ARGO-ITALY:

ANNUAL REPORT 2017

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1. Introduction

ARGO-ITALY is the Italian component of a worldwide in situ global observing system, based on autonomous profiling floats, surface drifters, gliders and ship-of-opportunity measurements. It is primarily focused on the Italian seas, the Mediterranean and Black seas and the Southern Ocean, and includes observations of temperature, salinity, currents and biogeochemical/optical properties of seawater. The ARGO-ITALY objective is to provide a significant and sustained Italian contribution to the global ocean monitoring.

ARGO-ITALY contributes to international programs such as Argo and Euro-Argo (global monitoring of water properties with profiling floats), GDP (Global Drifter Program to measure near-surface temperature and currents), EGO (gliding vehicles to measure water properties) and SOOP (Ship-Of-Opportunity Program to temperature profiles) which have been developed to monitor the entire World Ocean on a long term basis.

ARGO-ITALY is a cost-effective long-term monitoring system that is a unique source of information to study the role of the oceans, and the Mediterranean Sea in particular, on the climate system. It also provides the data required by operational ocean monitoring systems in order to improve significantly extended forecasts of the atmosphere and oceans. ARGO-ITALY contributes to programs of operational oceanography, such as MONGOOS (Mediterranean Oceanography Network for the Global Ocean Observing System) and is essential for the production of marine core and downstream services products of Copernicus Marine Environment Monitoring Service (CMEMS). It is also an important component of GEOSS (Global Earth Observation System of Systems).

ARGO-ITALY is funded by the Italian Ministery of Instruction, University and Research (MIUR) since 2011. The operation of instruments at sea and the collection of data began in February 2012. A dedicated web site was developed to help with the internal organization of the project, to publish graphical and tabulated summaries and photographs on the operation of instruments in near-real time, and to post news, related links, small project calls, etc. related to ARGO-ITALY. The web address is: www.argoitaly.ogs.trieste.it

This report summarizes the activities of ARGO-ITALY in 2017 in terms of procurements of the instruments, their preparation and their deployments. Information about data processing and archiving is also given. Plans for 2018 and beyond are included in the last section.

2. Argo float activities in 2017

2.1 Float procurement

The following Argo floats were purchased in 2017 with funds of ARGO-ITALY:

1. Three (3) BGC floats from NKE, Lorient, France (Figure 1). They are Provor CTS 4 floats with Iridium global telephone network (RUDICS) for data telemetry and a GPS receiver for position. They measure at 1 m vertical resolution not only temperature and salinity (Sea-Bird CTD) but also irradiance at three wavelengths (412 nm, 490 nm, 555 nm), fluorescence of Colored Dissolved Organic Matter (CDOM), fluorescence of chlorophyll-a, backscattering coefficient (530 nm) and attenuation coefficient (660 nm). They are also equipped with an Aanderaa optode oxygen sensor and a SUNA nitrate sensor. On one of them, the SUNA firmware was updated in order to measure simultaneously the nitrate and the hydrogen sulphide concentrations. This float was shipped to Varna in Bulgaria and will be deployed in the Black Sea in Spring 2018. The other two will be deployed in the Adriatic and north Ionian seas in 2018.

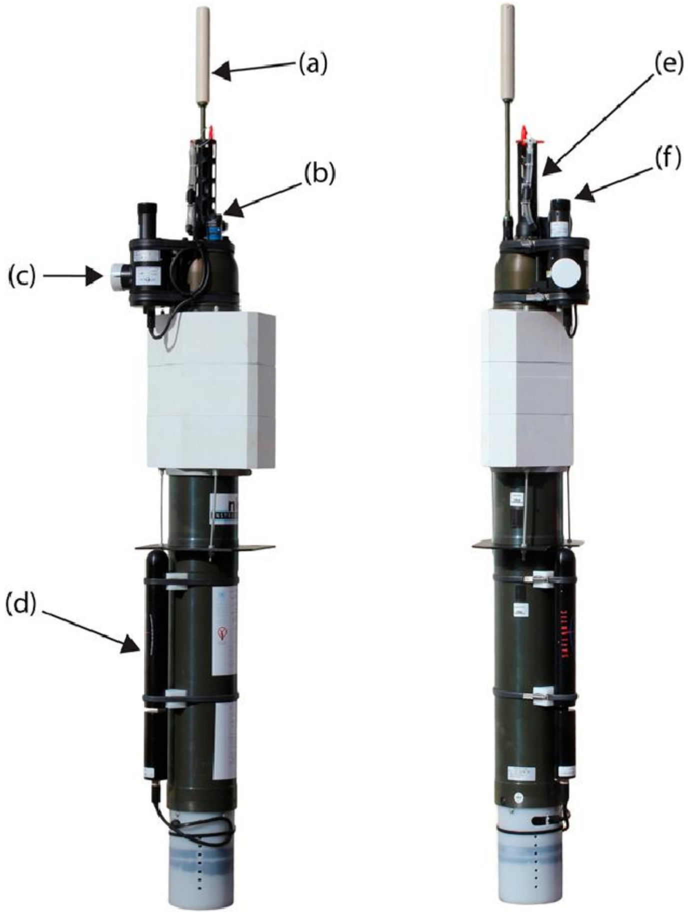


Figure 1. Provor CTS 4 equipped with (a) Iridium antenna; (b) oxygen sensor; (c) sensor for chlorophyll fluorescence, CDOM fluorescence, and particle light backscattering at 700 nm; (d) nitrate sensor; (e) conductivity–temperature–depth sensor; (f) radiometer [3 E d (l) 1 PAR]. Photo by T. Jessin (LOV).

2. Thirteen (13) Arvor-I floats and three (3) Arvor-I floats with dissolved oxygen sensor from NKE, Lorient, France. These instruments were acquired via the Euro-Argo ERIC. They are fitted with a Sea-Bird CTD (SBE 41 CP) (and Aanderaa optode sensor) and transmit data via Iridium. Three units were shipped to South Africa for deployments in the Southern Ocean in January 2018 (from R/V Agulhas II). The others were shipped to OGS and will be used in the Mediterranean and Black seas in 2018.

3. Two (2) Arvor-C floats from NKE, Lorient, France. These coastal floats are equipped with a Sea-Bird CTD (SBE 41 CP) and transmit data via Iridium. They were shipped to OGS and will be used in the Mediterranean in 2018.

2.2 Float recovery and refurbishment

In 2017, 2 BGC floats were recovered in the Mediterranean Sea:

1. One (1) Provor CTS 4 float (prov-bio without SUNA, WMO 6901863). This float was released in the Ionian Sea in May 2015. After two years in water, it was intentionally recovered by French colleagues with R/V Pourquoi pas? in the eastern Ionian on 24 May 2017. It was shipped back to NKE and after a limited refurbishment it will be redeployed in the Mediterranean Sea in March 2018.

2. One (1) Provor CTS 4 float (prov-bio with SUNA, WMO 6903197). This float was deployed in the south Adriatic in April 2016. Starting on 6 February 2017 it suffered transmission problems. As a result, it was decided to put it in "end-of-life" mode to have it drift at the surface. It was eventually recovered by colleagues from Dubrovnik on 13 May 2017. The float was shipped back to NKE where it was diagnosed with several major problems. It will be refurbished entirely (including all the sensors) and redeployed in 2018.

2.3 Float deployments

In total, **27 Italian floats** were deployed in 2017 (see Tables 1 and 2 for details). These floats were Arvor-L, Arvor-I and Arvor-Ice designs manufactured by NKE (France), Apex floats produced by Teledyne Webb Research (USA) and Nova/Dova profilers manufactured by MetOcean (Canada). The majority of the floats transmit data via Iridium telemetry (Arvor-I, Arvor-Ice, Nova/Dova) and some have Argos telemetry (Apex and Arvor-L).

Two floats were 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.

Most floats were deployed from research vessels of opportunity (i.e., R/V Beautemps-Beaupré, R/V Minerva I, R/V Medexplorer for the Mediterranean and R/V Akademic for the Black Sea) with the help of colleagues from France, Italy, Israel (Figure 2) and Bulgaria. In the framework of the International Seakeepers Society (http://www.seakeepers.org/), two floats were deployed in the Tyrrhenian and Ionian seas from the maxi-yatch Exuma (Figure 3).

In total, 5 floats (out of 10) stopped functioning before the end of the year 2017. Nova (WMO 6903221) and Dova (WMO 6903222) floats deployed in the Eastern Levantine stopped transmitting data after 69 and 75 cycles, respectively. The Apex float (WMO 6903202) deployed in the north Tyrrhenian had a very short operational life (10 cycles). Dova float (WMO 6903226) did not work upon deployment in the Black Sea and drifted at the surface. It was not possible to reset it using the Iridium downlink. Nova float (6903228) stopped functioning after only 9 cycles in the Black Sea.

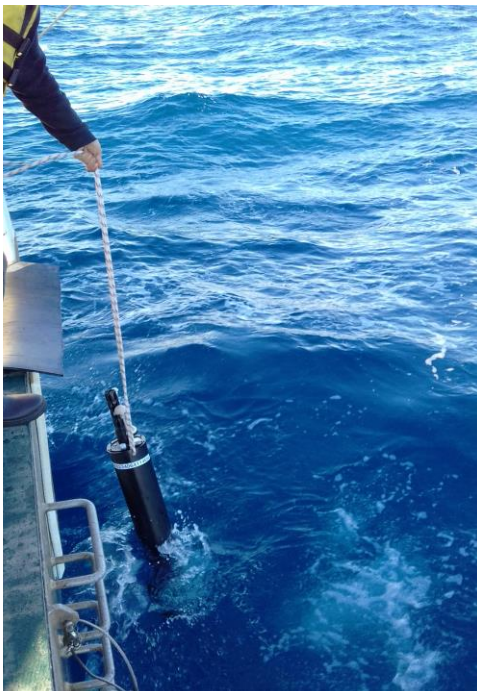


Figure 2. Deployment of a DOVA float (WMO 6903222) off Israel from R/V Medexplorer in February 2017.

Figure 3. Deployment of an Arvor-L float (WMO 6903224) in the north Ionian Sea from M/Y Exuma in June 2017.

Model	WMO	Argos	Deploy Date	Lat	Lon	Cycles	Last TX Date	Lat	Lon	Status*	Cycle**
Arvor-I	3901907		21/01/2017 13:53	37,49	6,48	70	08/01/2018 03:14	39,22	6,38	A	5
Arvor-I	3901908		25/01/2017 15:51	34,50	20,25	69	07/01/2018 21:10	32,68	24,01	A	5
Nova	6903221		07/02/2017 10:20	32,34	34,23	69	12/11/2017 03:32	34,20	35,34	D	5
Dova	6903222		07/02/2017 13:32	32,51	33,68	75	27/12/2017 02:50	32,06	34,21	A	5
Apex	6903202	133511	30/03/2017 12:56	42,20	10,83	10	16/05/2017 04:18	42,26	11,05	D	5
Dova	6903225		23/05/2017 18:25	39,42	14,63	47	08/01/2018 04:14	39,80	15,10	A	5
Arvor-L	6903224	114256	10/06/2017 11:15	38,52	20,16	74	08/01/2018 14:21	38,62	18,27	A	5
Dova	**6903226**		**11/10/2017 07:50**	**43,16**	**29,00**	**0**	**14/11/2017 18:41**	**42,83**	**31,88**	**AS**	**5**
Nova	**6903228**		**20/10/2017 18:49**	**43,41**	**29,52**	**9**	**04/12/2017 03:12**	**41,81**	**28,74**	**A**	**5**
Arvor-I	6903227		19/11/2017 07:09	40,59	11,76	10	04/01/2018 23:49	40,90	11,03	A	5

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

Table 1. Status information for the 10 Italian floats deployed in the Mediterranean and Black Sea (bold) during 2017.

