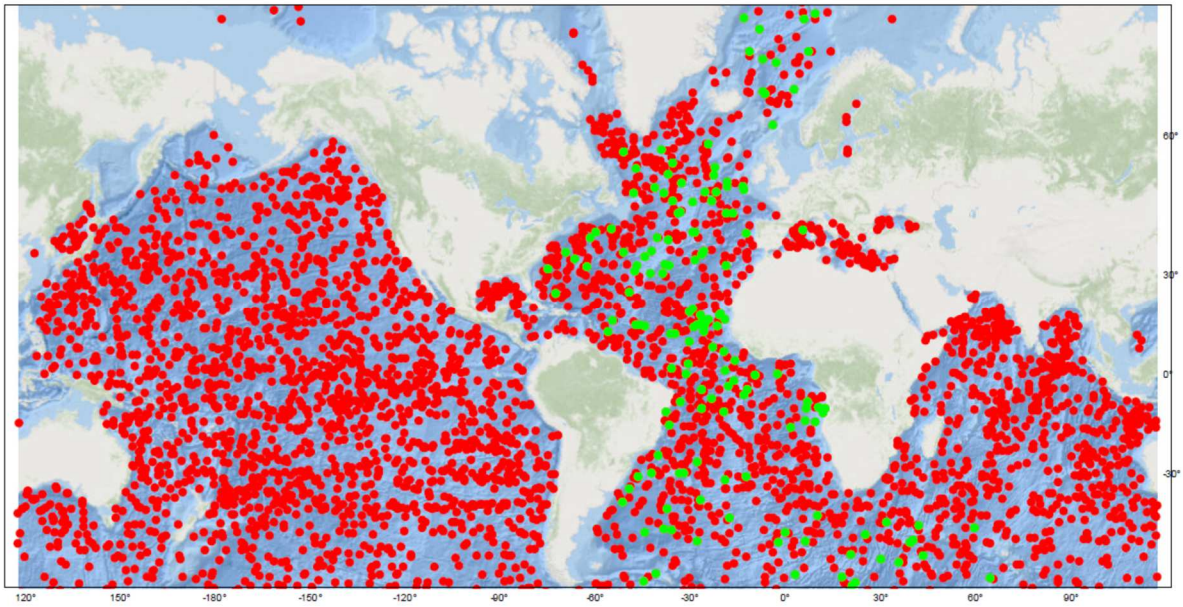


Fig. 2: Locations of active German floats (green) and active international floats (red) (Argo Information Centre, April (2020).

- technical problems encountered and solved

One of our three APEX floats equipped with ph- and O2-sensor deployed in 2018 had been malfunctioning due to a defect pressure sensor. A replacement for this float has been received and the replacement float will be deployed at its original location in the Labrador Sea. One float in the Nordic Seas was caught in a net by a fishing trawler and turned over to our colleagues in Norway. Since it was in good shape, it was returned TWR for refurbishment and recalibration of the CTD. Another float had beached at Faeroe Islands. It was returned to Germany with the assistance of Martin Kramp (ship coordinator at AIC) and sailed back to Germany on the sailboat Germania (Fig.3).

Fig. 3: Martin Kramp (middle) and colleagues are returning a beached German float.

Inspection of floats suspected of fast salinity drift in the SN range 6000-7100 have all been finished and data are completely d-moded. Sudden salty drift is also detected for SNs that are far more recent and some of the floats show depth dependent drift. Kim Martini from SBE is continuously informed when a float with fast salty drift is discovered in dmqc. In preparation for AST21 a report is being prepared with diagnostic plots from all floats that show fast salty drift. The report is shared through github with all European DMQC operators and has been send to the working group led by John Gilson.

- 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 have deployed deep-floats and bio-Argo floats within this project. Germany is responsible in the framework of the MOCCA project (coordinated by the ERIC) for the delayed-mode quality control of 65 MOCCA floats, in the Nordic Seas, the subpolar gyre and Southern Ocean and contributes to the at-sea monitoring of the fleet. Within MOCCA an

ice-algorithm has been developed for the Arctic ocean from a combination of quality controlled hydrographic data and ice-edge information. In 2019 we have stared reprocessing all the Argo data in the Nordic Seas after updating the CTD reference data set for this area and check for small biases still remaining due to lack of recent CTD data in previous versions of the reference data set. We are also preparing a reference data set for the Arctic from the UDASH CTD data set collected and quality controlled by AWI.

