

German National Report 2020 for the Argo Steering Team Meeting AST22

Submitted by Birgit Klein on behalf of Argo Germany

1. The status of implementation of the new global, full-depth, multidisciplinary Argo array (major achievements and problems in 2020) a. floats deployed and their performance

All floats deployed by Germany in 2020 were operated by BSH. Due to cancellation of cruises because of the COVID pandemic only 27 of the planned 48 German floats could be deployed. The remaining deployments had to be redirected to other ships or had to be delayed until 2021. The South African Weather Service (Tamaryn Morris) kindly accepted to store 21 of our floats on their premises to be picked up by German Ships calling into Cape Town and to be deployed on the regular South African cruises (SANAE, SAMBA, Good Hope). All deployments have been carried out on research vessels, which comprised German, Norwegian, South African and UK ships. The deployment locations for 2020 are shown in Fig. 1. All deployed floats except for one were Arvor floats with TS sensor only, one APEX float deployed in the Labrador Sea carried additional pH and O₂ sensors. In 2020 we deployed our first two floats in the Arctic proper and tested our newly developed ISA algorithm.

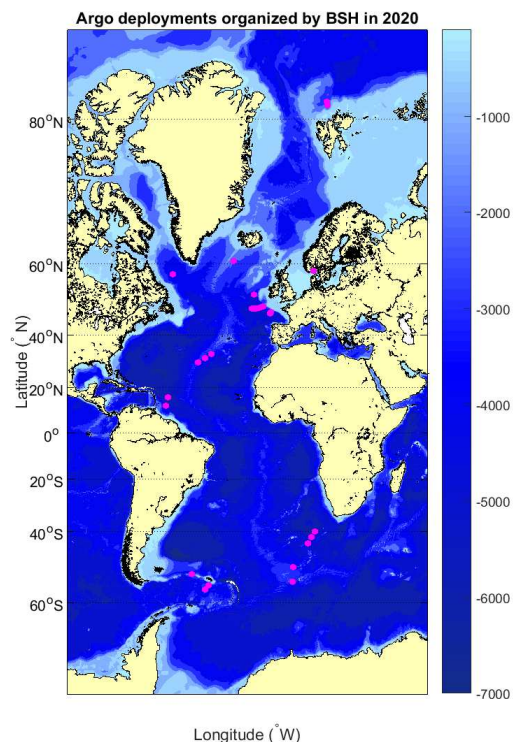


Fig. 1: Deployment positions for floats operated by BSH in 2020 in the Atlantic Ocean.

b. technical problems encountered and solved

None of our floats deployed in 2020 has experienced serious technical problems. One of our three APEX floats equipped with a pH- and O₂-sensor deployed in 2018 had been malfunctioning due to a defect pressure sensor. The replacement for this float has been received and was deployed at its original location in the Labrador Sea in 2020.

c. status of contributions to Argo data management (including status of high salinity drift floats, decoding difficulties, ramping up to include BGC or Deep floats, etc.)

Germany has continued its work in the European Research Infrastructure Consortium EURO-ARGO-ERIC, which was established in July 2014. In 2020, the EuroArgo ERIC has started a joint census of floats affected by fast salinity drift at European level to estimate the effects on the data stream. Initially, the list was established on GitHub and shared as a google-docx document. The working group on fast salinity drift reported at ADMT-21 on the issue. It was decided to collect the information in a joint spreadsheet. BSH has offered to update the spreadsheet with information from all DMQC operators. The link to the spreadsheet is given below and entries can be entered either from all DMQC operators directly or be send as lists to Birgit.klein@bsh.de for inclusion in the table.

<https://docs.google.com/spreadsheets/d/1TA7SAnTiUvCK7AyGtSTUq3gu9QFbVdONj9M9zAq8CJU/edit?usp=sharing>

The spreadsheet has been updated with all the contributions received so far and progress will be reported at AST-22.

d. status of delayed mode quality control process

BSH had adopted floats from all German universities and agreed last year to perform similar services for the AWI floats. The status of delayed mode quality process for German floats is good. The overall percentage of D-files from all German programs is remaining at a quota of 89%. A preliminary DMQC for the subset of re-processed AWI floats (now in V3.1) has now been performed, but the submission of D-files has been postponed to increase the reference data base in the Weddell gyre which is outdated. Therefore, only 42% of the AWI files are available as D-files so far. For all other German floats (741 floats) the DMQC quota is at 95%. The census of the delayed mode quality control is given in detail in the data management report from November 2020. Additional time was spend to check files updated to format V3.1 and repeat DMQCs (if necessary), particular for old floats from the universities with BGC sensors with format inconsistencies in the older formats. Occasionally also new R-files are created during reprocessing.

