

Report on the Italian Argo Program for 2020

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

In total, 24 Italian floats were deployed in 2020 (see Tables 1 and 2 for details). These floats were Arvor-I and Arvor-Ice designs manufactured by NKE (France). All floats transmit data via Iridium telemetry.

Mediterranean and Black Sea deployments

One float was deployed in the Black Sea and 8 units were released in the Mediterranean (Table 1). In the Mediterranean, most 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 except for one Arvor-I float (WMO 6903784) which had short cycles of 3 h during most of their initial operating life to measure high-frequency processes in the Sicily Channel.

Most floats were deployed from research vessels of opportunity (i.e., R/V Alliance, R/V Dallaporta, R/V Laura Bassi, R/V Pourquoi Pas?, R/V Bat-Galim for the Mediterranean and R/V Akademik for the Black Sea) with the help of colleagues from CMRE, France, Italy, Israel and Bulgaria.

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 Laura Bassi while sailing from New Zealand to the Ross Sea. Two Italian floats were deployed in the Ross Sea polynya. Seven floats out of 10 are ice detection type. 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. All floats (with the exception of those in the Ross Sea polynya) were programmed to cycle between the surface and 2000 dbar every 10 days and to drift at the parking depth of 1000 dbar. The adopted configuration for the polynya area was a drifting and profiling depth of 1000 dbar and a cycling period of 5 days. The floats were still active in early 2021.

Five Italian floats were deployed in the South Atlantic Ocean in February 2020 (Table 2) with the help of Italian colleagues onboard the R/V Agulhas II. Three out of 5 floats are Arvor-Ice model. 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 2020.

<u>Model</u>	<u>WMO</u>	<u>Depl. Date</u>	<u>Lat</u>	<u>Lon</u>	<u>Cycles</u>	<u>Last Date</u>	<u>Lat</u>	<u>Lon</u>	<u>Status*</u>	<u>Cyc.**</u>
Arvor - T/S Core	6903780	14-Mar-2020 09:43	40.18	13.99	66	03-Feb-2021 06:16	41.97	10.68	A	5
Arvor - T/S Core	6903779	17-Mar-2020 11:45	41.59	10.40	66	01-Feb-2021 05:56	40.27	11.61	A	5
Arvor - T/S <u>Diss. Oxy</u>	6903781	25-Jun-2020 16:20	41.62	17.62	43	17-Jan-2021 06:22	42.40	17.98	A	5
Arvor - T/S Core	6903782	23-Jul-2020 22:52	43.03	28.75	40	31-Jan-2021 06:06	43.30	35.96	A	5
Arvor - T/S Core	6903784	24-Aug-2020 10:20	35.92	14.17	230	03-Feb-2021 05:56	37.19	16.92	A	5
Arvor - T/S Core	6903785	16-Sep-2020 07:26	32.95	34.77	1	17-Sep-2020 02:31	32.91	34.78	D	5
Arvor - T/S <u>Diss. Oxy</u>	6903786	16-Sep-2020 09:01	33.06	34.5	29	04-Feb-2021 06:16	34.04	35.21	A	5
Arvor - T/S Core	6903787	25-Oct-2020 19:23	39.81	14.12	21	03-Feb-2021 05:59	39.48	13.24	A	5
Arvor - T/S Core	6903788	28-Oct-2020 14:20	35.6	14.88	164	04-Feb/2021 05:57	35.57	17.76	A	5

*Status in early February 2021: A = active, D = dead

**Cycle: Length of cycle in days

Table 1. Status information for the 9 Italian floats deployed in the Mediterranean and Black Sea (bold) during 2020.

