Report on the Italian Argo Program for 2018

1. The status of implementation (major achievements and problems in 2018).

- floats deployed and their performance:

In total, **30 Italian floats** were deployed in 2018 (see Tables 1 and 2 for details). These floats were Provor, Arvor-I, Arvor-Ice and Arvor-Deep designs manufactured by NKE (France), and one Dova profiler produced by MetOcean (Canada). All floats transmit data via Iridium telemetry.

Mediterranean and Black Sea deployments

One float was deployed in the Black Sea and 21 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 2 Arvor-I floats (WMO 6903242 and 6903248) which had short cycles of 3 h during most of their operating life to measure high-frequency processes.

Most floats were deployed from research vessels of opportunity (i.e., R/V Atalante, R/V Maria S. Merien, R/V Alliance, R/V OGS Explora, R/V Dallaporta, R/V Leonardo for the Mediterranean and R/V Akademik for the Black Sea) with the help of colleagues from France, Italy, Malta and Bulgaria. In the framework of the Seakeepers Society (https://www.seakeepers.org), two floats were deployed in the Tyrrhenian and Ionian seas from the maxi-yatch Reo.

South Atlantic, South Pacific and Southern Ocean

Five 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 Palmer while sailing from New Zealand to the Ross Sea. These floats included 1 Dova and 4 Arvor-Ice floats. 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 were programmed to cycle between the surface and 2000 dbar every 10 days and to drift at the parking depth of 1000 dbar. The floats were still active in early 2019.

Three Italian floats were also deployed in the South Atlantic Ocean (Table 2) with the help of Italian colleagues onboard the R/V Agulhas II. These floats were all Arvor-I instruments. 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 2019.

Two Arvor-Ice floats (WMO 6903229 and 6903230) drifted in areas with a presence of surface sea ice south of 62°S and the ISA prevented the floats to perform their usual surfacing. More specifically, float WMO 6903229 did not surface between early August and mid October (6 cycles without surfacing). Float WMO 6903230 stayed longer under the ice, from mid June to mid December (17 cycles). Profile data while under the ice were recorded internally and transmitted later when surfacing was possible.

Model	WMO	Depl. Date	Lat	Lon	Cycles	Last Date	Lat	Lon	Status*	Cycle**
Arvor-I	6903234	04-Mar-2018 20:39	34.27	24.60	66	20-Jan-2019 06:12	33.78	22.62	A	5
Arvor-I	6903236	11-Mar-2018 11:09	37.38	20.33	64	22-Jan-2019 06:20	40.52	18.70	A	5
Provor Bio	6903235	11-Mar-2018 22:50	38.40	20.03	54	02-Sep-2018 10:55	40.19	16.93	D	5
Arvor-I-DO	6903237	16-Mar-2018 19:58	35.49	18.50	64	22-Jan-2019 06:29	35.01	17.92	A	5
Arvor-I-DO	6903238	21-Mar-2018 13:42	39.18	13.33	63	22-Jan-2019 06:11	40.22	10.11	A	5
Arvor-I	6903239	22-Mar-2018 06:08	39.22	11.75	63	23-Jan-2019 06:04	39.46	13.04	A	5
Provor Nut	**6903240**	**29-Mar-2018 04:32**	**43.17**	**29**	**61**	**05-Jan-2019 04:44**	**42.49**	**34.65**	**A**	**5**
Arvor-I	3901974	30-May-2018 11:10	35.84	-2.21	191	22-Jan-2019 16:12	36.59	-4.21	A	5
Arvor-I	6903241	04-Jul-2018 02:46	39.38	17.86	41	22-Jan-2019 06:07	37.82	15.98	A	5
Arvor-I	3901975	04-Jul-2018 18:12	38.95	13.74	42	22-Jan-2019 06:09	40.23	12.70	A	5
Arvor-I	3901973	21-Jul-2018 06:49	42.87	14.82	37	13-Jan-2019 06:19	42.74	15.28	A	5
Arvor-I	6903242	20-Aug-2018 08:14	35.93	14.17	907	13-Dec-2018 09:16	34.20	15.99	D	0.125
Arvor-I	6903248	26-Sep-2018 10:20	43.84	9.82	181	19-Jan-2019 12:25	42.89	5.54	A	0.125, 5
Provor Nut	6903249	06-Oct-2018 11:19	39.10	18.22	37	23-Jan-2019 12:37	38.92	17.34	A	5
Provor Nut	6903250	08-Oct-2018 22:31	39.10	18.22	34	22-Jan-2019 12:35	42.02	17.65	A	5
Arvor-I	6903245	18-Oct-2018 04:35	34.21	26.05	18	20-Jan-2019 06:16	34.21	25.69	A	5
Provor Nut	6903247	18-Oct-2018 04:40	34.21	26.05	38	24-Jan-2019 09:51	34.19	26.91	A	5
Arvor-I	3901977	22-Oct-2018 04:20	35.61	28.23	20	21-Jan-2019 06:10	35.04	27.39	A	5
Arvor-Deep	6903243	24-Oct-2018 00:00	35.56	28.18	1	24-Oct-2018 06:16	35.56	28.18	D	5
Arvor-I	6903244	25-Oct-2018 10:13	35.82	25.01	20	24-Jan-2019 06:21	36.01	25.91	A	5
Arvor-I-DO	6903246	25-Oct-2018 22:50	34.98	23.25	20	24-Jan-2019 06:25	34.35	24.02	A	5
Arvor-I	3901976	05-Nov-2018 09:50	36.11	21.61	17	20-Jan-2019 06:06	35.79	21.29	A	5

