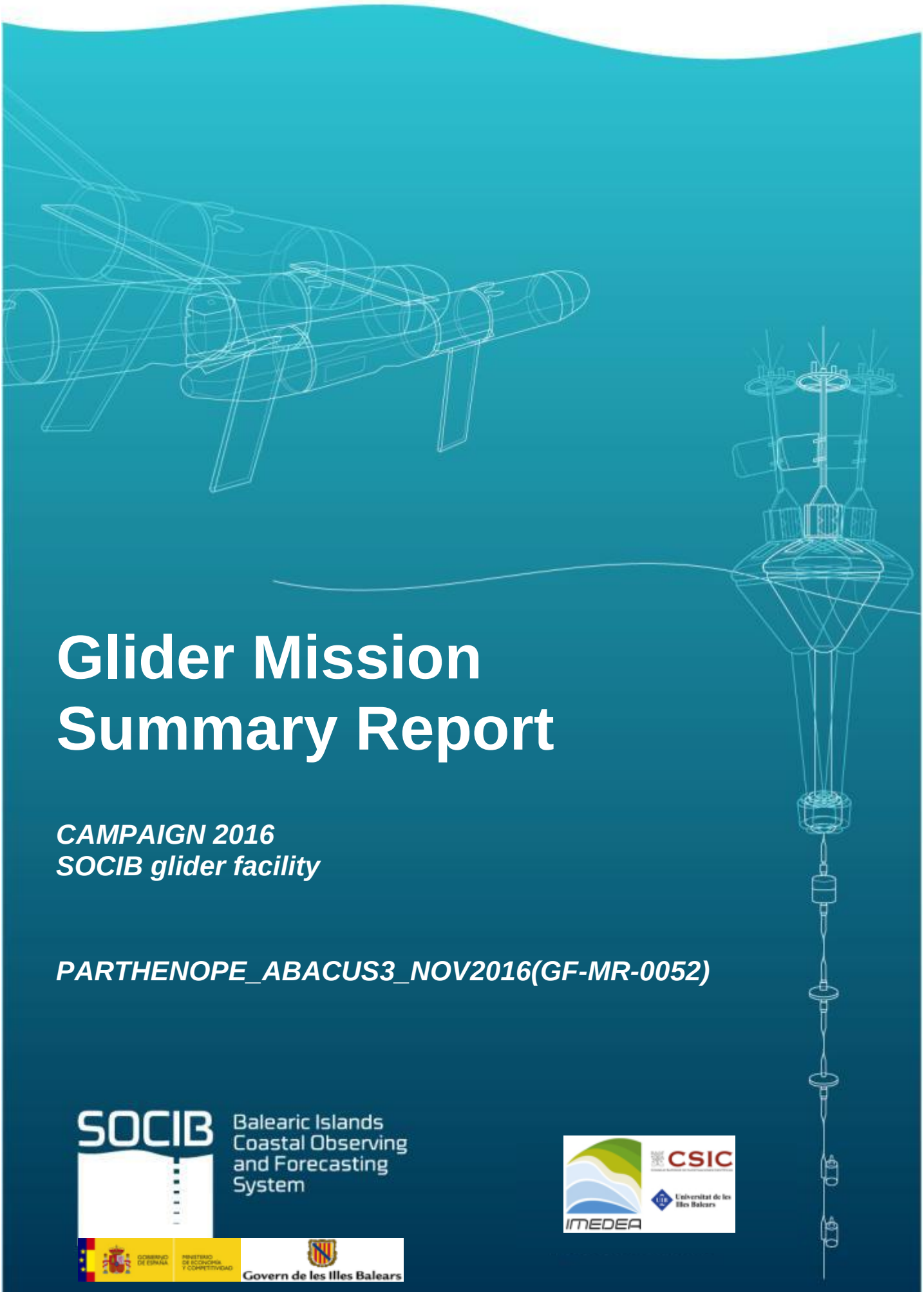

Glider Mission Summary Report

CAMPAIGN 2016
SOCIB glider facility

PARTHENOPE_ABACUS3_NOV2016(GF-MR-0052)

