ARGO-ITALY:

ANNUAL REPORT 2016

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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 webb address is: www.argoitaly.ogs.trieste.it

This report summarizes the activities of ARGO-ITALY in 2016 in terms of procurements of the instruments, their preparation and their deployments. Information about data processing and archiving is also given. Plans for 2017 and beyond are included in the last section.

2. Argo float activities in 2016

2.1 Float procurement

The following Argo floats were purchased in 2016 with funds of ARGO-ITALY:

1. Twenty (20) Nova floats from MetOcean, Dartmouth, Canada (Figure 1). The Nova uses the Iridium global telephone network (SBD) for data telemetry and has a GPS receiver for position. It is equipped with a Sea-Bird CTD (SBE 41 CP). Five of these units have SBE dissolved oxygen sensors (Dova). They were delivered at OGS in summer 2016.

Figure 1. Photograph of a Nova float, with the CTD sensors and Iridium antenna at the top and blader (to change buoyancy) at the bottom.

2. Ten (10) Arvor-Ice floats from NKE, Lorient, France. The Arvor-Ice uses an algorithm based on temperature readings to abort surfacing when sea ice is present at the sea surface. Five units were delivered in New Zealand and Tasmania for deployments in the Southern Ocean in winter 2017.

2.2 Float deployments

In total, **28 Italian floats** were deployed in 2016 (see Tables 1 and 2 for details). These floats were Arvor, Deep Arvor and Provor 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, Provor Bio, Provor Nut, Nova/Dova) and some have Argos telemetry (Apex).

One float was deployed in the Black Sea and 12 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 the deep float WMO 6903200 which has cycles of 10 days.

Most floats were deployed from research vessels of opportunity (i.e., R/V Minerva I, R/V Tethys II, R/V Aegaeo and R/V OGS Explora for the Mediterranean and R/V Mare Nigrum for the Black Sea) with the help of colleagues from Italy, France, Greece, Romania and Bulgaria. The French Navy deployed three floats in the Tyrrhenian Sea from the F/S Belle Poule (Figure 2).

Figure 2. Arvor-I float being deployed in the Tyrrhenian Sea by the French Navy in June 2016.

The Nova float WMO 6903179 deployed in the Tyrrhenian Sea on 13 February 2016 suffered a malfunction after cycle 35 (on 9 August 2016) and subsequently remained at the surface. The Deep Arvor float WMO 6903200 was deployed on 8 June 2016 in the deep areas southwest of Greece (Figure 3, see also Pacciaroni et al., 2016). The maximal profiling depth and the parking depth were both set to 4000 dbar in order to minimize the horizontal motions of the float. Unfortunately this float, the first deep float to be deployed in the Mediterranean, provided only 10 profiles and stopped transmitting after 3 August 2016. The cause of this failure has still to be investigated. The second Deep Arvor float WMO 6903203 was deployed in December 2016 at about the same location SW of Greece. This time, in order to minimize grounding, the float was programmed to profile down to 3000 dbar and to drift at a parking depth of 3000 dbar. Both deep Arvor floats have Aanderaa oxygen sensors, but for the second one deployed in December, the oxygen profiles appeared to be erroneous.

One float equipped with biogeochemical and optical sensors (Provor Nut) was deployed in the South Adriatic Sea. The Provor Nut is a Provor CTS 4 with Iridium global telephone network (RUDICS) for data telemetry and a GPS receiver for position. It measures at 1 dbar vertical

resolution not only temperature and salinity (SBE CTD) but also irradiance at three wavelengths (412 nm, 490 nm, 555 nm), fluorescence of colored dissolved organic matter, fluorescence of chlorophyll-a, backscattering coefficient (530 nm) and attenuation coefficient (660 nm), dissolved oxygen (Aanderaa optode) and nitrate (SUNA) concentrations.

Figure 3. Deep Arvor float (WMO 6903200) before deployment on the R/V Aegaeo on 8 June 2016.

Model	WMO	Deploy date	Lat	Lon	Cycles	Last_TX date	Lat	Lon	Status*	Cycle**
Nova	6903179	25-Feb-2016 12:39	41.25	10.5	35	13-Feb-2017 11:04	40.43	13	AS	5
Provor Nut	6903197	07-Apr-2016 21:46	41.57	17.38	83	10-Feb-2017 10:37	41.17	18.14	A	5
Apex	6903196	14-May-2016 04:24	37.1	17.4	44	09-Feb-2017 02:29	38.39	18.22	A	5
Dova	6903180	31-May-2016 21:42	41.33	12.08	52	10-Feb-2017 12:03	39.67	9.94	A	5
Arvor-I	6901833	01-Jun-2016 08:59	42.24	39.87	51	13-Feb-2017 09:06	44.38	35.32	A	5
Arvor-I	3901848	04-Jun-2016 16:32	40.08	13.34	42	10-Feb-2017 12:16	40.63	12.06	A	5
Arvor-I	3901849	05-Jun-2016 11:43	39.26	10.77	41	11-Feb-2017 12:10	39.52	6.62	A	5
Apex	6903198	06-Jun-2016 09:15	34.4	26.02	46	12-Feb-2017 06:09	32.82	30.89	A	5
Arvor-D	6903200	08-Jun-2016 05:47	35.25	22.77	11	03-Aug-2016 06:12	35.16	22.44	D	10
Apex	6903199	24-Jun-2016 10:09	43.73	9.69	16	10-Feb-2017 08:36	42.61	9.67	A	5
Nova	6903201	21-Oct-2016 00:24	33	33	36	03-Feb-2017 01:53	33.99	32.4	A	5
Arvor-D	6903203	07-Dec-2016 23:51	35.35	22.98	15	12-Feb-2017 06:12	35.61	22.67	A	5
Dova	6903204	08-Dec-2016 14:38	34.18	25.25	14	11-Feb-2017 04:03	33.87	25.83	A	5

**Status in early February 2017: A = active, D = dead; AS = active but drifting at surface.*
***Cycle: Length of cycle in days.*

Table 1. Status information for the 13 Italian floats deployed in the Mediterranean and Black Sea (grey rows) during 2016.

Two Nova floats equipped with SBE 63 optical dissolved oxygen sensor (also called Dova) were deployed in the Tyrrhenian and Levantine Seas in spring and fall 2016, respectively.

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 (Figure 4). These floats included 8 Nova and 2 Dova floats. 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. Only 5 of these 10 floats were still active in early 2017. Float WMO 6903181 stayed at the surface and stopped transmitting after about 9 days. Float WMO 6903184 stopped transmitting after 20 cycles. Floats WMO 6903185 and 6903188 failed right after deployment. Float WMO 6903186 stopped transmitting after 26 cycles.

Figure 4. A Nova float ready to be deployed on R/V Italica in January 2016.

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. These floats included 4 Nova and 1 Dova floats. 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. Float WMO 6903193 failed at deployment. The Dova float WMO 6903191 stopped transmitting after only 13 cycles, whereas 3 Nova floats were still active in early 2017.

In summary, at the end of 2016, the ARGO-ITALY program had a total of 62 active floats, including 37 instruments in the Mediterranean Sea, 5 in the Black Sea (Figure 5) and 20 in the South Pacific, South Atlantic and Southern Oceans (south of 60˚S) (Figure 6).

