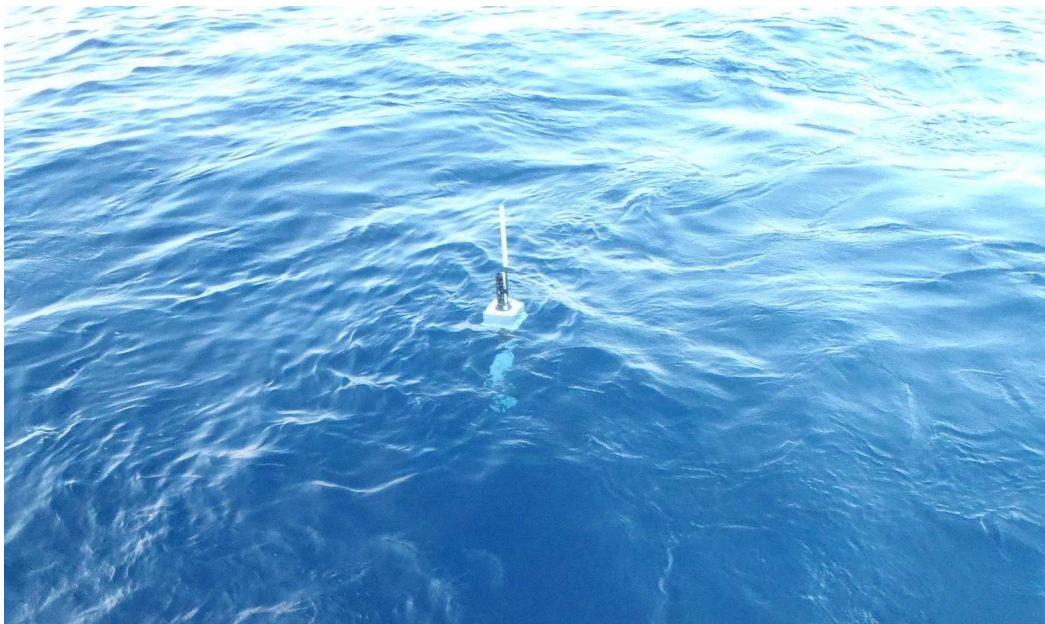


# LAGRANGIAN MEASUREMENTS IN ALBOREX 2014 CAMPAIGN



Pierre-Marie Poulain , Milena Menna, Giulio Notarstefano and Antonio Bussani

Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS),  
Trieste, Italy

Contribution to Task 3.3.4 of the EU FP7 Perseus Project

Approved for release by: .....

Dr. Paola Del Negro  
Director, Oceanography Section

---

**TABLE of CONTENTS**

<b>1. Introduction .....</b>	<b>3</b>
<b>2. Lagrangian Instruments .....</b>	<b>3</b>
2.1 SVP drifters .....	3
2.2 Argo floats ..	4
<b>3. Deployments.....</b>	<b>4</b>
<b>4. Preliminary Results .....</b>	<b>9</b>
4.1 Drifters.....	9
4.2 Floats.....	13
<b>5. Acknowledgements.....</b>	<b>20</b>
<b>6. References.....</b>	<b>20</b>

## 1. Introduction

As part of the EC FP7 Perseus project, a multi-platform and multi-disciplinary campaign, ALBOREX 2014, was carried in the eastern Alboran Sea on 24 May – 2 June 2014. Measurements were concentrated across a frontal area detected from satellite images of sea surface temperature (SST), and included in-situ observations from Lagrangian platforms (drifters and floats), gliders and a research vessel. The Lagrangian instruments and their data collected between their deployments during the ALBOREX 2014 campaigns and early July 2014 are briefly described in this technical report.

## 2. Lagrangian Instruments

### 2.1 SVP drifters

Surface Velocity Program (SVP) drifters are the standard design of the Global Drifter Program (Lumpkin and Pazos, 2007). The SVP drifters used in ALBOREX 2014 are the mini-World Ocean Circulation Experiment (WOCE) SVP drifters. They consist of a surface buoy that is tethered to a holey-sock drogue, centered at a nominal depth of 15 m, that holds the drifter almost motionless with respect to the horizontal layer studied [for details on the SVP design, see Sybrandy and Niiler (1991)]. They have a drag area ratio of the drogue to the tether and surface buoy in excess of 40. A tension sensor, located below the surface buoy where the drogue tether is attached, indicates the presence or absence of the drogue. Measurements of the water-following capabilities of the SVP have shown that when the drogue is attached, they follow the water to within  $1 \text{ cm s}^{-1}$  in 10 m/s winds (Niiler et al., 1995). The drifters are equipped with a thermistor on the lower part of the top spherical buoy to measure SST.

Some drifters were localized by GPS and transmitted data (SST, voltage, drogue presence indicator, etc.) to the Iridium satellite system at hourly intervals. Others were positioned by, and transmitted data to, the Argos Data Collection and Location System (DCLS) onboard polar-orbiting satellites at non-uniform intervals of 2-3 h. Drifters were procured by different participants and from different manufacturers. See Table 1 for details.

*Table 1. Details on the SVP drifter used during ALBOREX 2014.*

Quantity	Manufacturer	Owner	Country	Telemetry
5	Pacific Gyre	OGS	Italy	Argos
4	Pacific Gyre	SOCIB	Spain	Iridium
6	Pacific Gyre	IMEDEA	Spain	Iridium
4	Data Buoy Inst.	SOCIB	Spain	Iridium
6	Data Buoy Inst.	IMEDEA	Spain	Iridium
TOTAL = 25				

## 2.2 Argo floats

Three types of battery-powered Argo profilers were operated in ALBOREX 2014, all manufactured by NKE in Hennebont, France:

- **Arvor-C:** This is a sub-surface profiling float designed to operate in coastal environment and perform oceanographic measurements as a pseudo-eulerian station. Its design has been optimized to reduce its drift thanks to a seabed standby and anti-drift claws, an optimized profiling speed (~25 cm/s) and a short data transmission duration. It can perform more than 300 profiles, and transmits its data in real time via the Iridium satellite system with Sea-Bird CTD sensors (model 41 pumped MicroCAT with accuracies of 0.002°C, 0.005 and 2.4 dbars for T, S and pressure, respectively).
- **Arvor-A3:** This float is equipped with a Sea-Bird CTD, and is localized, and transmit data to, the Argos-3 bi-directional satellite system. The deployment and test of this float with the new Argos-3 telemetry is part of the EC FP7 E-AIMS project.
- **Provor-bio:** This float is a Provor CTS 4 with Iridium global telephone network (RUDICS) for data telemetry and a GPS receiver for position. It measures 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, fluorescence of Chlorophyll-a, backscattering coefficient (530 nm) and attenuation coefficient (660 nm).

