

Post Mission Report

‘sdeep02 trimming, depth tests and first navigation experiences’

Team Leaders

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Launch date	12/03/2012
Launch location	Sóller
Glider	538-sdeep02 iRobot Seaglider 1KA
Duration of mission	15 days
Recovery location	N/A

1.0 Plan

1.1 Operations

Distance from port to Launch is 5,7 nm, about 30 min sail (Fig 1). Valiant vessel will be used.

Field team will be composed of DR, CC and EV. SC will pilot from IMEDEA. Backup pilots will be MT, MM and DR. Communications between field team and pilot team will be mostly using WhatsApp messaging and regular mobile phone calls.

EV will film deployment operations and the glider diving.

Piloting during the mission will be done either from IMEDEA or from home.

Recovery is planned for March the 16th using the Valiant.

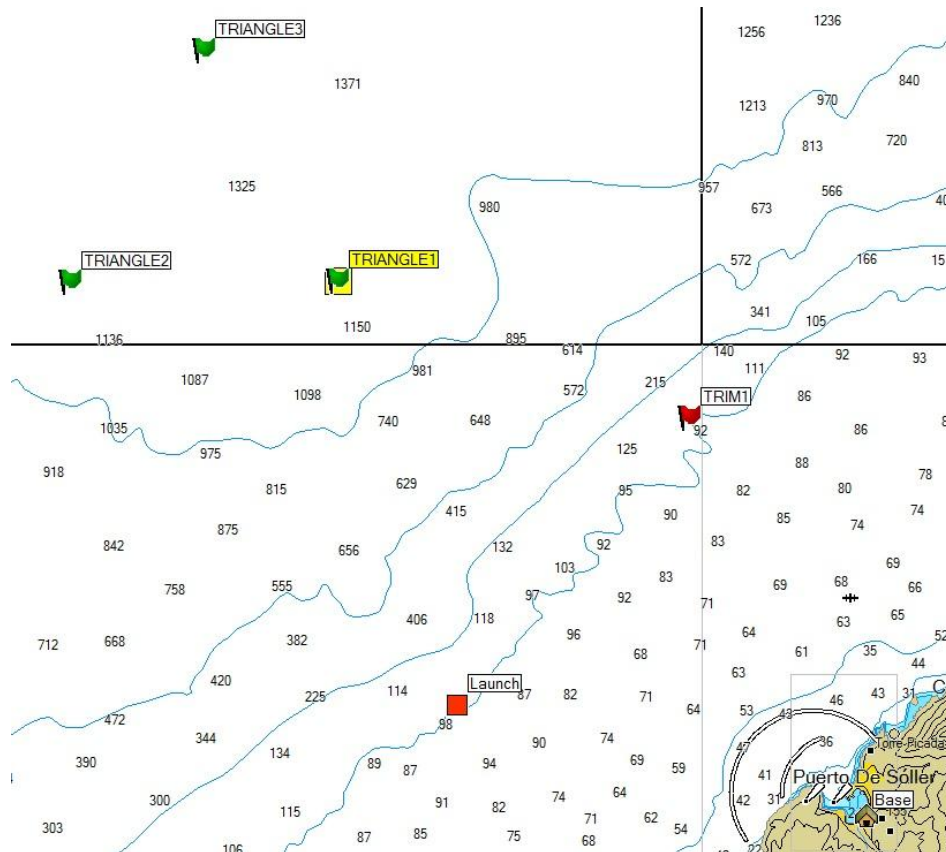


Fig 1: Planned working area for the mission

1.2 Piloting and Technical

The mission has 3 different parts aimed at validating the technical side of the glider so that it will be ready for a scientific mission:

First two parts will take place along the line linking Launch point and TRIM1 (Fig 1, in red). The glider will fly between these two waypoints (bathymetry 100m) until:

1. Trimming is done: last mission (GF-MR-0004) showed sg538 had a very unstable pitch during ascent. The glider will dive down to 60 meters all the time and successive tunings will be applied until it is considered trimmed (i.e. flies correctly).
2. Altimeter is calibrated: while the glider is being trimmed, the altimeter will be calibrated. The purpose is to find the ground when it is 50 meters away. This distance will allow apogeeing in time and also saving energy pinging only every 10 meters.

