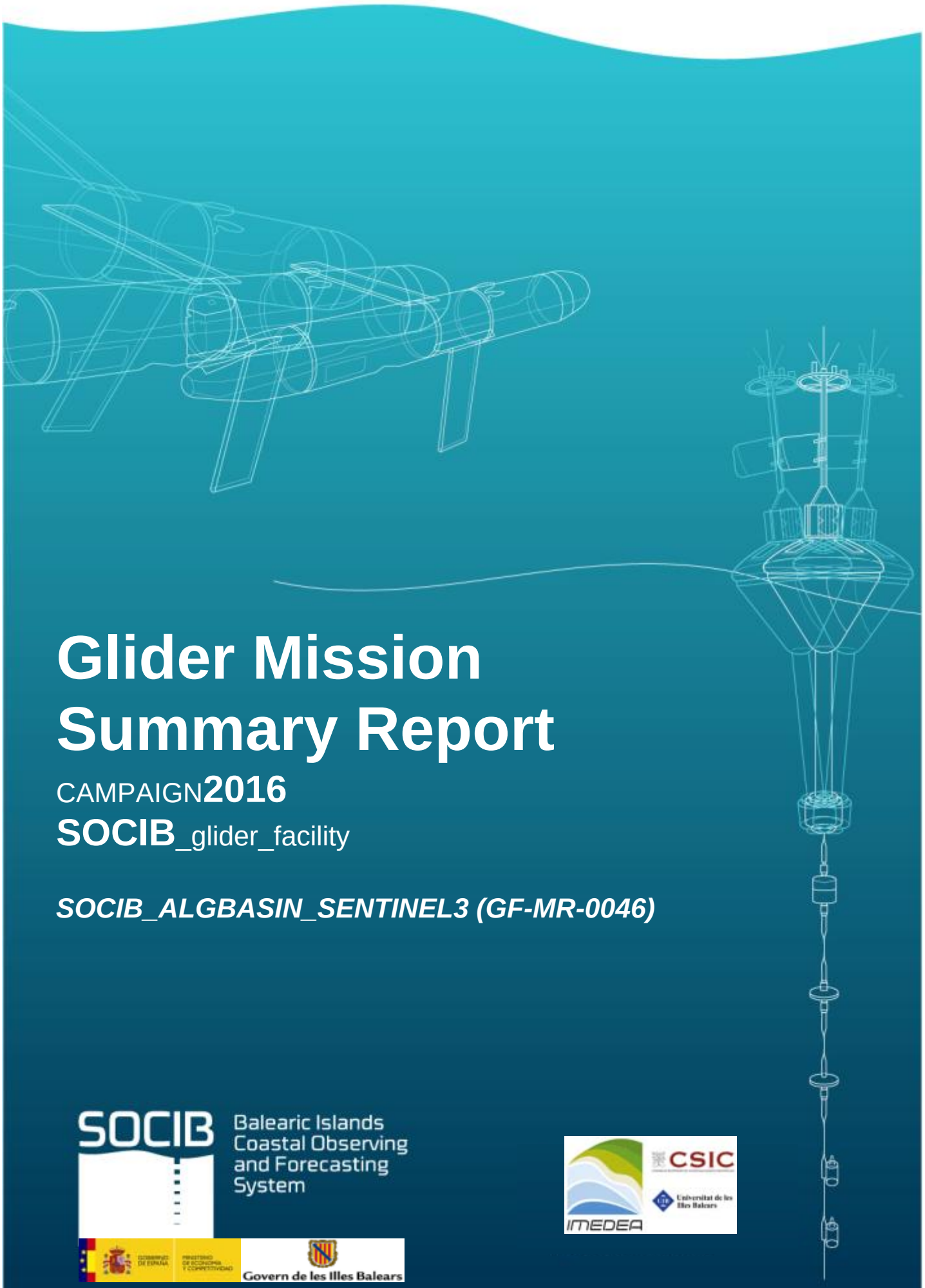

Glider Mission Summary Report

CAMPAIGN**2016**

SOCIB_glider_facility

SOCIB_ALGBASIN_SENTINEL3 (GF-MR-0046)