**Status in early January 2018: A = active, D = dead;*
***Cycle: Length of cycle in days.*

Table 1. Status information for the 22 Italian floats deployed in the Mediterranean and Black Sea (bold) during 2018.

Model	WMO	Depl. Date	Lat	Lon	Cycles	Last Date	Lat	Lon	Status*	Cycle**
Arvor-I	3901961	29-Jan-2018 23:22	-61	-24.44	37	16-Jan-2019 21:25	-54.26	15.09	A	10
Arvor-I	3901963	30-Jan-2018 05:35	-60	-26.28	36	17-Jan-2019 03:32	-60.01	-26.28	A	10
Arvor-I	3901962	06-Feb-2018 23:11	-53.98	1.67	36	14-Jan-2019 21:05	-52.57	16.27	A	10
Arvor-I-ICE	6903229	23-Feb-2018 16:54	-63.02	161.09	35	21-Jan-2019 05:53	-61.62	155.8	A	10
Arvor-I-ICE	6903230	24-Feb-2018 09:06	-61	158.34	32	02-Jan-2019 05:45	-63.99	174.68	A	10
Arvor-I-ICE	6903231	25-Feb-2018 00:41	-59.02	155.82	35	23-Jan-2019 05:51	-64.67	-174.04	A	10
Arvor-I-ICE	6903232	25-Feb-2018 17:30	-56.98	153.44	35	23-Jan-2019 05:31	-55.57	174.47	A	10
Dova	6903233	26-Feb-2018 07:22	-55.03	152.5	34	22-Jan-2019 04:46	-56.55	170.01	A	10

**Status in early January 2017: A = active, D = dead.*
***Cycle: Length of cycle in days.*

Table 2. Status information for the 8 Italian floats deployed in the Southern Ocean, South Atlantic and South Pacific during 2018.

Overall status at the end of 2018

In summary, at the end of 2018, the ARGO-ITALY program had a total of **65 active floats**, including 30 instruments in the Mediterranean Sea Figure 1), 6 in the Black Sea (Figure 1) and 29 in the South Pacific, South Atlantic and Southern Oceans (south of 60˚S) (Figure 2).