It is expected these two points can be done in 2 days. Experience gained by pilots is a very important by-product of these two first days. The glider should be located via Argos within these two days. If it is not, part 3 of the mission will not take place.

Once 1 and 2 are achieved, the glider will head to TRIANGLE1 (Fig 1) to perform:

3. Depth tests: Successive dives will be commanded increasing 75 meters depth every time. Once 975 meters depth have been reached without issues (leaks or errors), the glider will fly describing a triangle all the time at maximum depth to ensure robustness.

iRobot basestation will be used.

1.3 Scientific

Will gather CTD, FLNTU and Oxygen.

Will make CTD sample as fast as it can.

Will try different sampling policies at different depths.

Matlab scripts will be written in order to have an idea of how the glider is sampling.

2.0 Events

2.1 Operations

The glider was deployed at Launch, between the points where the trimming navigation was planned (Fig 2), in order to shorten the vessel's route from Sóller's port. Everything went as planned.

This mission has no recovery operation as a scientific mission, GF-MR-0006, follows it.

2.2 Piloting and Technical

On dive 10, the glider was already trimmed and navigating at a pitch of 26 degrees and vertical velocity of 17,5 cm/s using MAX_BUOY,150.

On dive 18 the ground was found 34m away using ALTIM_PULSE,7 and ALTIM_SENSITIVITY,2.

The glider was trimmed, the floor detected at a safe distance and the Argos tag had sent messages but had not been located. It was decided to head to TRIANGLE1 for depth tests.

On dive 43 the altimeter gave a false positive with ALTIM_PULSE,7 and ALTIM_SENSITIVITY,2 at 140m depth. ALTIM_SENSITIVITY,3 was set and now the glider gave a false positive at 190m depth. With ALTIM_SENSITIVITY,4 the false positive issue was solved but detecting the ground was not checked.

On dive 51 the maximum depth, 975m, was reached for first time. After 15 dives to 975m the glider was considered leak-proof.

The communications worked well and no errors popped up so it was decided to navigate to NAV1 (fig 2) and try different things on the glider.

On dive 71, CALL_NDIVES,2 was set to check the glider would surface to just get a GPS fix and dive again skipping communications. The time between GPS1 (fix the glider gets right after surfacing) and GPS2 (fix the glider gets before diving the next dive) was 1:58 minutes. On dive 75 (a 975m deep dive), for example, this time was 15:06 minutes.

On dive 76, the glider was located via Argos for first time when transferring data and being on the surface for 34 minutes. Location quality was 1 and the distance between the GPS and ARGOS fixes was 127 meters.

From dive 77 the glider was set to navigate at a pitch of 17 degrees and vertical velocity of 12,5cm/s using MAX_BUOY,180. This way, a horizontal velocity of 40 cm/s and a CTD sample every 0,5m of depth would be reached, mimicking the Slocum vertical scientific resolution and synopticity but with less horizontal resolution.

It is observed that on the way from TRIANGLE3 to NAV1 (Fig 2) the glider moves at 21,7 cm/s horizontally (dive 89) when the pitch is 17° and the vertical velocity 12,5cm/s. Glider's bearing is 55° and the current calculated by the glider (\$CURRENT) is 7,9 cm/s at $9,5^\circ$. This gives the glider was facing a 5,5 cm/s current giving a total glider horizontal velocity of 27,2 cm/s.

On dive 90, the direction is changed 180 degrees and the horizontal velocity reaches 33,9 cm/s. Current in the direction of the glider is positive, 8,4 cm/s. So, total glider horizontal velocity on this dive was 25,5 cm/s.

On dive 99, N_NOSURFACE,3 was set and therefore dive 99 and dive 102 ended below surface.

DIVE,108 was set in order to use N_NOSURFACE,-6 and do 6 consecutive dives without surfacing. The glider surfaced on dive 114 and sent data of all not surfaced dives. Then UPLOAD_DIVES_MAX,1 was set and when the glider surfaced after dive 120, it only sent data of dive 120 keeping the not surfaced dives in the hard drive to be sent later.

On dive 142, Slocum navigation features are sought. Vertical velocity gets to 20 cm/s and pitch 26° . However, horizontal velocity reaches only 31 cm/s compared to the Slocum's 38cm/s .