SOCIB Balearic Islands Coastal Observing and Forecasting System

Govern de les Illes Balears

IMEDEA CSIC Universitat de les Illes Balears

Mission Name	*SOCIB_ALGBASIN_SENTINEL3 (GF-MR-0046)*
Platform Model	*Slocum 1000 G1*
Platform ID / Name / WMO Code	*U184 / IDEEP00 / 68452*
Related Platforms / Missions	*SDEEP00 (Parallel execution of CanalesMAY2016)* *SOCIB-R/V (ADCP sampling-day under SENTINEL-3)* *SENTINEL-3 satellite*
Start Date	*2016-05-25*
End Date	*2016-06-17*
Total Days	*23*
Total distance (Km / Nm)	*601 / 325*
Survey Area (NODC or SDN region)	*Algerian Basin - Mallorca-Algeria (Western Mediterranean Sea)*
Objective(s)	• *Hydrographic and geochemical survey of Algerian Basin (EL2 Spring-mission)* • *Validation of new along-track (L3) and gridded interpolated maps (L4) altimetry products, provided among others by the Sentinel-3 altimetry mission, in the western Mediterranean Sea by using the in-situ Glider and SOCIB-R/V available observations* • *Demonstration of technical and tactical feasibility of EL2 as SOCIB's endurance line*

Scientific Sensors (name & model / serial_number / calibration date)	• *CTD -SBE- / sn 0195 / 10-April-2013* • *FLNTU -WetLabs- / sn2128 / 01-Feb-2011* • *OPTODE -Aandera- / sn 0841 / 01-May-2013* *(calibration sheets available upon request to glidertech@socib.es)*
Number of Profiles	*876 (CTD), 439 (FLNTU), 439 (OXY)* *(majority of deep dives between 15 and 950m)*
Significant Events	• *1st **ALG-BAS** demo-mission in 2016 (G1 deep glider)* • *2nd mission undertaken by **IDEEP00** in 2016 (powered by SAFT Lithium battpack.)* • *Overlapped transects (triangular shape) South of Cabrera to begin the SENTINEL-3 1st leg on the appropriate date in order to synchronize with SOCIB-R/V transect* • *May-30th: **SENTINEL-3** over-passing and **SOCIB-R/V** simultaneous sampling. SOCIB-R/V transect completed (by IDEEP00) on June-1st* • *'silent-mode' activated in DAPP (mission not shown since* • *2 complete SENTINEL-3 swath legs covered during this mission (over Orbit #713)* • *Deep-flying mode turned on during >2000m navigated waters (UTC surface strategy during the rest of it)* • *Very good overall performance (no critical aborts nor errors)* • *Data backup using radio link (without hull disassembly)*

Mission Summary

Introduction

This mission, the 2nd one by IDEEP00 in 2016, stands for the first one in multiple senses: first SENTINEL-3 (S3) swath-sampling; first Algerian-Basin(AB) mission of the year (demo mission for an eventual AB endurance-line); first AB mission with a G1 Glider, first SOCIB-External-Access (SEA) mission and first synoptic mission with SOCIB-R/V out of Eïvissa-Channel (EC). Internal code for this mission is GF-MR-0046. Days 29 and 30 of May were under SEA and the rest was a SOCIB demo-mission.

Pre-mission Report

Created prior to the start of the preparations, compiling the key preliminary aspects of this GF-MR-0043, derived from planning sessions.

Preparation

Phases were executed between 11/May/2016 to 26/May/2016. All checks and configurations were undertaken according to the pre-mission-report and applicable protocols. There were neither relevant issues nor problems worth to be mentioned here. Compass error was measured in a EMI-free forest location (max. error > 20 deg so the compass needs recalibration).

Launching

This field operation (25/May) was executed by 1 ETD and 1 GF facility members on board SOCIB RIB Hurricane 9m. Glider was released in N39° 11.802' E02° 37.944' at 11:05-utc. The deployment was an operative and tactical success (environmental conditions were very good). Pilot was onshore. Glider executed successful test dives prior to the initial survey dive.

Survey

In general terms, it was very successful. Main preliminary objectives were all accomplished without major setbacks. The absence of critical situations resulted in no emergency actions.