Model	WMO	Deploy date	Lat	Lon	Cycles	Last_TX date	Lat	Lon	Status*	Cycle**
Nova	6903181	17-Jan-2016 16:41	-50.98	173.15	34	28-Jan-2016 00:44	-50.62	173.65	D	10
Dova	6903183	17-Jan-2016 21:55	-51.98	173.19	57	13-Feb-2017 02:20	-52.34	179.59	A	10
Nova	6903182	18-Jan-2016 03:09	-53.01	173.17	72	11-Feb-2017 11:16	-43.92	177.7	A	10
Nova	6903184	18-Jan-2016 12:29	-54.99	173.53	20	26-Jul-2016 13:59	-56.13	177.17	D	10
Nova	6903185	18-Jan-2016 17:01	-55.99	173.4	0	18-Jan-2016 17:22	-56.02	173.44	D	10
Nova	6903186	19-Jan-2016 02:10	-58	173.28	26	15-Sep-2016 13:57	-56.46	179.81	D	10
Nova	6903187	19-Jan-2016 11:20	-60	173.32	40	12-Feb-2017 14:08	-55.59	-164.17	A	10
Nova	6903189	19-Jan-2016 16:06	-61	173.33	40	02-Feb-2017 13:53	-60.65	-166.46	A	10
Dova	6903190	19-Jan-2016 20:41	-62	173.4	40	12-Feb-2017 14:19	-60.96	-167.34	A	10
Nova	6903188	20-Jan-2016 01:09	-63	173	0	20-Jan-2016 01:26	-62.96	173.6	D	10
Nova	6903193	04-Feb-2016 06:50	-58	0	0	04-Feb-2016 07:11	-58.02	0	D	10
Nova	6903192	04-Feb-2016 21:23	-55	-0.03	38	08-Feb-2017 13:53	-51.19	20.9	A	10
Dova	6903191	05-Feb-2016 15:10	-51.5	0	13	15-May-2016 13:45	-50.69	4.71	D	10
Nova	6903194	06-Feb-2016 11:14	-48.01	3.6	38	10-Feb-2017 14:03	-50.46	38.37	A	10
Nova	6903195	07-Feb-2016 09:45	-44.96	6.55	38	11-Feb-2017 13:56	-44.43	19.99	A	10

**Status in early February 2016: A = active, D = dead; ANP = active without positions.*
***Cycle: Length of cycle in days.*

Table 2. Status information for the 15 Italian floats deployed in the Southern Ocean during 2016.

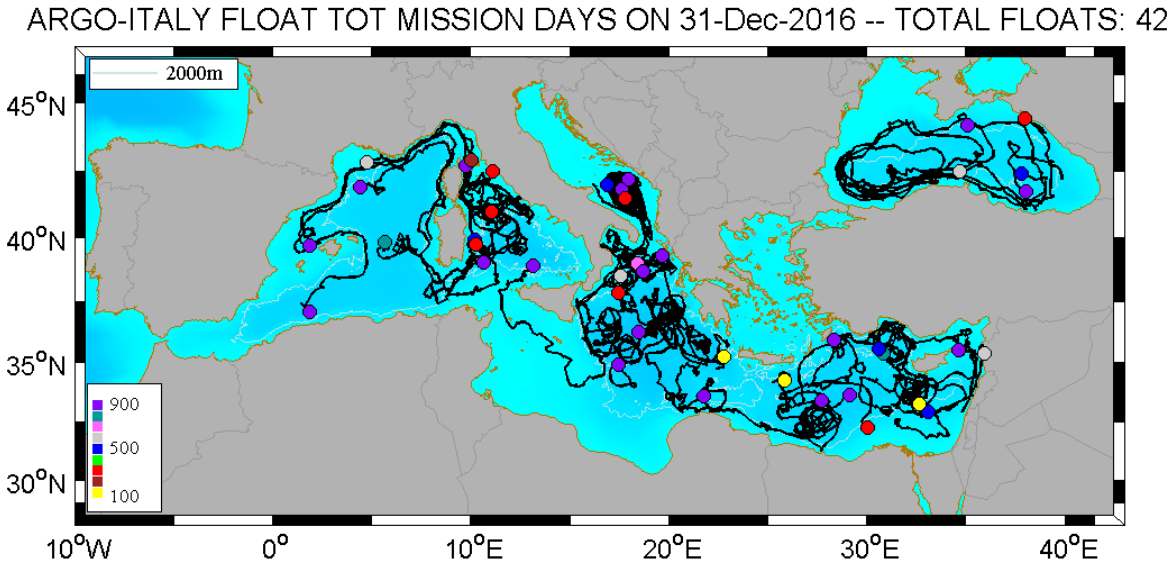

Figure 5. Trajectories and positions (circle symbols) on 31 December 2016 of the 42 ARGO-ITALY floats active in the Mediterranean and Black Sea at the end of 2016. The circle symbols are color-coded as a function of float age in days.