SOCIB Balearic Islands Coastal Observing and Forecasting System

Govern de les Illes Balears

IMEDEA CSIC Universitat de les Illes Balears

Mission Name	*PARTHENOPE_ABACUS3_NOV2016 (GF-MR-0052)*		
Platform Model	*Slocum 1000 G2*		
Platform ID / Name / WMO Code	*U244/ SDEEP01 / 68967*		
Related Platforms / Missions	*None*		
Start Date	*2016-11-04*		
End Date	*2016-12-23*		
Total Days	*50*	**Total distance (Km / Nm)**	*1142 / 617*
Survey Area (NODC or SDN region)	*Algerian-Basin (AB) region in between South-Mallorca-Coast and North-Algerian-Coast [Western Mediterranean Sea]*		
Objective(s)	• *To continue the time series of oceanographic data collected in the Algerian Basin along the endurance line between Mallorca and Algeri;* • *To identify the physical and biological properties of the surface and intermediate water masses between Balearic Islands and Algerian Coast;* • *To intercept any mesoscale eddy identified during the mission;* • *To understand the sub-basins dynamics and the complex interactions due to eddies;* • *To assess the ocean description capabilities of several satellite products when approaching coastal areas, also comparing them to glider high resolution in situ data;* • *To validate the new along-track (L3) and gridded interpolated maps (L4) altimetry products provided by the Sentinel-3 altimetry mission and the other satellites for the western Mediterranean Sea.*		

Scientific Sensors (name & model / serial_number / calibration date)	• *GPCTD -SBE- / sn 0107 / 15-Mar-2016* • *FLNTU -WetLabs- / sn4124 / 08-Oct-2015* • *OPTODE -Aandera- / sn 994 / 21-Nov-2014* *(calibration sheets available upon request to glidertech@socib.es)*
Number of Profiles	*Out of 937 profiles:* • *GPCTD: 906 profiles , 601 vms[1]/profile* • *OPTODE: 906 profiles, 601 vms[1]/profile* • *FLNTU: 905 profiles, 216 vms[1]/profile* *(See Figure 2 on profiles max. depth)* *[1]: vms=Vertical Meters Sampled (in water column)*
Significant Events	• *20161111 EDDY crossing* • *20161112 SENTINEL3 overflight* • *20161207 SENTINEL3 overflight*
Mission Summary	*Introduction* *This mission (GF-MR-0052), the first by SDEEP01 after its latest factory-refurbishment and the only one in 2016, stands for the 3rd ABACUS of all times and 1st ABACUS in the frame of JERICO-NEXT-TNA. Finally, the most recent precedent in the AB was mission SOCIB_ENL_ALGBASIN_MAY2016_IDEEP00_GFMR0046_SENTINEL3.* *Pre-mission Report* *Created prior to the beginning of preparations. It compiles key preliminary aspects of GF-MR-0052 derived from pre-mission planning sessions.*

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Preparation

Phases were executed between 25/10/2016 to 04/11/2016 (last phase, Harbor-Check, was performed the same day than the Launching operation). All checks and configurations were undertaken according to the pre-mission-report and applicable protocols. The most relevant issue during this phase was the discovery that this glider's original OPTODE sensor was not working properly (although it had just arrived from factory, twice, for re-calibration). Compass error was measured in a EMI-free forest location (max. error around 08º, see Figure-4) following an innovative procedure that pursues characterizing the compass with the glider being in three essential pitch-positions. As mentioned, there was no stand-by time between the Preparation and Launching phases.

Launching

This field operation (04/11/2016) was executed by 1 ETD and 1 GF facility members on board a Valiant 7m RIB. Glider was released in N39.3707º E3.3461º at 11:59am-utc. Base-harbor was Porto-Colom in order to minimize navigation while choosing a launching-wpt as closer to the first SENTINEL-3-expected-wpt as possible. The deployment was an operative and tactical success (environmental conditions were not ideal but the field-team managed to overcome all inconveniencies).

Survey

In general terms, it was very successful.

- ***Navigation***
  - *SDEEP01 was ballasted pretty well. During the first third of the mission time the buoyancy drive was ±190cc for navigation. When deep-flying-mode was activated the glider started to fly using an oil-drive of ±220cc. See Figure 1. The overall ratio of pump usage was 3.73% and the mean time the oil was moving, during inflections, 116.31 secs*
  - *Lat-Lon advancement (surface projection of traced route) was fluid and continuous during the whole survey period with a mean deviation from commanded route of 1.22Km*
  - *There were no forward-movement interruptions due to frontal currents*
  - *Waypoint list for this mission was stable and constant since the beginning of the survey. The majority of the waypoints were accomplished successfully (max. dead....)*
  - *Multiple waypoint-lists were commanded with modifications to implement a current-evasion maneuver and extending the target-number of IC transects.*
  - *The majority of waypoints were accomplished successfully (max. dead-reckoning error of 1Km).*
  - *The return trip was smooth and without problems. Navigation was not altered for recovery considering the glider continued along the IC while waiting for the field-team.*
  - *An average X-Y speed of 0,36m/s was accomplished.*
  - *Surface periods lasted (pre-post fix time in avg.) 506secs with a drifted distance of 119 meters.*
  - *Current-correction algorithm was on during the entire mission.*