The floats were programmed to cycle at intervals varying between 3 h and 5 days, and to drift at a parking depth of 350 or 1000 m, and collect oceanographic data in the water column between 400-2000 m and the surface (see Table 2 for details). Using the iridium downlink, the cycle length and parking depth of the provor-bio were changed after 7 June 2014 from 1 to 5 days, and from 1000 m to 350 m, respectively. Likewise, the Arvor-A3 was reset on 17 June 2014 using the iridium downlink.

*Table 2. Details on the Argo floats used during ALBOREX 2014.*

Type	Owner	Project	Telemetry	Cycle	Parking	Max depth
Arvor-C	SOCIB		Iridium	3 h		400 m
Arvor-A3	OGS	E-AIMS	Argos-3	2 days	350 m	2000 m
Provor-bio	OGS	Argo-Italy	Iridium	1-5 days	1000/350 m	1000 m

## 3. Deployments

Figures 1 to 3 show the drifters on the aft deck of R/V SOCIB, their preparation (labelling, switching on) and their deployment. The 25 SVP drifters were all deployed on 25 May 2014 in a tight square patterns (typical distance between drifters of ~3 km) located across a strong frontal area identified in SST satellite images (Figure 4). Information about the deployments can be found in Table 3.



*Figure 1. SVP drifters lying on the aft deck of R/V SOCIB before deployment.*



*Figure 2. Preparation of SVP drifters (labelling and switching on) prior to deployment on R/V SOCIB.*



Figure 3. Deployment of a SVP drifter in the eastern Alboran Sea. The surface buoy, tether and hoely sock drogued (folded) are clearly visible.

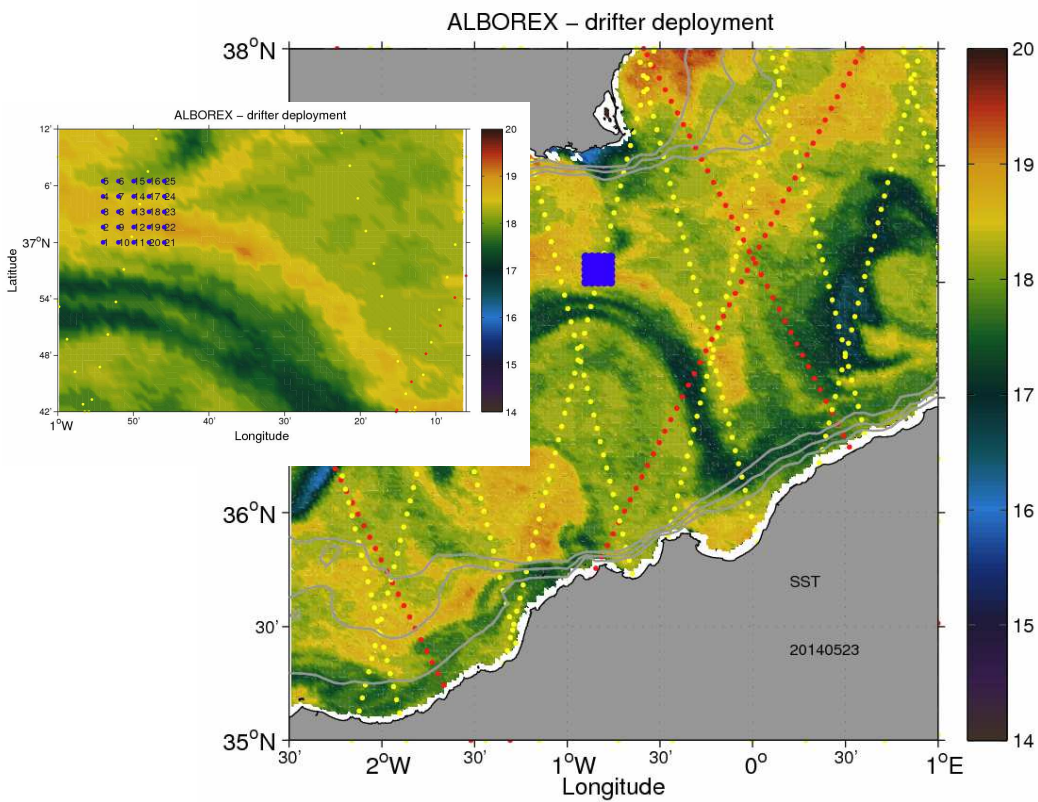


Figure 4. Color-coded satellite SST image on 23 May 2014 showing the thermal front in which the drifters were deployed.

*Table 3. Information on the drifter deployments during ALBOREX 2014 and the drifter status on 8 July 2014.*

<b>ID Argos</b>	<b>Deploy date</b>	<b>Lat</b>	<b>Lon</b>	<b>Last Date</b>	<b>Lat</b>	<b>Lon</b>	<b>Status*</b>
a116396	25 May 2014 16:07	37.08	-0.8	08 July 2014 04:18	37.96	-0.01	A
a116397	25 May 2014 16:16	37.11	0.8	08 July 2014 03:53	38.37	2.44	A
a116398	25 May 2014 16:26	37.07	0.83	08 July 2014 04:19	37.15	2.53	A
a116399	25 May 2014 16:36	37.08	0.83	28 May 2014 17:43	36.87	-0.15	D
a116401	25 May 2014 16:46	37.06	0.83	08 July 2014 04:17	38.75	4.31	A
a127159	25 May 2014 17:05	37	0.83	08 July 2014 04:18	37.94	3.8	A
a127160	25 May 2014 17:22	37	0.88	08 July 2014 03:53	38.59	4.2	A
a127161	25 May 2014 17:32	37.03	0.87	03 July 2014 19:05	38.84	5.31	D
a127162	25 May 2014 17:41	37.05	0.87	01 June 2014 20:31	36.66	0.56	D
a127163	25 May 2014 17:50	37.08	0.87	08 June 2014 04:29	36.74	0.64	D
a127164	25 May 2014 18:00	37.11	0.87	08 July 2014 03:52	37.26	0.14	A
a131972	25 May 2014 14:44	37.1	0.77	17 June 2014 03:28	37.15	0.63	D
a131973	25 May 2014 14:57	37.08	0.77	14 June 2014 03:57	37.63	0.65	D
a131974	25 May 2014 15:09	37.05	0.77	17 June 2014 04:42	37.05	4.65	D
a131975	25 May 2014 15:18	37.03	0.76	17 June 2014 04:29	37.73	5.11	D
a134924	25 May 2014 15:28	37	0.77	08 July 2014 04:00	37.81	3.84	A
a134926	25 May 2014 15:39	37	0.8	08 July 2014 04:00	38.3	4.7	A
a134927	25 May 2014 15:48	37.03	0.8	08 July 2014 04:00	38.73	4.77	A
a134929	25 May 2014 15:58	37.05	0.8	08 July 2014 03:01	37.15	-0.62	A
a134931	25 May 2014 16:55	37.03	0.83	08 July 2014 04:01	38.8	5.56	A
a136010	25 May 2014 18:13	37.11	0.9	08 July 2014 02:00	37.15	2.47	A
a136011	25 May 2014 18:27	37.08	0.91	25 June 2014 10:01	37.53	0.27	D
a136013	25 May 2014 18:32	37.05	0.9	08 July 2014 04:01	37.71	-0.48	A
a136014	25 May 2014 18:43	37.03	0.9	08 July 2014 03:01	37.97	4.01	A

\* A = Alive and D = Dead on 8 July 2014.