BSH has also adopted floats from Finland (37 floats), the Netherlands (92 floats), Norway (58 floats) and Poland (26 floats) for DMQC and 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 the Southern Ocean. The progress in these programs providing D-files is generally good. Since Argo-Norway has received funding from the national

research council to increase the number of Norwegian floats deployed per year, the program will get more involved in the DMQC activities. We organized a DMQC training workshop for Norway and Poland in 2019 and floats deployed from 2020 onward will be covered by Norwegian DMQC operators. The same is true for Argo-Poland, which already submitted D-files for their newer floats.

2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo, and funding for sustaining the core mission and the enhancements: BGC, Deep, Spatial (Polar, equator, WBCs)

In 2020, we have held several meetings at government level to prepare the transition to the new multidisciplinary Argo strategy. Among these was a meeting at BMVI (Federal Ministry of Transportation and Digital Infrastructure) in February 2020, which included participation from the Federal Ministry of Science (BMBF). During the year, we have also given reports at inter-ministerial meetings in April and August. In September, we have opened budget negotiations with BMVI to increase our budget to implement both BGC and Deep contributions nationally. At the moment all our funding is for core Argo only. The aim is to switch our contribution to a mix of 36 core floats, 14 deep floats and 12 BGC floats annually. The budget proposal for 2022-2026 was approved at BMVI level but the negotiations for the national budget are presently continuing at federal level. The final decision is expected during the first half of 2022 the latest.

The Federal Ministry of Science (BMBF) has provided considerable funding in 2020 to start the transition into the new multidisciplinary strategy. The project DArgo2025 (08/2020-12/2021) received funding in 2020 for 20 floats, 15 of which are BGC floats and 5 core floats, but equipped with RBR CTDs. The proposal was submitted jointly by BSH and the newly created BGC group (GEOMAR, ICBM and IOW). Deployments of all DArgo2025 floats are scheduled for 2021 and will address open technological questions. Some of the BGC floats will carry novel sensors such as a nitrate sensors and hyperspectral sensors from the German TRIOS company. In the project C-Scope (01/2021-12/2023) additional funding has been received to promote pH measurements on floats. In 2022-2023 six floats will be upgraded with pH and O₂ sensors and a new sensor of pCO₂ will be tested.

In the context of the European Project EuroArgo-Rise the BSH has worked on a contribution for the Arctic and has developed a decision tool for selecting parameters for Ice Avoidance algorithms (ISA). Two floats from national funding were deployed in 2020 north of Svalbard.

Birgit Klein of the Federal Maritime and Hydrographic Agency (BSH) has continued to act as national leader of the Argo Germany program and is also responsible for data management of the floats. The BSH logistics related to technical aspects, float deployments and satellite data transmission are handled by Anja Schneehorst and Simon Tewes. Ingrid Angel Benavides and Corinna Jensen are involved in Argo in project related matters. For the Southern Ocean AWI has restarted its activities in float deployments including RAFOS technology. The national BGC group established in 2020 involves three research institutes: GEOMAR, ICBM and IOW. A complete list of people involved is given below.

The following people contribute to the logistics and data management for Argo Germany

Name and institution	Area of expertise
Ingrid Angel-Benavides (BSH)	Research scientist (EuroArgo Rise) and related DMQC obligations
Henry Bittig (IOW)	Research scientist (DArgo2025, C-Scope), BGC group, DMQC operator (BGC sensors)
Hendrik Bünger (ICBM)	Research engineer, BGC group, DMQC operator (BGC sensors)
Corinna Jensen (BSH)	Research scientist (DArgo2025) and related DMQC obligations
Birgit Klein (BSH)	National program lead, research scientist (DArgo2025, C-Scope, EuroArgo Rise), DMQC operator (core Argo)
Arne Körtziner (GEOMAR)	Research scientist, BGC Argo, DMQC operator (BGC sensors)
Anja Schneehorst (BSH)	Technician, float procurement, contracting, deployment logistics and performance monitoring
Tobias Steinhoff (GEOMAR)	Research scientist, BGC group, DMQC operator (BGC sensors)
Simon Tewes (BSH)	Technician, technical support, and performance monitoring
Malin Waern (IOW)	Research scientist, BGC group
Oliver Zielinski (ICBM)	Research scientist, BGC group
Olaf Boebel (AWI)	Research scientist, RAFOS technology

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

Because of the COVID related deployment delays in 2020 and additional floats funded by research projects the total number of floats scheduled for deployment in 2021 is nearly twice as high as usual. A total of 92 German floats is scheduled for 2021 (see figure 2) including 5 floats with RAFOS capability from AWI. Deployment opportunities come mostly from regular research cruises but also from the Atlantic Charter organized by the AST and the co-operation with the South African Weather Service. German research cruise providers have already issued a warning, that in the second half of 2021 cruises might be cancelled, and ships might need to operate to and from German ports exclusively. We are presently reviewing our agreements with PIs and will adapt our plans where necessary. The commitment table at OceanOPS ([link](#)) has been edited based on the present plans and will be modified when the situation is clearer.