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- ***Navigation****: was very satisfactory. Fluid and continuous advancements without relevant deviations from commanded route (1,2Km in average). A single waypoint-list commanded with modifications to implement a track repetition between 28-May and 30-May and also to extend the return route to get closer to Palma's Bay. All waypoints were accomplished successfully (max. dead-reckoning error of 2,8Km). There were no interruptions due to currents nor to mission aborts. A track repetition was commanded to 'spend time' while waiting for the SOCIB-R/V(RV) sampling to occur (May-30th). Then, that day, both RV and S3 sampled synoptically with the Glider. No signs of stronger currents in the region closer to the Algerian coast. The return trip was smooth and without problems. Due to the favorable context, the Glider was commanded to approach closer to Palma's bay seeking for an easier recovery. Final traced route composed out of: (a) 2 complete legs over S3 swath-orbit #713 and (b)2 transit routes (initial and final) to move from/to release/catch sites to/from #713 leg. An average X-Y speed of 0,32m/s was accomplished (0,29m/s on diving and 0,38m/s on climbing)*
- ***Underwater Maneuvering****: was initially configured accordingly to scientific objectives, environmental conditions (mainly bathymetry for this mission) and 'flying' efficiency. (See Chart **1** for details). During the mission the strategy was changed multiple times to adapt to variations in these aspects. Basically, during the initial and final travel-routes a standard configuration (surface by UTC time, 4 times a day, infinite yo-ing, altimeter on, manual pitch control) was implemented whilst during #713 legs a deep-flying-mode was turned on (no UTC surface, surface after 2 consecutive yo's, altimeter off, manual pitch control) seeking for energetic efficiency and maximum sampling performance. Average vertical speeds of 0,15m/s (climbing) and 0,19m/s (diving) were accomplished. Both target depths (upper and bottom) remained constant during the whole mission (15 and 950 meters respectively).*
- ***Data Logging****: sampling seemed to have been successful and according to details shown in Chart 2 (89 non-critical oddities raised by science-super). The strategy remained unchanged during the whole duration of the survey and resulted in 876 CTD profiles and 439 for OXY and FLNTU each (307747m of water-column sampled with CTD and 75839m with OXY/FLNTU). Intersample mean-times for CTD, OXY and FLNTU are 2.939sec, 5.169sec and 10.056sec respectively. The number of samples taken have been: 1202292 (CTD), 748561 (OXY) and 393262 (FLNTU).*
- ***Engineering***
  - *Power Source: Brand new Primary Lithium Battery pack with 420Ah of nominal capacity. The supply was stable and capable of fulfilling the requirements of all the on-board systems. Finally, 95,92Ah were consumed with a final reading of 98,16Ah.*
  - *Electro-Mechanical: actuators and sensors exhibited an excellent performance (but Oddities raised by pitch-motor and digifin); Pitch control remained in 'servo-mode' during the entire survey*
  - *Communication Systems: were very reliable and fluent. There were only 7 drop-calls and 0 missing-calls. ARGOS sent 862 messages. GPS fix time (mean) was 254 seconds and there were no pre-fix failures.*
  - *Electronic Modules: (processors, memory cards, control boards,...) revealed no evidences of problems at all.*
  - *Hydrodynamics: no signs of problems*
  - *Device Error-Statistics: 0 Errors, 0 Warnings and 874 Oddities (2 ocean_pressure, 65 pitch_motor, 93 science_super (Input ringbuf overflow odds. during surface dialog), 479 digifin, 185 iridium and 50 coulomb). None of this are to be considered critical.*
  - *Mission Runs: the same mission run lasted the whole survey (log-file identifier 0349xxxx)*

Recovery

This conclusive field operation took place as planned (17/June) in N39° 09.632' E02° 37.677', which is closer to Calanova home-port than the launching location (it was feasible to get the glider closer to coast). Glider was already at surface waiting for the recovery team (on-board SOCIB RIB Hurricane 9m, formed by 1-ETD and 1-GF) and was extracted with no problem availing a favorable sea-state. Note: a communication test was done to validate the capability of the Iridium handset to act as a 4800baud modem for a field-portable dockserver.

Conclusion

This phase started the same day of the recovery (17/June), which was a Friday. In order not to disassemble de hull, IDEEP00 was left downloading EBD+DBD files over the Freewave interface. By next day, Saturday, all files had been downloaded. On 21/June the conclusion resumed following the applicable protocol mainly focusing on: (1) avoiding disassembly to preserve the pressure seal; (2) external-surfaces and sensor cleaning/refurbishment (light signs of corrosion in hull side rings and almost inexistent bio-fouling growth) ; (3) gathered-data backup (by radio) and uploading to SOCIB's data-center for post-processing; and, finally, (4) avoiding preparation for storage and leaving in GliderLAB (enough battery capacity to undertake next Canales mission). After that, the storage status of the vehicle was "80% ready for a new preparation" (since it had not been disassembled and there was almost 200Ah available).