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 Italica while sailing from New Zealand to the Ross Sea. These floats included 7 Nova and 3 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 (Pacciaroni et al., 2017). 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. Nine of these 10 floats were still active in early 2018. Float WMO 6903206 stopped transmitting after only 8 cycles in March 2017.

Five Italian floats were also deployed in the South Atlantic Ocean (Table 2) with the help of Italian colleagues onboard the R/V Agulhas II (Figure 4). These floats were all Nova 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 2018.

Figure 4. A Nova float beeing deployed on R/V Agulhas II in January 2017.

Two Arvor-Ice were also deployed from R/V OGS Explora south of Tasmania (WMO 6903214 & 6903215) in January 2017 (Figure 5).

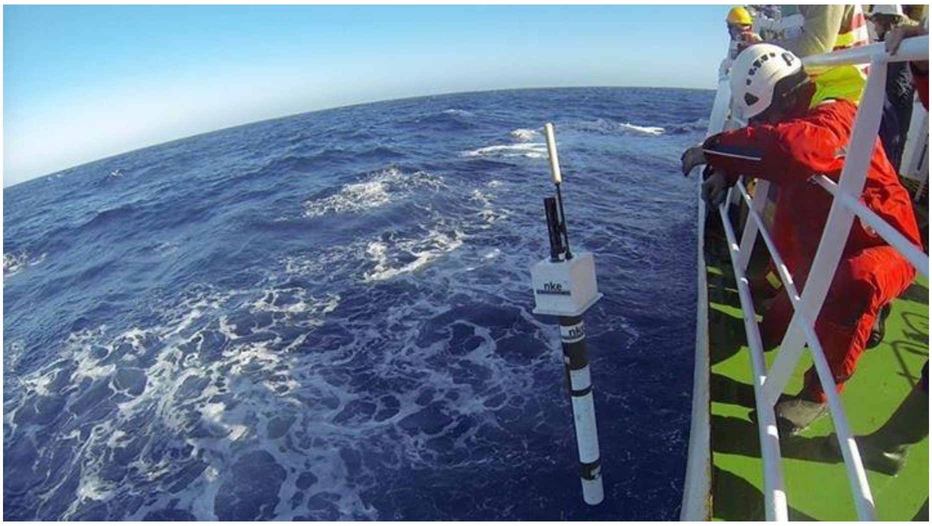


Figure 5. An Arvor-Ice float beeing deployed on R/V OGS Explora in January 2017.

Some of the Arvor-Ice floats (WMO 6903211, 6903212 and 6903213) drifted in areas with a weak presence of surface ice in August. However it appears that the ISA did not prevent the float to perform their usual surfacing.

Model	WMO	Deploy Date	Lat	Lon	Cycles	Last Date	Lat	Lon	Status*	Cycle**
Nova	6903208	02/01/2017 03:57	-55,03	175,50	39	07/01/2018 04:53	-51,78	-169,58	A	10
Nova	6903209	02/01/2017 10:05	-56,04	175,77	39	07/01/2018 04:50	-52,00	-174,41	A	10
Nova	6903207	02/01/2017 15:38	-57,02	176,11	38	07/01/2018 04:46	-52,00	-157,99	A	10
Nova	6903206	02/01/2017 21:20	-58,04	176,40	8	03/03/2017 04:50	-58,19	179,14	D	10
Nova	6903210	03/01/2017 02:05	-59,02	176,75	39	08/01/2018 04:51	-57,95	-163,22	A	10
Nova	6903205	03/01/2017 07:12	-60,03	177,07	39	08/01/2018 04:51	-58,53	-167,02	A	10
Arvor-ICE	6903213	03/01/2017 11:52	-61,03	177,26	39	10/01/2018 05:48	-61,98	-172,13	A	10
Arvor-ICE	6903211	03/01/2017 16:41	-62,04	177,58	38	04/01/2018 05:45	-59,83	-171,51	A	10
Arvor-ICE	6903212	03/01/2017 21:35	-63,05	177,93	38	10/01/2018 05:55	-63,25	-173,19	A	10
Arvor-ICE	6903214	22/01/2017 06:22	-48,01	149,23	37	09/01/2018 05:15	-46,65	138,35	A	10
Arvor-ICE	6903215	23/01/2017 07:04	-52,37	148,95	37	10/01/2018 05:35	-48,30	157,80	A	10
Nova	6903216	28/01/2017 07:36	-54,00	-30,99	36	03/01/2018 04:49	-55,91	-16,80	A	10
Nova	6903217	30/01/2017 14:33	-54,00	-9,00	36	05/01/2018 04:59	-53,26	-8,68	A	10
Nova	6903218	31/01/2017 10:08	-54,00	-9,00	35	06/01/2018 04:39	-54,89	-0,56	A	10
Nova	6903220	31/01/2017 19:06	-52,00	0,01	35	06/01/2018 04:50	-51,84	30,78	A	10
Nova	6903219	01/02/2017 05:20	-50,00	1,54	36	07/01/2018 05:04	-49,36	26,50	A	10
Nova	6903223	19/02/2017 04:27	-54,01	173,00	33	05/01/2018 04:51	-53,90	-178,40	A	10

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

Table 2. Status information for the 17 Italian floats deployed in the Southern Ocean, South Atlantic and South Pacific during 2017.

In summary, at the end of 2017, the ARGO-ITALY program had a total of 68 active floats, including 32 instruments in the Mediterranean Sea, 7 in the Black Sea (Figure 6) and 29 in the South Pacific, South Atlantic and Southern Oceans (south of 60˚S) (Figure 7).

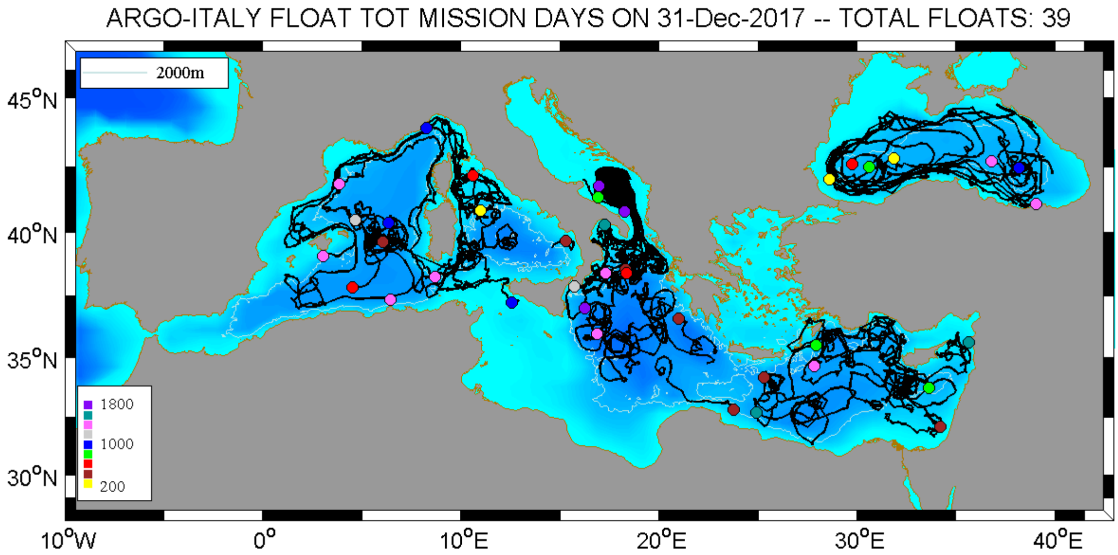


Figure 6. Trajectories and positions (circle symbols) on 31 December 2017 of the 39 ARGO-ITALY floats active in the Mediterranean and Black Sea at the end of 2017. The circle symbols are color-coded as a function of float age in days.

The temporal evolution of the number of active floats is shown in Figure 8 with weekly resolution, along with the annual numbers of float deployments and float deaths for the period 2012-2017. The float population in 2012-2017 is essentially increasing and reaching 70-80 active instruments in 2017. In 2015 and 2016 the annual numbers of deployments (26 and 28, respectively) were related to annual losses of 13 in 2015 and 14 in 2016. In 2017, the number of floats which stopped transmitted was rather high (22) probably due to the natural aging of the ARGO-ITALY network and also due to the short operating lifes of some float types.

Since 18 February 2012, a total of **136 ARGO-ITALY floats** have been deployed, 82 in the Mediterranean and Black seas, and 54 in the oceans of the Southern Hemisphere. In less than 6 years, they have provided about **15000 CTD profiles**. The histograms of number of CTD profiles per float is shown in Figure 9. Thirtyeight floats have done more than 180 profiles. In total, 13 floats (~10 %) have failed just after deployment.

After about 6 years of activities in the Mediterranean and Black seas, the maximum operating life of the ARGO-ITALY floats is a bit less than 5 years (~1750 days, see Figure 10). If we consider all the floats (dead + alive) the mean half life is about 700 days for all floats in the Mediterranean and Black seas (Figure 10, top). Excluding the floats still alive but with life <= 700 days, we obtain a better estimate of mean half life reaching 900 days (Figure 10, middle). Floats with Argos positioning and telemetry appear to have a shorter mean half life (600-800 days), compared to 700-1000 days for the floats with Iridium. Arvor floats show the longest performances with a mean half life of more than 950 days.