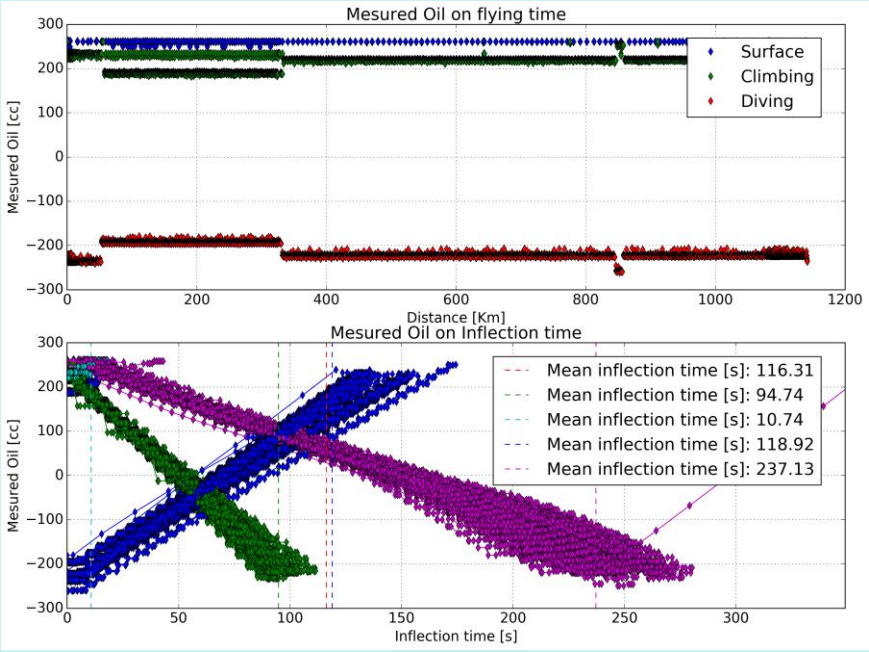

Figure 1. Oil Inflection

- ***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 slightly changed multiple times to adapt to*

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variations in these aspects (mainly flotation parameters to fly more efficiently). Basically, a standard configuration (surface by UTC time, 4 times a day, infinite yo-ing, altimeter on, manual pitch control) was implemented. Average vertical speeds of 0,41m/s (climbing) and 0,19m/s (diving) were accomplished resulting in a mean horizontal speed of 0,26m/s. Both target depths (upper and bottom) remained constant during the main part of the mission (15 and 950 meters respectively). In general, top and bottom inflections occurred at the expected depths (due to bottom detection or max. depth reached).

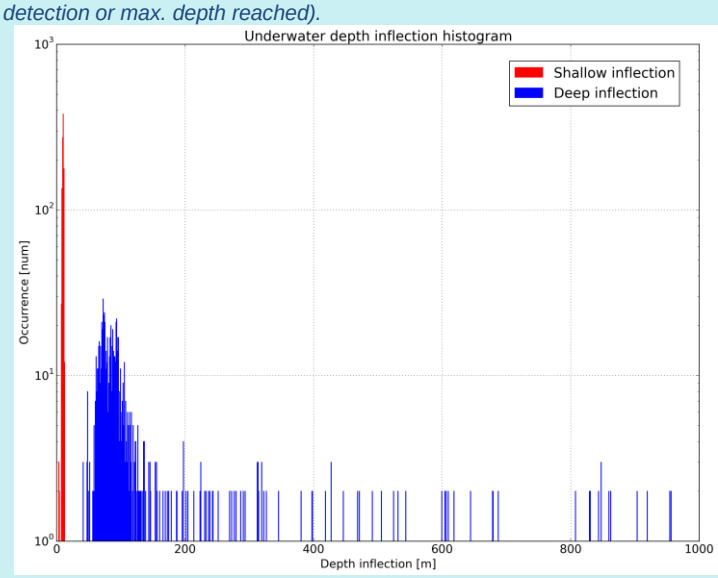

Figure 2 - Diving Max-Depth Histogram

- ***Data Logging**: sampling seemed to have been successful and according to details shown in Chart 2 (334 non-critical oddities and 2 warnings raised by science-super). The strategy was changed multiple times in order to save energy by turning on/off the optical sensors whilst CTD remained ON during the whole mission. This resulted in:*

	Profiles [num]	*Intersample time [s]*	*Samples [num]*	*Mesured water [m]*
CTD	*2361*	*2.981*	*1951876*	*492084*
OXY	*247*	*5.149*	*302715*	*49237*
FLNTU	*247*	*9.771*	*211210*	*32695*