Germany has adopted a few of the orphaned US Navy floats and has provided quality control for these floats, as well as for some floats belonging to the University of Maine. Germany is also acting as delayed mode quality control operator for European contributions from Denmark, Finland, Norway, the Netherlands and Poland. In December 2019 we have held a week long dmqc training session for Poland and Norway. Malgorzata Merchel from IOPAN (Poland) and Jan Even Øie Nilsen from Havforskningsinstituttet (Norway) participated in the training and will act as DM-operators for the national programs in future. In 2020 a follow-up training session is planned and will include the new DMQC operator for Finland (Petra Roiha, FMI).

Coriolis had just finished the process of reformatting Nemo floats from AWI into V3.1 at the end of 2019, and the newly decoded files are on a priority list for DMQC.

The annual user meeting was held at BSH on 22.08.2019 and was attend by more than 20 people. User presentations were given and showed the wide range of application from science to data assimilation in forecast models. As a result of the meeting a BGC group was established which includes ICBM (Oliver Zielinski), GEOMAR (Arne Körtzinger, Tobias Steinhoff) and IOW (Henry Bittig) and provides national expertise for all BGC parameters. BSH and the BGC group have prepared a science briefing to advocate the new multidisciplinary Argo strategy and gave a presentation at the BMVI on 25.02.2020. The federal ministry of transportation and digital infrastructure (BMVI) funds the operational core Argo floats at a level of ~50 floats per year. Several other ministries were invited but only the science ministry (BMBF) could attend the meeting. In general the new capabilities of the multidisciplinary Argo were appreciated and it was decided to continue discussions about the budget for the implementation at inter-ministerial level to find a way forward for the 2022 national budget negotiations. The science ministry (BMBF) has offered to provide some interim funds for 2020/2021 and a proposal has been submitted.

- status of delayed mode quality control process

In the past the delayed mode processing had been distributed between the various German institutions contributing to Argo, depending on their area of expertise. The Alfred-Wegener Institute had been responsible for the Southern Ocean and GEOMAR was processing floats in the Pacific with oxygen data. The DMQC for the core Argo parameters is now performed by BSH, including the AWI floats. Reprocessing of these has been finished by Coriolis and the floats are on the priority list for DMQC. DMQC on oxygen will still be performed at PI level and work is carried out by GEOMAR respectively Henry Bittig now at IOW. The processing of the pH-data is carried out by Arne Körtzinger's group at GEOMAR.

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. The national programs of Finland, Norway and Poland will start their own dmqc operations now that trained dm-operators are available. BSH will finish dmqc for all floats from these programs which have already been started.

The DMQC process for German floats is continuing without major problems, and the frequency of delayed-mode visits has remained at ~ half-yearly levels in 2019 to check for fast salty drift. The total number of available profiles from German floats is 76544 (April 3rd, 2020), the number of DM profiles is 68506. The percentage of DM profiles with respect to the total number of profiles has increased to about 90% in 2019. The main delays remain with the floats in the Southern Ocean owned by AWI, for the other float programmes managed by BSH the delayed mode is at 94%. All delayed mode profiles have been sent to the Coriolis GDAC node.

The table below lists the status of dmqc efforts for the various national and adopted international programs.