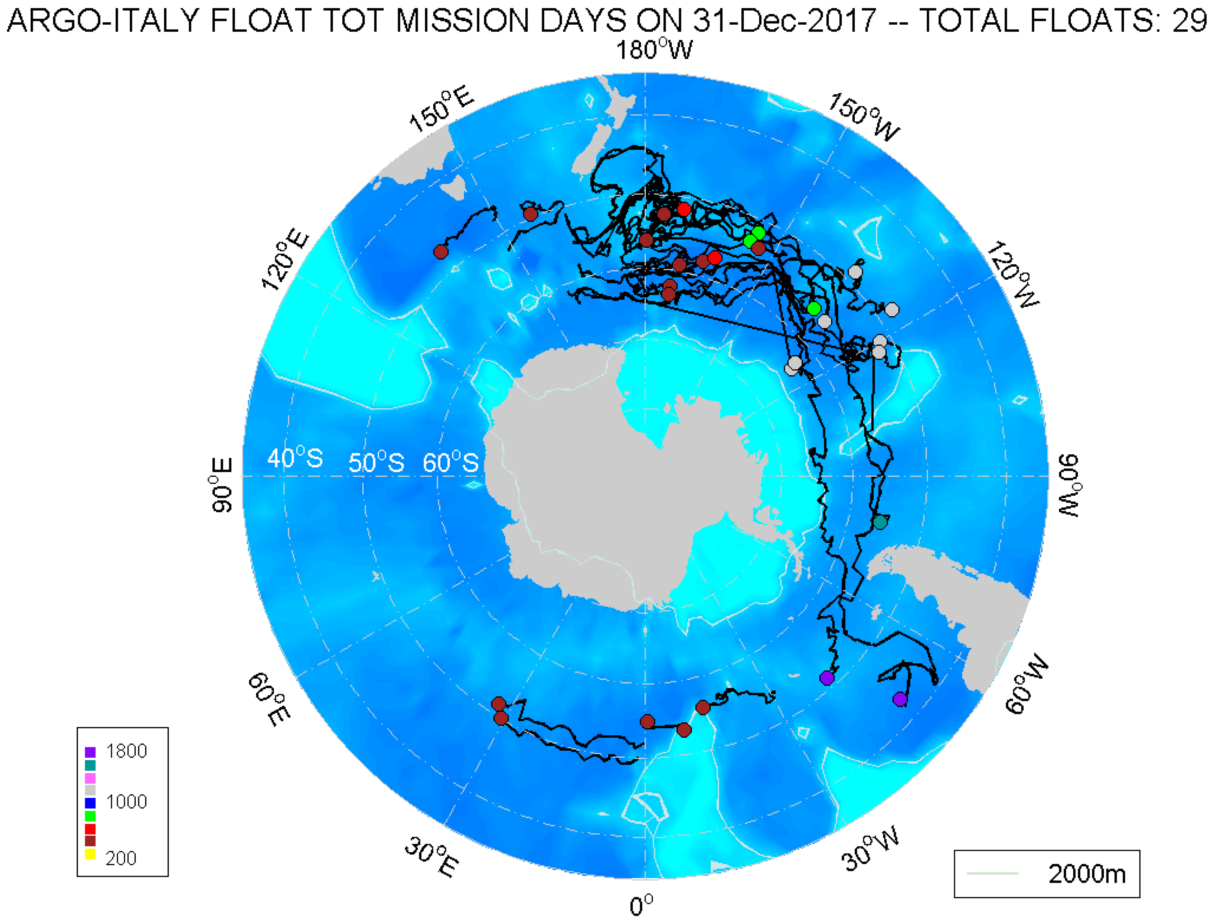


Figure 7. Trajectories and positions (circle symbols) on 31 December 2017 of the 29 ARGO-ITALY floats in the South Pacific, South Atlantic and Southern Oceans. The circle symbols are color-coded as a function of float age in days.

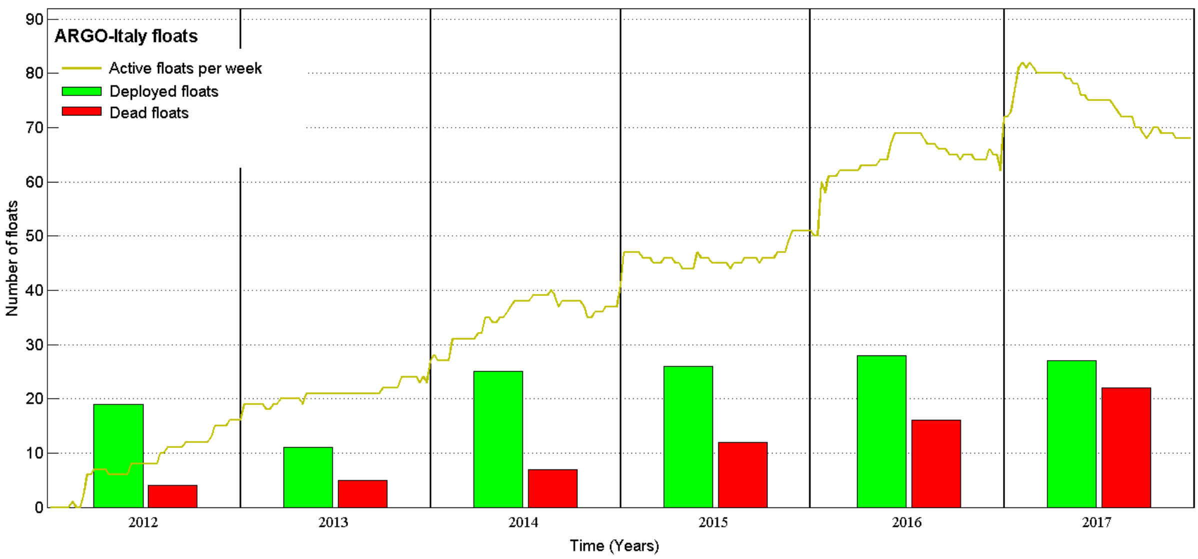


Figure 8. Temporal evolution of the number of active floats with weekly resolution and histogram of the annual float deployments and losses.

For the floats deployed in the South Pacific, South Atlantic and Southern Ocean the maximal operating life is about 5 years, and the mean half life is only about one year (Figure 11). In general, the Nova and Dova floats have significantly lower survival rates. After a little more than 2 years since their first deployments in October 2015, only 18 floats (out of 39 units, i.e., about 46%) were still fully operational (some of them collecting weird data!) in early 2018.

Note that these survival rate statistics have to be interpreted with caution since most of the floats are still alive (39 floats out of 82 units for the Mediterranean and Black seas, 29 floats out of 54 in the Southern Hemisphere). Furthermore, these statistics include the floats with all the types of "end of operating life" (low battery power, stranding, unvolontary and voluntary recovery, etc.).

Table 3 summarizes the main statistics of the ARGO-ITALY floats for the period 2012-2017. In 2017, more than 4100 CTD profiles were obtained with Italian Argo floats. These profiles provided data on a total vertical distance of more than 5600 km in 2017. For the period 2012-2017, the 136 floats of ARGO-ITALY provided data on a total vertical distance of more than 17000 km in about 15000 profiles.

2.3 Other float activities

In collaboration with colleagues from CNR-ISMAR in La Spezia, Italy we are working on the integration of a camera on an Apex float for the monitoring of jelly fish. This camera is fitted with an independent telemetry system for data transmission to Iridium satellites when the float is at the sea surface. The corresponding hardware and software components were designed and developed in 2016, whereas the integration on the float and sea-going tests started in 2017 (Marini et al., 2018).

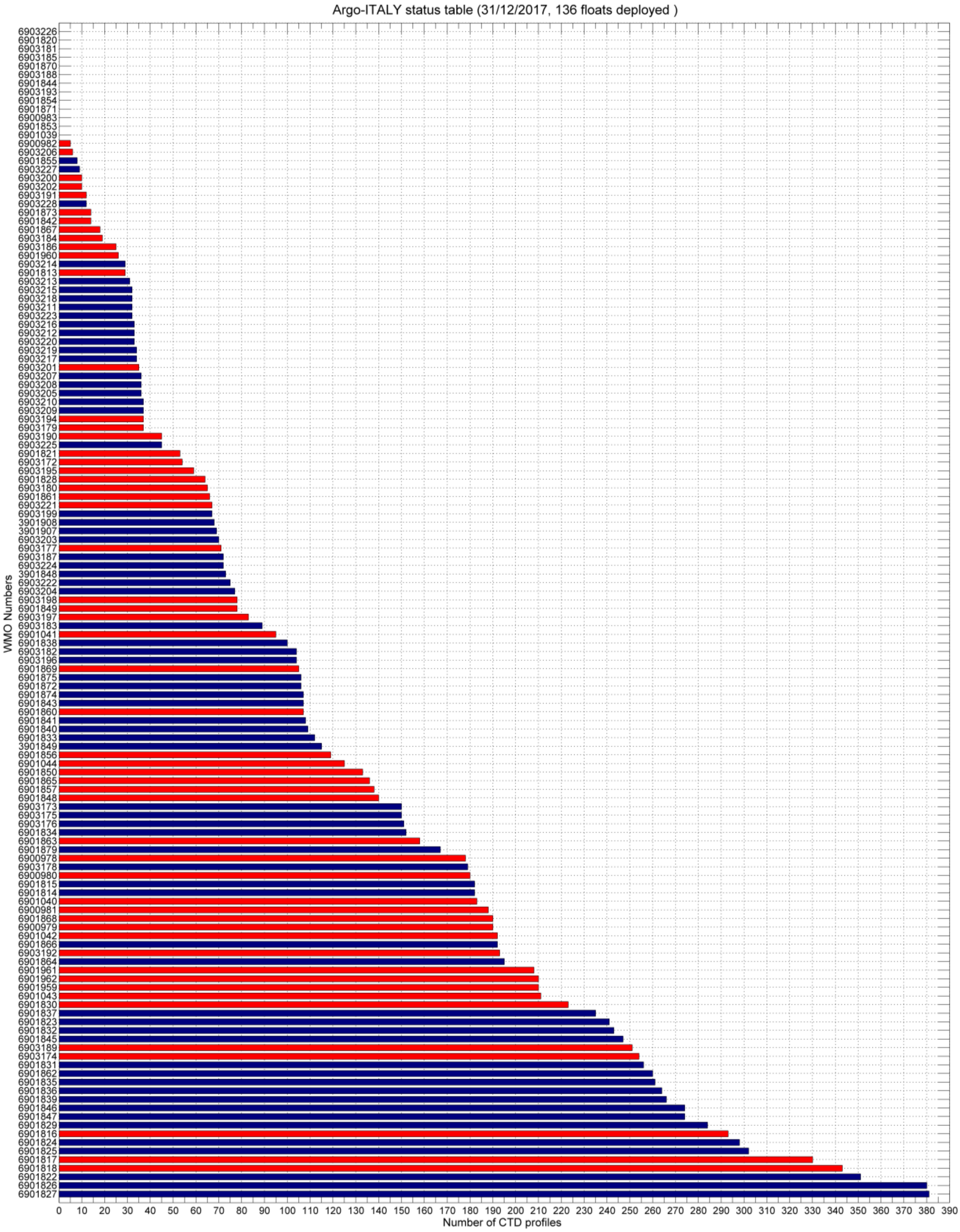


Figure 9. Histogram of the number of CTD profiles per float (red: dead float, blue: alive at the end of 2017).