The Argo floats were also deployed in the thermal front in the vicinity of the drifters. See Table 4 for deployment information. Figures 5 to 7 show the preparation of the floats onboard R/V SOCIB and the consecutive deployment. Information about the deployments can be found in Table 4.

Table 4. Information on the float deployments during ALBOREX 2014 and the float status on 15 July 2014.

Type	Argos/Iridium	Deploy date	Lat	Lon	Last Date	Lat	Lon	Status
Arvor-C	300234061375680	25-May-2014 19:24	36.94	-0.9	15-Jul-2014 06:45	38.73	4.17	A*
Arvor-A3	109222	25-May-2014 18:59	37.01	-0.9	17-Jun-2014 13:16	36.31	0.54	A**
Provor-bio	300125010112590	25-May-2014 19:54	36.9	-0.9	12-Jul-2014 11:39	36.35	0.18	A

\* The Arvor-C executed its last profile on 14 June 2014 and thereafter drifted at the surface.

\*\* The Arvor-A3 was reset on 17 June 2014 in order to optimize its surfacing time.



Figure 5. Argo floats lying on the aft deck of R/V SOCIB before deployment.



Figure 6. Preparation of the floats prior to deployment on R/V SOCIB.





*Figure 7. Deployment of an Argo float*

## 4. Preliminary Results

### 4.1 Drifters

Figure 8 displays the trajectories of drifters deployed during the ALBOREX 2014 campaign with their initial (circles, on 25 May 2014) and final (asterisks, on 14 July 2014) positions. Drifters deployed more to the south were quickly captured by the Algerian Current (Figure 9) and transported along the Algerian coast for ~500 km. At ~5°E they turned northward describing an anticyclonic eddy located between 37.5°-38.5°N and 4-5°E. Drifters deployed more to the north were transported south-eastward for ~100 km (Figure 10), then were deflected northward and splitted in two directions: some of them moved eastward and traced an anticyclonic eddy whereas the others moved north-eastward and described a cyclonic pathway.

Figure 11 shows the weekly displacement of the drifters during the period 25 May 2014 - 12 July 2014.

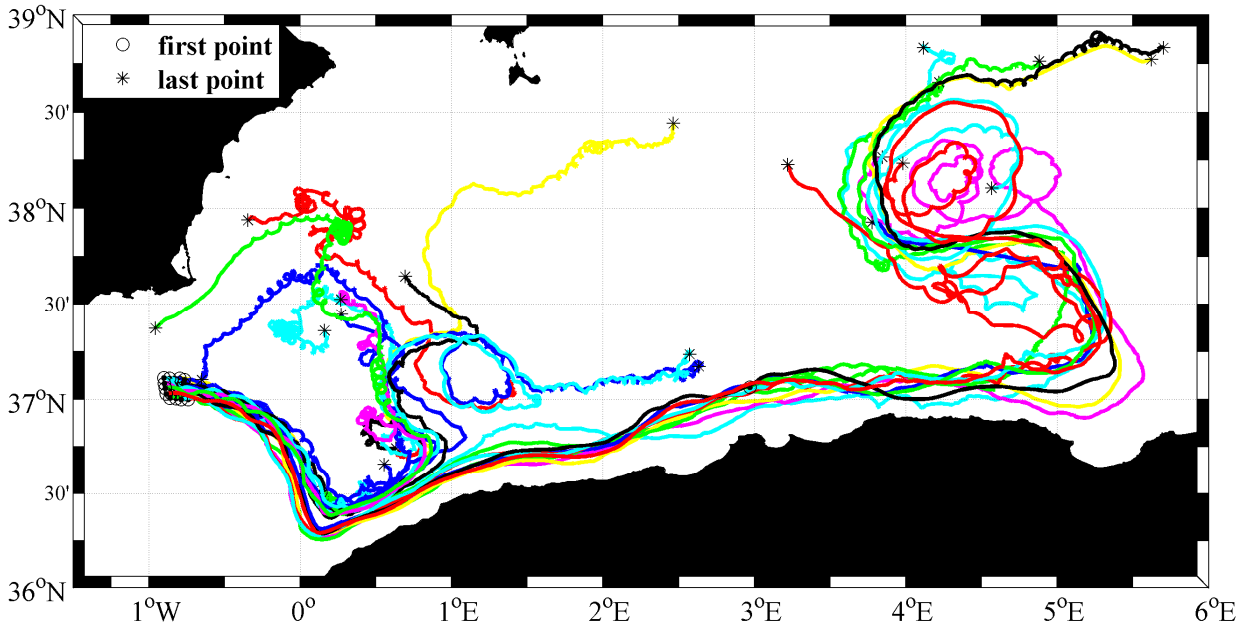


Figure 8. SVP drifter tracks between 25 May 2014 and 14 July 2014.