Program Name	Number of profiles	Number of D-files	D-files pending	Comments
Argo BSH	52483	48307	1147	
Argo AWI	7240	3548	3692	Are on priority list
Argo GEOMAR	13474	13393	81	
Argo U. HH	3347	3258	89	
Argo Poland	2949	975	1126*	*Baltic floats mostly
Argo Finland	3214	795	2017*	*Baltic floats mostly
Argo Denmark	360	360	0	Old floats associated with U. HH
Argo Netherlands	11147	10665	184	
Argo Norway	5100	3632	621	

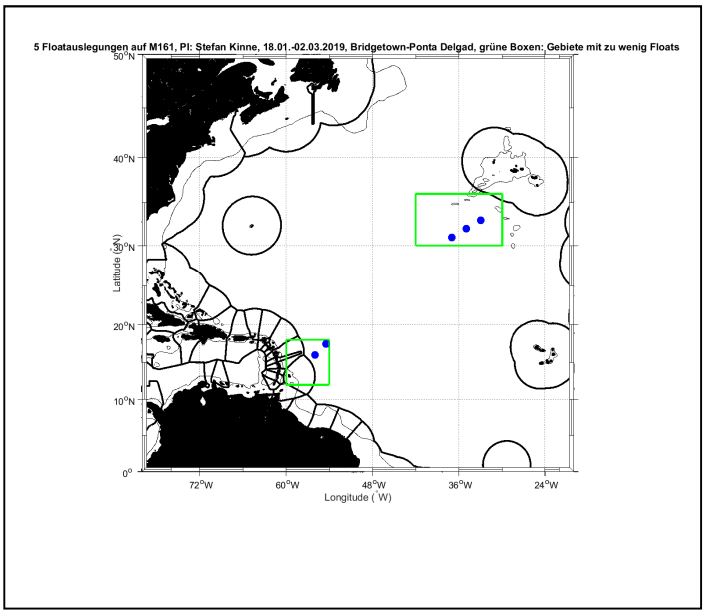
2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.

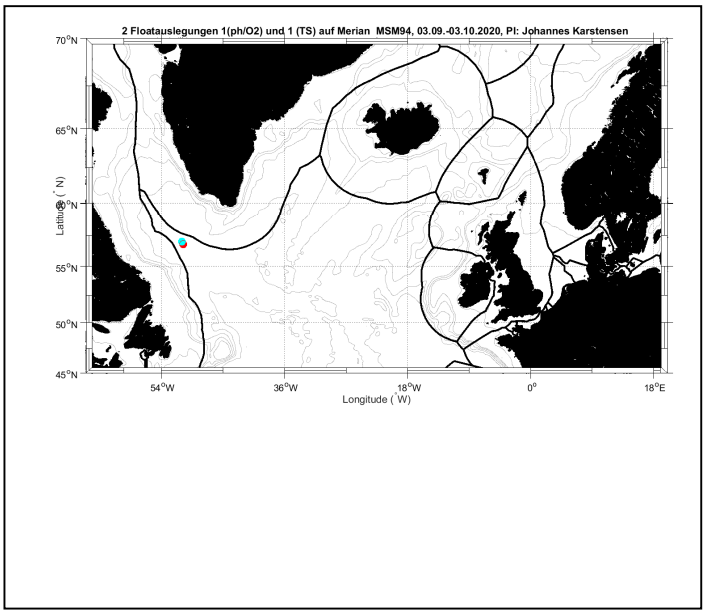
The present level of national funding for Argo been increased in 2019 from a previously flat funding and the number of floats purchased per year is now closer to 50, as originally envisioned. The human resources remain at the same level as before in 2019 and Birgit Klein, Jan-Hinrich Reissman, Anja Schneehorst and Simon Tewes cover activities such as 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. Ingrid Angel Benavides has been employed with funding of European Union.

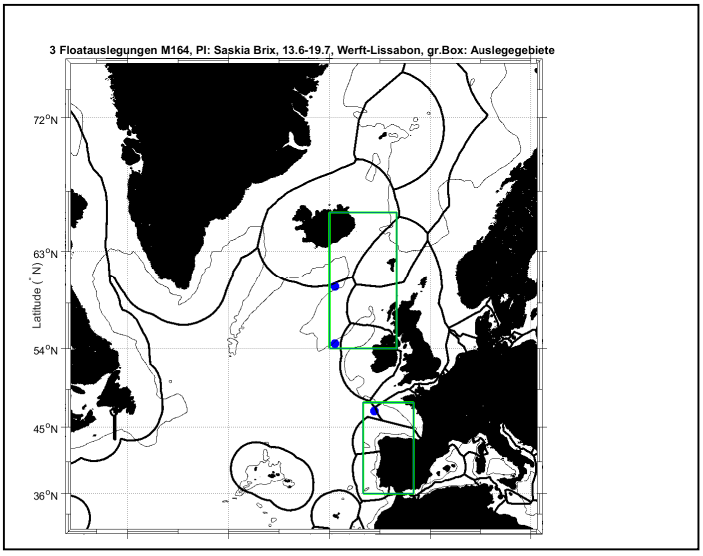
Funding for complementary oxygen and ph-sensors has been provided by the science ministry (BMBF) and three floats equipped with these sensors had been deployed in the Labrador Sea in 2018. One float is malfunctioning due to a defect in the pressure sensor, and a replacement float was delivered in 2019 by Webb Research. The University of Oldenburg has received funds from BMBF to buy 6 BGC floats and test new hyperspectral sensors. Four of the floats have deployed in 2019.