Planned Argo deployments organized by BSH in 2021, AWI floats in green and ICBM in white

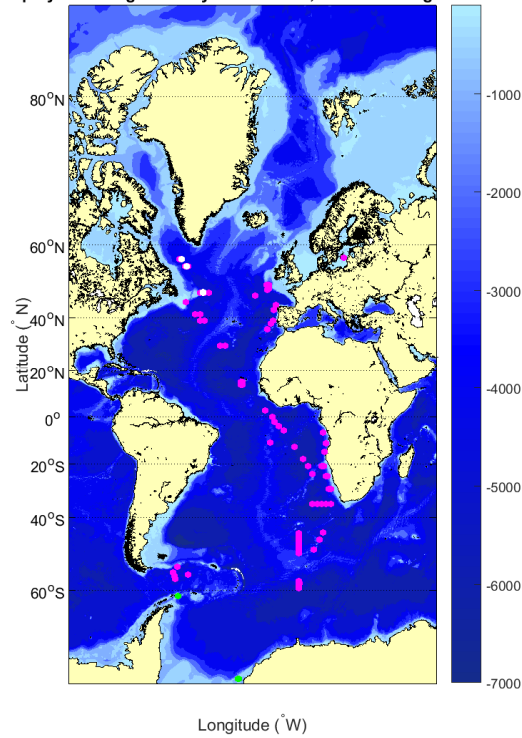


Fig. 2: Deployment positions for floats operated by BSH in 2021 in the Atlantic Ocean. Included are also the planned deployments in the Weddell Gyre by AWI (in green) and the ICBM (in white).

GER	2021						
	Total	T/S Core	T/S/O2	BGC	Bio	Deep	
Nordic Seas							
Mediterranean Sea	3				3*		
Black Sea							
Baltic Sea/North Sea	2				2		
Southern Ocean	5	5					
Arctic Ocean							
Global Ocean	82	71			11		
Total	92	76			16		

Table 2: German (BSH, AWI, ICBM) deployments in 2021 according to area and subprogram. * ICBM floats from the DArgo2025 project with hyperspectral sensors will be tested in the Mediterranean.

The numbers in for 2022 depend on the national budget negotiations for 2022, at minimum there will be 50 core TS floats from the operational BSH budget, 23 floats from AWI in the Southern Ocean and 3 Bio-floats from the C-Scope project. Deployment positions are not yet determined, the AWI Floats will all be deployed in the Southern Ocean and the remaining floats will go mostly to the Global Ocean.

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

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

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. Their needs are communicated by a liaison officer stationed at BSH . The SeaDataNet portal uses German Argo data operationally for the Northwest European Shelf. Argo data are routinely assimilated into the GECCO reanalysis, which is used for the initialisation the decadal prediction system MiKlip. At BSH, the data are used within several projects for data interpretation in the eastern North Atlantic and the Expert Network on climate change of the BMVI.

The annual user workshop for 2020 was cancelled due to COVID and postponed until 2021. Due to the ongoing COVID pandemic we held virtual meeting held early in 2021 on 18.02.2021. The meeting was well attended and 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 data for research applications for

BSH related projects (e.g. 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 joined recently 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.**

Nothing to 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.**

BSH regularly ask PIs from our deployment cruises to provide us with any CTD profiles recorded after float deployments for calibration and comparison. These data are shared with Coriolis. A list of CTD data collected in 2020 is given below. In addition, we have collected reference data for the Arctic and performed quality checks on the soon to be released update of the global CTD reference data base.