Model	WMO	Depl. Date	Lat	Lon	Cycles	Last Date	Lat	Lon	Status*	Cyc.**
Arvor-T/S Diss. Oxy	6903767	09-Jan-2020 06:36	-55.00	173.04	41	04-Feb-2021 06:14	-54.15	-148.91	A	10
Arvor-T/S Diss. Oxy	6903768	09-Jan-2020 16:39	-57.03	173.30	41	04-Feb-2021 06:08	-55.64	-169.97	A	10
Arvor-T/S ICE	6903769	10-Jan-2020 03:30	-59.03	174.61	40	05-Feb-2021 04:38	-56.48	-159.57	A	10
Arvor-T/S ICE	6903770	10-Jan-2020 13:27	-61.03	176.18	40	05-Feb-2021 11:30	-60.25	-155.24	A	10
Arvor-T/S ICE	6903771	10-Jan-2020 23:18	-63.04	177.85	40	04-Feb-2021 19:29	-60.39	-157.88	A	10
Arvor-T/S ICE	6903772	28-Jan-2020 04:20	-77.37	174.56	99	16-Jan-2021 06:47	-75.71	171.10	A	5
Arvor-T/S ICE	6903773	28-Jan-2020 17:35	-77.20	169.32	89	31-Jan-2021 05:41	-75.26	163.97	A	5
Arvor-T/S ICE	6903774	17-Feb-2020 04:12	-64.00	0.02	37	03-Feb-2021 06:18	-60.37	-9.25	A	10
Arvor-T/S ICE	6903775	17-Feb-2020 08:41	-63.00	0	37	03-Feb-2021 05:24	-64.43	-7.41	A	10
Arvor-T/S ICE	6903776	17-Feb-2020 13:56	-62.00	0	37	03-Feb-2021 06:14	-60.61	6.59	A	10
Arvor-T/S Diss. Oxy	6903777	18-Feb-2020 10:56	-60.24	0.13	37	04-Feb-2021 06:30	-58.81	6.66	A	10
Arvor-T/S Core	6903778	19-Feb-2020 19:55	-53.98	-0.02	36	05-Feb-2021 06:03	-52.93	-1.32	A	10
Arvor-T/S Core	6903789	27-Dec-2020 04:47	-57.03	173.04	5	06-Feb-2021 05:46	-56.18	174.67	A	10
Arvor-T/S ICE	6903791	28-Dec-2020 00:43	-61.03	173.16	5	07-Feb-2021 05:46	-61.91	174.71	A	10
Arvor-T/S ICE	6903790	28-Dec-2020 09:45	-63.04	173.18	5	07-Feb-2021 05:46	-65.14	-179.88	A	10

*Status in early February 2021: A = active, D = dead

**Cycle: Length of cycle in days

Table 2. Status information for the 15 Italian floats deployed in the Southern Ocean, South Atlantic and South Pacific during 2020. Two Arvor-I in the Ross Sea polynya (bold).

Overall status at the end of 2020

In summary, at the end of 2020, the ARGO-ITALY program had a total of 85 active floats, including 37 instruments in the Mediterranean Sea, 1 in the Atlantic Ocean (it escaped from the Mediterranean through the Strait of Gibraltar), 5 in the Black Sea (Figure 1) and 48 in the South Pacific, South Atlantic and Southern Oceans (south of 60°S) (Figure 2).