From dive 156, the glider navigates using N_NOSURFACE,-5 in order to test subsurface navigation for 5 dives (Fig 3). Using this feature, the glider does not correct currents (NAV_MODE,1) and uses the last GPS fix it got before diving to set the heading of each subsurface dive. When the glider surfaces, it does not calculate the DAC (Depth Average Current) of the 5 dives and therefore it cannot correct it.

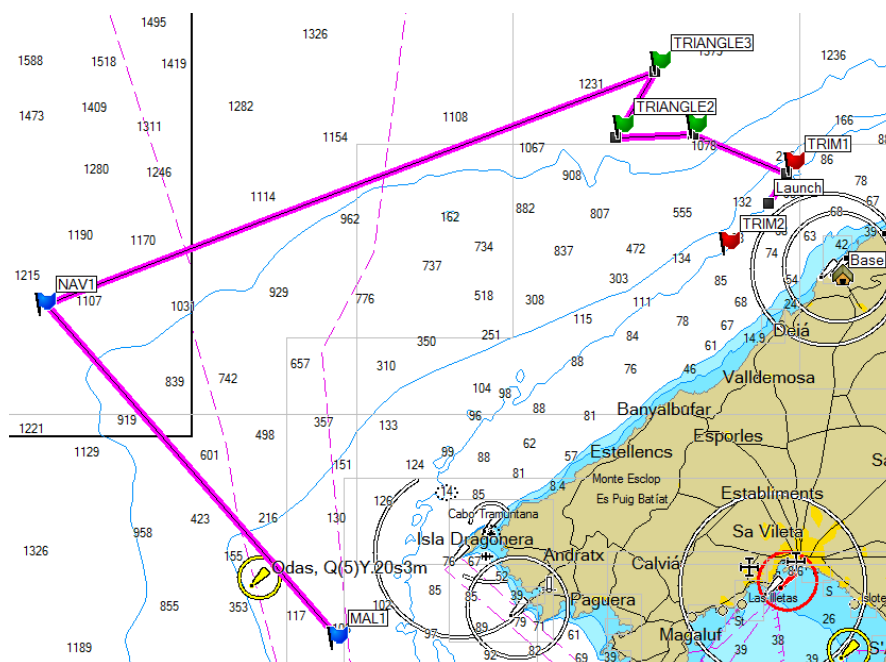


Fig 2: sg538 approximate trajectory during the mission

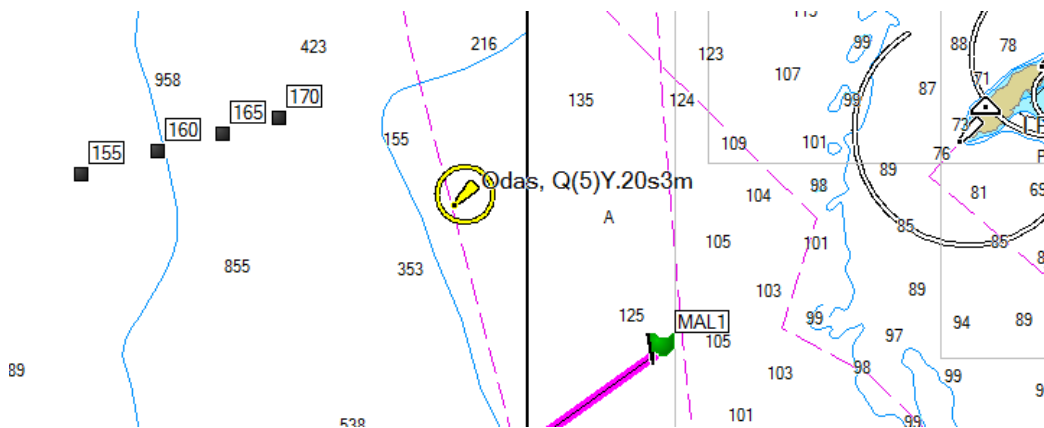


Fig 3: Subsurface Seaglider navigation does not correct for the currents while trying to reach MAL1 (green flag)

On dive 171, N_NOSURFACE,0 is set (disabled) and navigates using ferry mode to MAL1 to start the scientific mission, GF-MR-0006. ALTIM_PULSE,7 and ALTIM_SENSITIVITY,2 give now no false positives and are used to detect the seafloor about 50m away.

SL started working on the dapp2 application to show in real time the Seaglider position and also basic engineering and navigation parameters.

