CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

SOCIB Balearic Islands Coastal Observing and Forecasting System

GLIDER MISSION REPORT

Reference: *GF-MR-0013*

Platform:	*GLIDER SEAGLIDER*
Platform ID:	*sdeep03 (Unit541)*
Mission:	*JERICO TNA SARDINIA JAN13*
Dates:	*January, the 31st , 2013* ***to*** *March, the 16th , 2013*

Issue:	Glider Post-mission Report
Description:	This document summarizes the mission definition, preparation, logistics and results obtained from the mission *JERICO TNA SARDINIA JAN13* in line with SOCIB glider facility monitoring operations and CSIC contribution to JERICO and PERSEUS projects.
Authors:	Simó Cusí
Involved Personnel:	Simó Cusí, Marc Torner, David Roque, Miguel Martínez, Benjamín Casas, Carlos Castilla, Irene Lizarán, Guillermo Vizoso, Joan Pau Beltran, Sebastián Lora, David March, Emma Heslop, Simón Ruiz, Ananda Pascual, Jose Luís Lopez Jurado, Rosa Balbín Chamorro, Joaquin Tintoré, Alberto Ribotti, Antonio Olita

DOCUMENT

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CHANGE RECORD

Issue	Date	Description of Change	Author	Checked By
0	January, 28 2013	Creation	S. Cusí	
1	May, 14 2013	First preliminary draft. Only first transect CTD results.	S. Cusí	
2	June, 17 2013	Second preliminary draft. Needs completion and commenting the results.	S. Cusí	

APPLICABLE AND REFERENCE DOCUMENTS

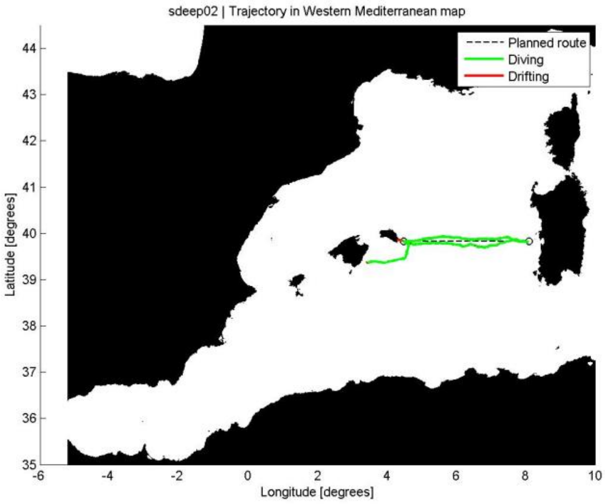
Applicable Documents

	Ref	Title	Date / Issue
DA 1	SG UserGuide	1KA SeagliderTM User's Guide	Revision D, 2012
DA 2	SG Endurance	iRobot – Seaglider Mission Endurance Estimator	Version 1
DA 3	SG Trim	iRobot – Trim Sheet for Seaglider 541	10/01/2012
DA 4	Calibration	sg_calib_constants.m – Calibration values for sg541	

Reference Documents

	Ref	Title	Date / Issue
DR 1	GF-MR-0002	Post Mission Report - 'First Seaglider Water Test'	11/11/2011
DR 2	GF-MR-0003	Post Mission Report - 'Shallow dives with two seagliders'	14/02/2012, 16/02/2012
DR 3	GF-MR-0004	Post Mission Report - 'Altimeter testing with two seagliders'	6/03/2012
DR 4	GF-MR-0005	Post Mission Report - 'sdeep02 trimming, depth tests and first navigation experiences'	12/03/2012
DR 5	GF-MR-0006	Post Mission Report - 'Canales apr12'	27/03/2012
DR 6	GF-RR-0002	Internal Repair Report – 'BaseStation Setup'	22/02/2012
DR 7	20121227-IS-538	Intervention Sheet - 'Sudden 24V battery voltage drop'	27/12/2012
DR 8	GF-MR-0012	Post Mission Report – 'Jerico TNA Sardinia oct12'	23/10/2012
DR 9	GF-MD-0013	Mission Definition Report – 'Jerico TNA Sardinia jan13'	23/01/2013
DR 10	20130624_IS_541_1510	Sdeep03 Compass Error Measurement	24/06/2013
DR 11		Sdeep03 Wet Labs offset determination	