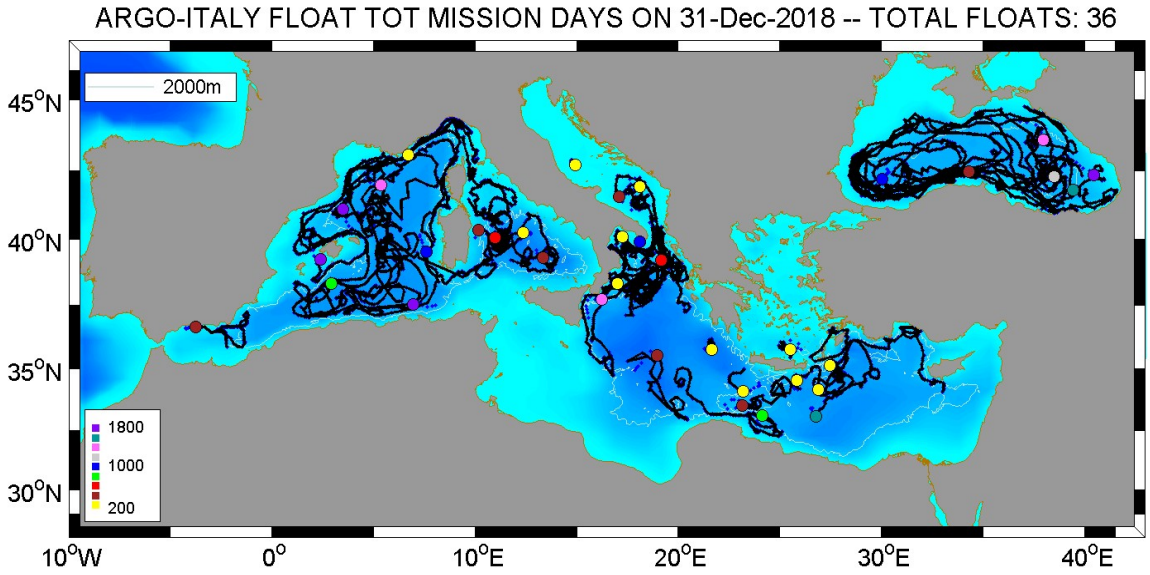

Figure 1. Trajectories and positions (circle symbols) on 31 December 2018 of the 36 ARGO-ITALY floats active in the Mediterranean and Black Sea at the end of 2018. The circle symbols are color-coded as a function of float age in days.

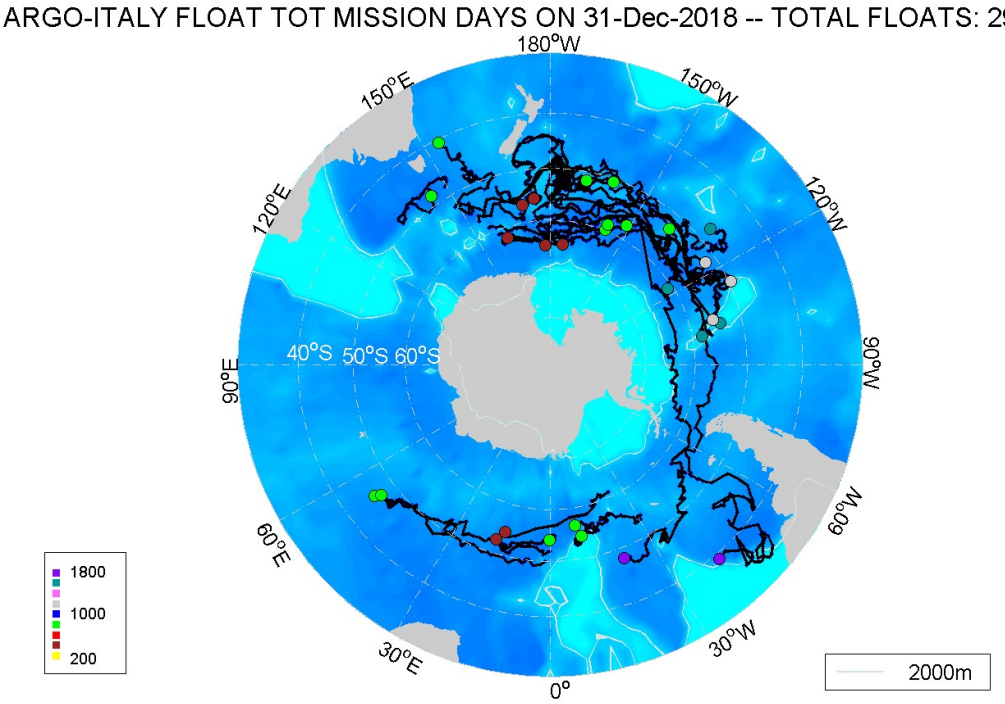

Figure 2. Trajectories and positions (circle symbols) on 31 December 2018 of the 29 ARGO-ITALY floats in the South Pacific, South Atlantic and Southern Oceans. The circle symbols are color-coded as a function of float age in days.