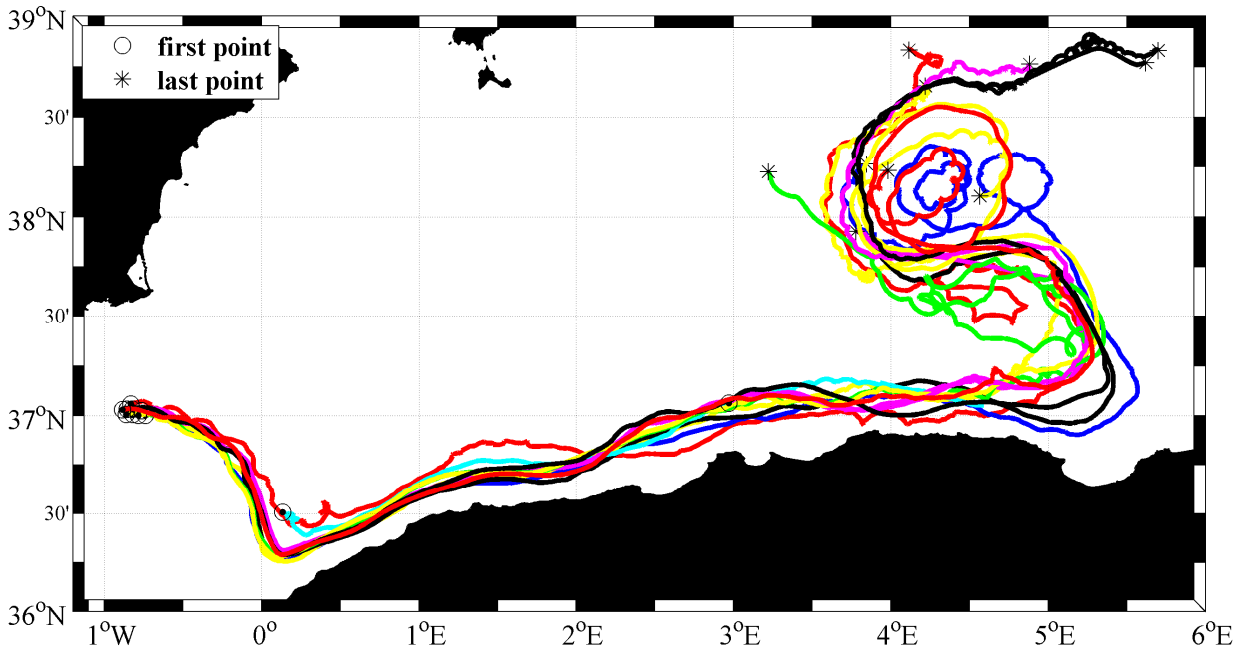


Figure 9. Trajectories of the 11 SVP drifters captured by the Algerian Current.

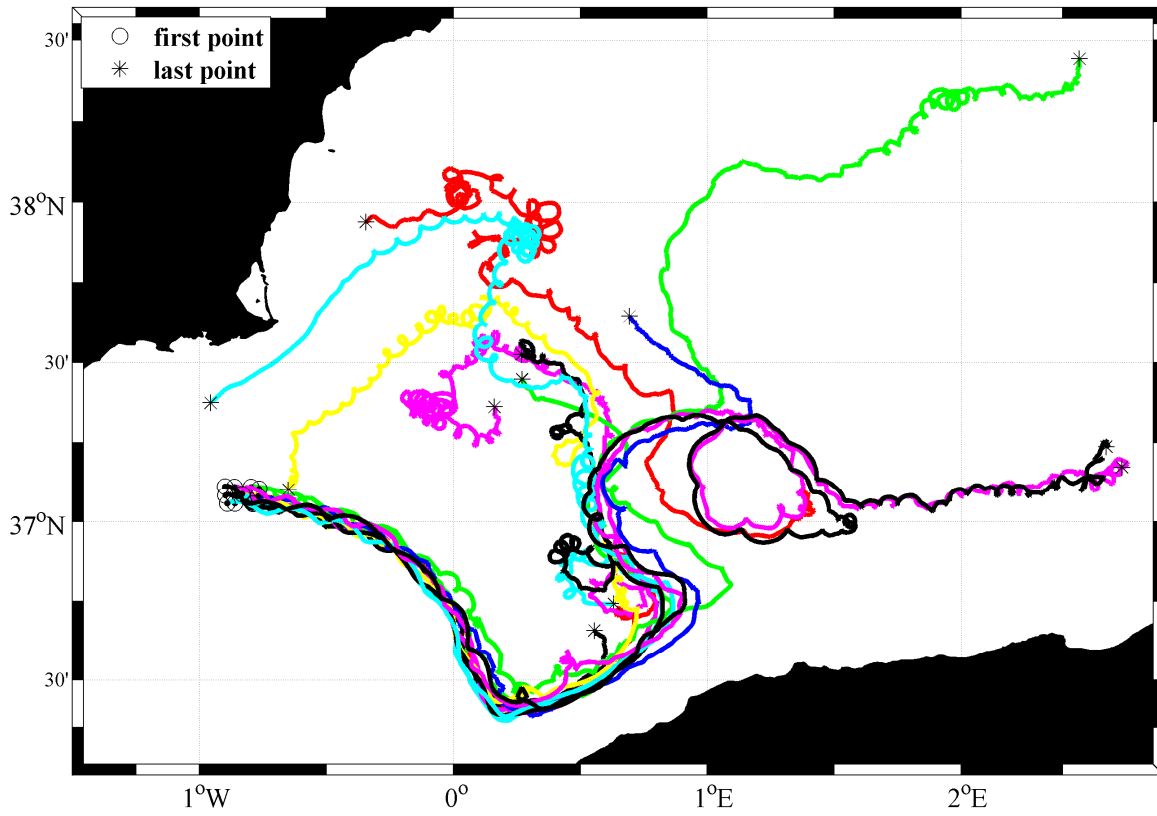


Figure 10. Trajectories of the 13 SVP drifters deflected northward at  $\sim 0.8^\circ\text{E}$ .