MISSION SUMMARY

Area	Western Mediterranean Sea (East Menorca to Sardinia)
Project	JERICO
Objective	JERICO TNA Agreement CSIC-CNR
Glider	sdeep03 (Seaglider 1KA-Unit 541)
Start Date	31/Jan/2013
End Date	16/Mar/2013
Total Days	44 days
Total Navigation Miles	445,2 NM
Number of Profiles	452
Number of Iridium Connections	391
Data transmitted through Iridium	3,8 MB
Raw data downloaded from glider	28,1 MB
Total mission data stored in DC	583,0 MB
Initial Batteries Voltage	25,2 V / 10,1 V
Final Batteries Voltage	24,8 V / 10,2 V
Battery Consumption	24,34 Ahr / 41,72 Ahr
Events	Mission completed successfully
Variables stored	'time' 'latitude' 'longitude' 'pressure' 'conductivity' 'temperature' 'chlorophyll' 'cdom' 'backscatter 650nm' 'oxygen'
Trajectory	

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I MISSION OBJECTIVE

The mission is part of a research proposed by CNR IAMC in Oristano (P.I. Mr Alberto Ribotti) to the First TNA call of project JERICO (http://www.jerico-fp7.eu/).

The central part of the Algero-Provencal sub-basin, where the glider mission is going on, is a buffer area between the northern Provencal sub-basin and the southern Algerian one, and is mainly characterized by the presence and action of the Balearic Front (interactions between more recent MAW and MW).

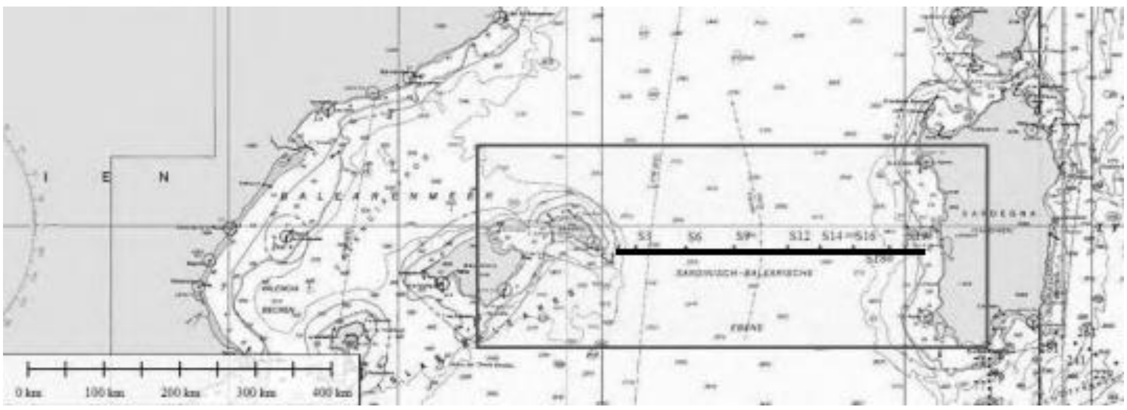
The purpose of the research is contributing to understand exchanges through the two sub-basins and the complex interactions through eddies. The area of work covers a transect between Balearic Islands and Oristano (Sardinia) that the Group in Oristano, in collaboration with the Institute of Marine Sciences of CNR in La Spezia, is annually repeating with CTD and current-meter casts for the last ten years during oceanographic cruises to study the inter-annual variability of physical and biochemical properties of water masses and understand the circulation, the exchanges through the sub-basins and the transport of salt and heat in the western Mediterranean.

In particular, the proposed research wants to identify the physical properties of the surface and intermediate water masses between Baleares and Sardinia with the aim of:

i) study the variability of the physical properties of surface and intermediate water masses between the Algerian and the Provencal sub-basins;

ii) evaluate the transport of water, salt and heat through the area and verify if the interannual variability of the surface and intermediate water masses is due to climatic changes;

iii) validate the operational hydrodynamic numerical model of the western Mediterranean (http://www.seaforecast.cnr.it/en/fl/wmed.php) through the use of in-situ and satellite data.