ARGO-ITALY FLOAT TOT MISSION DAYS ON 31-Dec-2020 -- TOTAL FLOATS: 37

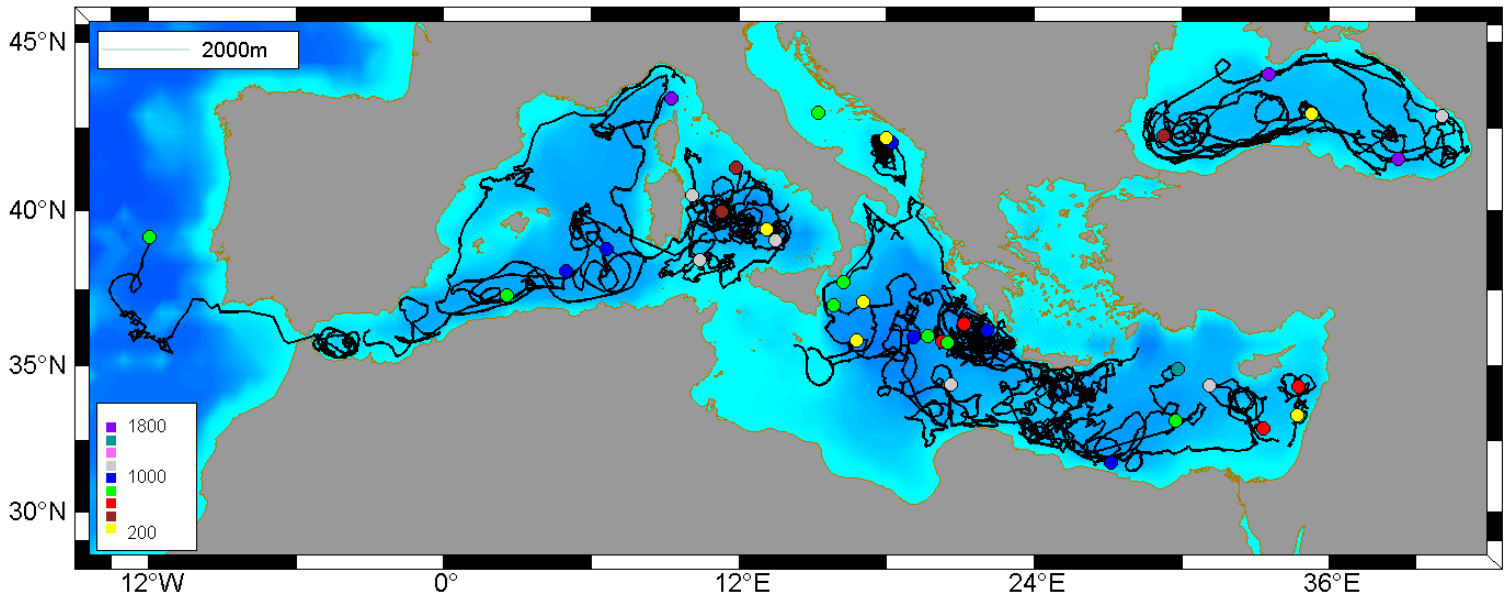


Figure 1. Trajectories and positions (circle symbols) on 31 December 2020 of the 37 ARGO-ITALY floats active in the Mediterranean and Black Sea. The circle symbols are color-coded as a function of float age in days.