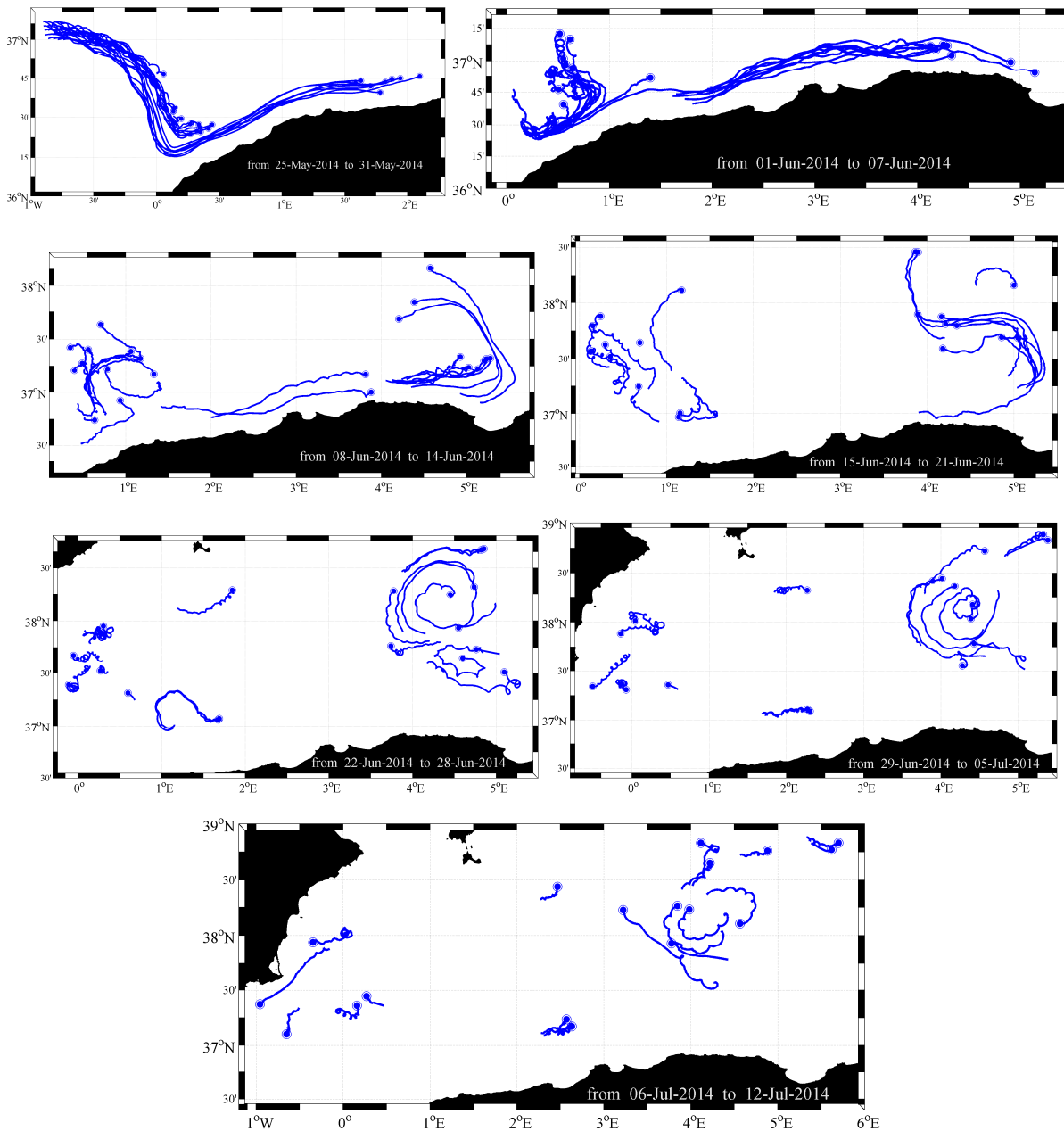


Figure 11. Weekly displacement of the SVP drifters during the period 25 May 2014 - 12 July 2014.

## 4.2 Argo floats

### Arvor-C:

The trajectory of the Arvor-C is shown in Figure 12. It drifted initially in the southeastward direction towards the African continent. Then it joined the Algerian Current and move rapidly along the coast in the northeastward direction as far as 4°E.

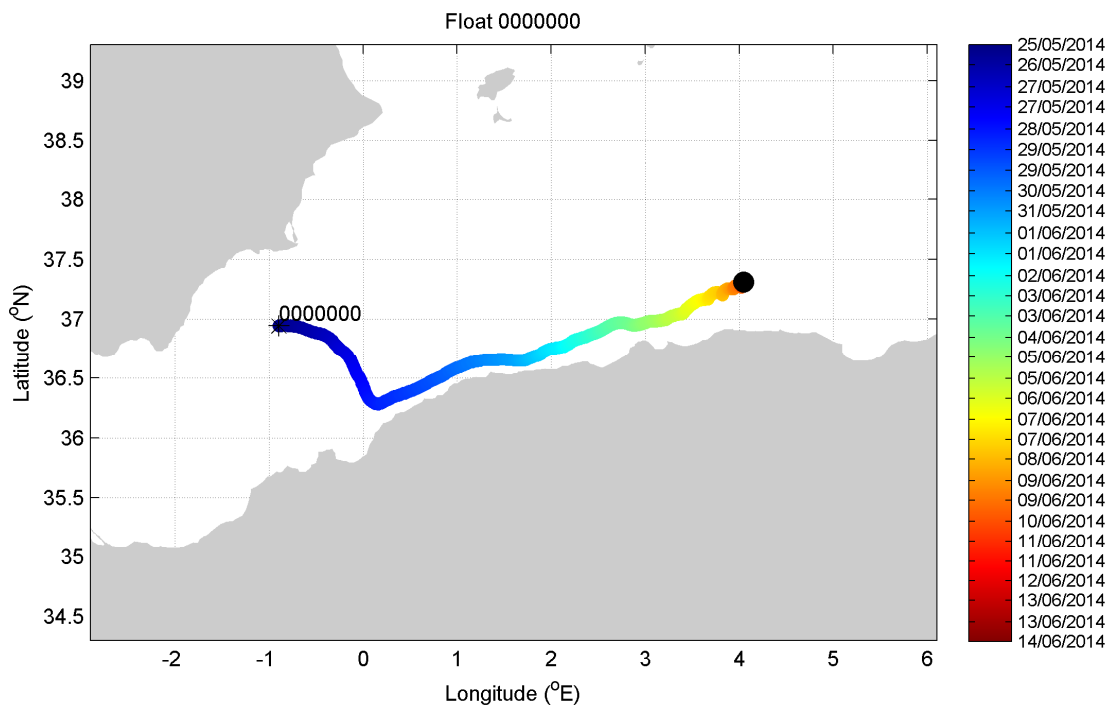


Figure 12. Trajectory of the Arvor-C (WMO 0000000) between deployment on 25/05/2014 (star symbol) and position on 14/06/2014 (black dot).

The Arvor-C executed more than 200 profiles between 400 m and the surface, at ~1.5 h intervals. The corresponding potential temperature and salinity profiles are plotted in Figure 13 (color-coded with date). The potential temperature and salinity data are also contoured versus depth and time in Figure 14.

The formation of the seasonal thermocline in late spring and the signature of the surface low-salinity water of Atlantic origin are evident. A secondary sub-surface (50-100 m) salinity minimum is also seen. It is mostly important during the first part of the drift (up to cycle 300).