Administration/Notification

Although multiple administrative and notification procedures took place during the different stages described above, these have not been reported because are considered out of the scope of this report. Same applies for multimedia and public-diffusion; and also for accounting.

HHRR

Coordination amongst multiple participants (glider-techs, field-techs, scientists & open-access-users) was fluent and efficient in spite of the field failure during recovery. There were no personal damages and the availability of each member, for all the tasks assigned at each moment, was

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correct (including on-alert shifts for field intervention and 24/7 glider monitoring during survey).

Detail Charts:

Date (utc)	D_{UTI}	D_{UBI}	T_{UND}	d_{BOT}	N_{DIV}	N_{COM}	t_{UTC}	H_{WPT}
25/May@(M.S.)	15	950	21600	40	∞	12	4,11,16,20	1000
31/May@08:13	15	950	14046	40	2[1]	12	(disabled)	1000
14/Jun@12:40	15	950	21600	40	∞	12	4,11,16,20	1000
16/Jun@15:39	15	950	21600	40	∞	12	4,7[2],11,20	1000
17/Jun@07:00	15	65[3]	1800	40	2	12	4,7,11,20	1000

[1]: Deep-flying mode. 2 dives at max. depth in >2000m waters of Algerian Basin
[2]: Replaced next day's call (recovery day), at 16utc, to make glider call at 7utc to allow recovery strategy configuration
[3]: At recovery day, 2 dives at 65m configured while waiting for recovery team

(M.S.): Mission Start
D_{UTI}: Underwater Top Inflection Depth (m)
D_{UBI}: Underwater Bottom Inflection Depth (m)
T_{UND}: Average Period of Underwater Navigation (secs)
d_{BOT}: Minimum Distance to Sea-floor to be kept (m)
N_{DIV}: Surface upon completion of this # of dives
N_{COM}: Surface if this amount of hours without stable communications (hrs)
t_{UTC}: Surface at this particular UTC times
H_{WPT}: Surface if a waypoint is hit within that distance (m)

Chart 1 Summary of Underwater Strategies (Navigation)

Date (utc)	S_{EN}	f_{SMP}	D_{RNG}	M_{DIV}	M_{CLI}
25/May/2016 (at Mission Start)	CTD	0,5000	[-5, 2000]	yes	yes
	OXY	0,2500	[-5, 2000]	yes	no
	FLNTU	0,1250	[-5, 150]	yes	no
	FLNTU	0,0625	[150, 300]	yes	no

S_{EN}: Sensor type
f_{SMP}: Frequency of sampling (Hz)
D_{RNG}: Depth range this configuration applies (m)
M_{DIV}: Sampling during Diving maneuver
M_{CLI}: Sampling during Climbing maneuver