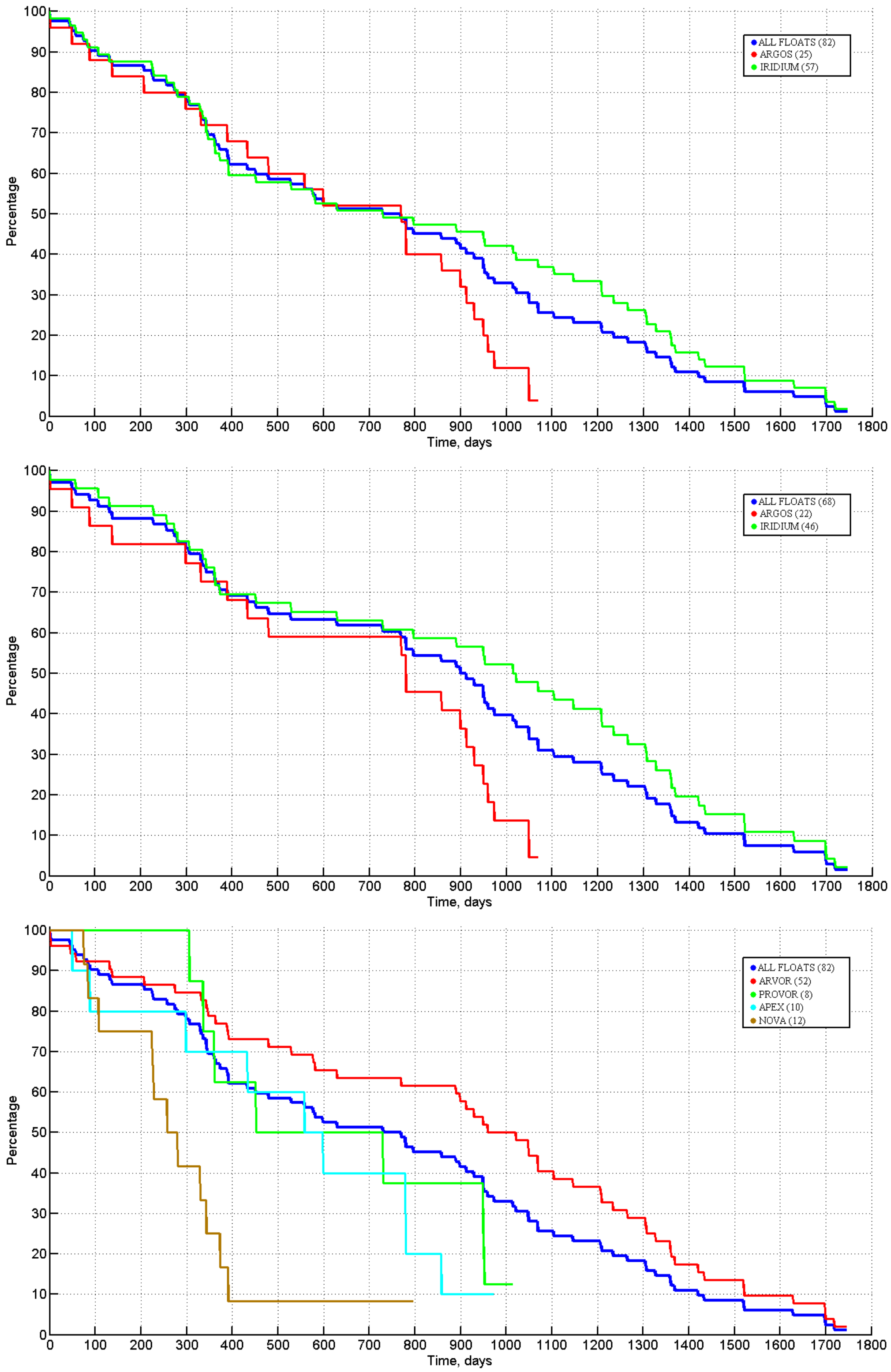
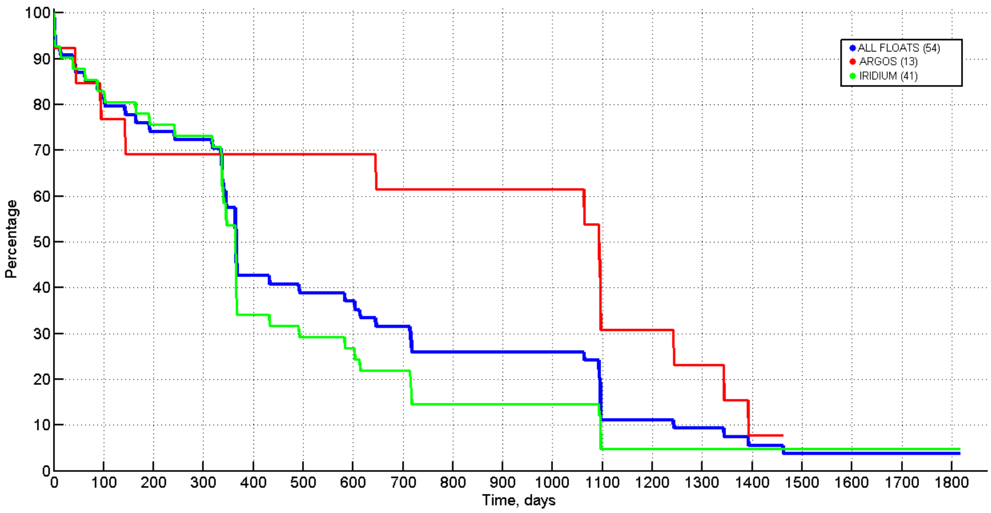


Figure 10. Survival rate diagrams for the ARGO-ITALY floats in the Mediterranean and Black seas, separated by transmission mode (top and middle) and float type (bottom).



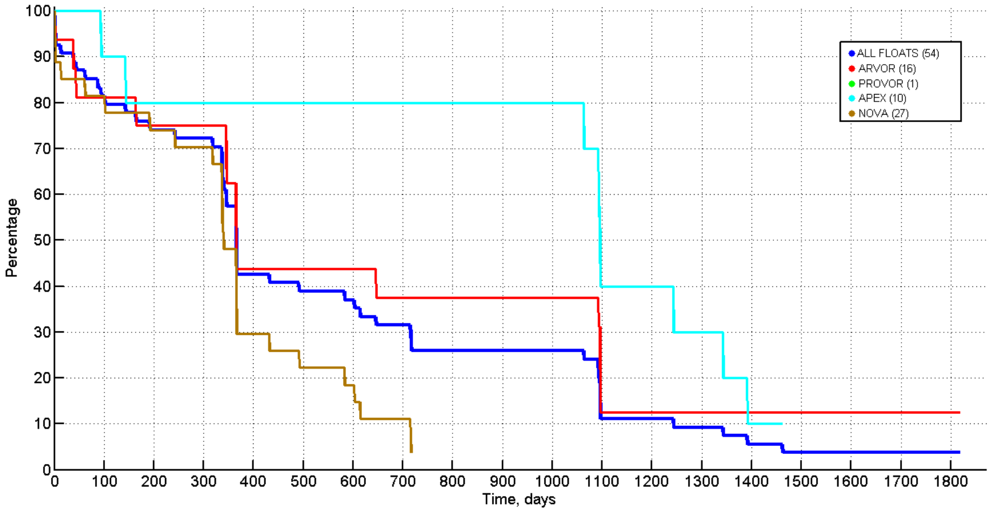


Figure 11. Survival rate diagrams for all the ARGO-ITALY floats in the South Pacific, South Atlantic and Southern Ocean, separated by transmission mode (top) and float type (bottom).

Year	2012	2013	2014	2015	2016	2017	2012-2017
Deployments							
CTD floats deployed in Med	13	7	13	11	9	8	61
CTD floats deployed in BS	4	1	2	1	1	2	11
CTD floats deployed in SO, South Pacific and Atlantic	2	3	7	10	15	17	54
Bio floats deployed	0	0	3	4	1	0	8
Deep floats					2	0	2
Total floats deployed	**19**	**11**	**25**	**26**	**28**	**27**	**136**
CTD profiles							
CTD profiles in Med	400	1099	1560	1743	2358	2147	9307
CTD profiles in BS	105	236	323	268	260	298	1490
CTD profiles in SO, South Pacific and Atlantic	6	90	205	475	815	1418	3009
Bio profiles	0	0	244	266	373	261	1144
Deep profiles					15	65	80
Total profiles	**511**	**1425**	**2332**	**2752**	**3821**	**4189**	**15030**
Vertical distances (km)							
Distance in Med	440	902	1485	1813	2195	2307	9142
Distance in BS	71	210	283	257	247	294	1362
Distance in SO, Souther Pacific and Atlantic	2	125	380	875	1374	2658	5414
Distance of bio floats	0	0	199	245	335	248	1027
Distance of deep floats					50	194	244
Total distance (km)	**513**	**1237**	**2347**	**3190**	**4201**	**5701**	**17189**

Table 3. Statistical information on the performance of the ARGO-ITALY floats in 2012-2017.

3. SVP drifter activities in 2017

3.1 Drifter procurement

In 2017, a total of 57 drifters were purchased from SIO, La Jolla, California, USA with ARGO-ITALY funding. They included 50 SVP drifters, 5 Directional Wave Spectrum (DWS) drifters and 2 ADOS drifters. Five SVP drifters were deployed in the Western Mediterranean in July 2017 during the IRENE cruise. Nine SVP drifters were shipped to Punt Arenas, Chile for deployment in the Southern Ocean in winter 2018. The other drifters (43 units) will be delivered at OGS in 2018.

3.2 SVP drifter deployments

In total, **23 SVP drifters** were deployed in 2017. Five drifters were released in the south-western Mediterranean Sea (Alboran Sea - Algerian Basin) with the help of Spanish colleagues (Table 4; Figure 12). Six and ten drifters were deployed in the South Atlantic (Southern Ocean – Atlantic Sector) and in the South Pacific (Southern Ocean - Pacific Sector), respectively, with the help of Italian colleagues (Tables 5 & 6; Figures 13 & 14). Two drifters were released off the coast of West Africa (Table 7; Figure 15), with the help of Senegalese colleagues. For all the drifters, hourly positions and SST are transmitted via the Iridium satellite system.

Table 4 shows the status information of drifters deployed in the Mediterranean Sea in 2017 as a contribution to the IRENE project. One of the five drifters deployed in the Alboran Sea (IMEI a300234063251260) was still operating in February 2018 (black track in Figure 12). These drifters were manufactured by SIO in La Jolla, California.

IMEI	Deploy Date	Lat	Lon	Last Date	Lat	Lon	Status
a300234063946680	20-Jul-2017 18:06	36.28	-1.57	15-Nov-2017 16:00	37.61	5.83	D
a300234063946700	20-Jul-2017 18:09	36.28	-1.57	06-Sep-2017 16:00	36.76	2.85	D
a300234063251260	20-Jul-2017 18:11	36.27	-1.57	20-Feb-2018 09:00	35.35	13.83	A
a300234063946690	20-Jul-2017 18:06	36.26	-1.57	29-Aug-2017 14:00	36.78	2.44	D
a300234063349360	20-Jul-2017 18:16	36.26	-1.58	20-Nov-2017 06:50	36.94	6.87	D

**Status in February 2018: A = active, D = dead*

Table 4. Status information for the Italian drifters deployed during the IRENE project

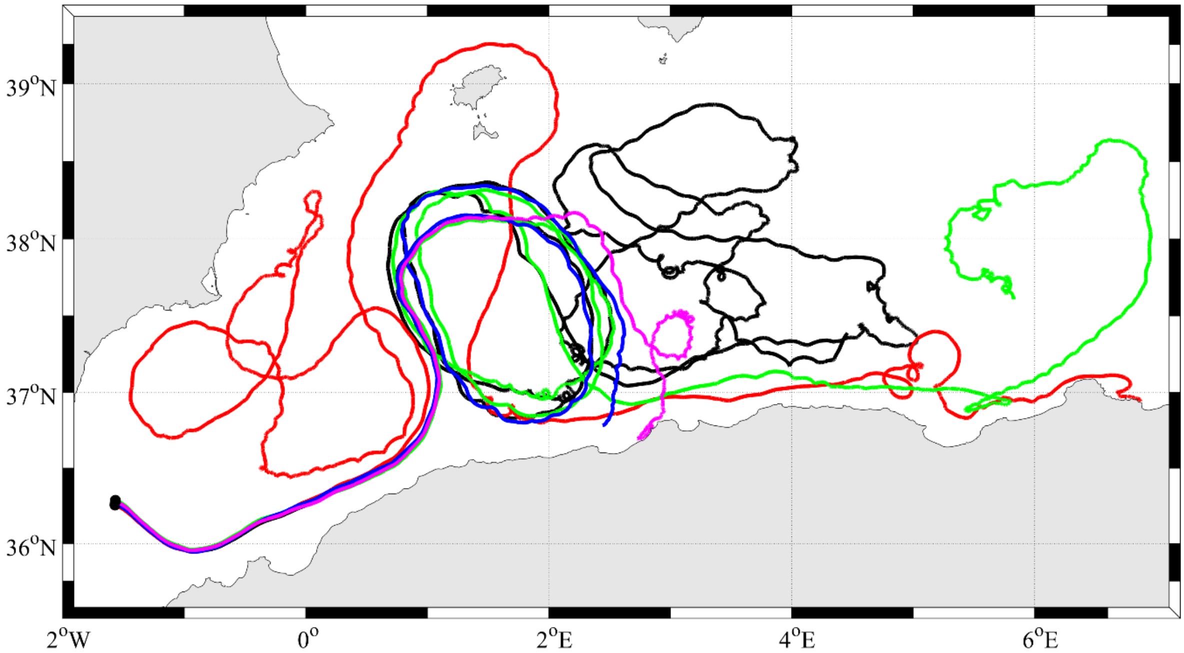


Figure 12. Trajectories and deployment positions (black dots) of the five Italian drifters deployed in the western Mediterranean during the IRENE project in July 2017. Drifter data are updated to 31-Dec-2017.

