Argo Germany National Report 2016

September 2016

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1. The status of implementation (major achievements and problems in 2016)

Data acquired from floats:

Most of the floats deployed by Germany are operated by BSH but additional funding has been acquired by various research institutes. BSH will have deployed 45 floats by the end of 2016, 5 floats purchased in 2016 will used for a deployment cruise early 2017. No floats will be deployed by GEOMAR and AWI this year.

Currently (September 5th, 2016) 144 German floats are active (Fig.1) and the total number of German floats deployed within the Argo program increased to 843. 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. These floats were equipped with alkaline batteries and suffered from battery flue because of a missing diode. TWR has provided 9 more floats during 2016 from the warranty agreement for the lost floats. In total 34 floats were provided by TWR between 2014 and 2016 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.

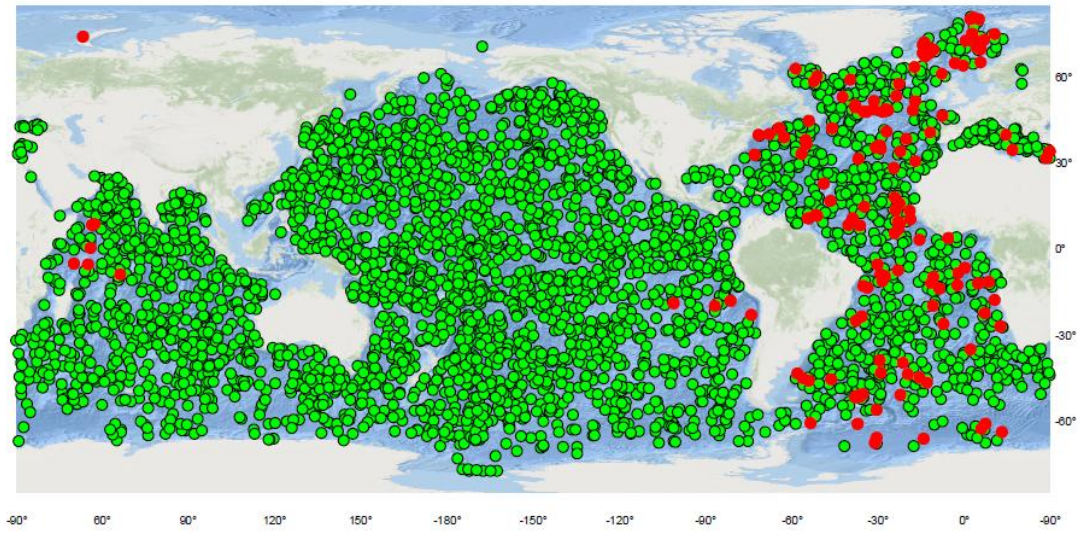


Fig. 1: Locations of active German floats (red) and active international floats (green) (Argo Information Centre, September 2016).

In the beginning most of the German floats were APEX floats purchased from Webb Research, and a smaller amount of floats were manufactured by the German company OPTIMARE. The company had been working in close collaboration with the AWI and had developed a float type suitable for seasonally ice covered seas. These floats were equipped with an ice sensing algorithm which prevents the float from ascending to the surface under ice conditions. Float profiles are stored internally until they can be transmitted during ice free

conditions. In the last year three manufacturers supplied floats to BSH: ARVOR floats from NKE, NOVA floats from METOCEAN and APEX floats from TELEDYNE/WEBB.

The major technical problems with the alkaline batteries in our APEX floats deployed since 2010 is slowly fading out. Until September 2016 more than 73 floats deployed between 2010 to 2014 expired early with life cycles of about 700-800 days. The technical data send back from the floats indicate 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 already replaced floats 34 floats in three batches (14 floats in 2014, 11 floats in 2015 and 9 floats in 2016).

As has been reported at AST-16 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). These floats should be covered by our warranty agreement and we will work with the company to settle the issue.

All of the German floats deployed in 2016 are standard TS floats. Deployment was carried on research vessels. The scientific research vessels comprised Canadian, German and UK ships. The deployment locations for 2016 are shown in Fig. 2.