WMO	Float type	Date	Ship / Cruise	Lat	Lon	Extra Sensors	Float ID	cast name acc. cruise report
7900576	Arvor I	29.12.2020	SA Agulhas II / SANAE	-44.015	6.760		AI2600-20DE036	
6904073	Arvor I	28.12.2020	SA Agulhas II / SANAE	-40.003	10.060		AI2600-20DE027	
6904071	Arvor I	28.12.2020	SA Agulhas II / SANAE	-42.009	8.439		AI2600-20DE029	
6904067	Arvor I	31.12.2020	SA Agulhas II / SANAE	-51.060	0.399		AI2600-20DE033	
6904068	Arvor I	31.12.2020	SA Agulhas II / SANAE	-55.032	0.006		AI2600-20DE032	
7900566	Apex	21.08.2020	RV Maria S. Merian / MSM94	57.582	-53	O2, PH	8903	MSM94_098
7900567	Arvor I	02.07.2020	RV Meteor / M164	48.368	-18.047		AI2600-20DE001	M164_028
7900568	Arvor I	01.07.2020	RV Meteor / M164	48.422	-17.038		AI2600-20DE002	M164_027
7900569	Arvor I	01.07.2020	RV Meteor / M164	48.476	-16.032		AI2600-20DE003	M164_027
7900570	Arvor I	01.07.2020	RV Meteor / M164	48.517	-15		AI2600-20DE004	M164_026
7900571	Arvor I	30.06.2020	RV Meteor / M164	48.748	-13.813		AI2600-20DE005	M164_023
7900572	Arvor I	29.06.2020	RV Meteor / M164	48.925	-12.956		AI2600-20DE006	M164_020
7900573	Arvor I	26.06.2020	RV Meteor / M164	47.383	-9.667		AI2600-20DE012	M164_001

7900539	Arvor I	15.08.2020	Navy	58.269	9.521		AI2600-20DE013	no
7900556	Arvor I	11.07.2020	RV Sonne / SO276	60.5372	-26.0482		AI2600-20DE009	SO276_099
7900557	Arvor I	19.07.2020	RV Sonne / SO276	52.367867	-17.104667		AI2600-20DE010	SO276_125
7900558	Arvor I	22.07.2020	RV Sonne / SO276	46.9737	-9.9404		AI2600-20DE011	SO276_140
7900549	Arvor I	02.10.2020	RV Kronprins Haakon / 2020706	81.03553	15.59796	ISA	AI2600-19DE044	nearby
7900550	Arvor I	02.10.2020	RV Kronprins Haakon / 2020706	81.30828	15.35910	ISA	AI2600-19DE045	nearby
7900548	Arvor I	27.02.2020	FS Meteor / M161_2	31.6705	-38.8119		AI2600-19DE028	M161_254
6900894	Arvor I	26.01.2020	FS Meteor / M161_2	12.187	-56.117617		AI2600-19DE031	M161_057
3901687	Arvor I	26.02.2020	FS Meteor / M161_2	30.0038	-41.978		AI2600-19DE033	M161_250
3901686	Arvor I	21.02.2020	FS Meteor / M161_2	15.81185	-55.2719		AI2600-19DE034	M161_239
7900538	Arvor I	28.02.2020	FS Meteor / M161_2	33.093167	-36.01955		AI2600-19DE038	M161_257
7900551	Arvor I	27.03.2020	BAS	-56.941	-38.936	ISA	AI2600-19DE039	no
7900552	Arvor I	22.03.2020	BAS	-52.9935	-44.628	ISA	AI2600-19DE040	no
7900555	Arvor I	27.03.2020	BAS	-55.948667	-37.336833	ISA	AI2600-19DE043	no

7. Keeping the Argo bibliography ([Bibliography | Argo \(ucsd.edu\)](#)) 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 ([Thesis Citations | Argo \(ucsd.edu\)](#)). 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.

Kepler, L., Landschützer, P., Gruber, N., Lauvset, S. K., & Stemmler, I. (2020). Seasonal carbon dynamics in the near-global ocean. *Global Biogeochemical Cycles*, 34, e2020GB006571. doi.org/10.1029/2020GB006571 <<https://doi.org/10.1029/2020GB006571>>

Kepler, Lydia; Landschützer, Peter; Gruber, Nicolas; Lauvset, Siv K.; Stemmler, Irene (2020). Mapped Observation-Based Oceanic Dissolved Inorganic Carbon (DIC), monthly climatology from January to December (based on observations between 2004 and 2017), from the Max-Planck-Institute for Meteorology (MOBO-DIC_MPIM) (NCEI Accession 0221526). NOAA National Centers for Environmental Information. Dataset. <https://doi.org/10.25921/yvzj-zx46>

Kieke, D., K. Bulsiewicz, I. Deschepper, O. Huhn, M. Kastens, A. Kersting, M. Köllner, L. Krisztian, I. Leimann, B. Mirau, M. Moritz, N. Rohlfs, A. Schneehorst, R. Steinfeldt, I. Stendardo, J. Stiehl, and R. Tao (2020), Long-term observations of the Atlantic Meridional Overturning Circulation, Cruise No. MSM83, May 17 - June 15, 2019, Las Palmas (Spain) - St. John's (Canada). *MARIA S. MERIAN-Berichte*, doi:10.2312/cr_msm83 <https://doi.org/10.2312/cr_msm83> .