Table 5 shows the status information of drifters deployed in January - February 2017 in the South Atlantic from R/V Agulhas II with the help of Italian colleagues as a contribution to the MOMA project (Multiplatform Observations and Modelling in a sector of the Antarctic circumpolar current; https://twitter.com/momapnra). All these drifters were still alive in February 2018. Figure 13 shows the drifters ready to be deployed on the deck of R/V Agulhas II in January 2017, whereas Figure 14 shows the drifters trajectories during the period January - December 2017. These drifters were Metocean instruments (Meteocean, Dartmouth, Nova Scotia, Canada).

IMEI	Deploy Date	Lat	Lon	Last Date	Lat	Lon	Status
a300234063568070	31-Jan-2017 10:08	-54	0	21-Feb-2018 06:00	48.08	72.16	A
a300234063566090	01-Feb-2017 00:06	-51	0.46	21-Feb-2018 06:00	42.81	83.17	A
a300234063662120	31-Jan-2017 14:48	-53	0.01	21-Feb-2018 06:00	45.43	100.86	A
a300234063665570	31-Jan-2017 19:07	-51.99	0.01	21-Feb-2018 06:00	45.67	52.3	A
a300234063663560	01-Feb-2017 05:22	-50	1.54	21-Feb-2018 06:00	43.27	69.39	A
a300234063567100	01-Feb-2017 10:44	-49	2.58	21-Feb-2018 06:00	41.98	80.79	A

**Status in February 2018: A = active, D = dead*

Table 5. Status information for the Italian drifters deployed in the South Atlantic in 2017.

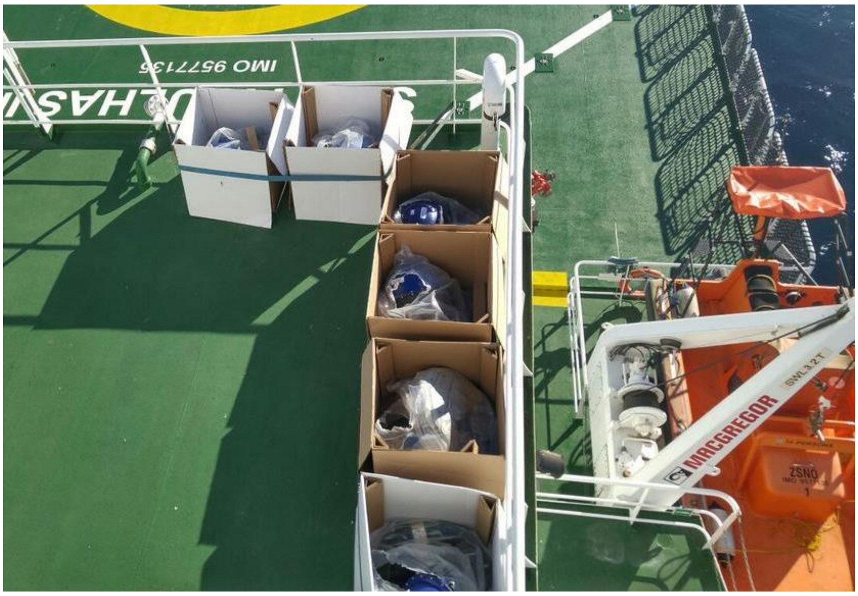


Figure 13. SVP drifters on the deck of R/V Agulhas II before deployment in the South Atlantic in January – February 2017 (upper panel); deployment of the first Italian drifter (lower panel).

Table 6 shows the status information of the ten drifters deployed in January 2017 in the South Pacific –Southern Ocean (south of New Zealand) from R/V Italica. Only four of them were still operating in February 2018, after a year of drift in the ACC (Table 6; Figure 14). Unfortunately, the transmitters of the other six drifters (IMEIs a300234063462670, a300234063465170, a300234063560070, a300234063562060, a300234063563050, a300234063566010), deployed during the same oceanographic campaign, failed upon deployment. These drifters were Metocean instruments (Meteocean, Dartmouth, Nova Scotia, Canada).

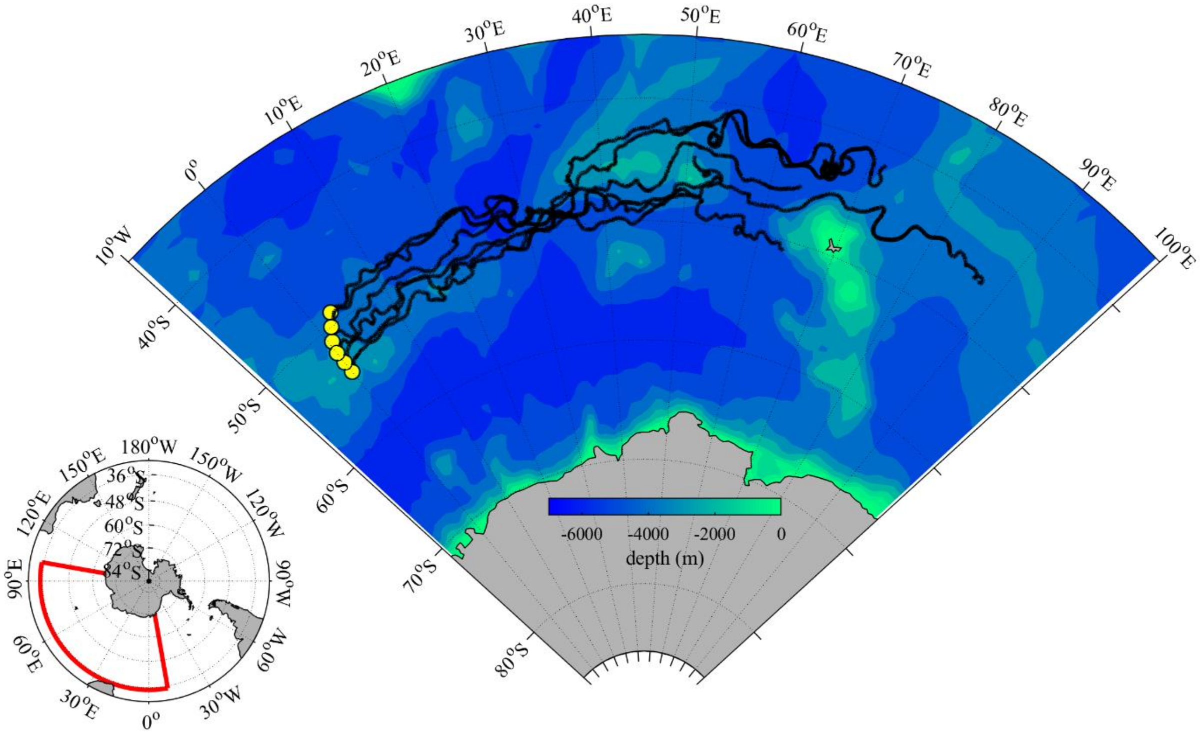


Figure 14. Trajectories and deployment positions (yellow dots) of the six Italian drifters deployed in the South Atlantic in January – February 2017. Drifter data are updated to 31-Dec-2017.

IMEI	Deploy Date	Lat	Lon	Last Date	Lat	Lon	Status
a300234063460240	03-Jan-2017 07:10	-60.03	177.07	21-Feb-2018 06:00	-53.91	-102.57	A
a300234063668980	02-Jan-2017 04:00	-55.04	175.49	21-Feb-2018 06:00	-46.85	-122.37	A
a300234063462670	03-Jan-2017 21:34	-63.05	177.93	03-Jan-2017 21:34	-63.05	177.93	D
a300234063465170	02-Jan-2017 10:10	-56.04	175.76	21-Feb-2018 06:00	-48.35	-114.85	A
a300234063669570	03-Jan-2017 07:11	-60.04	177.07	03-Jan-2017 07:11	-60.04	177.07	D
a300234063560070	03-Jan-2017 16:42	-62.04	177.58	03-Jan-2017 16:42	-62.04	177.59	D
a300234063560190	02-Jan-2017 15:40	-57.01	176.11	21-Feb-2018 06:00	-44.91	-129.96	A
a300234063562060	02-Jan-2017 21:21	-58.04	176.4	02-Jan-2017 21:21	-58.04	176.4	D
a300234063563050	03-Jan-2017 11:54	-61.03	177.25	03-Jan-2017 11:54	-61.03	177.25	D
a300234063566010	03-Jan-2017 02:06	-59.02	176.74	03-Jan-2017 02:06	-59.02	176.74	D

**Status in February 2018: A = active, D = dead*

Table 6. Status information for the Italian drifters deployed in the South Pacific / Southern Ocean in 2017.

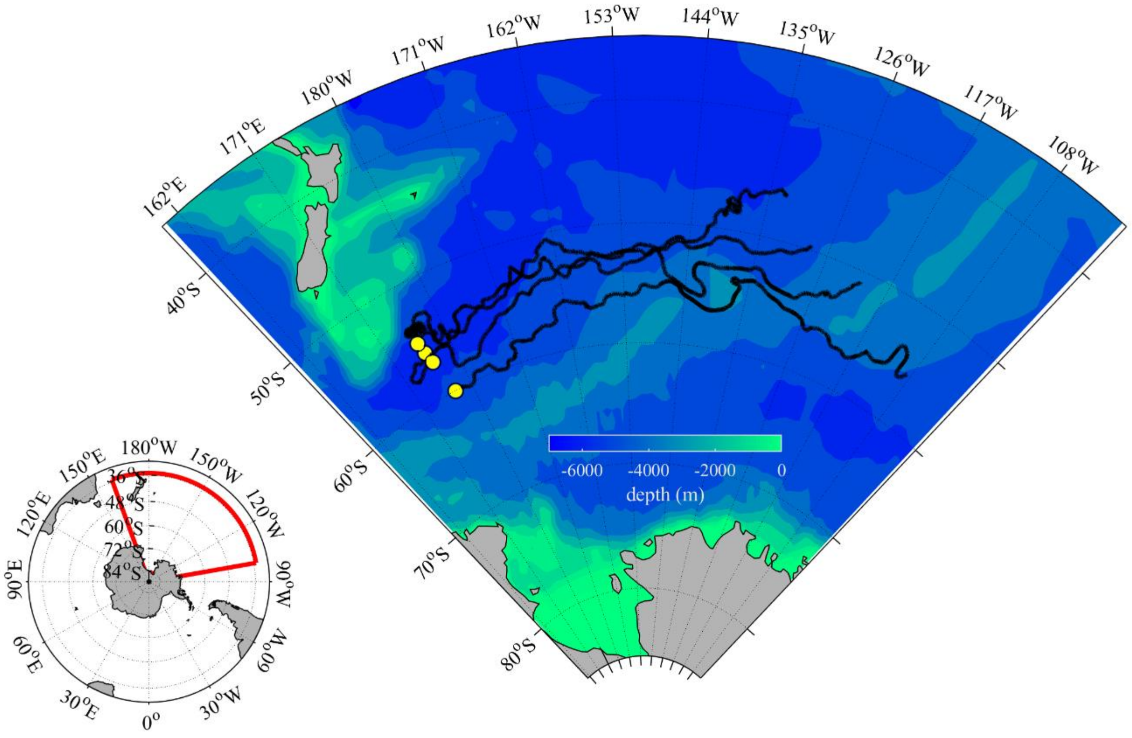


Figure 15. Trajectories and deployment positions (yellow dots) of the 4 Italian drifters deployed in the South Pacific (Southern Ocean) in January 2017. Drifter data are updated to 31-Dec-2017.