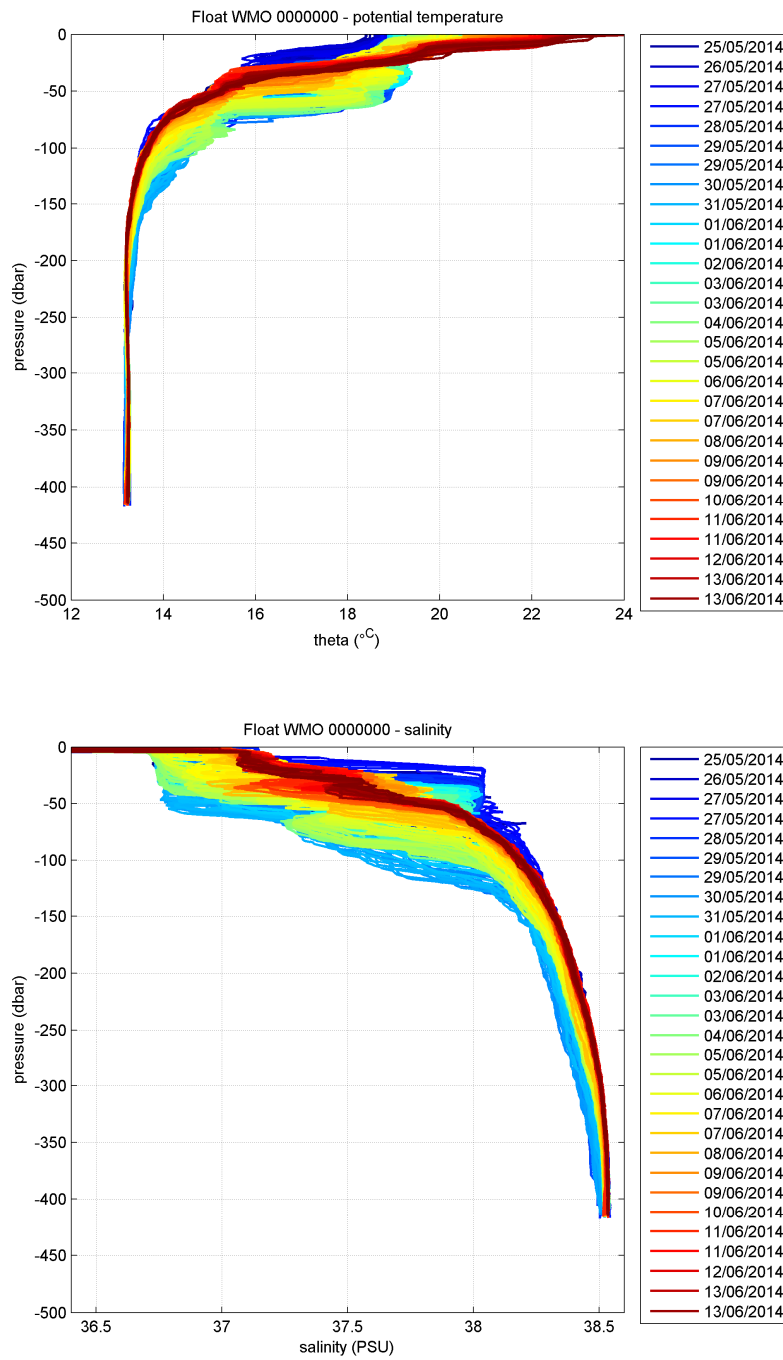


Figure 13. Potential temperature (top) and salinity (bottom) profiles measured by the Arvor-C every 1.5 h along its trajectory.

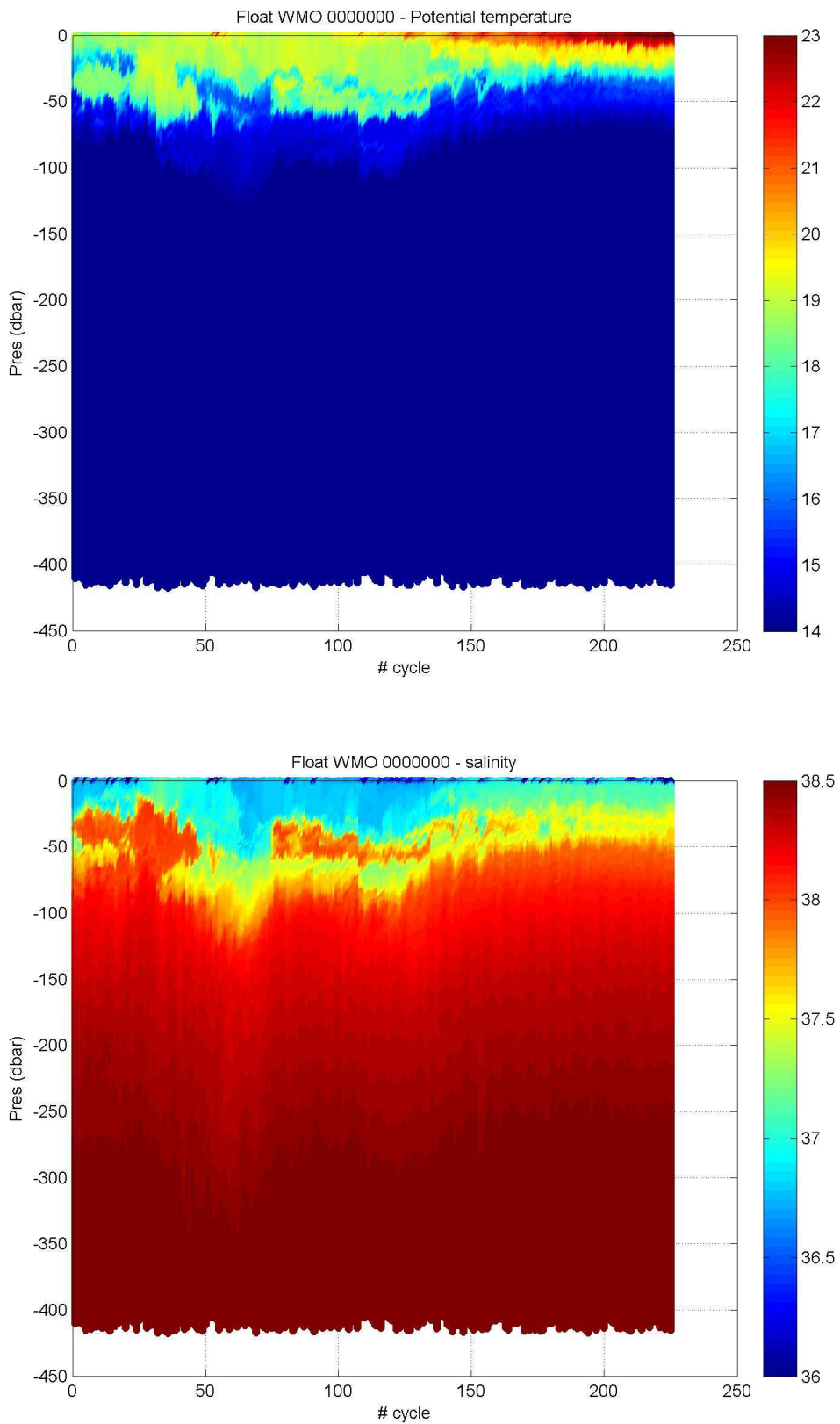
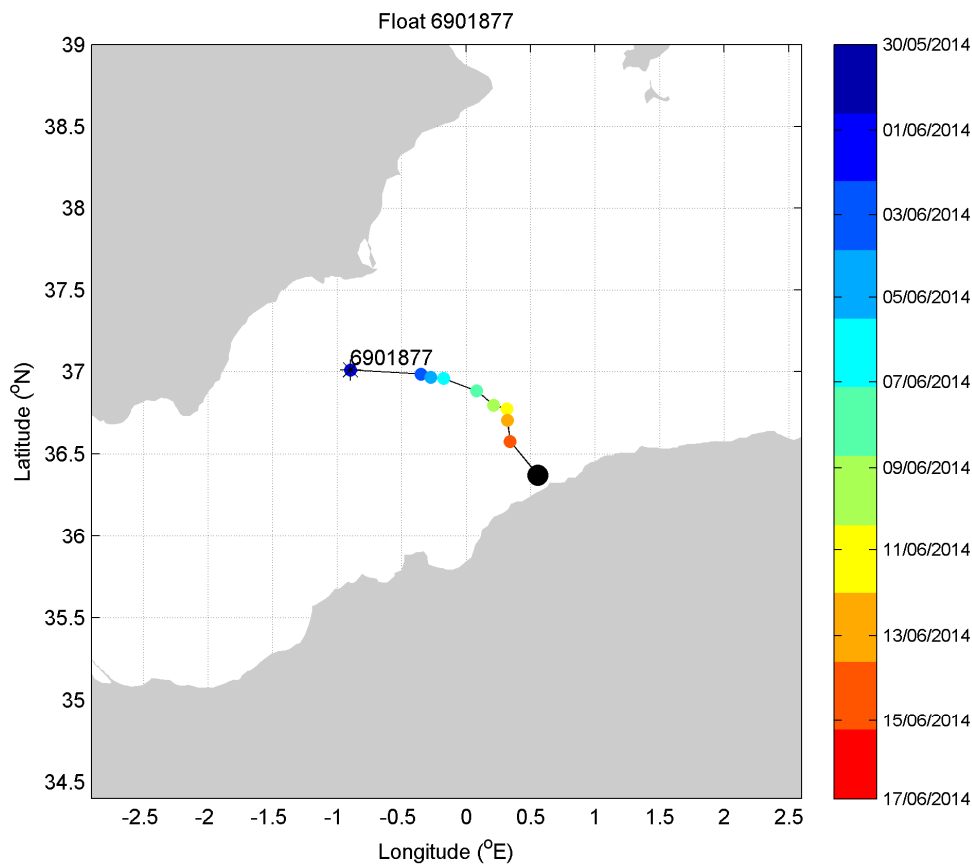