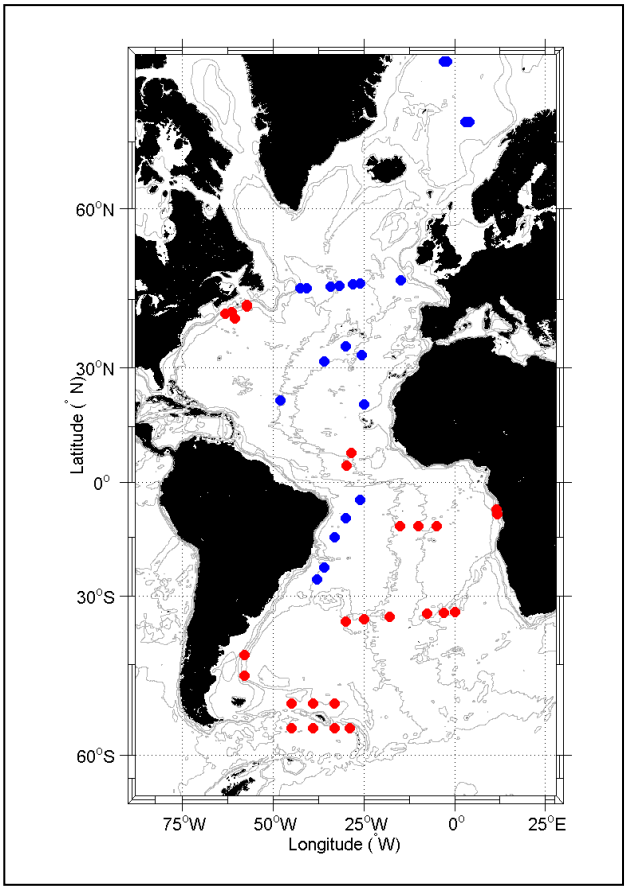


Fig. 2a-b: Deployment positions for floats operated by BSH in 2016 in the Atlantic Ocean. At positions marked in blue the deployment has already been carried out and those in red will be achieved until the end of the year.

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.

2. Deployment plan for 2017

The deployment plans for 2017 at present comprise about 43 floats from BSH in the Atlantic, the Nordic Seas, the Weddell Gyre and the Arctic and consists of 5 floats purchased already in 2016 and funds from 2017 (Fig. 3a, Fig. 4a-c and Fig. 5, Fig. 6). Contacts with researchers on potential deployment cruises have been established and agreement has been reached on the possibility to deploy floats and formal clearance for floats deployed in EEZs. The priority of our deployments is grid completion and extension of the core Argo array into the seasonally ice covered oceans in the Nordic Seas and the Southern Ocean in accordance with the EuroArgo implementation plan. The deployments in the Weddell Gyre will be coordinated in close contact with the AWI. They will follow the same set of requirements defined by AWI (Olaf Boebel) for under-ice floats with additional RAFOS antenna. In order to test the new set-up only a subset of the floats depicted in Fig. 5 will be deployed by both BSH and AWI. The test should help to ensure that the floats function properly at sea under ice conditions. If tests with the new floats are successful, the AWI will purchase about 20 floats for deployment in the Weddell Gyre in 2018. The AWI is now planning to deploy its remaining 13 NEMO floats in 2017 during the Polarstern cruise PS103 (Dec. 2016-Feb. 2017). No deployments are planned yet for 2017 by GEOMAR. But GEOMAR is partner in the ATLANTOS consortium and will be involved in the deployment of deep floats as part of the pilot study in the Atlantic. The German Navy has been contacted again about potential deployments in the Indian Ocean during their regular survey operations. If additional funds become available from warranty agreements more deployments will be added.

The three deployments in the Arctic Ocean (Fig. 6) are in preparation for the contribution to intensive field phase of the YOPP program in 2018. These floats should operate in the marginal ice zone and provide subsurface ocean information for the coupled reanalysis. Testing of the floats will be performed in the context of the EuroArgo Eric and in cooperation with our colleagues from Finland and Poland.