ARGO-ITALY FLOAT TOT MISSION DAYS ON 31-Dec-2020 -- TOTAL FLOATS: 48

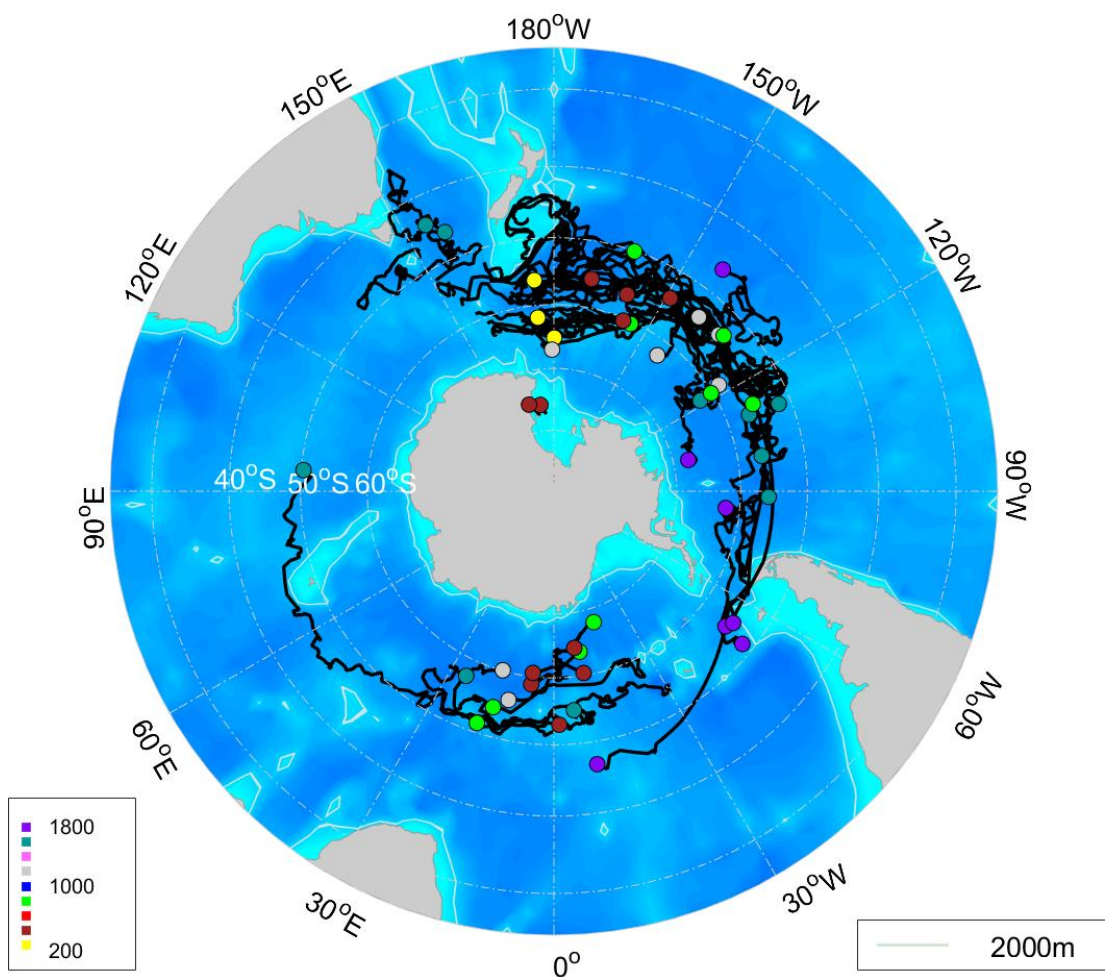


Figure 2. Trajectories and positions (circle symbols) on 31 December 2020 of the 48 ARGO-ITALY floats in the South Pacific, South Atlantic and Southern Oceans. The circle symbols are color-coded as a function of float age in days.

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 2012-2020. The float population in 2012-2020 is essentially increasing and with a maximum of 85 active instruments in 2020. In 2020, the number of deployments exceeded the number of dead floats.

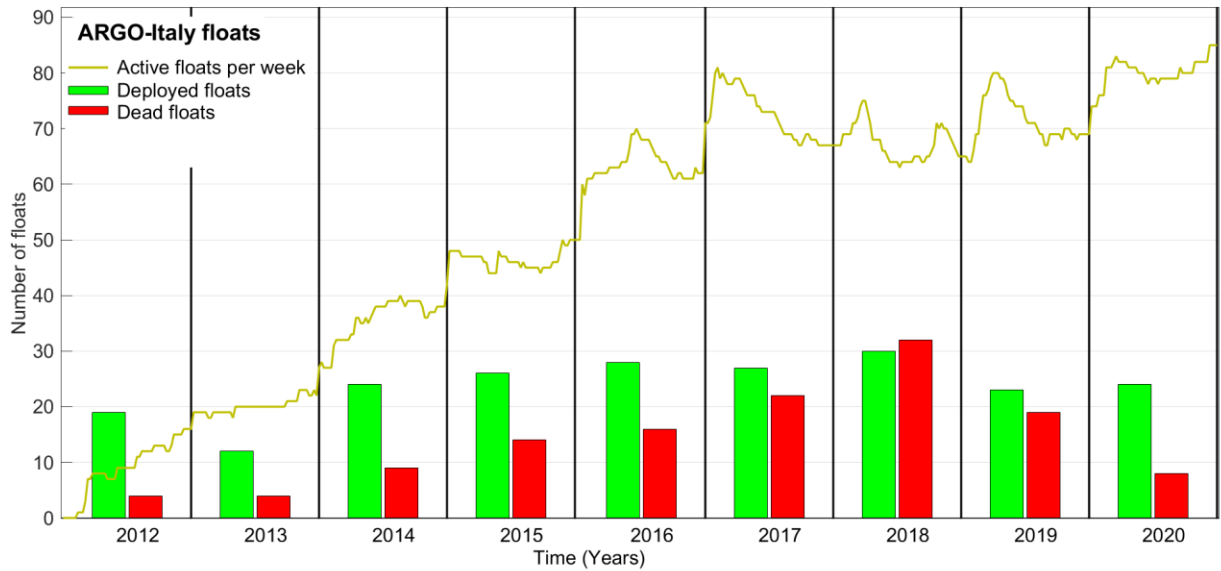


Figure 3. Temporal evolution of the number of ARGO-ITALY active floats with weekly resolution and histogram of the annual float deployments and losses.