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 2012-2018. The float population in 2012-2018 is essentially increasing and reaching 60-70 active instruments in 2018, although we notice a slight decrease starting in 2017. In 2018, the number of floats which stopped transmitted was rather high (32) probably due to the natural aging of the ARGO-ITALY network and also due to the short operating lifes of some float types.

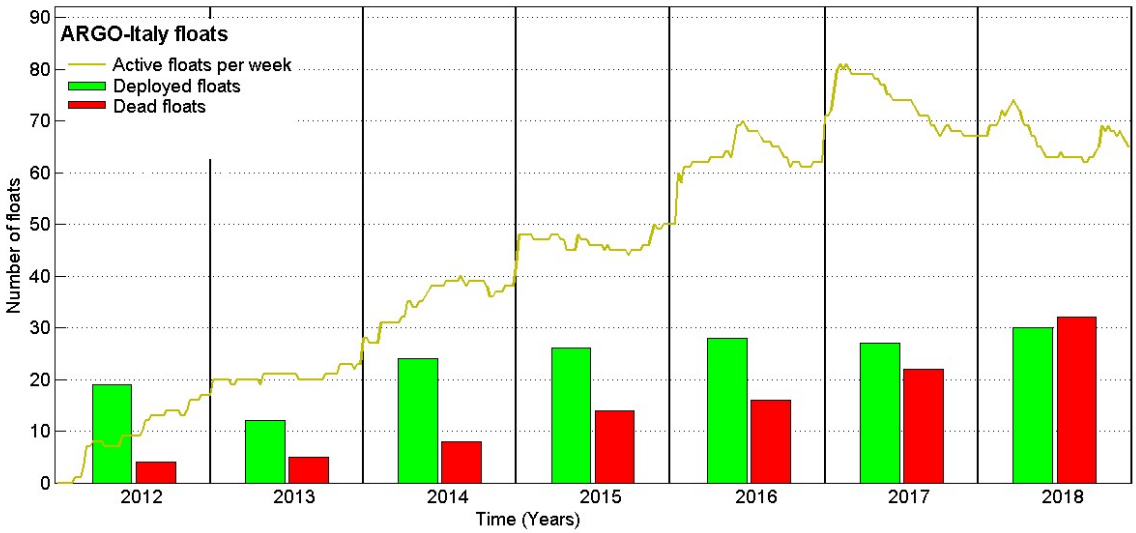

Figure 3. Temporal evolution of the number of ARGO-ITALY active floats with weekly resolution and histogram of the annual float deployments and losses.

Since 18 February 2012, a total of **166 ARGO-ITALY floats** have been deployed, 104 in the Mediterranean and Black seas, and 62 in the oceans of the Southern Hemisphere. In less than 7 years, they have provided about **19700 CTD profiles**. In total, 14 floats (~8 %) have failed just after deployment.

- technical problems encountered and solved

Mediterranean and Black Sea

Two floats stopped functioning prematurely before the end of the year 2018. The Arvor-Deep float (WMO 6903243) deployed southeast of Rhodes stopped transmitting data after its first cycle. Provor CTS 4 (WMO 6903235, equipped with biogeochemical sensors) was deployed in the northern Ionian in March 2018 and stopped functioning at cycle 55 in the Gulf of Taranto in September 2018. This float was a refurbished instrument. Reasons for these early failures are still under investigation.

Nova/Dova floats

In general, the Nova and Dova floats have significantly lower survival rates. After a little more than 3 years since their first deployments in October 2015, only 12 floats (out of 40 units, i.e., 30%) were still fully operational in early 2019. It appears that these floats are not produced anymore!