Figure 14. Contour plots of potential temperature (top) and salinity (bottom) data measured by the Arvor-C along its trajectory.

### Arvor-A3:

The trajectory of the Arvor-A3 is shown in Figure 15, along with the positions of the CTD profiles executed by the float. It drifted to the southeast and arrived in the vicinity of the Algerian coast by mid-July 2014.

The potential temperature and salinity profiles provided by the Arvor-A3 are plotted in Figure 16. The thermal stratification and the low-salinity Atlantic water signature are evident.



*Figure 15. Trajectory of the Arvor-A3 (WMO 6901877) between deployment on 25/05/2014 (star symbol) and position on 17/06/2014 (black dot).*



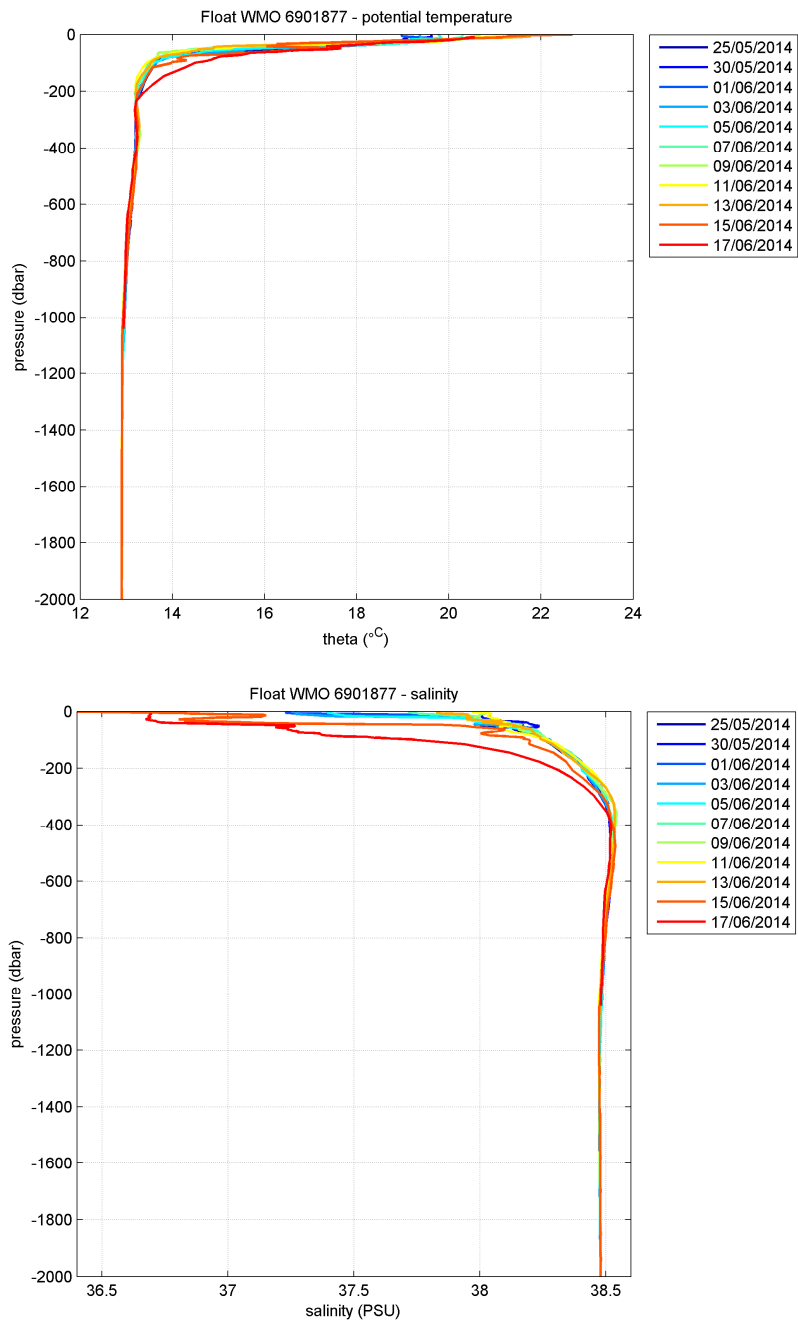


Figure 16. Profiles of potential temperature and salinity measured by the Arvor-A3, color-coded with date.

Provor-bio:

The Provor-bio trajectory and its profile locations (daily from deployment to 7 July 2014 and every 5 days thereafter) are shown in Figure 17. Daily profiles were collected until 7 June 2014 before the float cycle length was changed from 1 day to 5 days.

As an example, the profiles of physical, biogeochemical and optical parameters are displayed in Figure 18 for 7 July 2014. The sub-surface maximum in chlorophyll-a concentration is noteworthy.