- ***Engineering***
  - *Power Source: Used Primary Lithium Battery pack with, as considered prior to the mission, 420Ah of nominal capacity. After this experience, the nominal capacity of the packs from this manufacturer are considered usable only until depleting 310Ah*

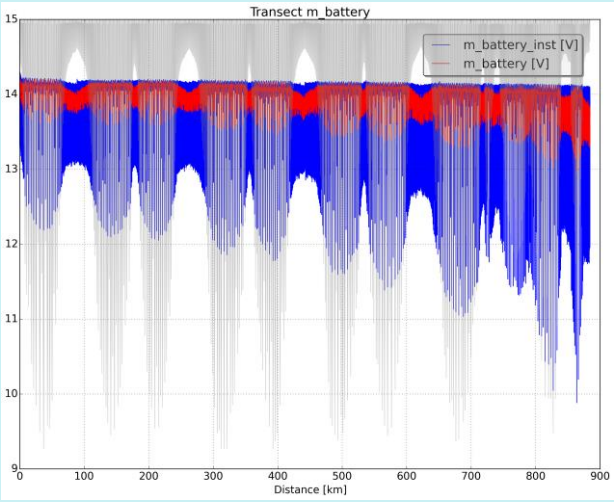

Figure 3 - Battery evolution and decay

  - *Electro-Mechanical: actuators and sensors exhibited an excellent performance during all*

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mission.

- *Communication Systems: were reliable and fluent.*
  - *There were 28 drop-calls and 2 missing-calls.*
  - *ARGOS sent 1510 messages.*
  - *GPS fix time (mean) was 240 seconds and there were no pre-fix failures.*
  - *No radio-link (900Mhz) issues during local communications.*
- *Electronic Modules: (processors, memory cards, control boards,...) revealed no evidences of problems.*
- *Contextual/Awareness Sensors: pressure transducer, internal vacuum and internal temperature seemed to have worked correctly. Altimeter and Compass also reported coherent values.*
- *Hull/Hydrodynamics: no signs of problems.*
- *Device Error-Statistics:*

Sensor	Oddities	Warning	Errors
GPS	0	5	0
attitude_rev	0	9	0
ocean_pressure	7	0	0
pitch_motor	184	0	0
science_super	334	2	0
digifin	856	0	0
IRIDIUM	368	2	0
coulomb	66	0	0

- *Mission Runs: 2 missions were ran due to Overtime abort on 11/08/2016*

Recovery

It was arranged and executed on August-23th 11:23 LT in N39° 28.928' E02° 12.4456'. A team formed by 1-ETD and 1-GF departed early in the morning and cruised (on board SOCIB-I RIB) for 1.5 hours until interception (Glider was already at surface waiting) and was extracted with no problem availing a favorable sea-state.

Conclusion

This phase started on the 13rd of September and took longer than usual due to vacation period. This phase concluded on 23rd with the following headlines: (1) vehicle's hull was disassembled, flight-mechanisms and electronics revised and batteries removed; (2) external surfaces and sensors cleaned and refurbished (light signs of corrosion and important evidences of biofouling growth); (3) gathered-data backed up by direct extraction of memory flash cards and uploading to SOCIB's data-center for post-processing; and, finally, (4) preparing the glider for storage.

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) was fluent and efficient in spite of the field failure during recovery. There were no severe personal damages and the availability of each member, for all the tasks assigned at each moment, was correct (including on-alert shifts for field intervention and 24/7 glider monitoring during survey)..

Detailed Charts:

Date (utc)	D_{UTI}	D_{UBI}	T_{UND}	d_{BOT}	N_{DIV}	N_{COM}	t_{UTC}	H_{WPT}
12/Jul@(M.S.) (1)	15	950	21600	40	∞	12	4,10,16,20	1000

(1): Prior to this nominal underwater strategy, preliminary test dives were performed (to validate trimming and bottom detection)
(2): Shallow diving to check (via NRT transmission) optical sensor sampling
(3): Shallow diving to keep the glider navigating underwater while waiting for recovery team to intercept it

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

Chart 1 Summary of Underwater Strategies (Navigation)