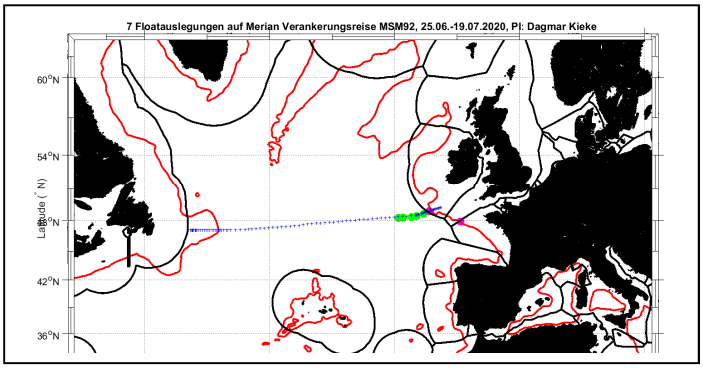
3. Summary of deployment plans (level of commitment, areas of float Deployment, low or high resolution profiles, Argo extensions) and other commitments to Argo (data management) for the upcoming year and beyond where possible.

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). For national science questions the eastern boundary currents in the North Atlantic also remain a priority. A maximum number of 48 will be deployed in 2020. 4 floats with BGC sensors are contributed by the University of Oldenburg and are financed by the ministry of research (BMBF). All profiles will be high resolution profiles. To assist the German Navy during a maneuver in fall 2020 a float will be deployed in the Norwegian Trench in the North Sea.