Altogether it is planned to deploy at least 56 German floats during 2017. When floats from the warranty agreements can be used this could increase by ~15 floats.

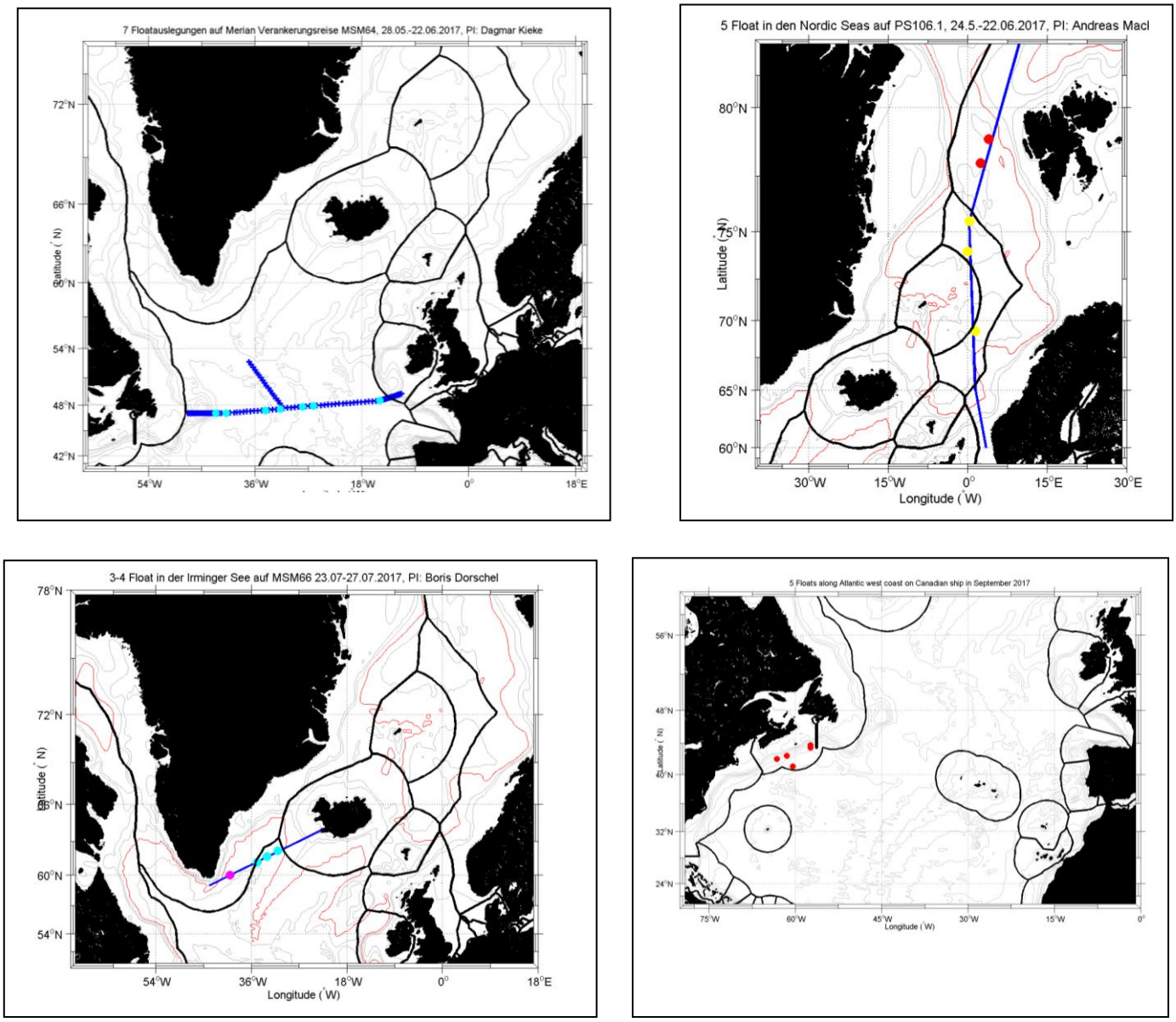
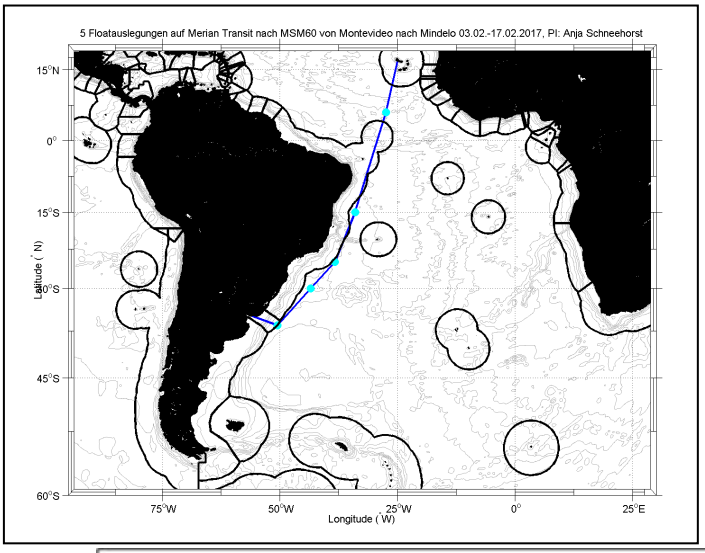
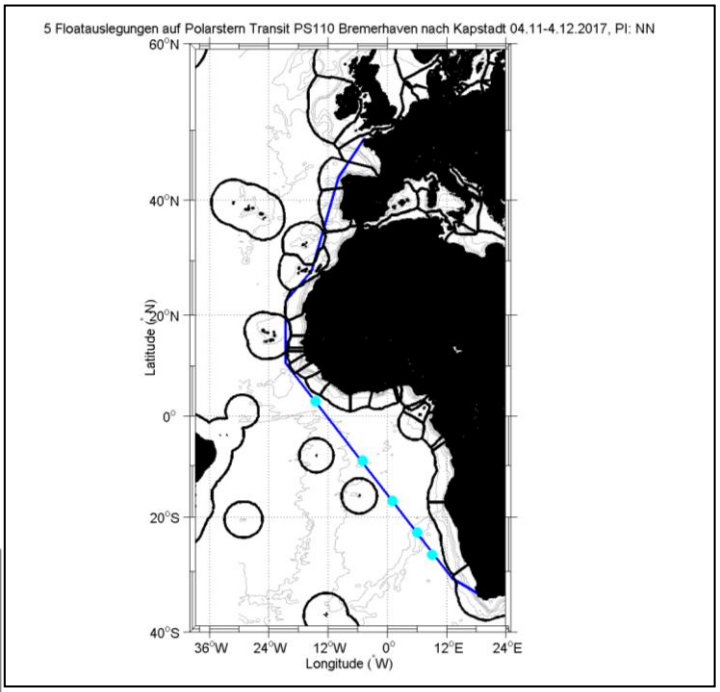