Chart 2 Summary of Commanded Sampling Strategies

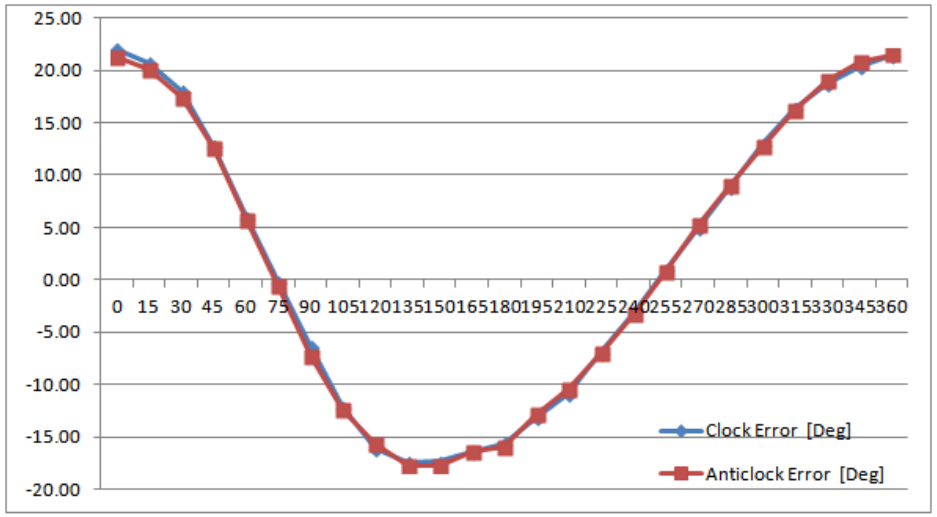

Fig 3.1- Error measured during Compass Error Check procedure in an electromagnetic-field-free environment located in a forest close to IMEDEA (in Esporles)

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Principal Investigator (e-mail or contact phone/address)	• *Prof. Joaquim Tintoré jtintore@socib.es (+34 971439821)* • *Dr. Ananda Pascual apascual@imedea.uib-csic.es (+34 971611732)*
Institute	*SOCIB in collaboration with IMEDEA*
Project Affiliation (web-site)	*http://www.socib.eu*
Partnership / Participation	• *SOCIB* • *IMEDEA*
Glider Software Version	*Nav : v7.13 Acomms, Payload: 3.17*
Data Retrieval (real-time [RT] / delayed-mode [DM])	• *RT: sub-set via satellite link during the first part of the mission. Engineering data only afterwards.* • *DM: wireless download via radio link to not disassemble the glider*
Compass Calibration (specify procedure)	*Compass error was measured. Observed error followed a well-known sinusoid-shape although the glider followed traced-route very well(See Figure 3.1)*
Battery Type	*SAFT Custom Lithium Pack (430Ah-nominal capacity) (With in-house-designed ballasting chassis)*
Battery Consumption (Ah)	*97.157Ah (reading from 1.539 to 98.697Ah)*
Data Available From	*http://thredds.socib.es/thredds/fileServer/auv/glider/ideep00-ime_sldeep000/L2/2016/dep0017_ideep00_ime-sldeep000_L2_2016-05-25_data_dt.nc*
Further Details	*glidertech@socib.es*

Figure 1 (Map providing general overview of Survey Area)

On-line Track: *http://apps.socib.es/dapp/?deployments=621-9-0-FFFF00&layers=isobaths,ocean_basemap&units=scientific*

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Figure 2

(Map providing detailed overview of Survey Area and traced Flight Path with surface points if possible)

Fig 2.1- Track of the first 4 days of mission showing repeated transects (overlapped triangle) to synchronize the glider with SENTINEL-3 passage and SOCIB-R/V ADCP mission; both on May-30th

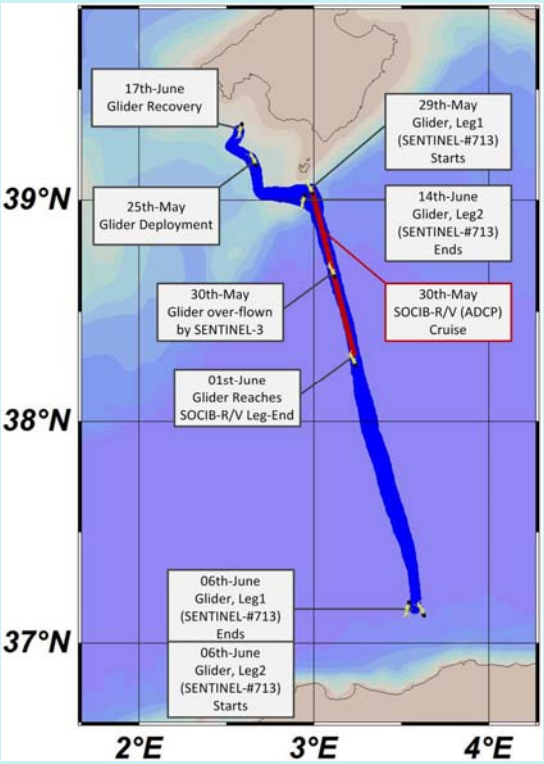
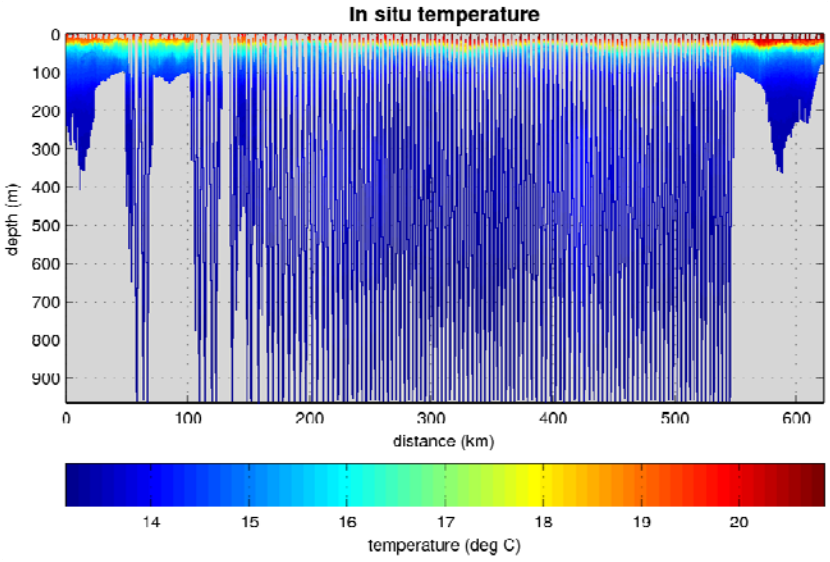