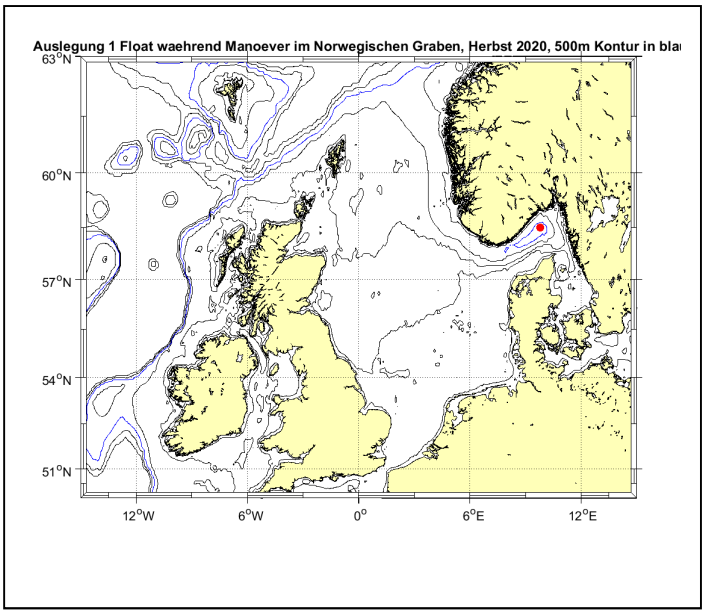
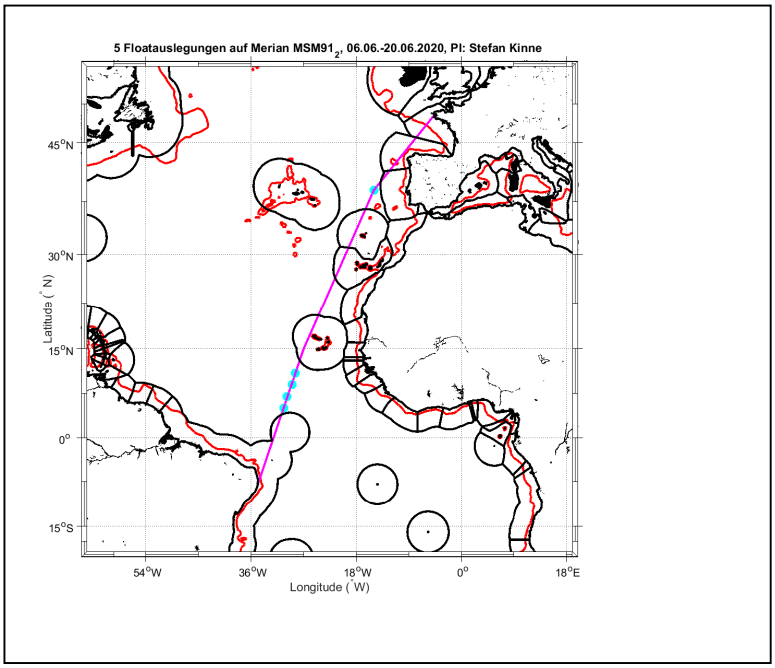
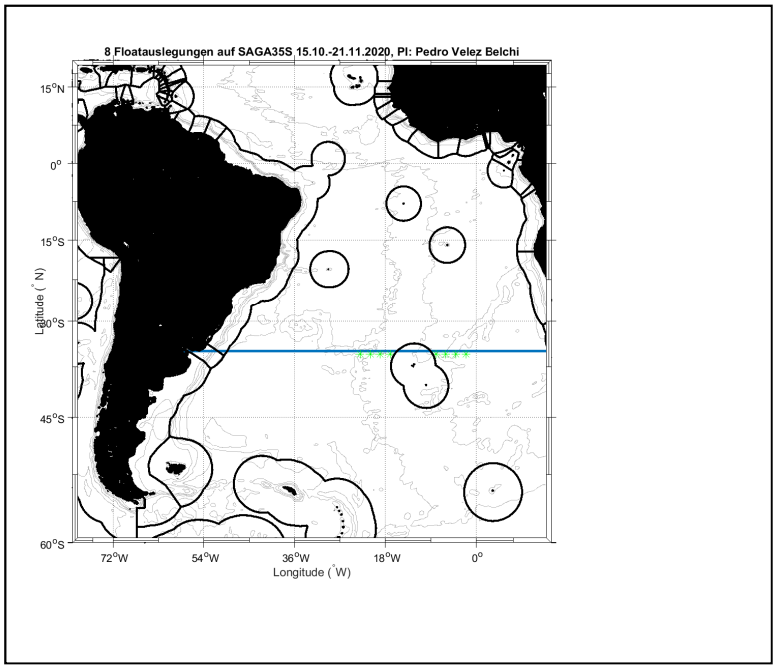
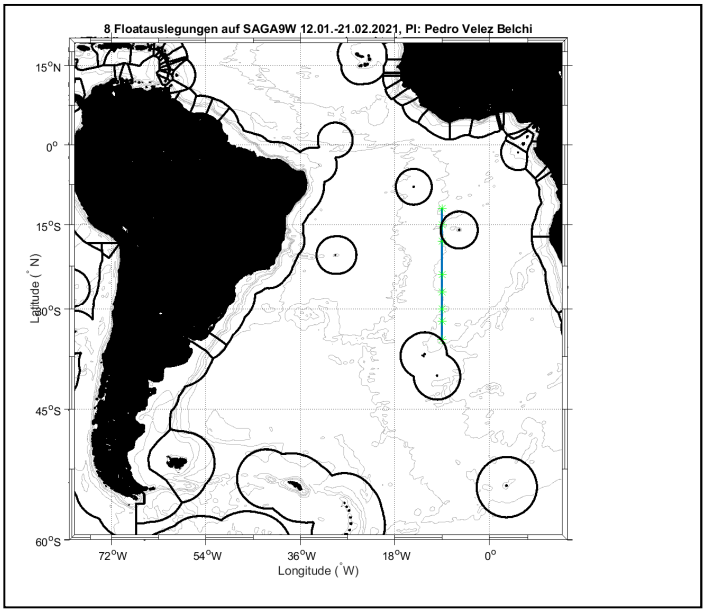
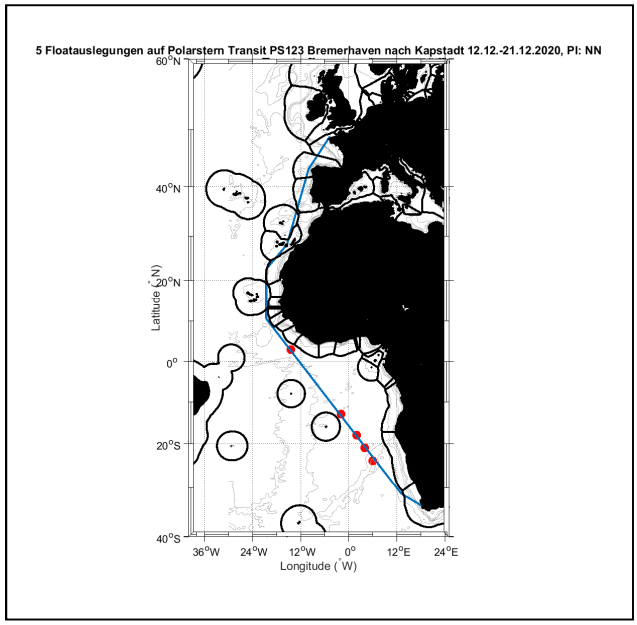