2.3 Scientific

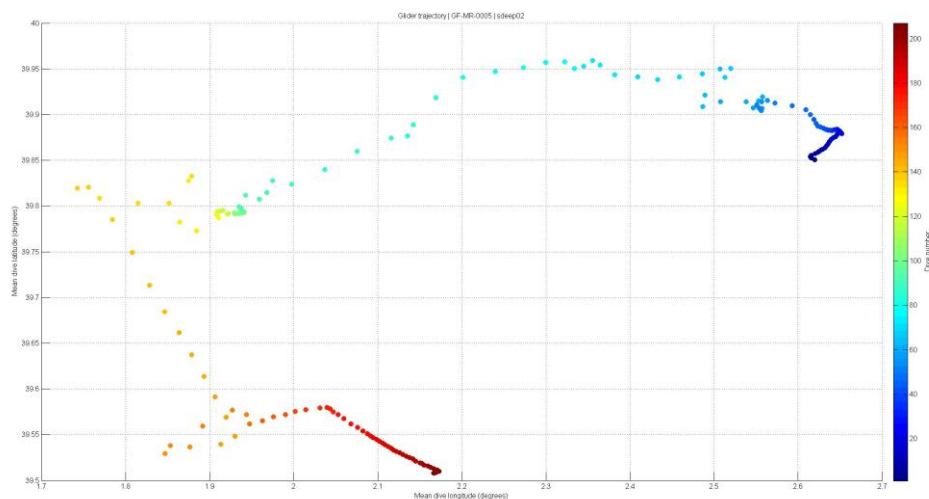


Fig 4: sdeep02 trajectory during the mission

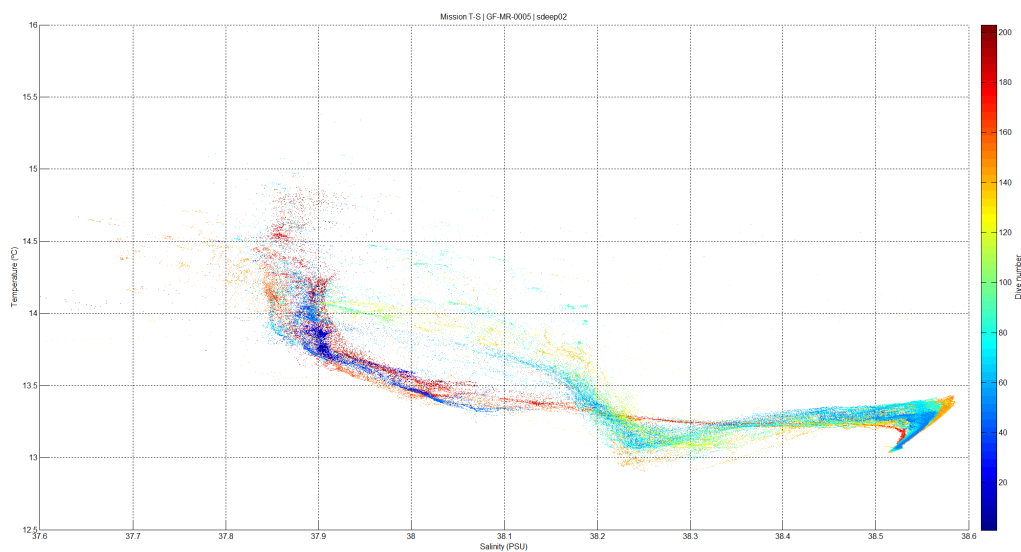


Fig 5: Mission T-S plot

Temperature:

No filter applied. The used variable is temp_nolag.

temp_nolag (°C)								
Filter Min	Filter max	Taken values	Filtered values	NaN values	Max value	Min value	Mean	Standard deviation
N/A	N/A	234036	N/A	1	15,8258	12,9003	13,2983	0,3135