Fig 2.2- Mission track with remarkable dates

Scientific Preliminary Review

(Compilation of preliminary post-processing plots provided by SOCIB's data-center glider-toolbox and processing services. Contact data.center@socib.es for further info. Plots available through DAPP - See Figure 1 -. Comments provided by SOCIB's scientific staff)

CTD



Plot 1 – In situ temperature (TOP: full depth range, BOTTOM: first 200m)

The temperature plot shows a subsurface low temperature feature in the LIW layer (300 – 600 m+), which can be more clearly seen in the potential temperature plot or in the salinity plot following this one. The thermocline is between 30 – 50 m. In there is a subsurface high salinity feature, which could represent an eddy core (at 200 km)). In addition on the return transect in the LIW layer there is a high salinity feature extending, from 200 m to 800+ m and some 10 km in width at 420 km, this could be a sub mesoscale vortex, for example as described by Bosse et al 2015, adjacent to the larger eddy feature. The signature of the Algerian current, with lower salinities in the surface to100 m is visible in the southern part of the transect (the center in the plot, around 320 km).

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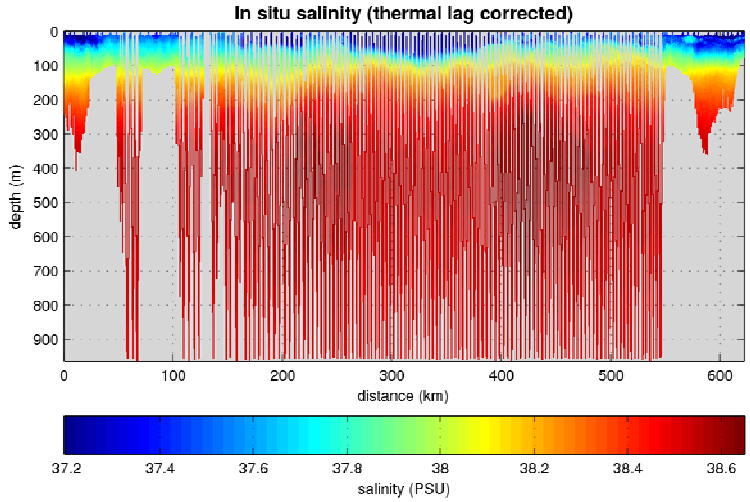
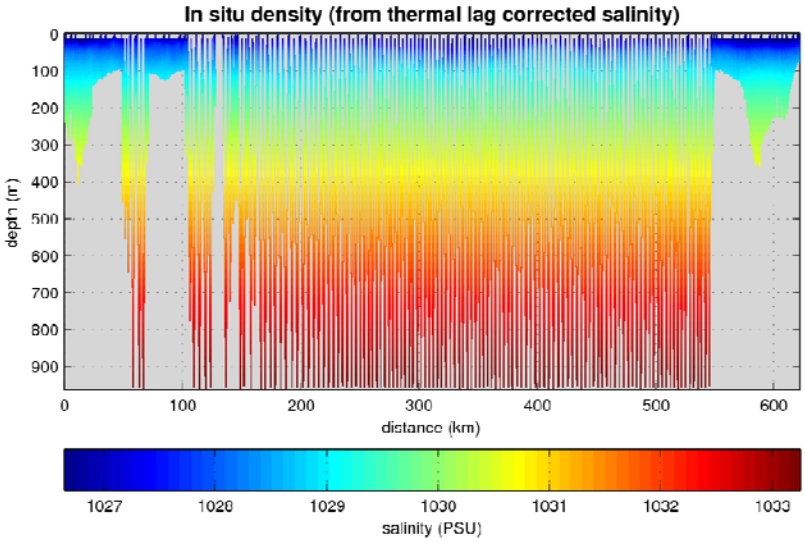
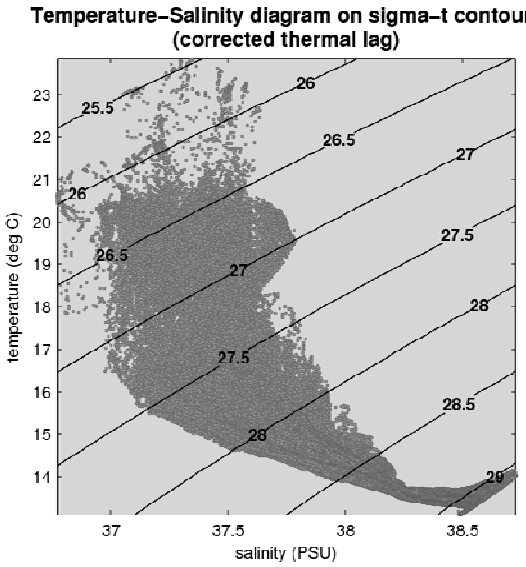