Fig.4: Planned deployments in the North Atlantic\North Sea in 2020









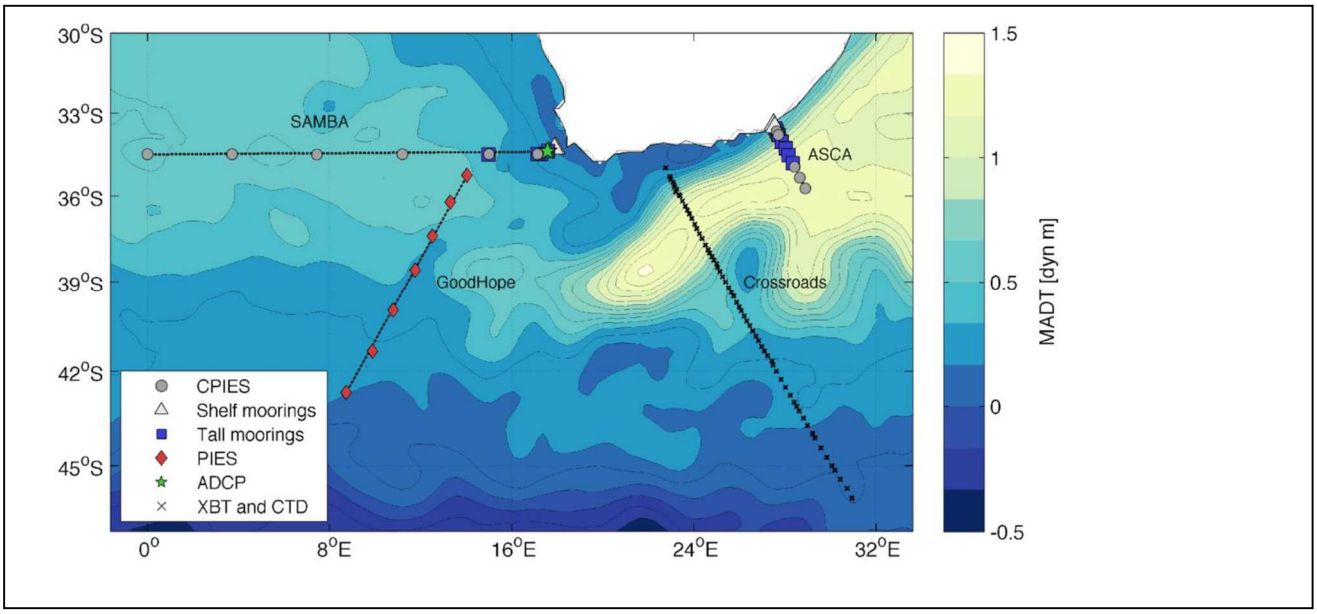


Fig. 5: Planned deployments in the South Atlantic in 2020. 5 Floats will be stored with South African Weather service to be deployed on their regular cruises.