Since 18 February 2012, a total of **213 ARGO-ITALY floats** have been deployed, 126 in the Mediterranean and Black seas, and 87 in the oceans of the Southern Hemisphere. In less than 9 years, they have provided about **28700 CTD profiles**. The histogram of the number of CTD profiles per float is shown in Figure 4. Sixtyseven floats have done more than 180 profiles. In total (during 2012-2020), ~6 % of the floats have failed just after deployment, while only one of those deployed in 2020 did not work after deployment.

Argo-ITALY status table (31/12/2020, 213 floats deployed)

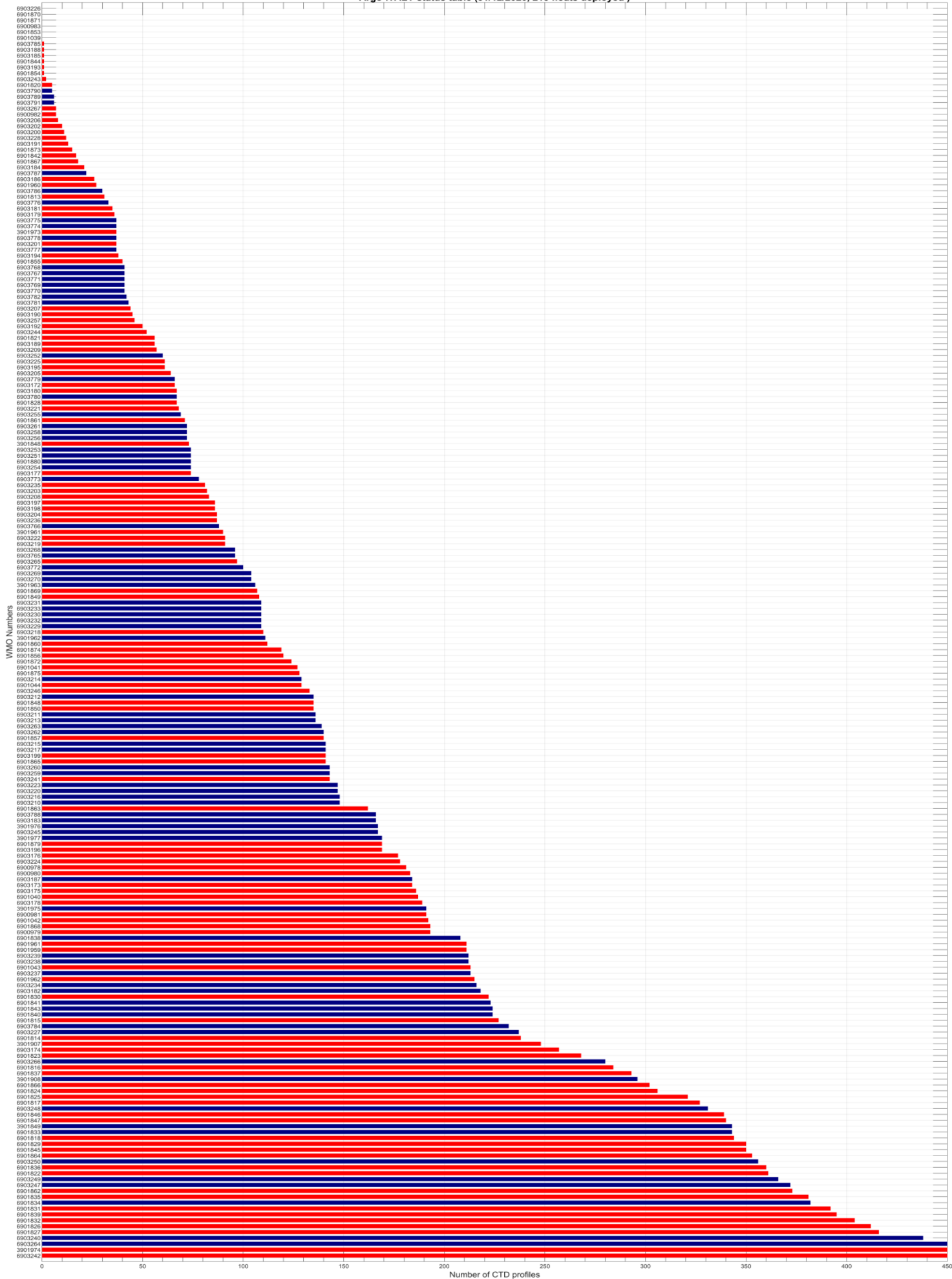


Figure 4. Histogram of the number of CTD profiles per float (red: dead float, blue: alive at the end of 2020).

b. technical problems encountered and solved

Mediterranean Sea

One float stopped functioning prematurely just after the deployment, in 2020. The Arvor-I float (WMO 6903785) deployed in the Levantine Sea stopped transmitting data after 1 cycle. The cause for this malfunction is due to the internal vacuum problem. The value was around 730 instead of a normal 610. The float was tested at OGS before being shipped to Israel and the internal vacuum was in the right range of values. We did not have the chance to test again the float before the deployment and we eventually lost it at sea.

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)

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. The status of high salinity drift is regularly updated on the dedicated share file available at <https://app.activecollab.com/186315/projects/45?modal=Task-4086-45>

d. 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 about 80 out of about 120 eligible 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 2010-2019. 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. For this reasons, OGS collected CTD data in complement of the official reference dataset using two approaches: personal contacts and regional data services. 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 adopted 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 reliability of the analysis. The DMQC of the Italian floats deployed in the Southern Ocean (and South Pacific and Atlantic oceans) started in 2019 and was applied to 45 out of about 70 eligible floats. A new delay-mode operator was hired in October 2020. She is currently under

training and she will be mainly involved with floats deployed in the Mediterranean and Black Seas.