It is interesting to note that one drifter (IMEI a300234062832730), deployed south of New Zealand in January 2015 (see Poulain et al., 2016), completed the circumnavigation of the Antarctica continent in early January 2018 (Figure 16) and it is still operating in February 2018.

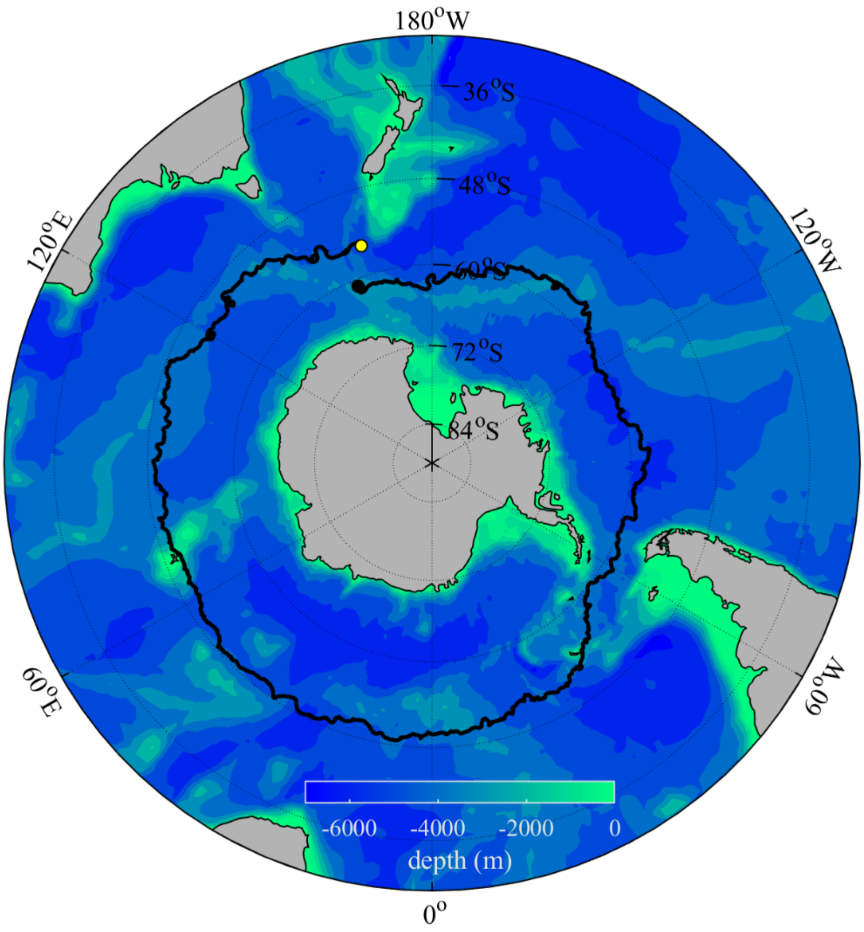


Figure 16. Trajectory, deployment position (black dot) and last position updated on 10 January 2018 (yellow dot), of drifter a300234062832730, deployed south of New Zealand in January 2015.

Two drifters were deployed in the tropical North Atlantic Ocean, off the Senegal coast, in November 2017 (Table 7; Figure 17). They were operated in water only for a few days before being picked up prematurely by local fishermen.

IMEI	Deploy Date	Lat	Lon	Last Date	Lat	Lon	Status
a300234063563180	30-Nov-2017 07:20	14.47	-17.57	06-Dec-2017 17:00	14.75	-17.51	D
a300234063464920	30-Nov-2017 15:03	13.97	-17.45	14-Dec-2017 13:00	14.41	-16.98	D

**Status in February 2018: A = active, D = dead*

Table 7. Status information for the Italian drifters deployed in tropical Atlantic in November 2017.

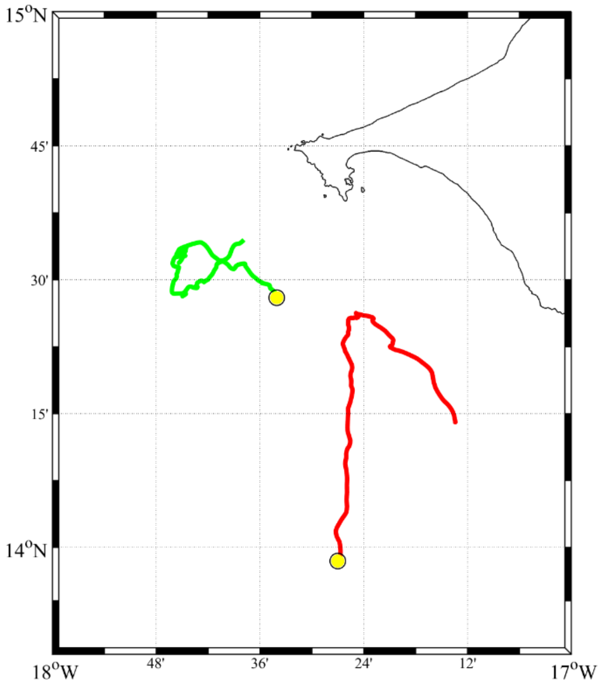


Figure 17. Trajectories and deployment positions (yellow dots) of the two Italian drifters deployed off Senegal in November 2017.

3.3 CODE drifter deployments

In 2017, OGS completed the development of the OGS low-cost drifter, a design similar to the original CODE drifter, but at a substantially reduced cost. A photograph of its final version (v2) is shown in Figure 18.

Figure 18. The OGS low-cost CODE v2.

In total, **16 OGS low-cost drifters** were released in the Ligurian Sea in support of the LOGMEC17 experiment (Long-term glider missions for Environmental Characterisation 2017) in September 2017 (Table 8; Figure 19). This experiment was realized in collaboration with CNR-ISMAR and CMRE, to study surface circulation/dispersion and to calibrate the CNR HF radar system. Three of these instruments (IMEI bTrace5, bTrace 12, bTrace 13) were recovered and re-deployed in early October 2017. Eight of these drifters were recovered after the LOGMEC17 experiment and will be employed in new missions during 2018. With a transmission period of 10 min, a maximal autonomy of about 1 month was reached (Gerin et al., 2018).

IMEI	Deploy Date	Lat	Lon	Last Date	Lat	Lon	Status
aTrace13	26-Sep-2017 14:58	43.89	9.84	30-Sep-2017 12:41	43.6	9.98	D
aTrace12	26-Sep-2017 11:17	43.82	9.7	30-Sep-2017 13:12	43.6	9.98	D
aTrace11	26-Sep-2017 11:05	43.81	9.71	26-Oct-2017 09:37	41.29	9.61	D
aTrace10	26-Sep-2017 12:28	43.84	9.7	30-Sep-2017 10:24	43.65	9.99	D
aTrace9	26-Sep-2017 12:10	43.83	9.68	30-Sep-2017 10:13	43.68	10	D
aTrace8	26-Sep-2017 11:23	43.82	9.71	26-Oct-2017 03:48	42.35	10.12	D
aTrace7	26-Sep-2017 12:35	43.84	9.7	30-Sep-2017 10:14	43.68	10	D
aTrace6	26-Sep-2017 13:55	43.87	9.82	30-Sep-2017 10:56	43.6	9.97	D
aTrace5	26-Sep-2017 13:37	43.87	9.82	30-Sep-2017 12:01	43.6	9.97	D
aTrace4	26-Sep-2017 11:52	43.82	9.68	14-Oct-2017 01:34	43.35	10.17	D
aTrace3	26-Sep-2017 11:35	43.82	9.71	25-Oct-2017 02:08	42.46	9.83	D
aTrace2	26-Sep-2017 14:51	43.88	9.84	30-Sep-2017 12:22	43.6	9.97	D
aTrace1	26-Sep-2017 12:02	43.83	9.68	27-Oct-2017 08:10	41.03	9.76	D
aSPOT3	26-Sep-2017 13:45	43.87	9.82	13-Oct-2017 03:09	43.37	10.24	D
aSPOT2	26-Sep-2017 15:11	43.89	9.85	12-Oct-2017 23:48	43.37	10.18	D
aSPOT1	26-Sep-2017 12:45	43.84	9.7	14-Oct-2017 08:34	42.75	10.05	D
bTrace5	01-Oct-2017 09:47	43.87	9.85	13-Oct-2017 13:05	44.01	9.89	D
bTrace12	01-Oct-2017 09:41	43.86	9.85	17-Oct-2017 08:42	43.85	10.11	D
bTrace13	01-Oct-2017 09:44	43.87	9.85	17-Oct-2017 08:25	43.91	10.15	D

Table 8. Status information for the CODE-OGS drifters deployed in the Ligurian Sea in September 2017.

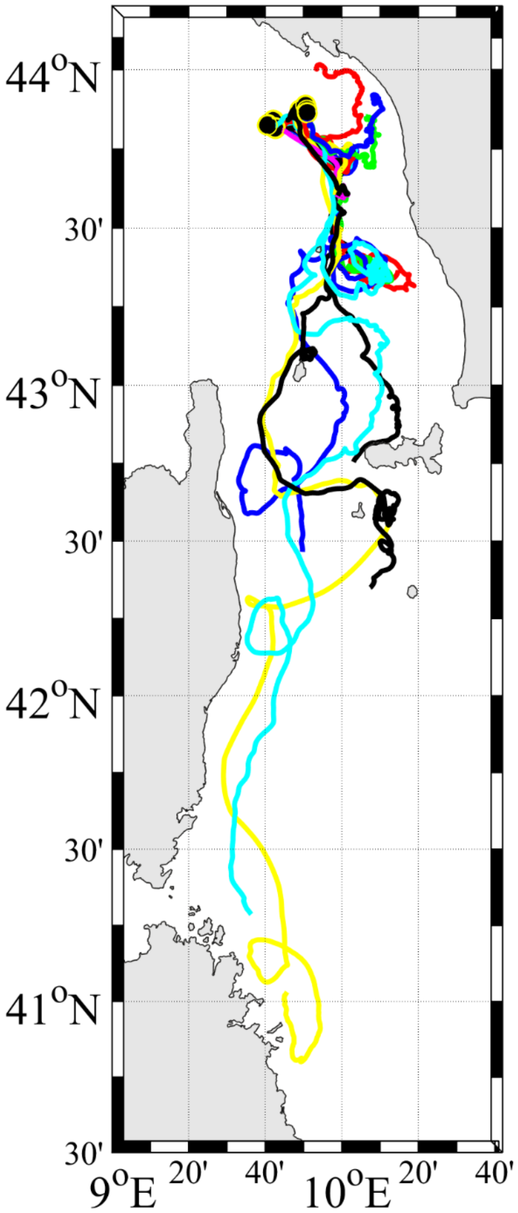


Figure 19. Trajectories and deployment positions (black dots) of the CODE-OGS drifters deployed south of La Spezia in September 2017.