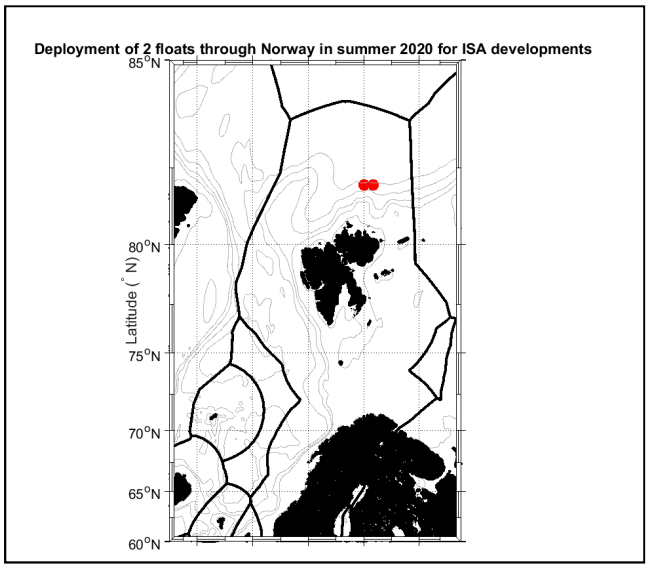


Fig. 6: Planned deployments in the ice covered areas

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

GER	2020						
	Total	T/S Core	T/S/O2	BGC	Bio	Deep	
Nordic Seas							
Mediterranean Sea	1			+1			
Black Sea							
Baltic Sea/North Sea	3	1		+2			
Southern Ocean							
Arctic Ocean	2	2					
Global Ocean	42	41		1			
Total	**48**	44		4			

GER	2021						
	Total	T/S Core	T/S/O2	BGC	Bio	Deep	
Nordic Seas	1			+1			
Mediterranean Sea							
Black Sea							
Baltic Sea	1			+1			
Southern Ocean	11	5+6					

Arctic Ocean	2	2					
Global Ocean	43	43					
Total	**58**	56		2			

Deployment plans for 2020/2021

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. We have recently moved our updated webpage to our institutional page and have added content.

https://www.bsh.de/DE/THEMEN/Beobachtungssysteme/ARGO/argo_node.html

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 was held in 22.08.2010. It was well attended. It provided a good forum for users to share their scientific work and methods.

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. Within the MOCCA project we are presently working on establishing services for the Nordic Seas.

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, mostly reference profiles from floats deployments from various cruises of Merian, Meteor and Polarstern. Additonally all data from Merian cruise MSM73 were provided by Uni Bremen (143 stations).

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.

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Featured also in the Euro-Argo Newsbrief (Science & Technology Highlights): https://www.euro-argo.eu/Activities/Data-Use-and-Applications/Scientific-Results/Global-core-Argo/Observed-Characteristics-and-Vertical-Structure-of-Mesoscale-Eddies-in-the-SouthWest-Tropical-Pacific

Kieke, D, W. Böke, S. Büttner, K. Bulsiewicz, C. Danek, T. Hempel, D. Khordakova, B. Mirau, A. Rochner, A. Roessler, N. Rohlfs, A. Schneehorst, R. Steinfeldt, P. Sültenfuß, H.-H. Uhde, S. Wett, K. Wiegand, F. Wischnewski (2018), Subpolar Gyre Variability, Cruise No. MSM53, March 31 - May 09, 2016, Kiel (Germany) - St. John's (Canada). *MARIA S. MERIAN-Berichte*, DFG-Senatskommission für Ozeanographie, doi:10.2312/cr_msm53