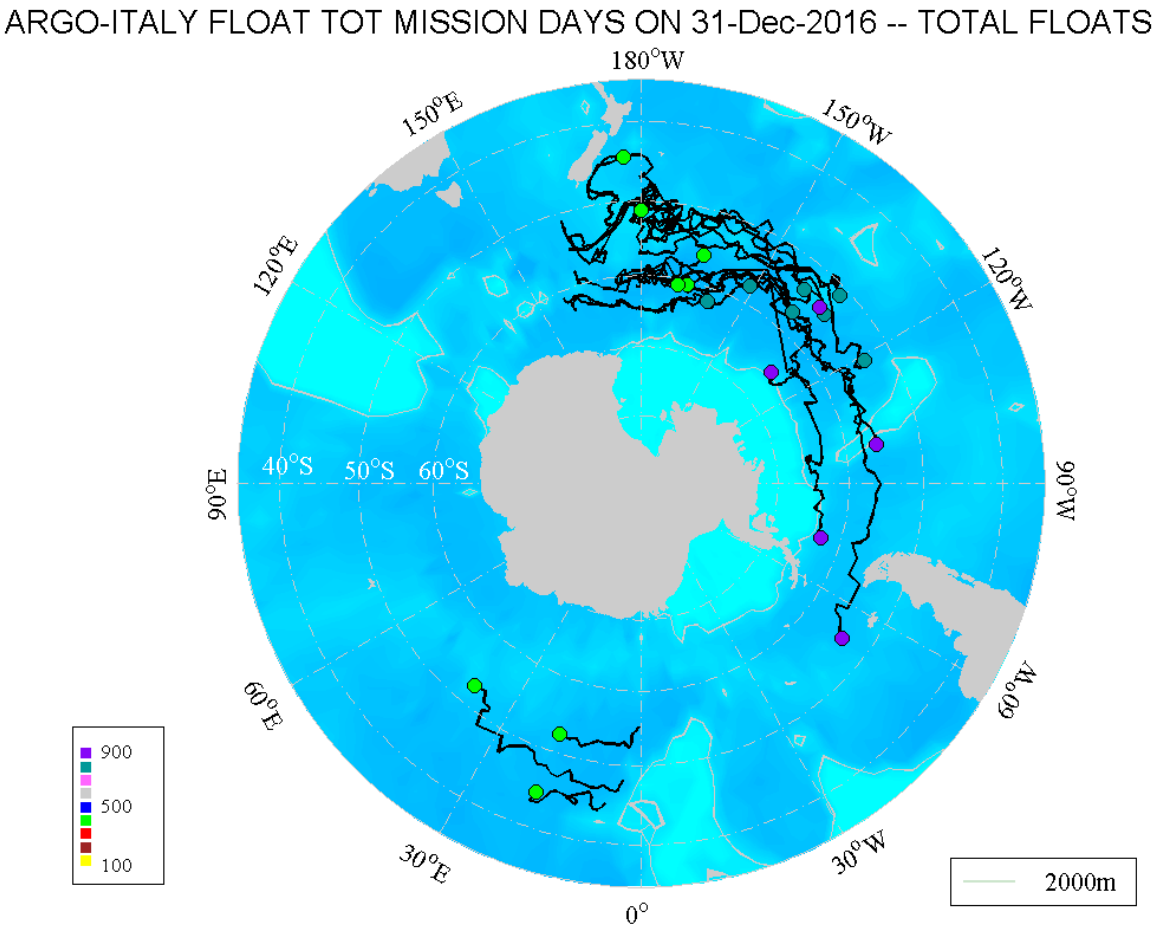

Figure 6. Trajectories and positions (circle symbols) on 31 December 2016 of the 20 ARGO-ITALY floats in the South Pacific, South Atlantic and Southern Oceans. The circle symbols are color-coded as a function of float age in days.

Since 18 February 2012, a total of 109 ARGO-ITALY floats have been deployed. In less than 5 years, they have provided about 11000 CTD profiles. The histograms of number of CTD profiles per float is shown in Figure 7. Twentyseven floats have done more than 180 profiles. In total, 12 floats (11 %) have failed just after deployment.

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 2012-2016. The float population in 2012-2016 is essentially increasing and reaching 60-70 active instruments in 2016. 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.

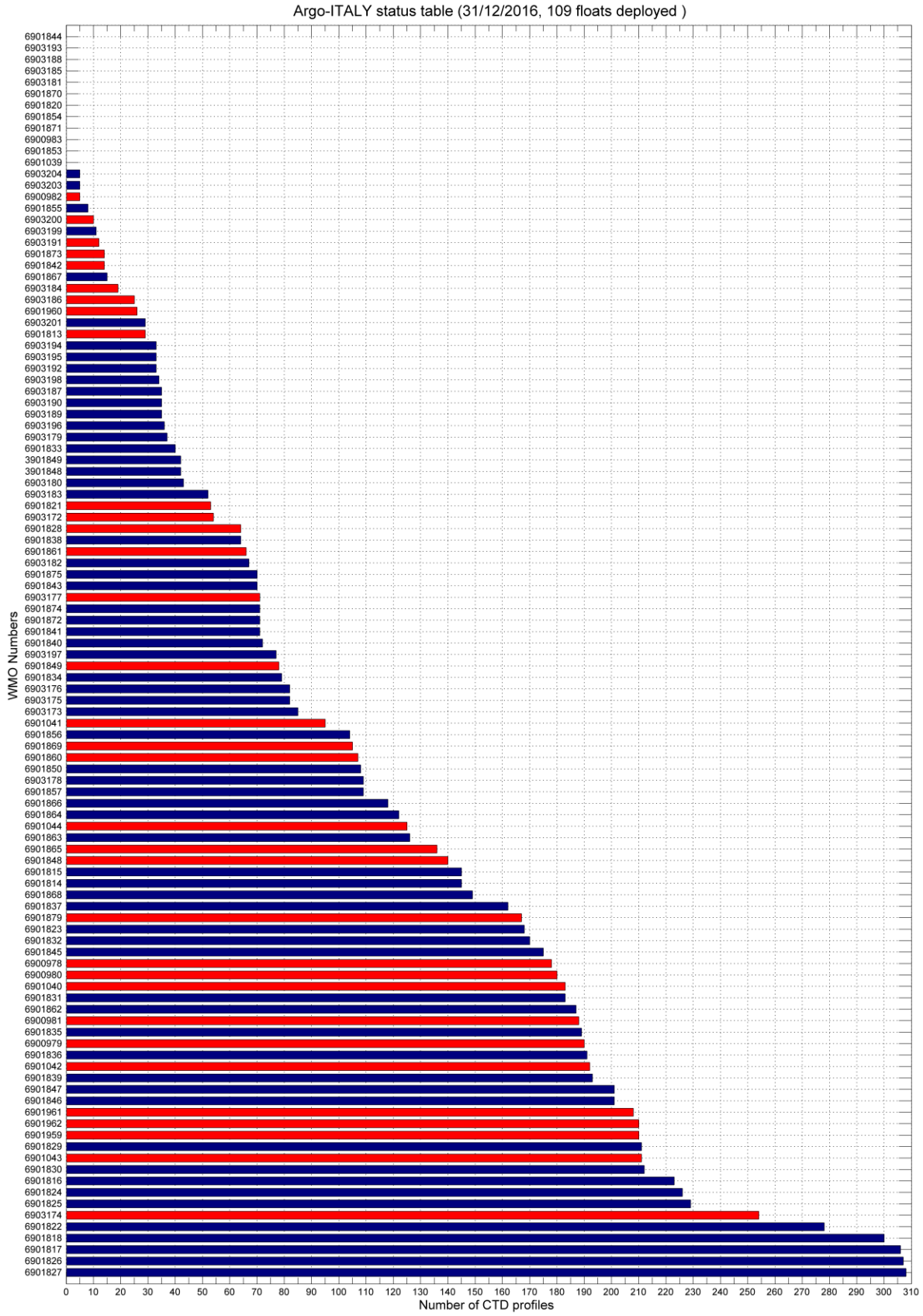

Figure 7. Histogram of the number of CTD profiles per float (red: dead float, blue: alive at the end of 2016).

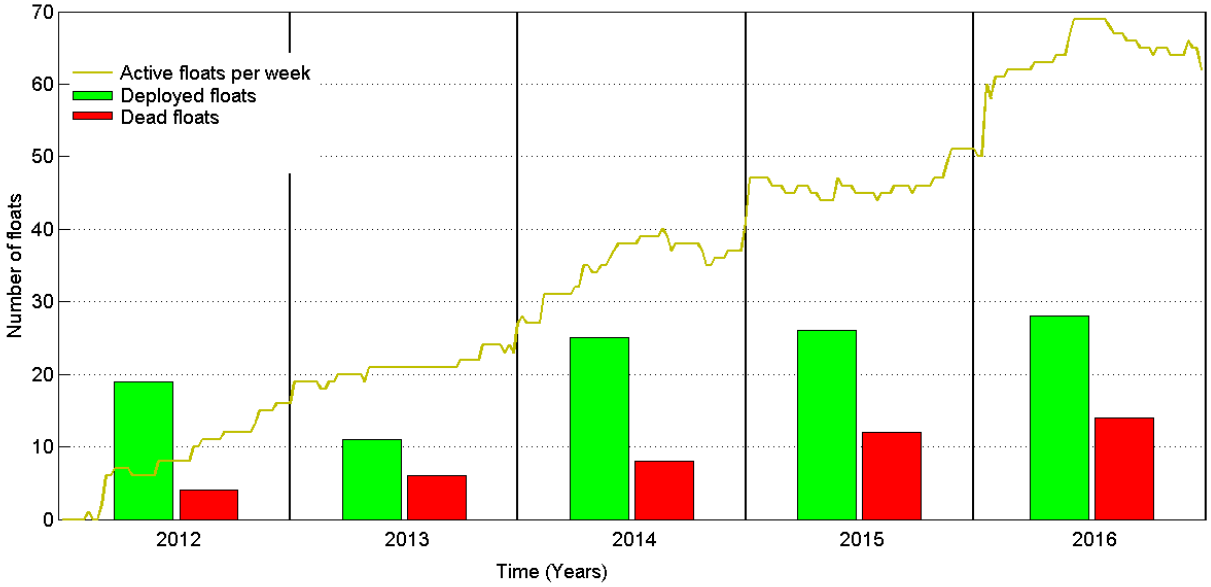

Figure 8. Temporal evolution of the number of active floats with weekly resolution and histogram of the annual float deployments and losses.