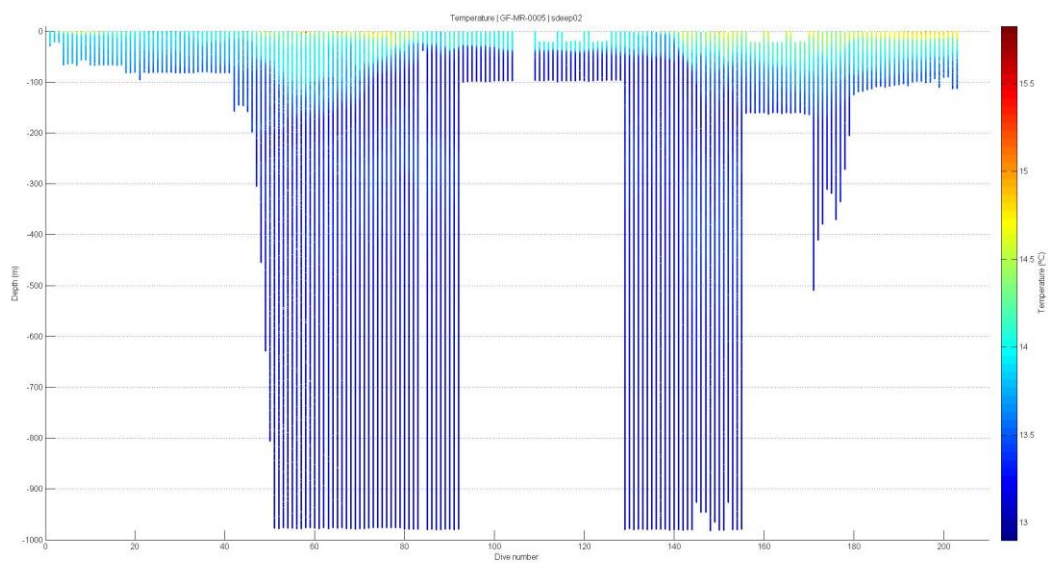


Fig 6: Temperature evolution during the mission

Salinity:

A filter has been applied to the salinity after plotting the T-S diagram (Fig 5) and performing a visual inspection of its data. The used variable is salinity_nolag.

salinity_nolag (PSU)								
Filter Min	Filter max	Taken values	Filtered values	NaN values	Max value	Min value	Mean	Standard deviation
37,6	38,6	233707	329	1	38,594	37,600	38,402	0,2256

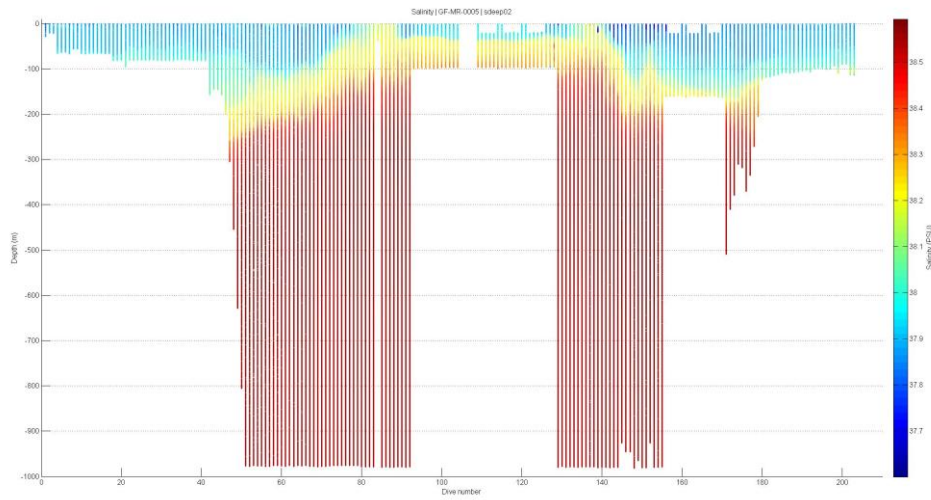


Fig 7: Salinity evolution during the mission

Density:

After plotting all data, values for the filter are obtained visually. The used variable is sigma_t.

sigma_t (kg/m3)								
Filter Min	Filter max	Taken values	Filtered values	NaN values	Max value	Min value	Mean	Standard deviation
28,0	29,2	233634	402	1	29,132	28,0038	28,9699	0,2325