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Date (utc)	S_{EN}	f_{SMP}	D_{RNG}	M_{DIV}	M_{CLI}
12/July/2016 (at Mission Start)	CTD	0,5000	[-5, 2000]	yes	yes
	OXY	0,2500	[-5, 2000]	yes	yes
	FLNTU	0,1250	[-5, 150]	yes	yes
	FLNTU	0,0625	[150, 300]	yes	yes
16/July/2016	CTD	0,5000	[-5, 2000]	yes	yes
	OXY	Off	-	-	-
	FLNTU	Off	-	-	-
	FLNTU	Off	-	-	-
28/July/2016	CTD	0,5000	[-5, 2000]	yes	yes
	OXY	0,2500	[-5, 2000]	yes	yes
	FLNTU	0,1250	[-5, 150]	yes	yes
	FLNTU	0,0625	[150, 300]	yes	yes
01/Augy/2016	CTD	0,5000	[-5, 2000]	yes	yes
	OXY	Off	-	-	-
	FLNTU	Off	-	-	-
	FLNTU	Off	-	-	-
23/Aug/2016 (until Mission End)	CTD	0,5000	[-5, 2000]	yes	yes
	OXY	Off	-	-	-
	FLNTU	Off	-	-	-
	FLNTU	Off	-	-	-

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

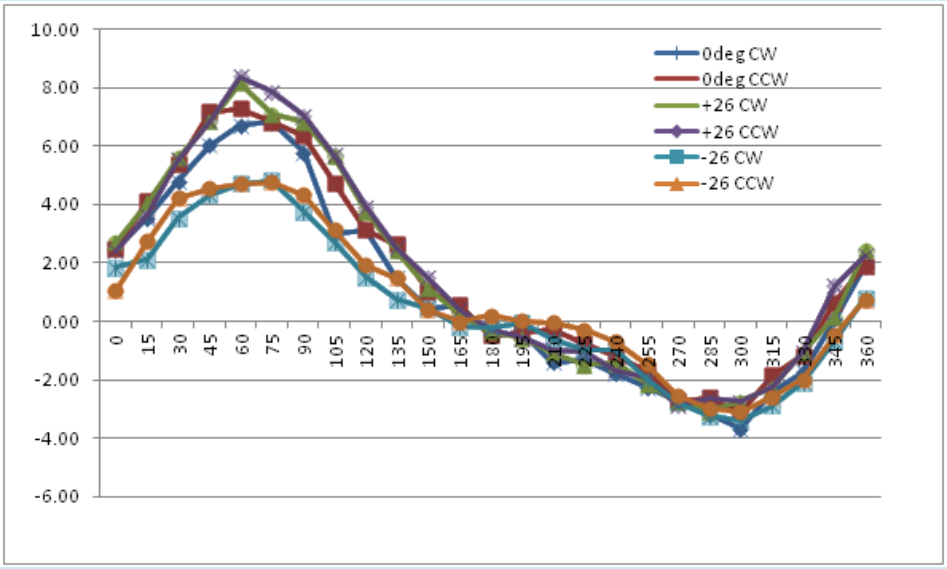

Figure 4 - Error measured during Compass Error Check procedure in an electromagnetic-field-free environment located in a forest close to IMEDEA (in Esporles). Three modalities (with 3 different pitch positions: 0deg, -26deg, +26deg) of the test produced the six series shown in this plot (clock-wise -CW- and counter-clock-wise -CCW- for each pitch position)

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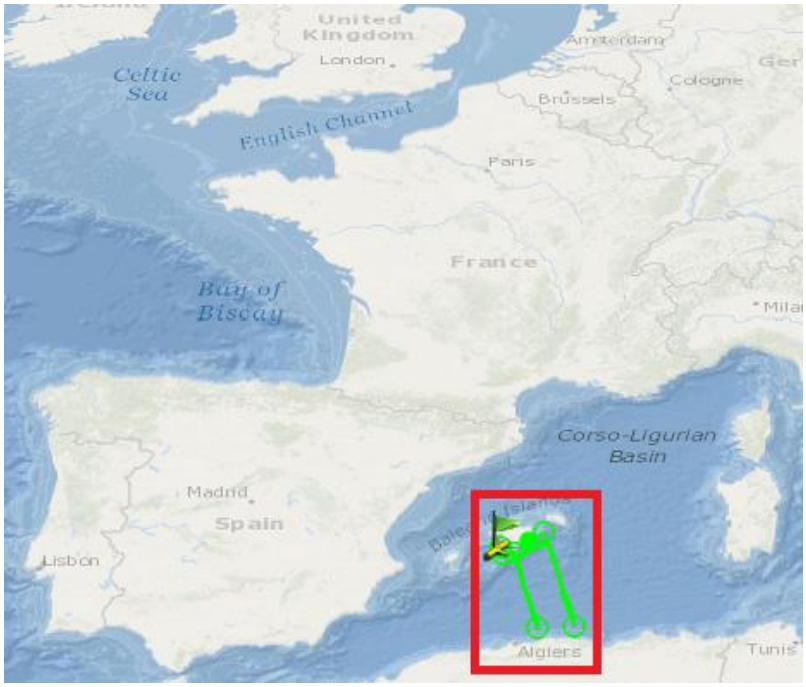
Project Affiliation (web-site)	*http://www.jerico-ri.eu/infrastructure/socib-glider-facility/*
Partnership / Participation	• *PARTHENOPE (Jerico-Next-TNA granted team)* • *SOCIB (Accessed Infrastructure)* • *IMEDEA (in-kind contribution)*
Glider Software Version	*Nav : v7.13 Acomms, Payload: 3.17*
Data Retrieval (real-time [RT] / delayed-mode [DM])	• *RT: sub-set via satellite link at each surface maneuver* • *DM: full/direct memory card backup after glider disassembly during Conclusion mission-phase*
Compass Calibration	*Compass error was measured. Observed error followed a well-known sinusoid-shape although the glider followed traced-route very well(See Figure 4)*
Battery Type	*Brand-new TWR official lithium set (667Ah-nominal capacity) Internal Reference: PACK_SN0013*
Battery Consumption (Ah)	*239,81Ah (reading from 3,27Ah to 243,08Ah)*
Data Available From	*http://thredds.socib.es/thredds/fileServer/auv/glider/sdeep01-scb_sldeep001/L2/2016/dep0021_sdeep01_scb-sldeep001_L2_2016-11-04_data_dt.nc*
Further Details	*glidertech@socib.es*