4. Glider activities in 2017

4.1 Glider component procurement and glider maintenance

In January 2017, the Slocum glider “unit 402” was sent to the factory for repair. It returned to OGS in May 2017. Two complete battery sets for the Slocum glider were purchased in summer 2017. The Slocum glider “unit 403” was refurbished with the new batteries at the OGS glider laboratory.

4.2 Glider testing

All the gliders were tested before their deployment. In particular, the glider “unit 403” was tested at the OGS laboratory in February 2017 before its deployment in the South Adriatic Sea. The glider “unit 402” was extensively tested in the laboratory and at sea (in the Gulf of Trieste) starting in June 2017 and was ballasted for the South Adriatic Sea waters in November 2017.

4.3 Glider laboratory

In 2017, only consumable goods were purchased for the OGS glider laboratory.

4.4 Glider operations

The OGS Slocum glider “unit 403” was deployed in the South Adriatic Sea on 6 May 2017 for the CONVEX17 experiment (Figure 20). The purpose of the experiment was to study the post convection and the effect of the deep water formation in the North Adriatic Sea. The glider covered only part of the transect Bari – Dubrovnik and was prematurely recovered on 10 May 2017 because of battery issue. The instrument collected scientific data (pressure, temperature, conductivity, oxygen, chlorophyll, CDOM and backscatter) down to almost 1000 m depth (200 m for the biological parameters) for 2 days only (Figure 21).

The OGS Slocum glider “unit 402” was successfully operated across the South Adriatic Sea from 2 to 14 December 2017 (PreConvex18 experiment; Figure 22). The purpose of the experiment was to study the pre-convection condition of the water column in the North Adriatic Sea. The glider covered the transect Bari – Dubrovnik and the central area of the South Adriatic Pit. It was piloted down to almost 1000 m depth in the area of the Pit, collecting high frequency data of pressure, temperature, conductivity, oxygen, chlorophyll, CDOM and backscatter (Figure 23).

Figure 20. Glider "unit 403" trajectory during the CONVEX17 experiment (concluded prematurely) in the South Adriatic Sea. The glider symbol indicates the last position of the instrument. Orange symbols correspond to surfacing locations.

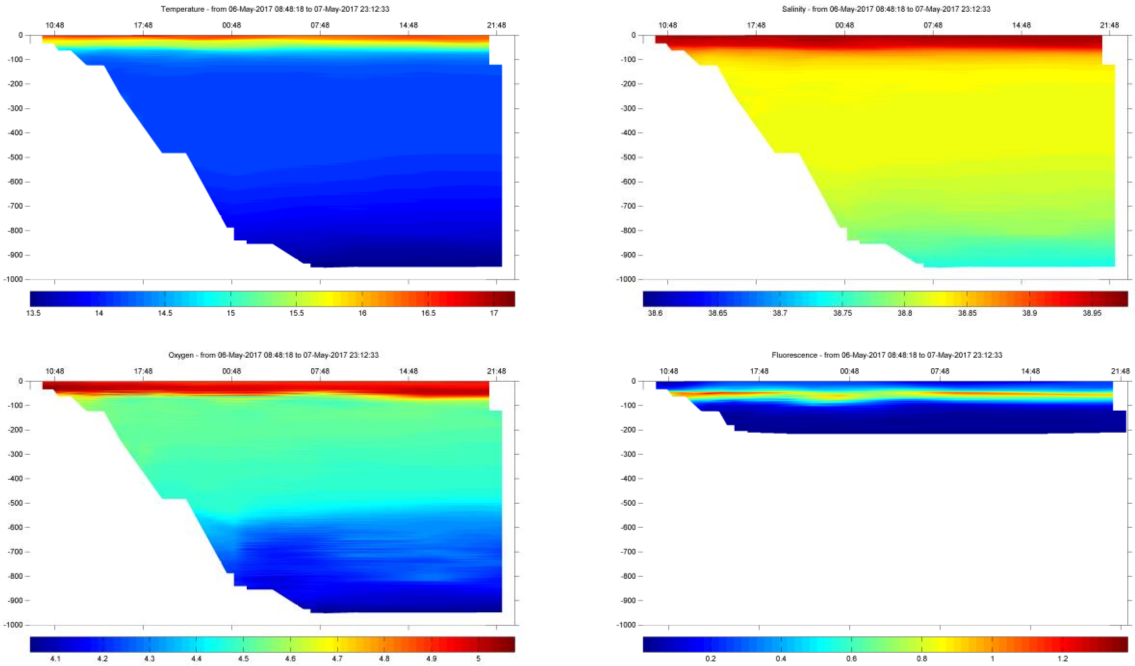


Figure 21. Color-coded vertical section along the glider path of temperature (top-left), salinity (top-right), dissolved oxygen (bottom-left) and fluorescence (bottom-right) during the CONVEX17 experiment in the South Adriatic Sea.

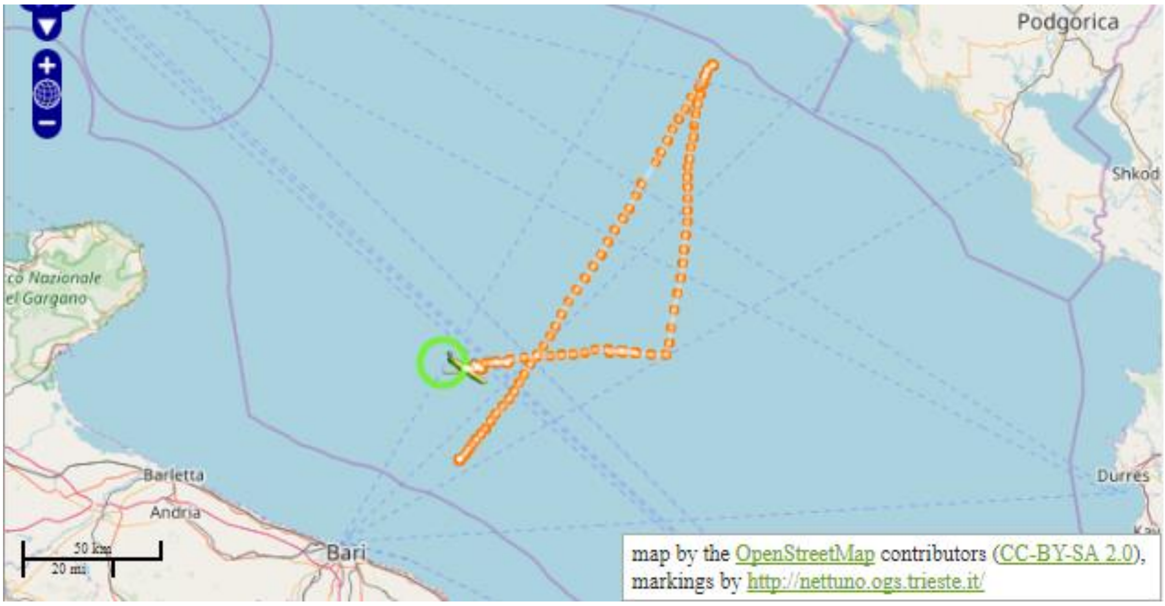


Figure 22. Glider "unit 402" trajectory during the PreCONVEX18 experiment in the South Adriatic Sea. The glider and the green circle symbols indicate the last position of the instrument and the last waypoint, respectively. Orange symbols correspond to surfacing locations.

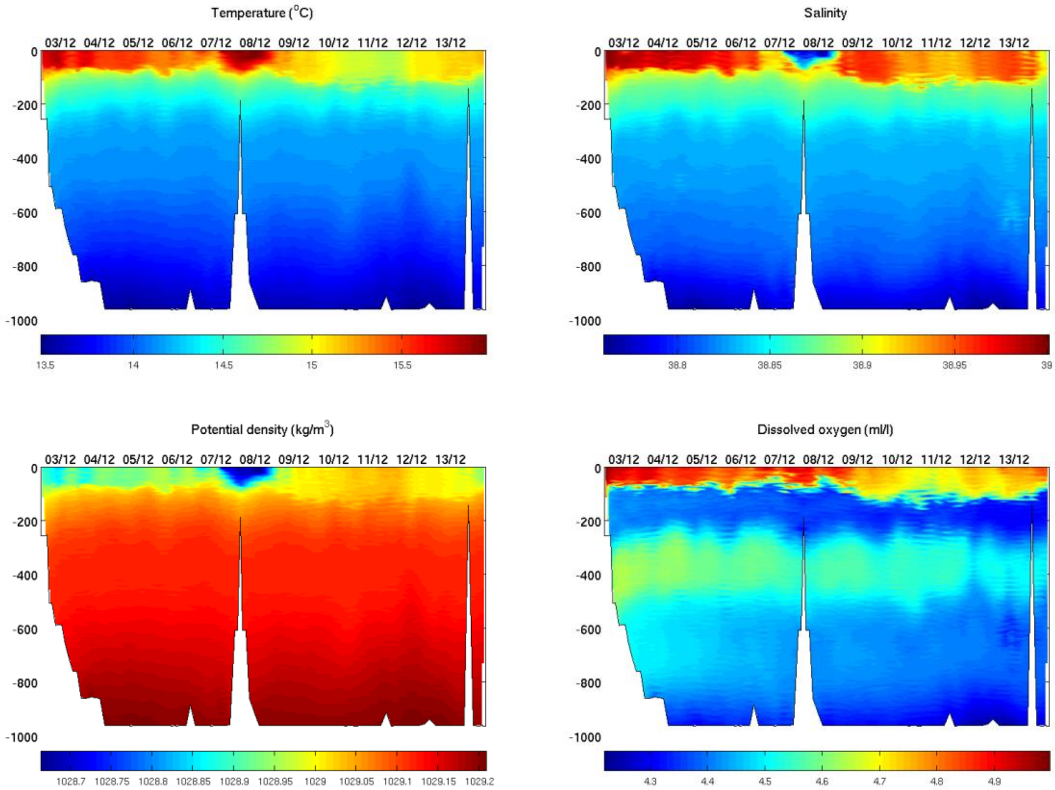


*Figure 23. Color-coded vertical section along the glider path of temperature (top-left), salinity (top-right), density (bottom-left) and dissolved oxygen (bottom-right) during the PreCONVEX17 experiment (*2 - 14 December 2017*).*

4.5 Glider data processing and webpage

The glider data acquired during all the missions were processed and displayed in real time on the webpage: http://nettuno.ogs.trieste.it/sire/glider/glider_mission_now.php

Other webpages (password protected) with technical informations and other parameters were available in real time to the OGS glider pilots. A first data elaboration was set up following EGO (Everyone Glider Observatories) recommendations to provide a unique and coherent data set in terms of format and quality.