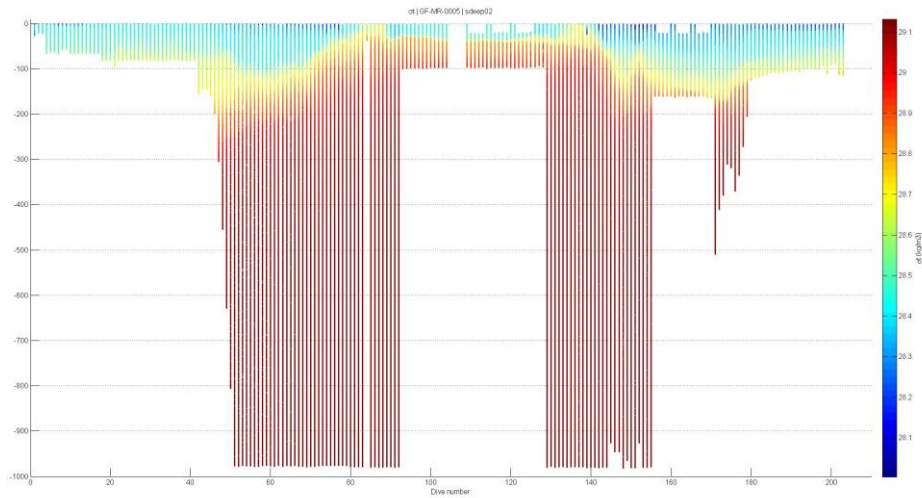


Fig 7: Density evolution during the mission

Oxygen:

Values higher than 500 and lower than 0 are discarded according to iRobot Matlab GUI matlab scripts. Then, values are divided by 44,61 to pass from uM to ml/l. The used variable is eng_aa4330_O2.

eng_aa4330_O2 (ml/l)								
Filter Min	Filter max	Taken values	Filtered values	NaN values	Max value	Min value	Mean	Standard deviation
0	11,2082	61365	3890	168782	11,1997	0,0354	5,0800	0,781

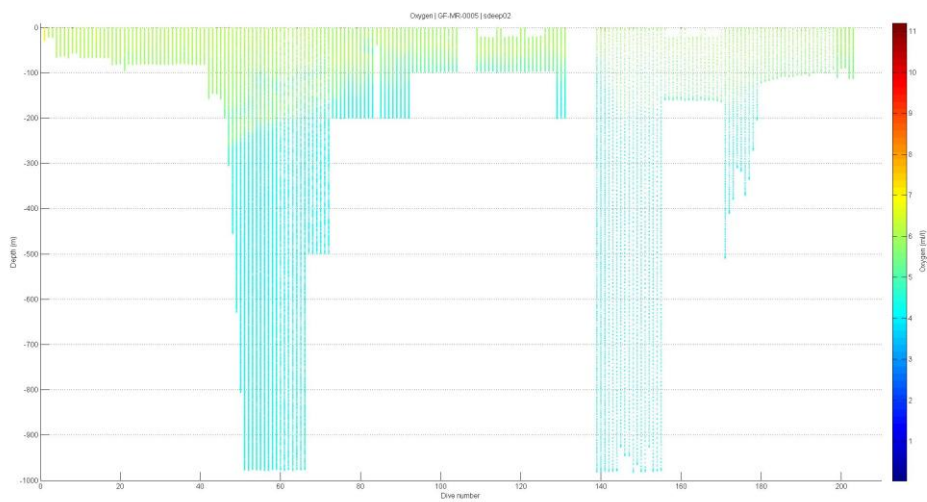


Fig 9: Oxygen evolution during the mission

Chlorophyll:

WetLabs calibration sheet constants are used: SF=0,0118 µg/l/count, Dark counts= 38.
This formula is used: $CHL(\mu g/l) = SF * (Output - Dark\ counts)$. The used variable for
'output' is eng_wlbbfl2vmt_Chlsig. For consistency, negative values are filtered.

CHL (µg/l)								
Filter Min	Filter max	Taken values	Filtered values	NaN values	Max value	Min value	Mean	Standard deviation
0	N/A	66627	7	167403	3,1034	0	0,3153	0,2435