- status of contributions to Argo data management (including status of pressure corrections, technical files, 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.

- 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 58 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 2010-2018. 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) is ready to start, since OGS has collected the reference dataset, implemented the technique and prepared the software.

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 Italian Ministry of Research has provided funding to buy 23 floats in 2018, including 5 instruments with dissolved oxygen sensors and 3 deep floats. 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 2018. It is expected that the same level will be maintained in 2019, including the procurement of 20 additional standard floats and 2 BGC floats. The Italian Ministry of Research is committed to provide funding in order to sustain the Italian contribution to Argo beyond 2019 as a founding member of the Euro-Argo Research Infrastructure Consortium. In addition to the Italian national funding, OGS has funding from EC (CMEMS, MOCCA, Euro-Argo RISE) and the Italian Ministry of Foreign Affairs (MELMAS) projects for several activities related to Argo.

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

The Italian deployment plans for 2019 and 2020 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 floats		Deep floats		Total
	Quantity	Area	Quantity	Area	Quantity	Area	
2019	14 2 10	Mediterranean Black Sea South Hemisphere	0 1	Mediterranean Black Sea	1	Mediterranean	**28**
2020	14 2 10	Mediterranean Black Sea South Hemisphere	1 0	Mediterranean Black Sea	1	Mediterranean	**28**

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

On the longer time frame, Italy is interest 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, MOCCA and Euro-Argo RISE projects over the next years.

The website for the Italian contribution to Argo (Argo-Italy) was improved and upgraded (http://argoitaly.ogs.trieste.it/). The link to the Mediterranean & Black Sea Argo Centre (MedArgo) is http://nettuno.ogs.trieste.it/sire/medargo/. A completely new web site for Argo-Italy is still in development and will be operational in 2019.

4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers.

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 AST.

N/A

6. Number of CTD cruise data added to the Argo reference database by Italian PIs in 2017.

N/A

7. Italian contribution to Argo bibliography in 2018.

Droghei, R., B. Buongiorno Nardelli, and R. Santoleri, 2018: A New Global Sea Surface Salinity and Density Dataset From Multivariate Observations (1993–2016). Frontiers in Marine Science, 5, https://doi.org/10.3389/fmars.2018.00084

Gentile, V., S. Pierini, P. de Ruggiero, and L. Pietranera, 2018: Ocean modelling and altimeter data reveal the possible occurrence of intrinsic low-frequency variability of the Kuroshio Extension. Ocean Modelling, 131, 24-39, https://doi.org/10.1016/j.ocemod.2018.08.006

Marini S., Corgnati L, Mantovani C., Bastianini M., Ottaviani E., Fanelli E., Agussi J., Griffa A. and Poulain P.-M., 2018: Automated estimate of fish abundance through the autonomous imaging device GUARD1. Measurement, 126, 72-75.

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Reseghetti, F., L. Cheng, M. Borghini, I. M. Yashayaev, G. Raiteri, and J. Zhu, 2018: Assessment of Quality and Reliability of Measurements with XBT Sippican T5 and T5/20. Journal of Atmospheric and Oceanic Technology, 35, 1935-1960, https://doi.org/10.1175/JTECH-D-18-0043.1

Sammartino, M., S. Marullo, R. Santoleri, and M. Scardi, 2018: Modelling the Vertical Distribution of Phytoplankton Biomass in the Mediterranean Sea from Satellite Data: A Neural Network Approach. Remote Sensing, 10, 1666, https://doi.org/10.3390/rs10101666

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Verri, G., N. Pinardi, P. Oddo, S. A. Ciliberti, and G. Coppini, 2018: River runoff influences on the Central Mediterranean overturning circulation. Climate Dynamics, 50, 1675-1703, https://doi.org/10.1007/s00382-017-3715-9

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Von Schuckmann, K.et al., 2018: Copernicus Marine Service Ocean State Report. Journal of Operational Oceanography, 11, S1-S142, https://doi.org/10.1080/1755876X.2018.1489208