After less than 5 years of activities in the Mediterranean and Black seas, the maximum operating life of the ARGO-ITALY floats is a bit more than 4 years (~1500 days, see Figure 9). The mean half life is about 600 days for all floats in the Mediterranean and Black seas. Floats with Argos positioning and telemetry appear to have a shorter mean half life (near 500 days), compared to near 600 days for the floats with Iridium. Arvor floats show the longest performances with a mean half life of more than 600 days.

For the floats deployed in the South Pacific, South Atlantic and Southern Ocean, after 4 years, the maximal operating life is about 4 years, and the mean half life is about one year (Figure 10).

In general, the Nova and Dova floats have significantly lower survival rates. After a year (in early 2017) only 8 floats (out of 15 units, i.e., about 53%) were still fully operational.

Note that these survival rate statistics have to be interpreted with caution since most of the floats are still alive (42 floats out of 72 units for the Mediterranean and Black seas, 20 floats out of 37 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.).

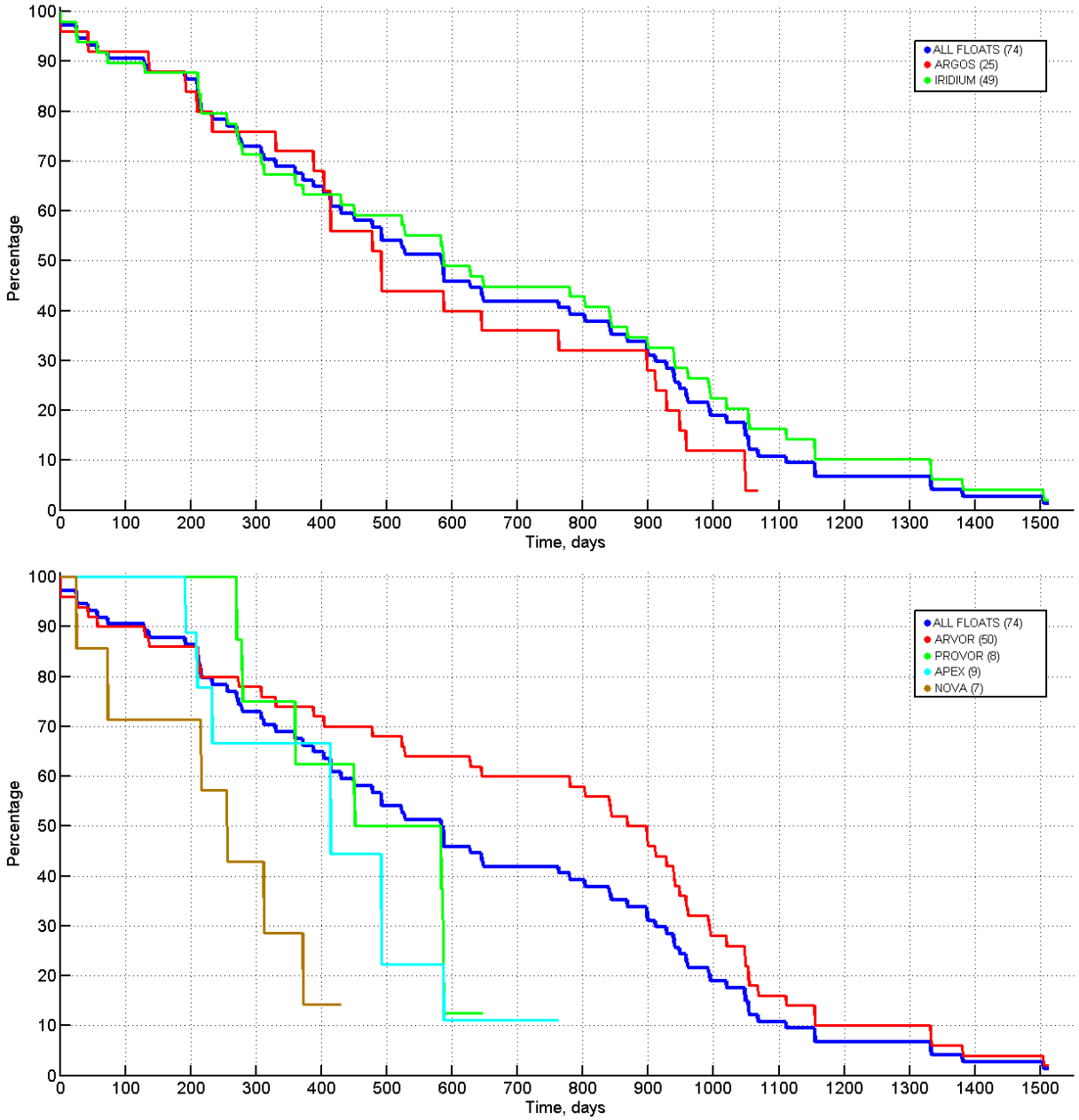

Figure 9. Survival rate diagrams for all the ARGO-ITALY floats in the Mediterranean and Black seas, separated by transmission mode (top) and float type (bottom).