Figure 1

(Map providing general overview of Survey Area)



On-line Tracker

http://apps.socib.es/dapp/?deployments=683-50-0-00FF00&layers=isobaths,ocean_basemap&units=scientific

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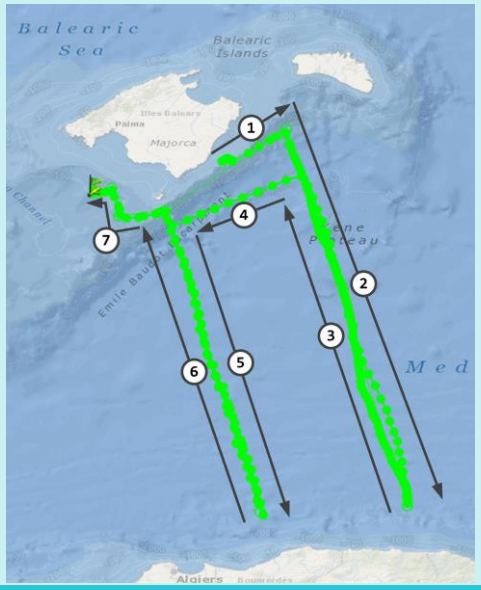
Figure 2

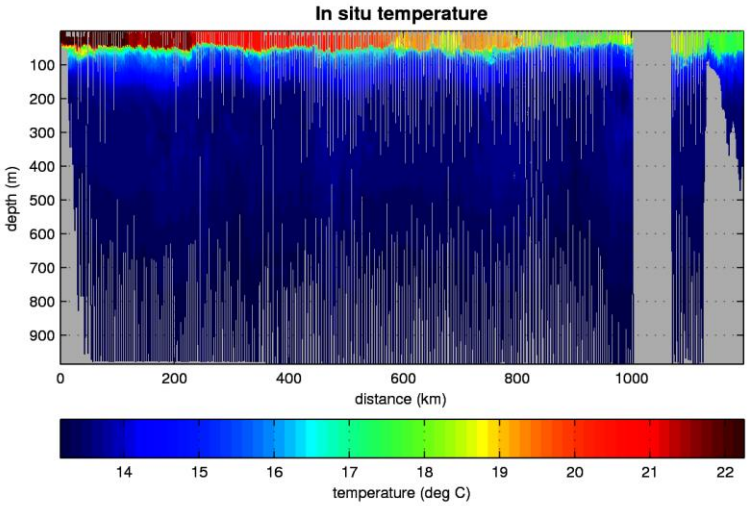
(Map providing detailed overview of Survey Area and traced Flight Path with surface-dots and ordered segments by index)