Fig. 3: a-d: Planned deployments of 21 floats in the North Atlantic





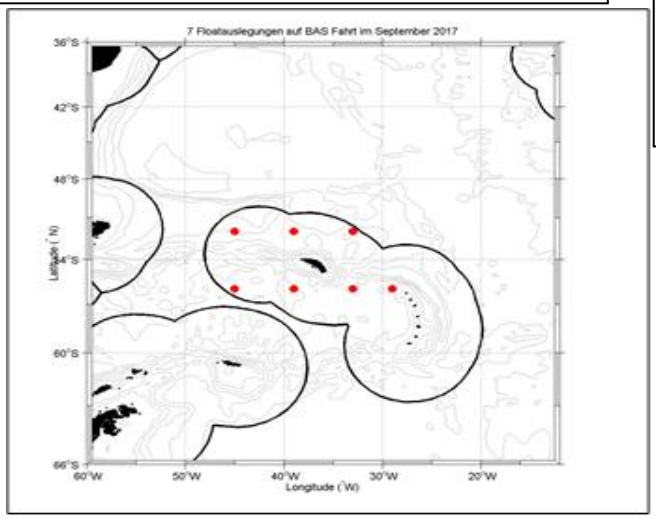


Fig. 4: a-c: Planned deployments of 17 floats in the South Atlantic

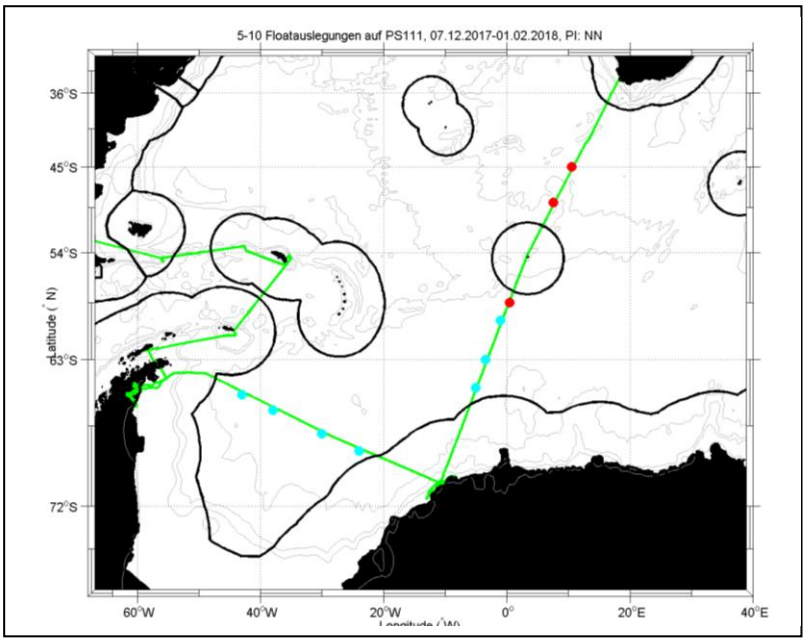


Fig. 5: Potential deployments in the Weddell gyre. Floats marked in cyan should have an additional RAFOS antenna and operate with an ice-sensing algorithm and interim-storage.