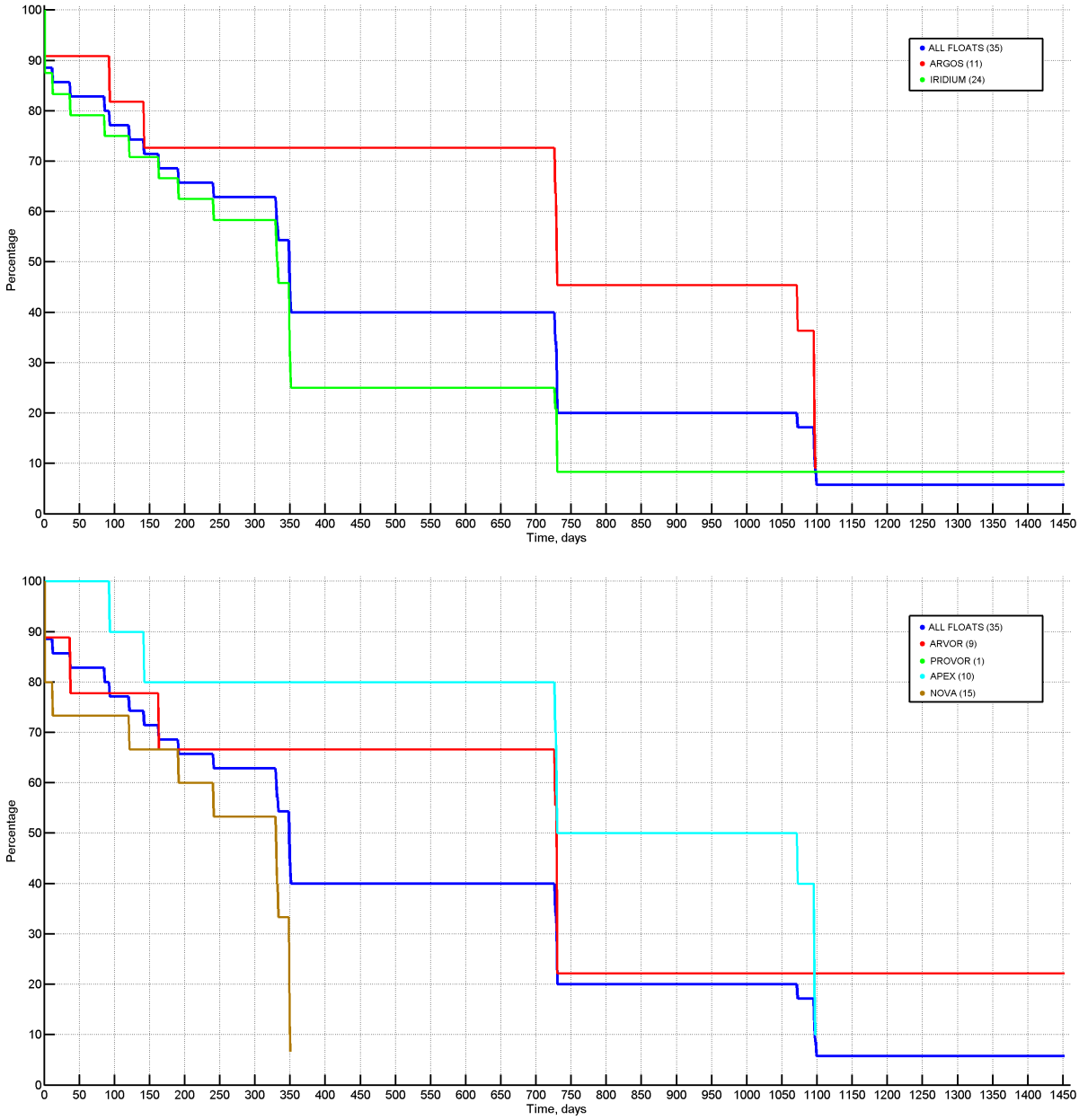

Figure 10. Survival rate diagrams for all the ARGO-ITALY floats in the South Pacific, South Atlantic and Southern Ocean, separated by transmission mode (top) and float type (bottom).

Table 3 summarizes the main statistics of the ARGO-ITALY floats for the period 2012-2016. In 2016, more than 3800 CTD profiles were obtained with Italian Argo floats. These profiles provided data on a total vertical distance of more than 4200 km in 2016. For the period 2012-2016, the 109 floats of ARGO-ITALY provided data on a total vertical distance of more than 11000 km in about 11000 profiles.

Year	2012	2013	2014	2015	2016	2012-2016
Deployments						
CTD floats deployed in Med	13	7	13	11	9	53
CTD floats deployed in BS	4	1	2	1	1	9
CTD floats deployed in SO, South Pacific and Atlantic	2	3	7	10	15	37
Bio floats deployed	0	0	3	4	1	8
Deep floats					2	2
Total floats deployed	**19**	**11**	**25**	**26**	**28**	**109**
CTD profiles						
CTD profiles in Med	400	1099	1560	1743	2358	7160
CTD profiles in BS	105	236	323	268	260	1192
CTD profiles in SO, South Pacific and Atlantic	6	90	205	475	815	1591
Bio profiles	0	0	244	266	373	883
Deep profiles					15	15
Total profiles	**511**	**1425**	**2332**	**2752**	**3821**	**10841**
Vertical distances (km)						
Distance in Med	440	902	1485	1813	2195	6835
Distance in BS	71	210	283	257	247	1068
Distance in SO, Souther Pacific and Atlantic	2	125	380	875	1374	2756
Distance of bio floats	0	0	199	245	335	779
Distance of deep floats					50	50
Total distance (km)	**513**	**1237**	**2347**	**3190**	**4201**	**11488**

Table 3. Statistical information on the performance of the ARGO-ITALY floats in 2012-2016.

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 are planned for 2017.

3. SVP drifter activities in 2016

3.1 Drifter procurement

In 2016, a total of 28 SVP drifters were purchased from Metocean, Dartmouth, Canada with ARGO-ITALY funding. They were delivered at OGS in July 2016. Some of them (12 units) were shipped to Dakar in Senegal for deployments in the tropical Atlantic Ocean in 2017 as part of a collaboration between CRODT (Dakar, Senegal), SIO (La Jolla, California) and OGS. The other drifters (16 units) were shipped to New Zealand and South Africa for deployments in the Southern Ocean in winter 2017.

3.2 Drifter deployments

In total, **15 drifters** were deployed in 2016. Ten drifters were deployed in the South Pacific and in the Southern Ocean (Pacific Sector) from R/V Italica with the help of Italian colleagues. Five drifters were released in the Mediterranean Sea (in the Malta Channel) with the help of Maltese colleagues. All drifters were SVP designs manufactured by Pacific Gyre in Oceanside, California. Hourly positions and SST are transmitted via the Iridium satellite system. Figure 11 shows a drifter ready to be deployed in the Southern Ocean from R/V Italica in January 2016.

Figure 11. SVP drifter manufactured by Pacific Gyre on the deck of R/V Italica before deployment in the Southern Ocean in January 2016.

Table 4 shows the status information of drifters deployed in 2016. Eight of the ten drifters deployed south of New Zealand were still operating in early 2017, after a year of drift in the Antarctic Circumpolar Current. One drifter (IMEI 300234062839720) stopped transmitting on 27 September 2016. Another one (IMEI 300234062838800) started to malfunction in May 2016 and eventually stopped transmitting on 1 September 2016. Three of the five drifters drifters deployed in the Malta Channel in August 2016 were still operating in early 2017. Two drifters (IMEI 300234062837770 and 300234062837560) stranded on Malta Island and were re-deployed. The first drifter stopped transmitting and the second was picked up in October 2017.

The trajectories of the drifters deployed in 2016 are displayed in Figures 12 and 13, for the Southern Ocean and Mediterranean Sea, respectively.