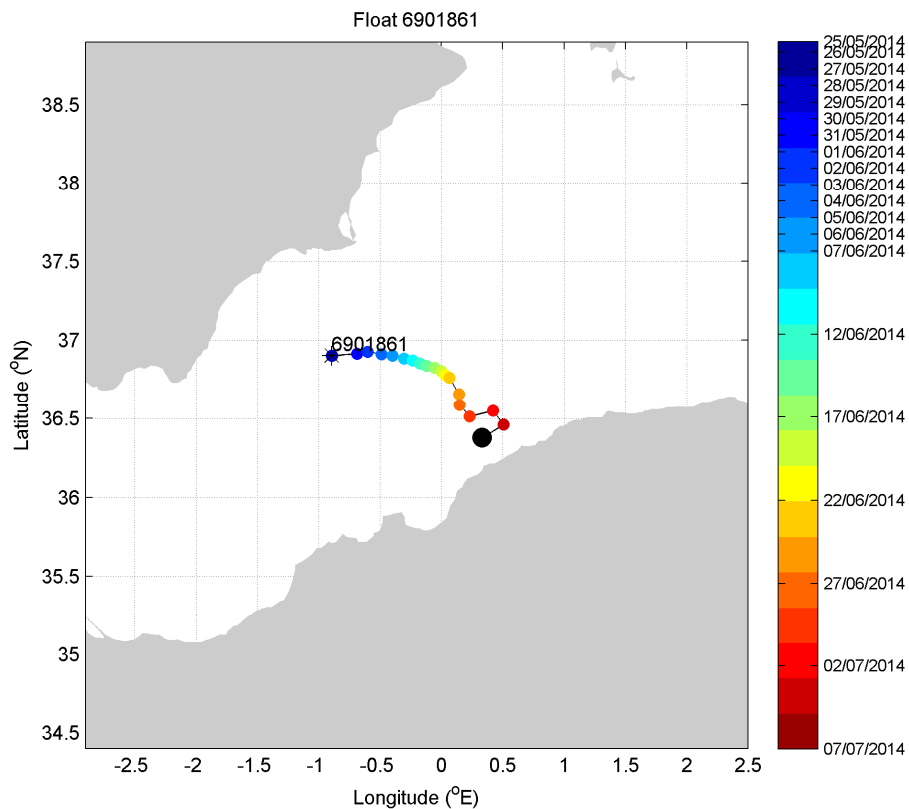


Figure 17. Trajectory of the Provor-bio (WMO 6901861) between deployment on 25/05/2014 (star symbol) and position on 7/07/2014 (black dot).

Ascent / 07 Jul 2014 11:39 UT / ogsbio001b\_018\_00

Jpeg created on Mon Jul 7 23:32:28 2014 with data processed on Mon Jul 7 14:50:21 2014 (Lon:0.33deg, Lat:36.38deg.)

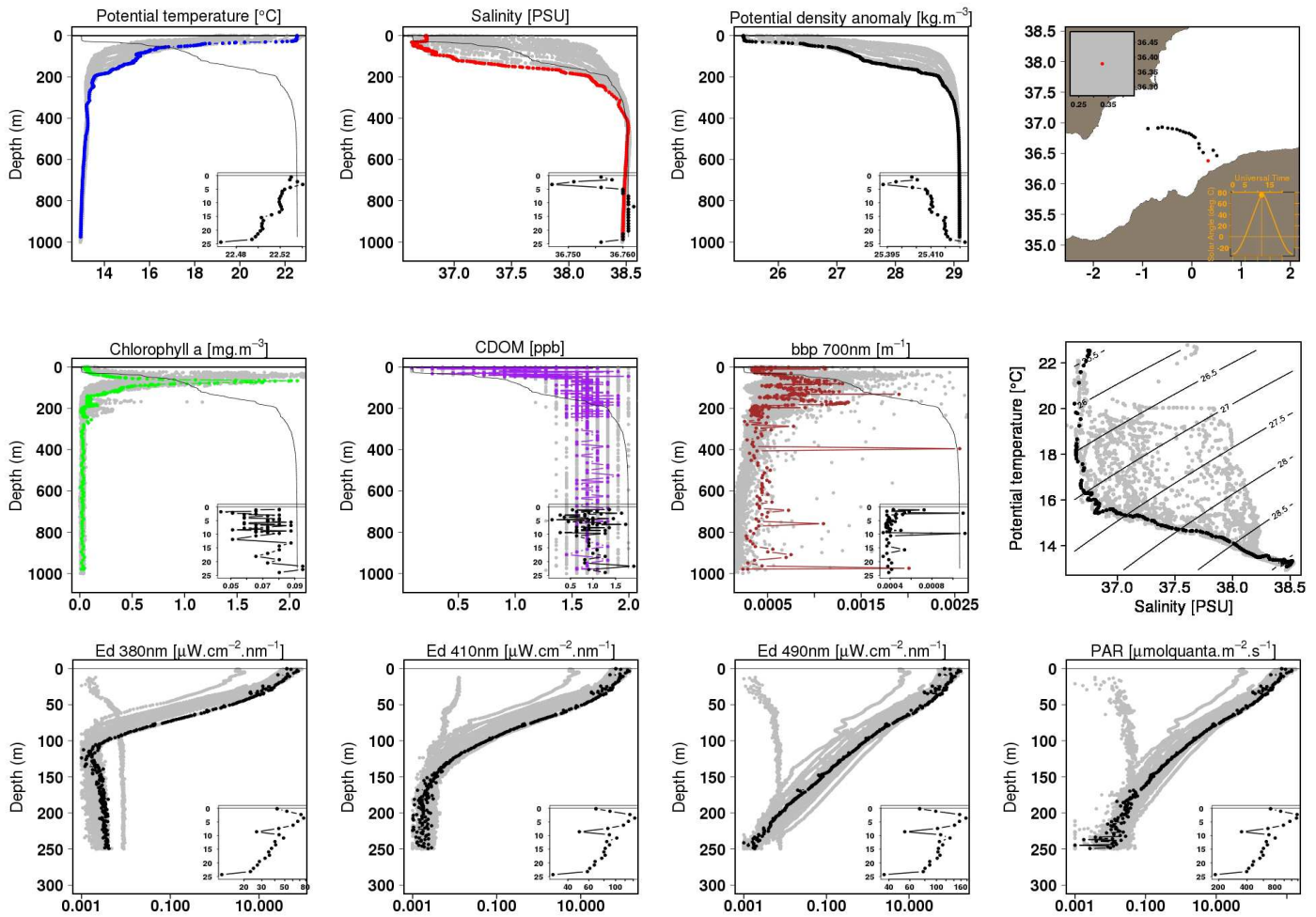


Figure 18. Profiles of physical, biogeochemical and optical parameters measured by the Provor-Bio (WMO 6901861) on 7 July 2014.

## 5. Acknowledgements

We would like to thank the following individuals for their help with the logistics of drifter and float operations:

Ananda Pascual, Benjamin Casas, Felix Margirier, Carlos Castilla, Irene Lizaran and others.  
IMEDEA, Desporles, Spain

The Captain and Crew of R/V SOCIB.

## 6. References

Lumpkin, R. and M. Pazos, 2007: Measuring surface currents with SVP drifters: The instrument, its data and some results. Lagrangian Analysis and Prediction of Coastal and Ocean Dynamics, A. Griffa et al., Eds., Cambridge University Press, 39–67.

Niiler, P.P., A. Sybrandy, K. Bi, P.-M. Poulain and D. Bitterman, 1995: Measurements of the water-following capability of holey-sock and TRISTAR drifters. Deep-Sea Res., 42, 1951–1964.

Sybrandy, A. L. and P. P. Niiler, 1991: WOCE/TOGA Lagrangian drifter construction manual. SIO REF 91/6, WOCE Rep. 63, Scripps Inst. of Oceanogr., San Diego, CA, 58 pp.