Plot 2– In situ salinity (thermal-lag corrected)



Plot 3 – density derived from corrected salinity (thermal-lag correction) and temperature



Plot 4 – T-S diagram (thermal-lag corrected)

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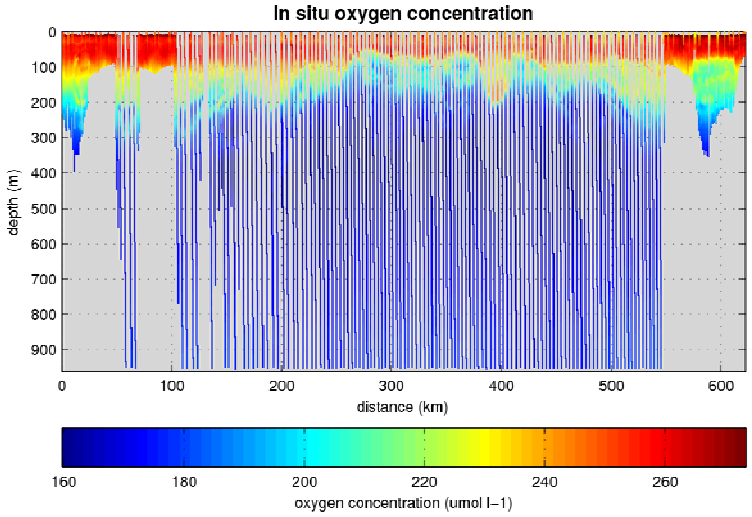
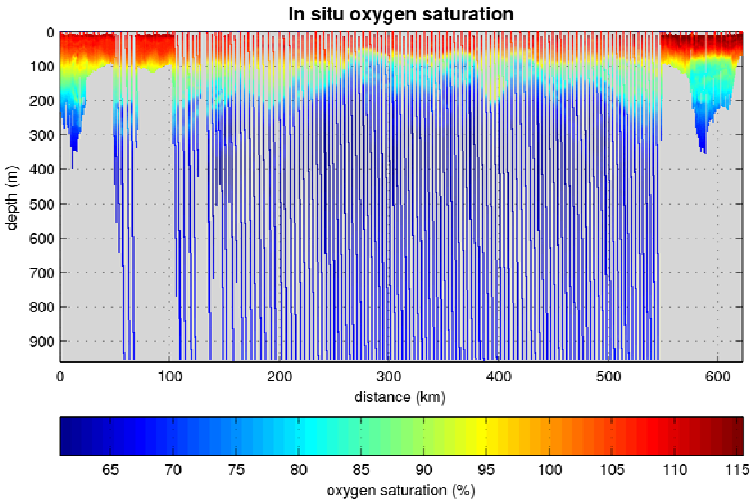
In the T-S diagram we can see the feature observed in plot 1 and plot 2, there is a high salinity water mass in the range of the LIW (S > 38.35 with θ > 13.0). Also we can see Atlantic fresh waters coming from the Algerian current corresponding to salinities lower than 37.5. Also MAW (Modified Atlantic Water) is observed with salinities 37.5 – 38.35. There is no evidence WIW or WMDW, however this is to be expected given the location of the transect and the depth to which the glider samples.