IMEI	Deploy Date	Lat	Lon	Last Date	Lat	Lon	Status*
a300234062839720	20-Jan-2016 01:04	-63	173.57	27-Sep-2016 23:00	-60.48	-135.58	D
a300234062839820	19-Jan-2016 20:04	-62	173.4	17-Feb-2017 12:00	-55.51	-121.47	A
a300234062839790	19-Jan-2016 16:04	-61	173.33	17-Feb-2017 12:00	-54.86	-106.79	A
a300234062838730	17-Jan-2016 16:40	-50.98	173.15	17-Feb-2017 12:00	-47.62	-161.8	A
a300234062839800	17-Jan-2016 21:57	-51.98	173.19	17-Feb-2017 12:00	-52.14	-152.51	A
a300234062838800	18-Jan-2016 03:07	-53.01	173.27	01-Sep-2016 22:00	-48.79	-160.48	D
a300234062839750	18-Jan-2016 12:27	-54.99	173.53	17-Feb-2017 12:00	-45.35	-121.75	A
a300234062839810	18-Jan-2016 16:59	-55.99	173.4	17-Feb-2017 12:00	-48.05	-128.43	A
a300234062837800	19-Jan-2016 02:07	-57.98	173.28	17-Feb-2017 12:00	-47.33	-99.92	A
a300234062838720	19-Jan-2016 11:20	-60	173.32	17-Feb-2017 12:00	-49.88	-112.97	A
a300234062837770	17-Aug-2016 12:00	36.15	14.27	28-Aug-2016 06:00	35.99	14.59	D
a300234062837560	17-Aug-2016 11:40	36.23	14.28	27-Aug-2016 07:00	35.95	14.46	D
a300234062836830	17-Aug-2016 11:20	36.32	14.31	15-Feb-2017 08:00	32.14	23.85	A
a300234062749250	17-Aug-2016 10:41	36.41	14.33	17-Feb-2017 12:00	31.28	18.43	A
a300234062052460	17-Aug-2016 10:15	36.5	14.37	14-Feb-2017 21:00	30.87	18	A
b300234062837770	25-Sep-2016 13:00	36.25	14.46	26-Oct-2016 04:00	35.86	14.62	D
b300234062837560	25-Sep-2016 11:00	36.41	14.51	08-Oct-2016 15:00	35.68	13.54	D

**Status in early February 2016: A = active, D = dead.*

Table 4. Status information for the Italian drifters deployed in the Mediterranean and South Pacific / Southern Ocean in 2016.

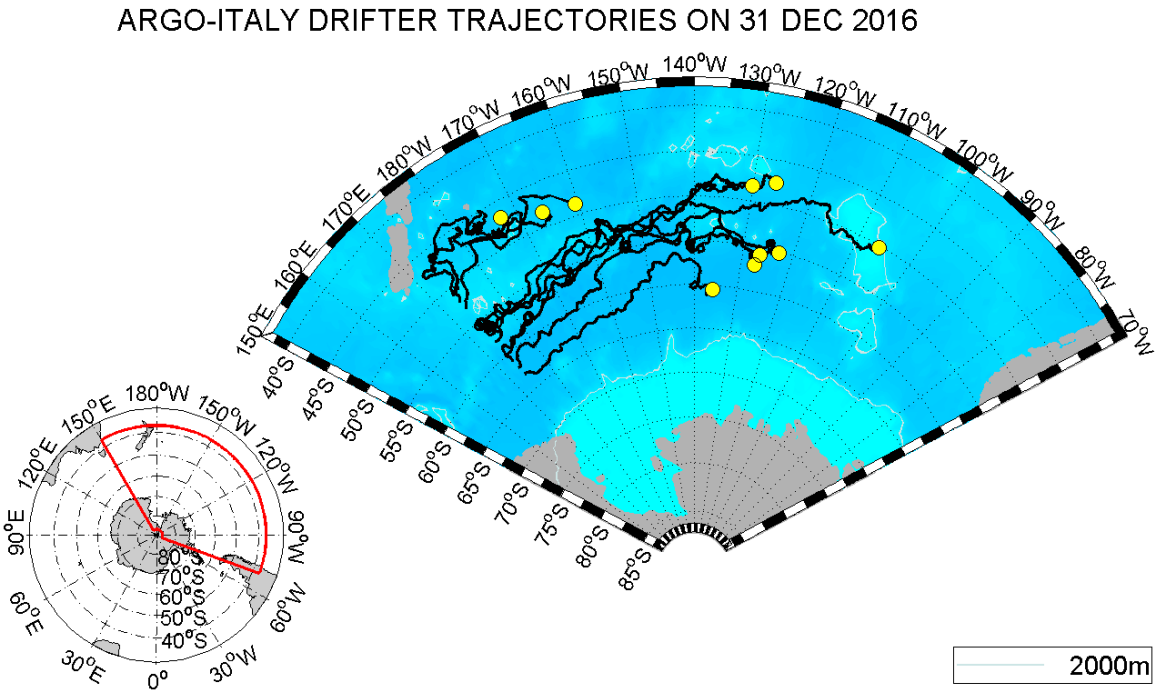

Figure 12. Trajectories and last positions (yellow dots) of the 10 Italian drifters deployed in the Souther Ocean in January 2016.

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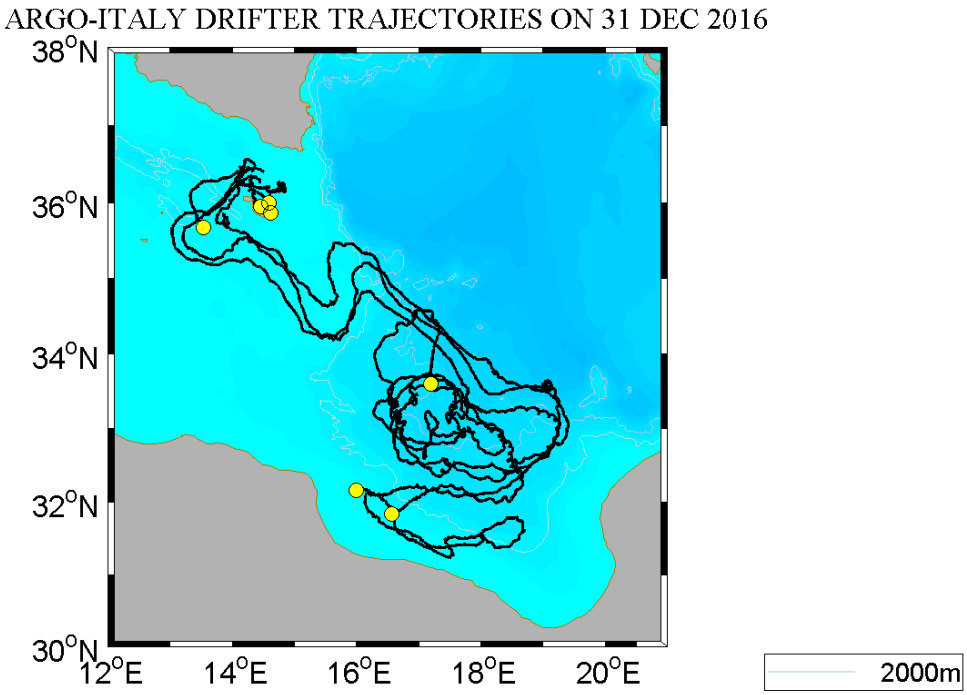

Figure 13. Trajectories and last positions (yellow dots) of the Italian drifters deployed in the Malta Channel in August 2016.

3.3 Other drifter activities

In 2016, OGS continued to work on the development of the OGS low-cost drifter (Figure 14), a design similar to the CODE drifter, but at a substantially reduced cost.

A company located in Udine, Italy, with expertise in molding and milling, was contacted for the production of the low-cost drifters. A number of design options were evaluated in order to minimize the costs and to optimize the production. In early 2017, the element of the structure that will host the GPS/transmission module was finalized.

Figure 14. The low-cost CODE drifter manufactured at OGS.