Nowitzki H, Rhein M, Roessler A, Kieke D, Mertens C (2021). Trends and transport variability of the circulation in the subpolar eastern North Atlantic. *J. Geophys. Res. Oceans*, 126, doi:10.1029/2020JC016693.

<https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2020JC016693>

Schmidt, H., Czeschel, R. und Visbeck, M. (2020) Seasonal variability of the Arabian Sea intermediate circulation and its impact on seasonal changes of the upper oxygen minimum zone. *Open Access Ocean Science*, 16 . pp. 1459-1474. DOI 10.5194/os-2020-9.

Schmidt, H., Czeschel, R. und Visbeck, M. (2019) Ventilation dynamics of the Oxygen Minimum Zone in the Arabian Sea. *Open Access Biogeosciences Discussions* . pp. 1-32. DOI 10.5194/bg-2019-168.

Stendardo, I., Rhein, M., & Steinfeldt, R. (2020). The North Atlantic Current and its volume and freshwater transports in the subpolar North Atlantic, time period 1993–2016. *Journal of Geophysical Research: Oceans*, 125, e2020JC016065. <https://doi.org/10.1029/2020JC016065>

Tuchen, F. P. , Lübbecke, J. F. , Brandt, P. und Fu, Y. (2020) Observed transport variability of the Atlantic Subtropical Cells and their connection to tropical sea surface temperature variability. *Open Access Journal of Geophysical Research: Oceans*, 125 (12). Art.Nr. e2020JC016592. DOI 10.1029/2020JC016592.

Tuchen, F. P. (2020) The Atlantic Subtropical Cells - mean state and variability from an observational perspective. *Open Access (PhD/Doktorarbeit)*, Christian-Albrechts-Universität zu Kiel, Kiel, Germany, 101 pp. (https://macau.uni-kiel.de/receive/macau_mods_00000769)

Tuchen, F. P. , Lübbecke, J. F. , Schmidtko, S. , Hummels, R. und Böning, C. W. (2019) The Atlantic Subtropical Cells inferred from observations. *Open Access Journal of Geophysical Research: Oceans*, 124 (11). pp. 7591-7605. DOI 10.1029/2019JC015396.

8. How has COVID-19 impacted your National Program's ability to implement Argo in the past year? This can include impacts on deployments, procurements, data processing, budgets, etc.

Nearly half of our deployments in 2020 had to be postponed and had to be shifted to 2021. Fortunately, budgets were not affected since the procurements could be finished in time in 2020, even though the delayed deliveries were rather last minute.

9. Argo is still interested in piloting the RBR CTD. Does your National Program have any deployment plans for RBR floats in the next couple years? If so, please indicate how many floats will you be buying in 2021 and 2022 (if known) and where they might be deployed.

BSH has just deployed a small ensemble of 5 RBR CTDs together with 5 SBE CTDs in January 2021 in the North Atlantic (Fig. 3 and 4) in the framework of the DArgo2025 project. The 10 floats were deployed in an eddy to minimize dispersion and reporting at a two-day cycle for the time being. The analysis of the data will be carried out during 2021 and a similar deployment can follow in 2022.



Fig.3: Deployment of Arvor floats equipped with RBR and SBE CTDs in January 2021 on RV Sonne cruise SO280.

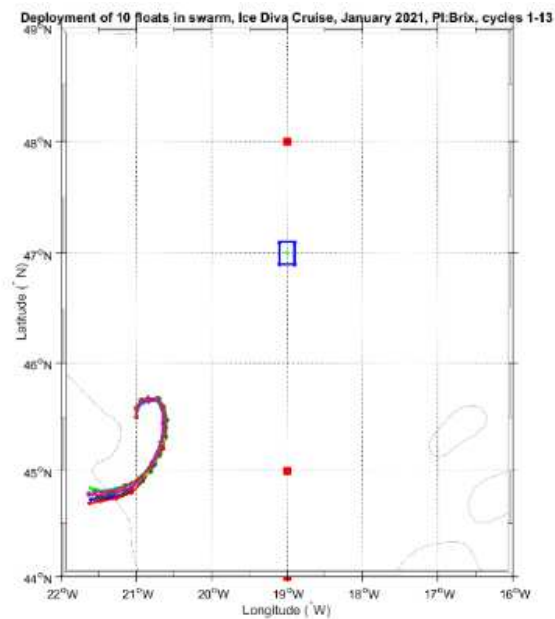


Fig. 4: Deployment positions for RBR pilot and trajectories of the swarm for the first 13 cycles.