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)

The Italian Ministry of Research has provided funding to buy 22 floats in 2020, including 5 instruments with dissolved oxygen sensors, 8 standard T/S floats, 7 standard T/S floats with Ice Detection Algorithm implemented and 2 Deep floats with dissolved oxygen sensors. 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 2020. It is expected that the same level will be maintained in 2021, including the procurement of 16 additional standard floats, 3 bio floats and an ALAMO float. The Italian Ministry of Research is committed to provide funding in order to sustain the Italian contribution to Argo beyond 2021 as a founding member of the Euro-Argo Research Infrastructure Consortium. In addition to the Italian national funding, OGS has funding from EC projects (e.g. Euro-Argo RISE) for several activities related to Argo.

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.

The Italian deployment plans for 2021 and 2022 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/BIO floats		Deep floats		Total
	Quantity	Area	Quantity	Area	Quantity	Area	
2021	10	Mediterranean	1	Mediterranean	2	Mediterranean	22
	1	Black Sea	1	Black Sea			
	7	South Hemisphere					
2022	10	Mediterranean	2	Mediterranean	0	Mediterranean	23
	1	Black Sea	0	Black Sea			
	10	South Hemisphere					

Table 3. Italian float deployment plans for 2019-2020.

On the longer time frame, Italy is interested 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 ARGO-ITALY and Euro-Argo RISE projects over the next years.

The websites for the Italian contribution to Argo (Argo-Italy) are <http://argoitaly.ogs.trieste.it/> and <http://maos.inogs.it/#/projects/argo-italy>. The link to the Mediterranean & Black Sea Argo Centre (MedArgo) is <http://nettuno.ogs.trieste.it/sire/medargo/>.

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.

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 some examples in the bibliography 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.

N/A

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.
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.
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.

We experienced some delays related to float procurements and deployments but the impact was not too strong

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.

Not planned yet