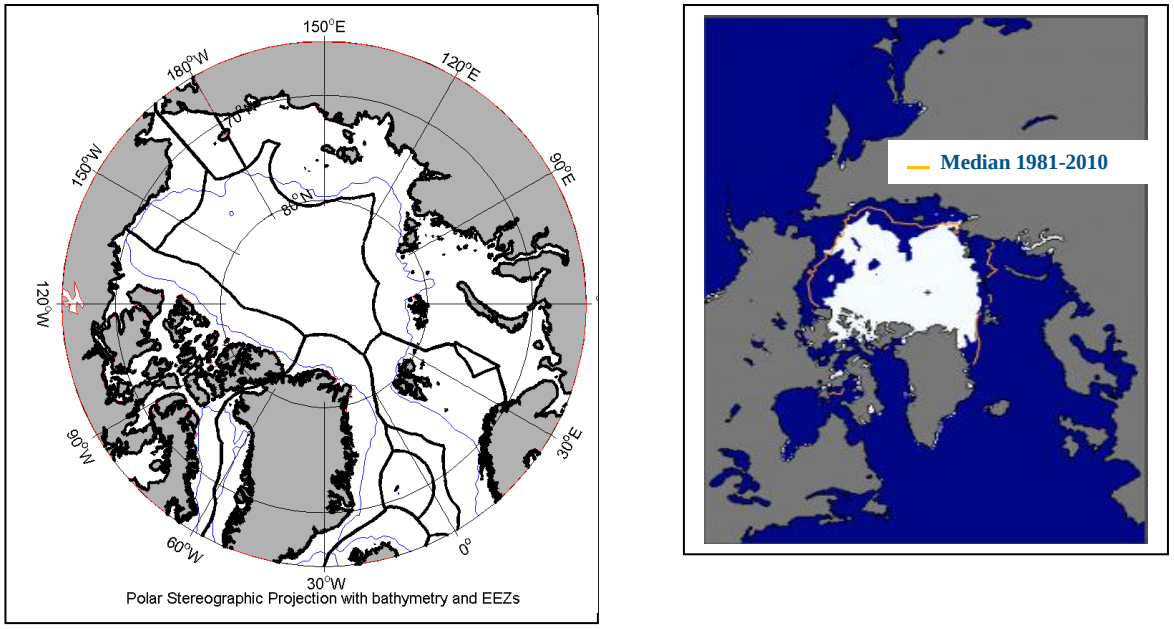


Fig. 6: Left: Arctic Ocean with indication of territorial waters, right: sea ice concentration in August 2016. Deployments in 2017 will be in preparation of the YOPP and will be carried out in cooperation with the EuroArgo ERIC.

3. Commitments to Argo data management

Data issued to GTS

The profiles for all German floats are processed by Coriolis and are distributed on the GTS by way of Meteo-France.

Data issued to GDACs after real-time QC

The real-time data processing for all German floats is performed at the Coriolis Center in France. Data processing follows the procedures set up by the Argo Data Management Team.

Data issued for delayed QC

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. BSH has also adopted some European floats which did not have a DMQC operator assigned to them, such as national Argo programs from the Netherlands, Denmark, Norway, Finland and Poland. 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 have occurred in the last year at AWI due to changes in personal and delays in replacement. The processing of the RAFOS information on the under ice floats needs reformatting of the files to file format 3.1. The intermediary RAFOS amplitudes and time-of-arrival will be stored in the trajectory data. AWI

is presently enhancing their decoders for the remaining NEMO floats to solve issues with the dating of under-ice profiles and will resubmit these data to Coriolis until beginning of October. These files will then be transformed to file format 3.1. Due to errors in some of the APEX manuals a larger subset of floats from the national programs of the Netherlands, Poland and Norway had to be grey-listed. These floats will now be reprocessed and will then be available for DMQC. Delayed-mode data processing follows the rules set up by the Data Management Team. The DMQC process is underway, but due to format issues with file format 3.1 and updates in hardware/software some delays have been encountered at BSH. The re-processing of APEX floats at Coriolis requires a replacement of already existing D-files with files based on the decoders. This will be finished until the end of year.

Delayed mode data send to GDACs

All delayed mode profiles from BSH have been sent to the Coriolis GDAC node. The total number of available profiles from German floats is 58644 (September 6th, 2016), the number of DM profiles is 44524. The percentage of DM profiles with respect to the total number of profiles is about 76%. The switch to file format 3.1 required some re-decoding of older versions of APEX floats. This is managed by Coriolis and since some of the floats affected already had been through delayed-mode quality control, their D-files have to be re-constructed.

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

Web pages

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.

Statistics of Argo data usage

Currently no statistics of Argo data usage are available. The German Navy uses Argo data on a regular basis for the operational support of the fleet and uses their liaison officer at BSH to communicate their needs. The SeaDataNet portal uses German Argo data operationally for the Northwest European Shelf. 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 was attended by a mixed group; it included users from the modelling community and users performing observational studies. The three institutions contributing floats to the German program outside of BSH were also represented.

Publications based on Argo:

Myriel Horn (2015), Frontal analysis on the shelf region of the western North Atlantic, Master Thesis, M.Sc. Marine Environmental Sciences, University of Oldenburg.

Stendardo, I., M. Rhein, and R. Hollmann (2016), A high resolution salinity time series 1993-2012 in the North Atlantic from Argo and altimeter data, J. Geophys. Res., 121, 2523-2551, doi:10.1002/2015JC011439

Kieke, D., and I. Yashayaev (2015), Studies of Labrador Sea Water formation and variability in the subpolar North Atlantic in the light of international partnership and collaboration, Prog. Oceanogr., 132(3), 220-232, doi:10.1016/j.pocean.2014.12.010.

Roessler, A., M. Rhein, D. Kieke, and C. Mertens (2015), Long-term observations of North Atlantic Current transport at the gateway between western and eastern Atlantic, J. Geophys. Res., 120, 4003-4027, doi:10.1002/2014JC010662.