OXYGEN



Plot 7 – in situ oxygen concentration

There are some interesting changes in the oxygen across the 2 transects, with higher concentrations in the surface out of the Algerian current around 320 km and a blob of higher oxygen concentration between 100 and 200 m around 400 km perhaps associated with the possible sub surface vortex feature.



Plot 8 – in situ oxygen saturation

TURBIDITY & CHLOROPHYLL

The levels of turbidity seems to be constant across both transects with a rising of turbidity in the surface layer associated with the Algerian Current (center of the plot). The level of chlorophyll remains constant over the two transects with a sub surface maxima below the thermocline at approximately 80 m. The turbidity sub surface maximum appears to be approximately coincident with the chlorophyll maxima.

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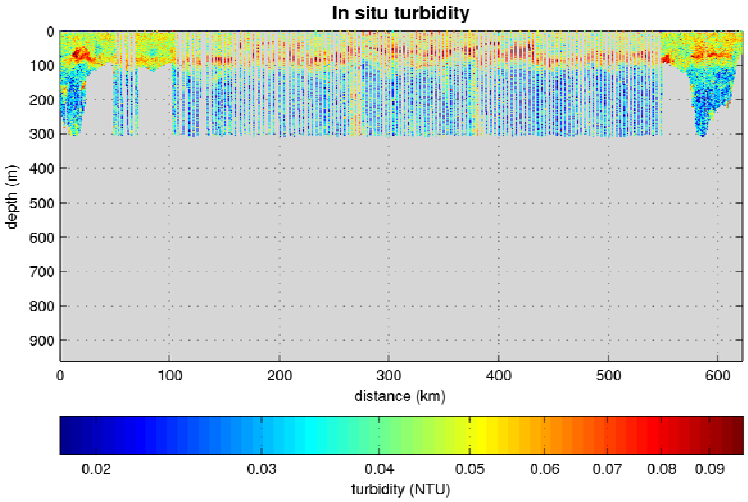
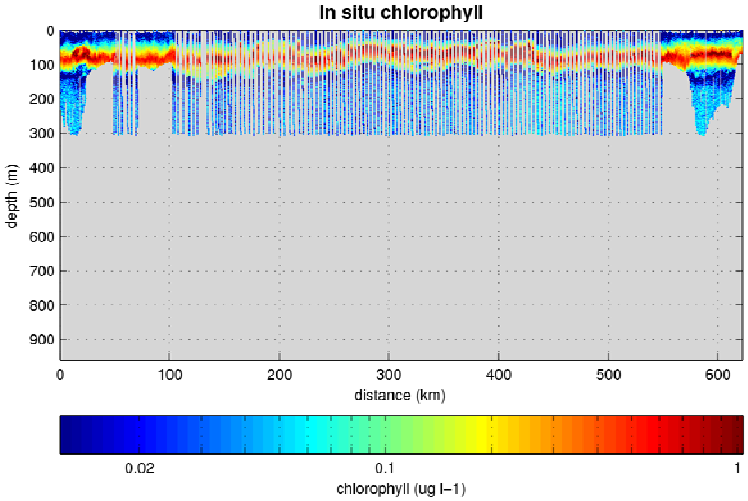


Plot 9 – in situ turbidity



Plot 10 – in situ fluorescence

Bosse A., P. Testor, L. Mortier, L. Prieur, V. Taillandier, F. d'Ortenzio and L. Coppola (2015a): Spreading of Levantine Intermediate Waters by Submesoscale Coherent Vortices in the Northwestern Mediterranean Sea as observed with gliders, JGR, DOI: 10.1002/2014JC010263

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