4. Glider activities in 2016

4.1 Glider component procurement and glider maintenance

The Slocum glider "unit 403" was sent to the factory for battery replacement in spring 2016. On this occasion, another 1000-m forward section for the Slocum glider was purchased and was installed on the glider to increase its operational depth to 1000 m (the first 1000-m forward section was already bought in spring 2015). The Slocum glider "unit 402" was sent back to the factory for repair due to failure during laboratory tests.

4.2 Glider testing

The Slocum glider "unit 402" was tested in the laboratory in February 2016 before its deployment in the South Adriatic Sea. All the performed tests failed and the instrument was sent to the factory for a deep investigation of the problem. The Slocum glider "unit 403", equipped with the new 1000-m forward section, was tested in the laboratory after the battery replacement in April 2016.

4.3 Glider laboratory

In 2016, only consumable goods were purchased for the OGS glider laboratory.

4.4 Glider operations

The OGS Slocum glider "unit 403" was successfully operated across the South Adriatic Sea from 22 April to 1 May 2016 (CONVEX16 experiment; Figure 15). 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 part of the transect Bari – Dubrovnik and an area close of the Italian slope to inquire about the cascading of the dense water. It was piloted down to almost 1000 m deep in the area of the South Adriatic pit, collecting high frequency data of pressure, temperature, conductivity, oxygen, chlorophyll, CDOM and backscatter (Figure 16).

The same glider was operated again in the same area for 10 days (3 - 12 December 2016) along the Bari-Dubrovnik transect to monitor the pre-convection condition in the area (PRE-CONVEX17 experiment; Figure 17). The glider sampled the water column characteristics down to 1000 m (Figure 18).

Figure 15. Glider "unit 403" trajectory during the CONVEX16 experiment in the South Adriatic Sea. The glider symbol indicates the last position of the instrument. Orange symbols correspond to surfacing locations.

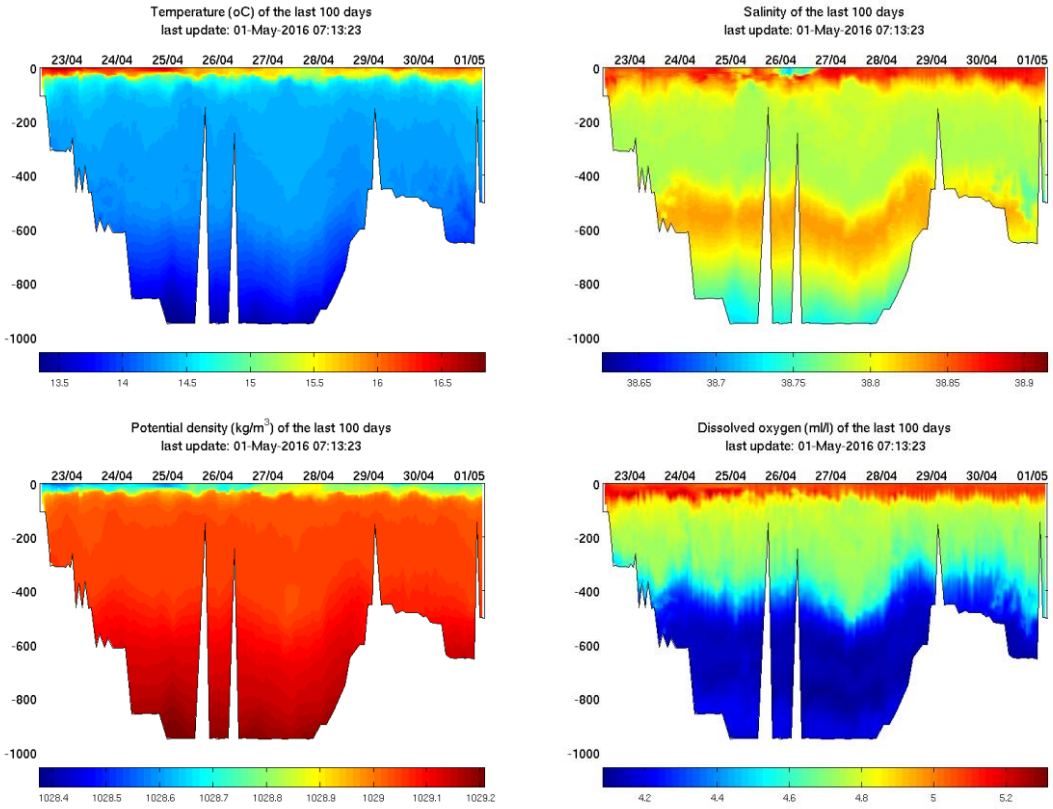

Figure 16. Color-coded vertical section along the glider path of temperature (top-left), salinity (top-right), density (bottom-left) and dissolved oxygen (bottom-right) during the CONVEX16 experiment in the South Adriatic Sea (22 April – 1 May 2016).

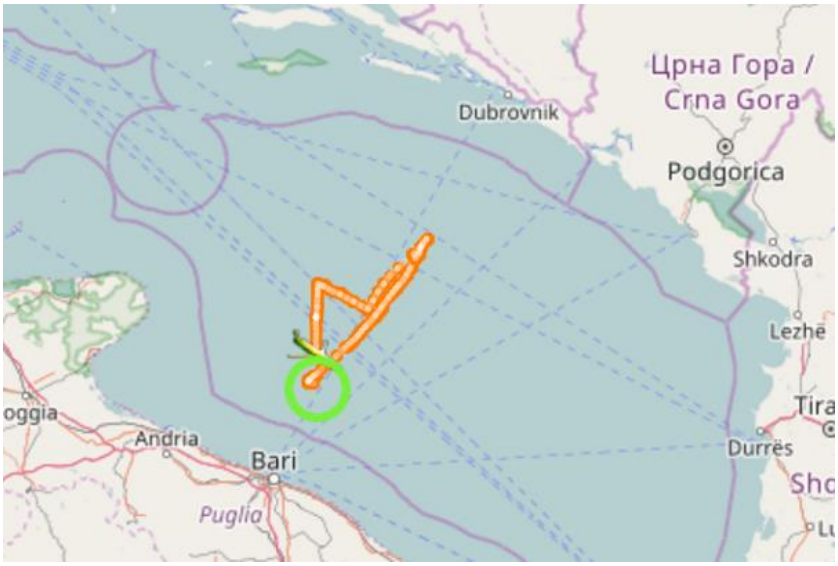

Figure 17. Glider "unit 403" trajectory during the PreCONVEX17 experiment in the South Adriatic Sea. The glider and the green circle symbols indicate the last position of the instrument and the last waypoint, respectively. Orange symbols correspond to surfacing locations.