Proposed mission route

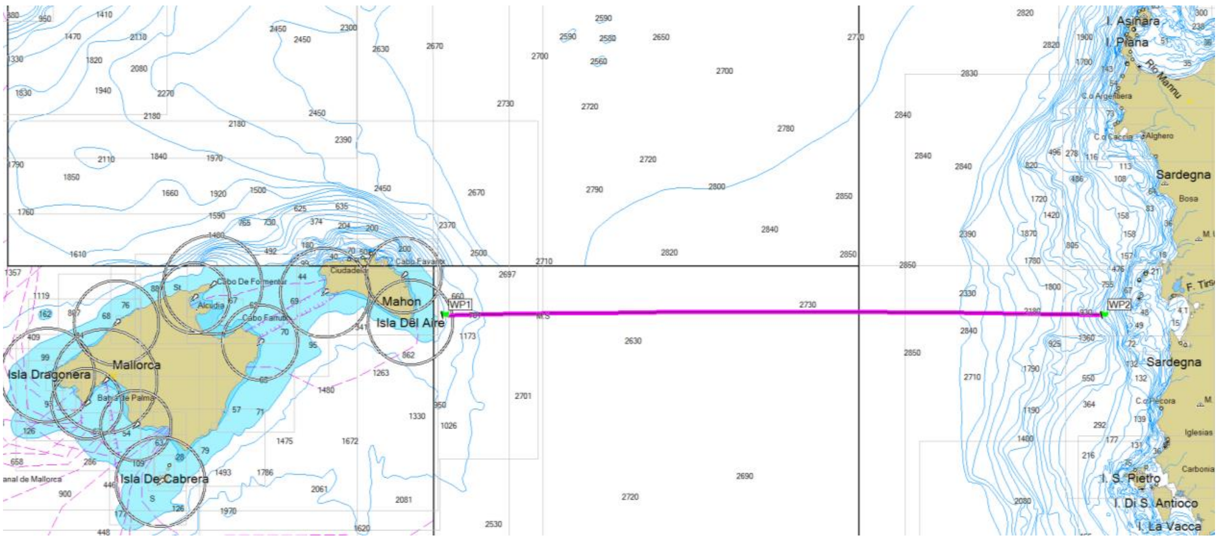
II MISSION DEFINITION

Mission Area: Western Mediterranean Sea - Menorca to Sardinia
Mission Objective: JERICO TNA Agreement CSIC-CNR
Deployment date: 31 January 2013
Recovery date: 17 March 2013 -tentative-
Mission Duration: 45 days
Glider: sdeep03 (Unit 541)
Glider backup: None
Route Distance: 333nm (617km)
Profiles: 392 approx.

Mission Waypoints

Latitude	Longitude	Name
39º 49.457’ N	4º 28.855’ E	***WP1***
39º 49.457’ N	8º 05.486’ E	***WP2***
39º 49.457’ N	4º 28.855’ E	***WP1***

Minimum Distance to Shore: 8.4nm (at WP1)



Mission route

III ENVIRONMENTAL PROPERTIES

Expected water properties

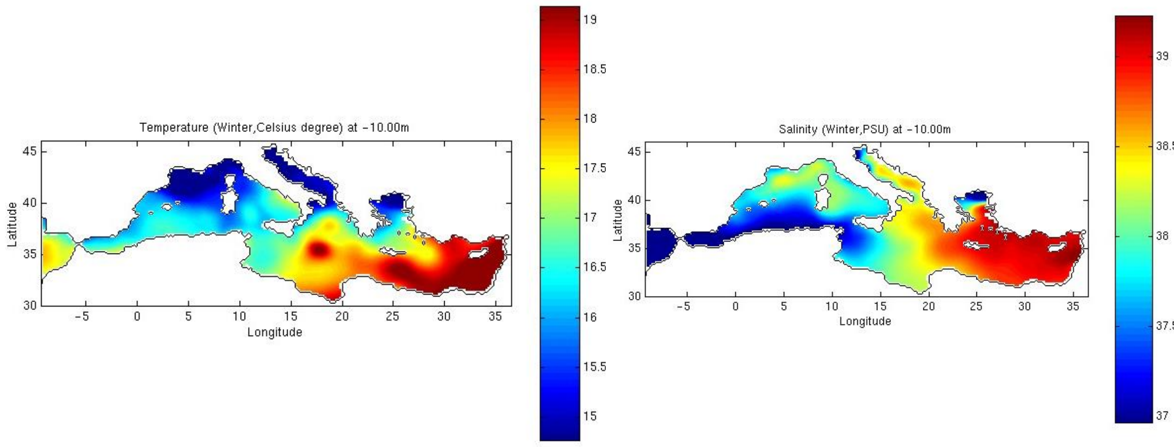
Source	Surface Temperature	Surface Salinity	Surface Density	Bottom Temperature	Bottom Salinity	Bottom Density	Average Density
CNR	15,1 ºC	37,5 PSU	1027,9 kg/m^3	13,1 ºC	38,5 PSU	1029,1 kg/m^3	**1028,5 kg/m^3**
MEDAR	15,0 ºC	37,2 PSU	1027,7 kg/m^3	13,0 ºC	38,5 PSU	1029,1 kg/m^3	**1028,4 kg/m^3**
APEX	14,0 ºC	38,3 PSU	1028,7 kg/m^3	13,0 ºC	38,5 PSU	1029,1 kg/m^3	**1028,9 kg/m^3**