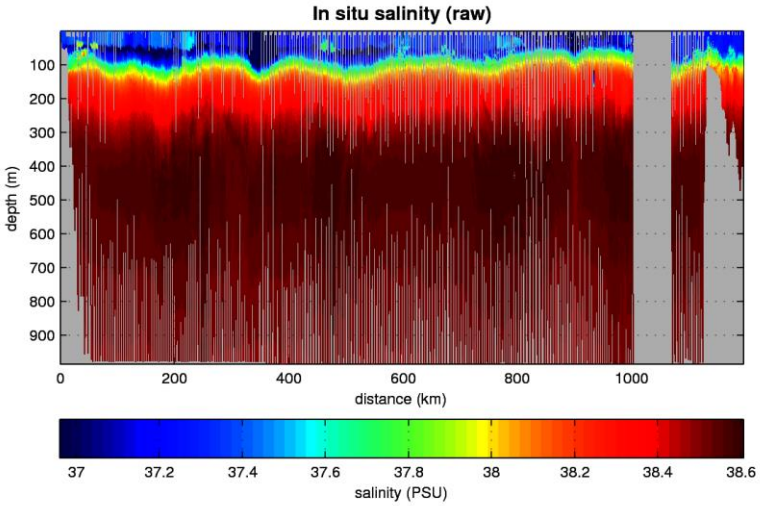
Scientific Preliminary Review

(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 -)

CTD



Plot 1 - In situ temperature (full depth range)



Plot 2– In situ salinity (full depth range)

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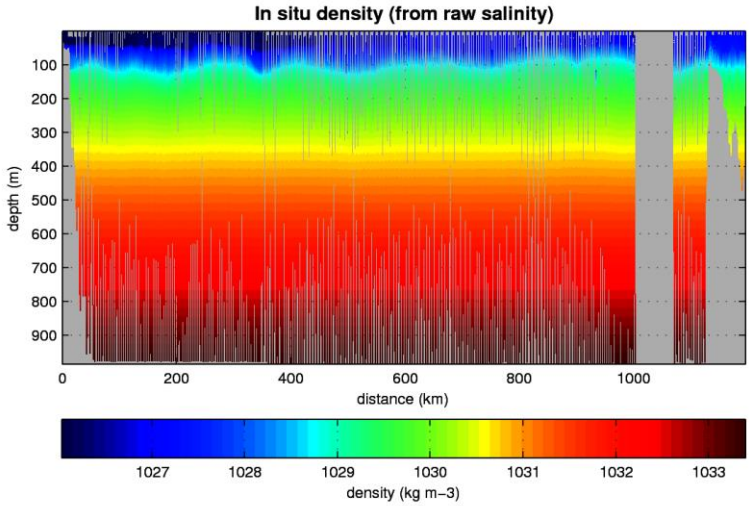
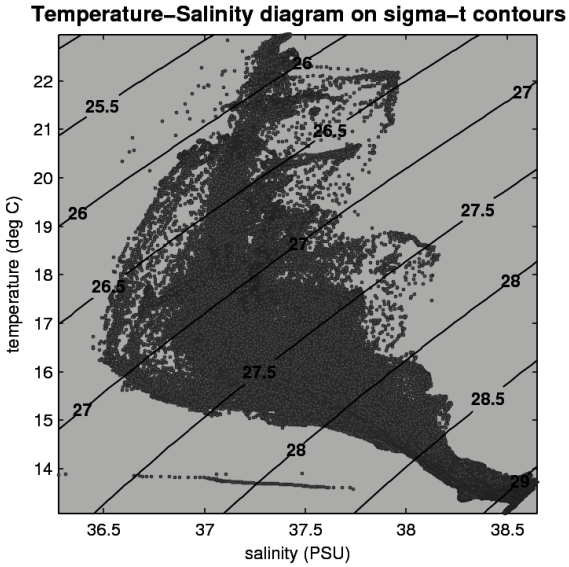


Plot 3 – density derived from corrected salinity and temperature (full depth range)

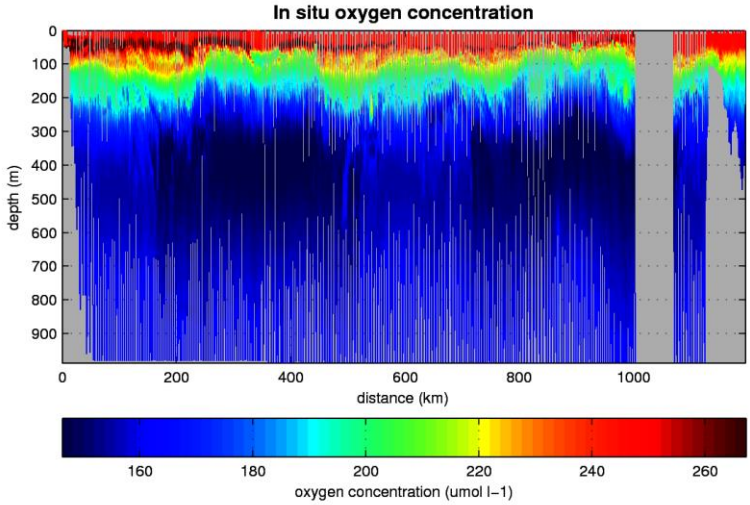
(Plot4 shown here is the result of a Quality-Control method applied by SOCIB's Data-Center to filter suspiciously low salinities that were totally out-of-range in the Balearic Channels region - see a miniaturization of the original-plot below-.