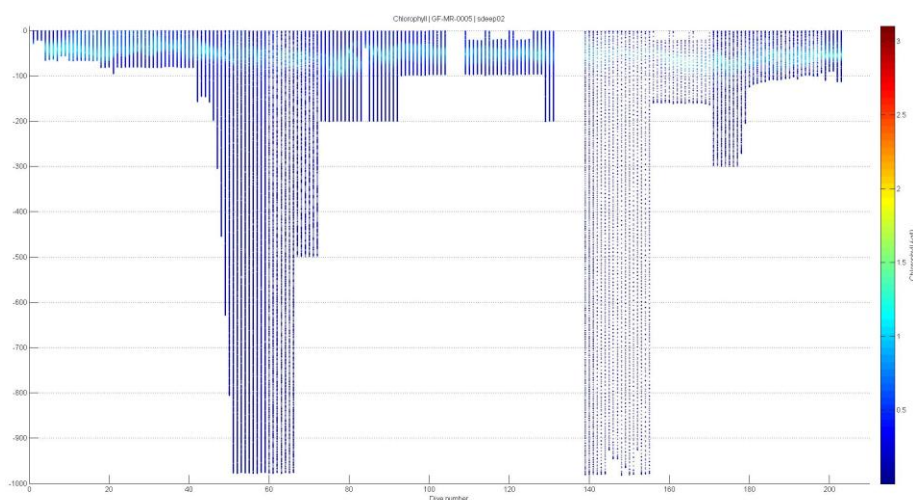


Fig 10: Chlorophyll evolution during the mission

CDOM:

WetLabs calibration sheet constants are used: SF=0,0878 ppb/count, Dark counts= 40.
This formula is used: $CDOM(ppb) = SF * (Output - Dark\ counts)$. The used variable for
'output' is eng_wlbbfl2vmt_Cdomsig. For consistency, negative values are filtered.
After a visual inspection it is decided to filter values greater than 3ppb.

CDOM (ppb)								
Filter Min	Filter max	Taken values	Filtered values	NaN values	Max value	Min value	Mean	Standard deviation
0	3	66613	21	167403	2,8974	0	1,8962	0,2429

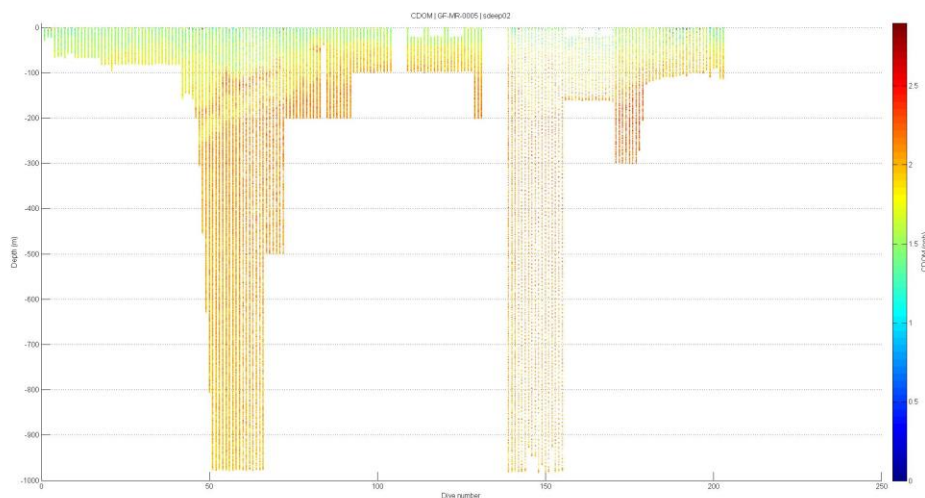


Fig 10: CDOM evolution during the mission

Scattering:

WetLabs calibration sheet constants are used: $SF=3,514E-06 \text{ m}^{-1}\text{sr}^{-1}/\text{counts}$, Dark counts= 33.

This formula is used: $\beta(\theta c) (\text{m}^{-1}\text{sr}^{-1})=SF*(\text{Output-Dark counts})$. The used variable for 'output' is eng_wlbbf12vmt_wl600sig. For consistency, negative values are filtered. After a visual inspection it is decided to filter values greater than $7E-04 \text{ m}^{-1}\text{sr}^{-1}$.

Scattering ($\text{m}^{-1}\text{sr}^{-1}$)								
Filter Min	Filter max	Taken values	Filtered values	NaN values	Max value	Min value	Mean	Standard deviation
0	7e-04	66593	41	167403	6,9226e-04	0,59738e-04	1,8405e-04	0,49808e-04