Schneider, L., D. Kieke, K. Jochumsen, E. Colbourne, I. Yashayaev, R. Steinfeldt, E. Varotsou, N. Serra, and M. Rhein (2015), Variability of Labrador Sea Water transported through Flemish Pass during 1993 - 2013, J. Geophys. Res., 120, 5074-5089, doi:10.1002/2015JC010939.

Burmeister, K., P. Brandt, and J. F. Lübbecke (2016), Revisiting the cause of the eastern equatorial Atlantic cold event in 2009, J. Geophys. Res. Oceans , 121 , 4777–4789, doi:10.1002/2016JC011719.

Schütte, F., Brandt, P. und Karstensen, J. (2016) Occurrence and characteristics of mesoscale eddies in the tropical northeast Atlantic Ocean Ocean Science, 12 (3). pp. 663-685. DOI 10.5194/os-12-663-2016.

Stramma, L., Czeschel, R., Tanhua, T., Brandt, P., Visbeck, M. und Giese, B. S. (2016) The flow field of the upper hypoxic Eastern Tropical North Atlantic oxygen minimum zone Ocean Science, 12 (1). pp. 153-167. DOI 10.5194/os-12-153-2016.

Hummels, R., P. Brandt, M. Dengler, J. Fischer, M. Araujo, D. Veleda, and J. V. Durgadoo (2015), Interannual to decadal changes in the western boundary circulation in the Atlantic at 11°S, Geophys. Res. Lett. , 42 , 7615 – 7622, doi:10.1002/015GL065254.

Czeschel, R., Stramma, L., Weller, R. A. und Fischer, T. (2015) Circulation, eddies, oxygen and nutrient changes in the eastern tropical South Pacific Ocean Ocean Science, 11 (3). pp. 455-470. DOI 10.5194/os-11-455-2015.

Karstensen, J., Fiedler, B., Schütte, F., Brandt, P., Körtzinger, A., Fischer, G., Zantopp, R. J., Hahn, J., Visbeck, M. und Wallace, D. W. R. (2015) Open ocean dead-zone in the tropical North Atlantic Ocean Biogeosciences (BG), 12 . pp. 2597-2605. DOI 10.5194/bg-12-2597-2015.

Stammer, D.; Balmaseda, M.; Heimbach, P.; Köhl, A.; Weaver, A.. “Ocean Data Assimilation in Support of Climate Applications: Status and Perspectives”. Annual Review of Marine Science 8. (2016): S. 491-518. doi: 10.1146/annurev-marine-122414-034113

Jochumsen, K.; Schnurr, S.M.; Quadfasel, D.. “Bottom temperature and salinity distribution and its variability around Iceland”. Deep Sea Research Part I: Oceanographic Research Papers 111. (2016): S. 79-90. doi: 10.1016/j.dsr.2016.02.009

Sena Martins, M., N. Serra, and D. Stammer (2015), Spatial and temporal scales of sea surface salinity variability in the Atlantic Ocean, J. Geophys. Res. Oceans , 120, 4306–4323,doi:10.1002/2014JC010649

Martins, M. S.; Stammer, D.. “Pacific Ocean surface freshwater variability underneath the double ITCZ as seen by satellite sea surface salinity retrievals”. Journal of Geophysical Research 120 (8). (2015): S. 5870-5885. doi: 10.1002/2015JC010895

K. Latarius, D. Quadfasel: Water mass transformation in the deep basins of the Nordic Seas: Analyses of heat and freshwater budgets, Deep_Sea Research I, 114 (2016): 23-42, http://dx.doi.org/10.1016/j.dsr.2016.04.012

Products generated from Argo data

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.

CTD data submitted to Reference data base:

MSM53 data in the subpolar North Atlantic have been submitted by Uni Bremen (Dagmar Kieke)

M130 and M131 data in subtropical South Atlantic will be submitted shortly after the cruises by GEOMAR (Markus Dengler/Peter Brandt).