Contact akrietemeyer@socib.es for further info.)



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

OXYGEN



Plot 7 – in situ oxygen concentration

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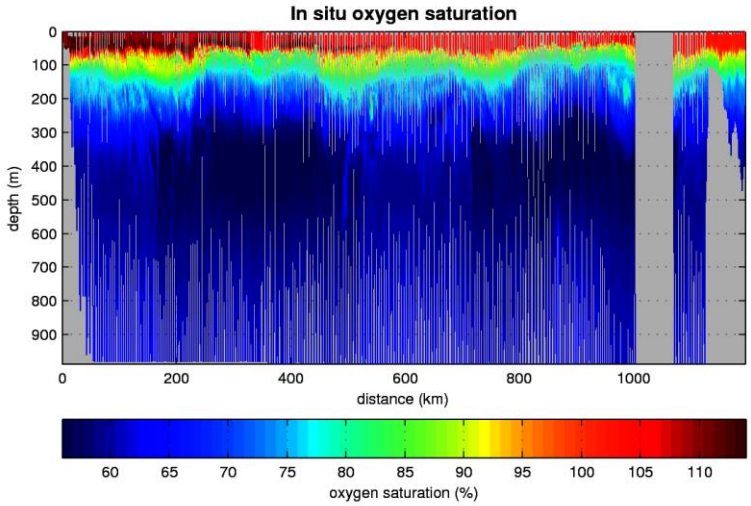
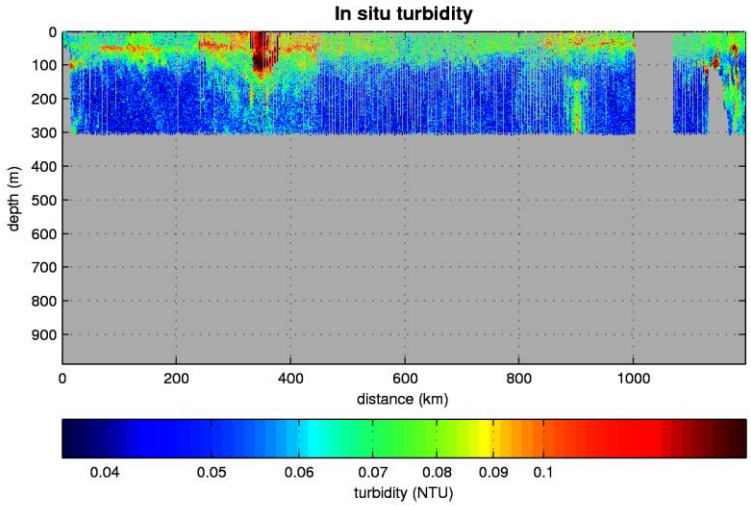
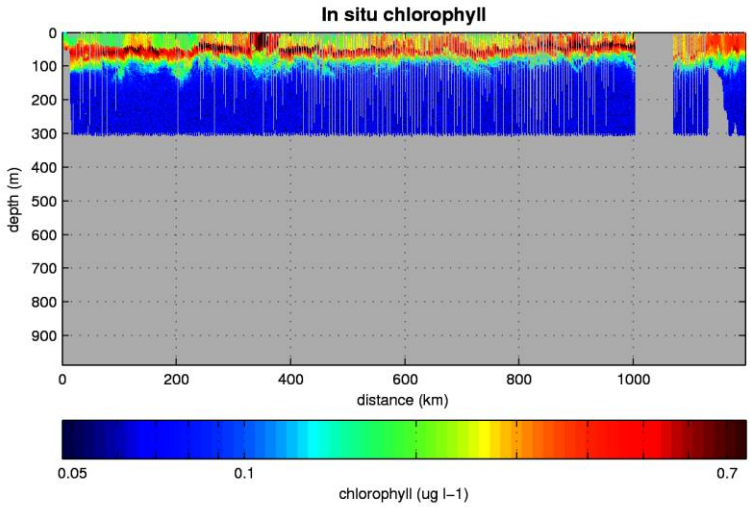


Plot 8 – in situ oxygen saturation

TURBIDITY & CHLOROPHYLL



Plot 9 – in situ turbidity



Plot 10 – in situ fluorescence

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