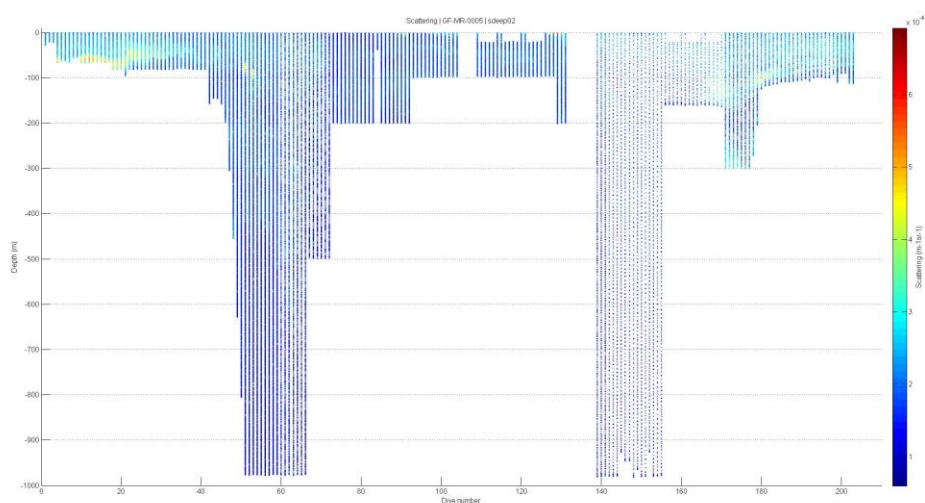


Fig 10: Scattering evolution during the mission

3.0 Results

3.1 Operations

Seaglider operations using the Valiant are consolidated.

3.2 Piloting and Technical

The glider is leak-proof at 1000m depth.

Communications between glider and iRobot's basestation are good.

ALTIM_PULSE,7 and ALTIM_SENSITIVITY,2 are good values to detect the ground at a safe distance (50m).

SM_CC needs to be adjusted at a value 100cc higher than the suggested CCsurf_min on plot 11 that gives the Matlab GUI.

The Argos tag sent several messages but was positioned just once with 127m error. The tag needs longer time than the usual 20min surfacings to position itself.

An automatic application to follow the Seaglider's trajectory will be very useful. Bathymetry and boat traffic added as layers on it would help while piloting the Seaglider. Currently Google Earth is being used.

CAPUPLOAD,0 avoids the glider sending the .cap file so that reduces surface time and Iridium costs.

Minimizing boat collision risk:

	\$CALL_NDIVES	\$N_NOSURFACE	\$NAV_MODE	\$KALMAN_USE	Current correction	Time on surface	\$DIVE	\$D_FINISH	\$UPLOAD_DIVES_MAX
Calling every N dives	N	0	2	2	Yes	4 min	Don't change	Any	0
Surfacing every N dives	1	-N	1	2	No	0 min	Can be increased to the needs	25	0

Navigation styles:

	\$MAX_BUOY	\$D_TGT	\$T_DIVE	\$GLIDE_SLOPE	Vertical velocity	Horiz. velocity	Pitch	24V consumption	Dives used
Slocum navigation	200	975	325	30	20 cm/s	31 cm/s	26°	0,062 Ahr/km	142:152
Slocum CTD vertical resolution	180	975	550	18	12,5 cm/s	26 cm/s	17°	0,045 Ahr/km	130:140

Mission summary:

Profiles	24V consumption	24V consumed %	10V consumption	10 V consumed %	Total consumption
203	26,105 Ahr	17,4%	21,831 Ahr	21,83%	47,936 Ahr

3.3 Scientific

Science file was modified several times to check different sampling policies at different depths. Sensors were turned off when they had to.

Some tools have been developed to easily plot the .nc files. The basestation creates a .nc file that contains concatenated data of all existing dives.

Maximum CTD theoretical frequency is 0,25 Hz. A low value compared to that of the Slocums (0,5 to 1 Hz), which makes navigation slower to get the same resolution. Data obtained seem reasonable.

Oxygen sensor gives noticeable signal until 250m depth. Data are coherent if we look at 'Scientific Validation Report (ScCR) of Dissolved Oxygen and Chlorophyll-A for period 010711 – 311211' from MyOcean project. Plots in this document give values between 6 and 7,5 ml/l, similar to those gotten by sdeep02 between 0 and 100m depth.

The mentioned MyOcean report also gives some plots for chlorophyll. Values are between 0 and 1 mg/m³, similar to those collected by sdeep02 between 0 and 100m depth.

CDOM and scattering plots need further analyse and comparison with published studies.

Quality control methods need to be used to filter data statistically and not visually.