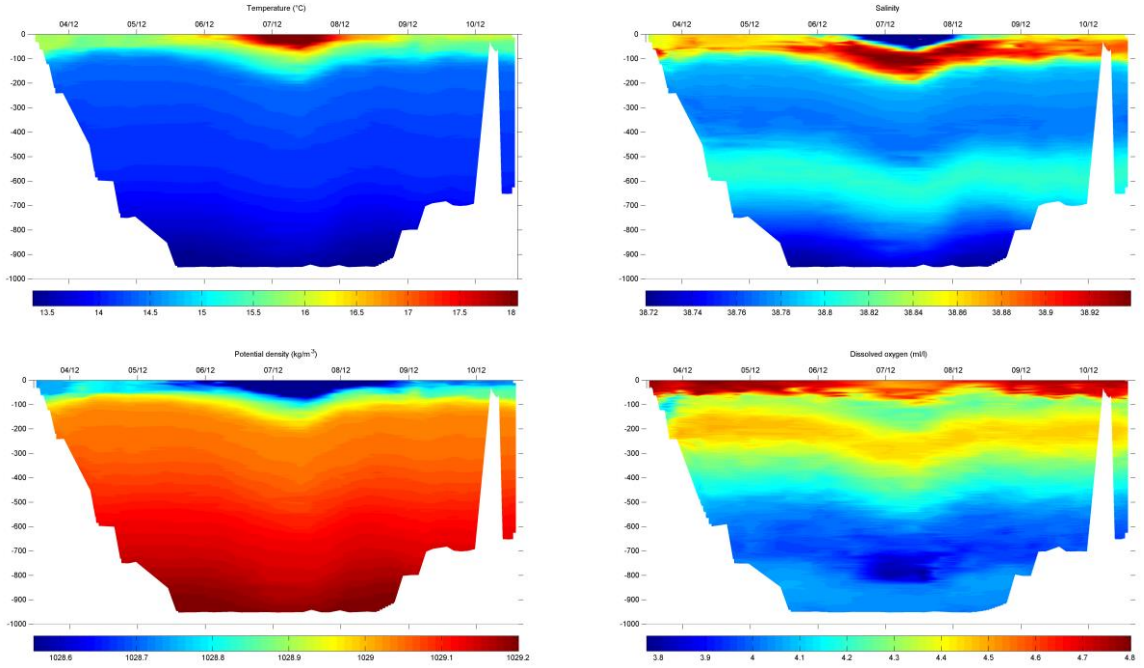

*Figure 18. Color-coded vertical section along the glider path of temperature (top-left), salinity (top-right), density (bottom-left) and dissolved oxygen (bottom-right) during the PreCONVEX17 experiment (*3 - 12 December 2016*).*

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 2016

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 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/).

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 37 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 2010-2016. 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) is kindly performed by CSIRO in Hobart, Tasmania.

5.3 Italian contribution to Argo bibliography in 2016.

The following papers involving Italian scientists were published in 2016. They use Argo data for basic oceanographic research and operational oceanography purposes.

Buongiorno Nardelli, B., R. Droghei, and R. Santoleri (2016) Multi-dimensional interpolation of SMOS sea surface salinity with surface temperature and in situ salinity data. Remote Sensing of Environment, 180, 392-402, http://dx.doi.org/10.1016/j.rse.2015.12.052

Capet, A., E. V. Stanev, J. M. Beckers, J. W. Murray, and M. Grégoire, 2016: Decline of the Black Sea oxygen inventory. Biogeosciences, 13, 1287-1297, http://dx.doi.org/10.5194/bg-13-1287-2016

Fratianni, C., N. Pinardi, F. Lalli, S. Simoncelli, G. Coppini, V. Pesarino, A. Bruschi, M. L. Cassese, and M. Drudi (2016) Operational oceanography for the Marine Strategy Framework

Directive: the case of the mixing indicator. Journal of Operational Oceanography, 9, s223-s233, http://dx.doi.org/10.1080/1755876X.2015.1115634

Riser, S. C., H. J. Freeland, D. Roemmich, S. Wijffels, A. Troisi, M. Belbeoch, D. Gilbert, J. Xu, S. Pouliquen, A. Thresher, P.-Y. Le Traon, G. Maze, B. Klein, M. Ravichandran, F. Grant, P.-M. Poulain, T. Suga, B. Lim, A. Sterl, P. Sutton, K.-A. Mork, P. J. Velez-Belchi, I. Ansorge, B. King, J. Turton, M. Baringer, and S. R. Jayne, 2016: Fifteen years of ocean observations with the global Argo array. Nature Clim. Change, 6, 145-153, http://dx.doi.org/10.1038/nclimate2872

5.4 OGS technical reports related to ARGO-ITALY published in 2016.

Bussani A. (2016) Replica Postgres V9.5 master-slave. Rel. 2016/53 Sez. OCE 26 MAOS. 11 pp.

Gerin R., Mauri E., Bussani A., Zuppelli P., Kuchler S., Kokkini Z., Pacciaroni M. and Poulain P.-M. (2016) The PreConvex16 and Convex16 glider missions in the South Adriatic Sea (November 2015 and April 2016.) Rel. 2016/72 Sez. OCE 33 MAOS, 25 pp.

Gerin R., Zuppelli P. and Poulain P.-M. (2016) Design and tests of the OGS low-cost code drifter Rel. 2016/12 OCE 7 MAOS, 25 pp.

Kokkini Z., Gerin R., Mauri E. and Poulain P.-M. (2016) Preliminary data analysis from Seaglider in Convex14 mission. Rel. 2014 / 81 sez. OCE 30 MAOS, 23 pp.

Notarstefano G., Bussani A. and Gerin R. (2016) Assessment procedure of the historical in-situ physical variables in the Mediterranean Sea: improvements and new tests 2016/40 Sez. OCE 19 MAOS, 14 pp.

Pacciaroni M., Poulain P.-M., Civitarese, G., Pavlidou A., Velaoras D. and Bussani, A. (2016) Deep-Arvor programming and deployment in the Western Cretan passage. Rel. 2016/56 Sez. OCE 28 MAOS, 18 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.

6. Plans for 2017 and beyond

6.1 Floats

With the funding available in 2016-2017, we plan to acquire the following instruments:

- 20 standard Argo floats with Iridium telemetry. Five of these floats will have additional oxygen sensors;
- 3 biogeochemical (BGC) floats.
- 2 floats for coastal applications.

The Italian deployment plans for 2017 and 2018 are detailed in Table 5. 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	
2017	15 2 15	Mediterranean Black Sea Southern Ocean	2 1	Mediterranean Black Sea	0	Mediterranean	**35**
2018	13 2 15	Mediterranean Black Sea Southern Ocean	2 1	Mediterranean Black Sea	2	Mediterranean	**35**

Table 5. Italian float deployment plans for 2016-2017.

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 5. OGS is committed to carry out DMQC on all the Argo floats of the Mediterranean and Black seas as part of the CMEMS, MOCCA and other European projects over the coming years.

6.2 Drifters

With the funding available in 2016-2017, procedures are underway for the procurement of 35 SVP drifters with Iridium telemetry.

Drifter deployment plans for 2017 and 2018 are described in Table 6.

Year	SVP drifters	
	Quantity	Area
2017	15	Southern Ocean
	20	Mediterranean
2018	15	Southern Ocean
	20	Mediterranean

Table 6. ARGO-ITALY drifter deployment plans for 2017-2018.

6.3 Gliders

The OGS Slocum Gliders are planned to be operated in the South Adriatic Sea in late winter and late autumn 2017 to monitor dense water formation processes. The Seaglider “Amerigo” is planned to be operated south of Cyprus and east of Israel in collaboration with the Cyprus and Jerusalem Universities in winter 2017.

6.4 Other

MIUR is committed to provide funding in order to sustain the Italian contribution to Argo beyond 2017 as a founding member of the Euro-Argo Research Infrastructure Consortium. In addition to the Italian national funding, OGS has funding from new EC (for instance the DG MARE MOCCA project) and ONR (CINEL) projects 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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