5. Other activities in 2017

5.1 Near real-time data processing

The data of drifters, floats and gliders were processed and archived in near real-time at OGS. This processing includes some editing and the production of graphics and tables which are posted on the ARGO-ITALY web pages. In parallel, the raw drifter and float data were sent to global Data Assembly Centers (AOML/NOAA, Miami, Florida for the drifters and Coriolis, Ifremer, Brest, France for the floats). In addition, the SVP drifter and float data were distributed in near real-time on the Global Telecommunication System (GTS) and were identified by a WMO number.

The data of the Provor Bio and Provor Nut floats were processed by LOV and made available in near-real time (files in Argo NetCDF format with real time QC) on their server (http://www.oao.obs-vlfr.fr/BD_FLOAT/NETCDF/).

A new web site for ARGO-ITALY was developed in 2017. It will be implemented and operational in early 2018, and will substitute the older ARGO-ITALY web pages. The new web site allows to visualize the data of the instruments in near-real time more efficiently.

5.2 Delayed Mode quality control of Argo physical data

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 43 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 2010-2017. 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. 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) will be performed OGS as soon as possible in 2018.

5.3 Italian contribution to Argo bibliography in 2017

The following papers involving Italian scientists were published in 2017. They use Argo data for basic oceanographic research and operational oceanography purposes.

Buongiorno Nardelli, B., S. Guinehut, N. Verbrugge, Y. Cotroneo, E. Zambianchi, and D. Iudicone, 2017: Southern Ocean Mixed-Layer Seasonal and Interannual Variations From Combined Satellite and In Situ Data. Journal of Geophysical Research: Oceans, 122, 10042-10060, http://dx.doi.org/10.1002/2017JC013314

Cipollone, A., S. Masina, A. Storto, and D. Iovino, 2017: Benchmarking the mesoscale variability in global ocean eddy-permitting numerical systems. Ocean Dynamics, 67, 1313-1333, https://doi.org/10.1007/s10236-017-1089-5

Clementi, E., P. Oddo, M. Drudi, N. Pinardi, G. Korres, and A. Grandi, 2017: Coupling hydrodynamic and wave models: first step and sensitivity experiments in the Mediterranean Sea. Ocean Dynamics, 67, 1293-1312, https://doi.org/10.1007/s10236-017-1087-7

Jordà, G., K. Von Schuckmann, S. A. Josey, G. Caniaux, J. García-Lafuente, S. Sammartino, E. Özsoy, J. Polcher, G. Notarstefano, P. M. Poulain, F. Adloff, J. Salat, C. Naranjo, K. Schroeder, J. Chiggiato, G. Sannino, and D. Macías, 2017: The Mediterranean Sea heat and mass budgets: Estimates, uncertainties and perspectives. Progress in Oceanography, 156**,** 174-208, https://doi.org/10.1016/j.pocean.2017.07.001

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Mancero-Mosquera I., Poulain P.-M., Gerin R., Mauri E., Hayes D., Testor P. and Mortier L., 2017: Analysis of frequency content of temperature glider data via Fourier and wavelet transforms. Bollettino di Geofisica Teorica ed Applicata, 58(2), 137-156.

Masina, S., A. Storto, N. Ferry, M. Valdivieso, K. Haines, M. Balmaseda, H. Zuo, M. Drevillon, and L. Parent, 2017: An ensemble of eddy-permitting global ocean reanalyses from the MyOcean project. Climate Dynamics, 49, 813-841, https://doi.org/10.1007/s00382-015-2728-5

Olita, A., A. Capet, M. Claret, A. Mahadevan, P. M. Poulain, A. Ribotti, S. Ruiz, J. Tintoré, A. Tovar-Sánchez, and A. Pascual, 2017: Frontal dynamics boost primary production in the summer stratified Mediterranean sea. Ocean Dynamics, 67, 767-782, https://doi.org/10.1007/s10236-017-1058-z

Pascual, A., S. Ruiz, A. Olita, C. Troupin, M. Claret, B. Casas, B. Mourre, P.-M. Poulain, A. Tovar-Sanchez, A. Capet, E. Mason, J. T. Allen, A. Mahadevan, and J. Tintoré, 2017: A Multiplatform Experiment to Unravel Meso- and Submesoscale Processes in an Intense Front (AlborEx). Frontiers in Marine Science, 4, http://dx.doi.org/10.3389/fmars.2017.00039

Reale, M., S. Salon, A. Crise, R. Farneti, R. Mosetti, and G. Sannino, 2017: Unexpected Covariant Behavior of the Aegean and Ionian Seas in the Period 1987–2008 by Means of a Nondimensional Sea Surface Height Index. Journal of Geophysical Research: Oceans, 122**,** 8020-8033, http://dx.doi.org/10.1002/2017JC012983

Storto, A. and S. Masina, 2017: Objectively estimating the temporal evolution of accuracy and skill in a global ocean reanalysis. Meteorological Applications, 24, 101-113, http://dx.doi.org/10.1002/met.1609

Storto, A., S. Masina, M. Balmaseda, S. Guinehut, Y. Xue, T. Szekely, I. Fukumori, G. Forget, Y.-S. Chang, S. A. Good, A. Köhl, G. Vernieres, N. Ferry, K. A. Peterson, D. Behringer, M. Ishii, S. Masuda, Y. Fujii, T. Toyoda, Y. Yin, M. Valdivieso, B. Barnier, T. Boyer, T. Lee, J.

Gourrion, O. Wang, P. Heimback, A. Rosati, R. Kovach, F. Hernandez, M. J. Martin, M. Kamachi, T. Kuragano, K. Mogensen, O. Alves, K. Haines, and X. Wang, 2017: Steric sea level variability (1993–2010) in an ensemble of ocean reanalyses and objective analyses. Climate Dynamics, 49, 709-729, https://doi.org/10.1007/s00382-015-2554-9

Storto, A., C. Yang, and S. Masina, 2017: Constraining the Global Ocean Heat Content Through Assimilation of CERES-Derived TOA Energy Imbalance Estimates. Geophysical Research Letters, 44, 10,520-10,529, http://dx.doi.org/10.1002/2017GL075396

Verri, G., N. Pinardi, P. Oddo, S. A. Ciliberti, and G. Coppini, 2017: River runoff influences on the Central Mediterranean overturning circulation. Climate Dynamics, https://doi.org/10.1007/s00382-017-3715-9

5.4 OGS technical reports related to ARGO-ITALY published in 2017

Gerin R., Mauri E., Bussani A., Zuppelli P., Kokkini Z., Pacciaroni M., Kuchler S. And Poulain P.-M, 2017: The CINEL16 and CINEL17 OGS glider missions. Rel. 2017/38 Sez. OCE 11 MAOS, Trieste, Italy, 28 pp.

Menna M., Gerin R., Bussani A. and Poulain P.-M., 2017: The OGS Mediterranean Drifter Dataset: 1986-2016. Rel. 2017/92 Sez. OCE 28 MAOS, Trieste, Italy, 34 pp.

Pacciaroni M., Poulain P.-M., Notarstefano G. and Bussani A., 2017: Arvor-I with ice detection deployments in the Southern Ocean. Rel. 2017/90 Sez. OCE 27 MAOS, Trieste, Italy, 32 pp.

Prigent A. and Poulain P.-M., 2017: On the Cyprus eddy kinematics. Rel. 2017/77 sez. OCE 19 MAOS, Trieste, Italy, 11 pp.

Prigent A., Poulain P.-M., Menna M. and Besio G., 2017: Comparison Between Stokes Drift And Wind-Induced Slip Of Mediterranean Drifters. Rel. 2017/78 sez. OCE 20 MAOS, Trieste, Italy, 21 pp.

Zuppelli P., Kuchler S. and Gerin R., 2017: Procedure per verificare le funzionalità e test del sensore Wetlabs BB2FL-VMT Eco Puck. REL. OGS 2017/29 OCE 9 MAOS, Trieste, Italy, 6 pp.

6. Plans for 2018 and beyond

6.1 Floats

With the funding available in 2017-2018, we plan to acquire the following instruments:

- 20 standard Argo floats with Iridium telemetry. Five of these floats will have additional oxygen sensors. Seven will have the Ice Sensing algorithm (ISA);
- 3 deep floats with oxygen sensors.

The Italian deployment plans for 2017 and 2018 are detailed in Table 9. The main areas of interest are the Mediterranean and Black seas and the Southern Ocean.

Year	T/S floats (some of them with DO)		BGC floats		Deep floats		Total
	Quantity	Area	Quantity	Area	Quantity	Area	
2018	12 1 8	Mediterranean Black Sea South Hemisphere	3 1	Mediterranean Black Sea	2	Mediterranean	**27**
2019	13 2 10	Mediterranean Black Sea South Hemisphere	1	Mediterranean Black Sea	1	Mediterranean	**27**

Table 9. Italian float deployment plans for 2018-2019.

On the longer time frame, Italy is interest to maintain contributions to the Argo Core mission and the BGC and Deep Argo Extension with numbers similar to those listed in Table 9. OGS is committed to carry out DMQC on all the Argo floats of the Mediterranean and Black seas, and on some floats in the World Ocean, as part of the CMEMS, MOCCA and other European projects over the coming years.

6.2 Drifters

We do not plan to buy any new drifters with the funding available in 2017-2018. Drifter deployment plans for 2018 and 2019 are described in Table 10.

Year	SVP drifters	
	Quantity	Area
2018	10 25	Southern Ocean Mediterranean
2019	10 15	Southern Ocean Mediterranean

Table 10. ARGO-ITALY drifter deployment plans for 2018-2019.

6.3 Gliders

We plan to acquire a new deep Seaglider with the 2018 funding. The addition of a fourth glider to the OGS glider fleet is deemed necessary to organize timely all the glider missions planned in ARGO-ITALY and other projects.

The OGS Slocum Gliders are planned to be operated in the South Adriatic Sea in winter and late autumn 2018 to monitor dense water formation processes. The Seaglider will be operated as part of the MELMAS project in the eastern Levantine Basin in winter and summer 2018.

6.4 Other

MIUR is committed to provide funding in order to sustain the Italian contribution to Argo beyond 2018 as a founding member of the Euro-Argo Research Infrastructure Consortium. In addition to the Italian national funding, OGS has funding from other projects (e.g., MOCCA funded by the EU DG MARE and MELMAS funded by the Italian Ministry of Foreign Affairs) for activities related to Argo.

7. Distribution list

This report will be distributed, amongst others, to the ARGO-ITALY International Scientific Advisory Committee:

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Institute of Oceanology-BAS,Varna, Bulgaria

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The captain (Luca Triggiani) and crew of M/Y Exuma and the Seakeepers Society.

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Marini, S., L. Corgnati, C. Mantovani, M. Bastianini, E. Ottaviani, E. Fanelli, J. Aguzzi, A. Griffa and P.-M. Poulain (2018) Automated estimate of fish abundance through the autonomous imaging device GUARD1. Submitted to Measurement.

Pacciaroni, M., Poulain P.-M., Notarstefano G. and Bussani A. (2017) Arvor-I with ice detection deployments in the Southern Ocean, Rel. 2017/90 Sez. OCE 27 MAOS, 32 pp.

Poulain, P.-M., Gerin R., Mauri E., Menna M., Notarstefano G., Jungwirth R., Bussani A., Zuppelli P. and Pacciaroni M. (2016). ARGO-Italy: annual report 2015. Rel. 2016/14 sez OCE 8 MAOS. 28 pp.