<u>CNR 17-Jan-2012 transect</u>

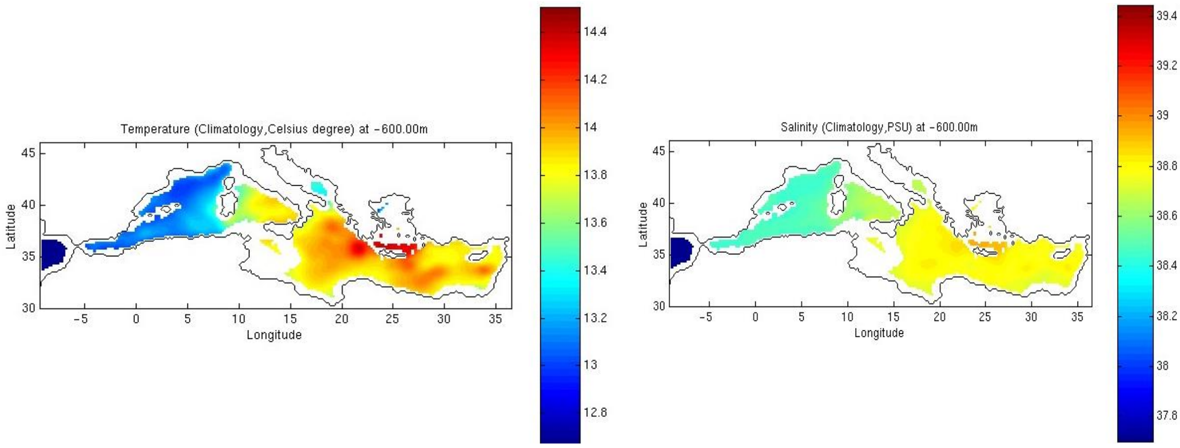
0 m T/Theta: from 14.5 to 15.1 °C
Salinity: from 37.48 to 38.07 psu

1000 m T: from 13.09 to 13.28 °C
Theta: from 12.94 to 13.13 °C
Salinity: from 38.49 to 38.53 psu

<u>Medar Winter Season</u>

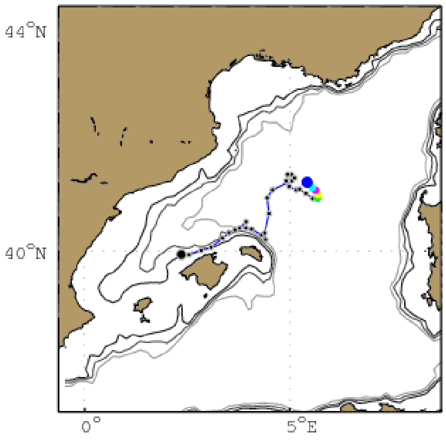


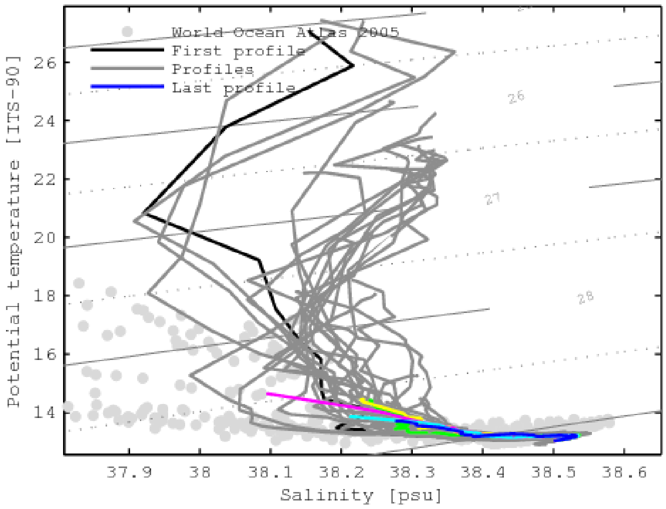
Seasonal (Winter) Temperature and Salinity MEDAR Climatology at ~10m depth

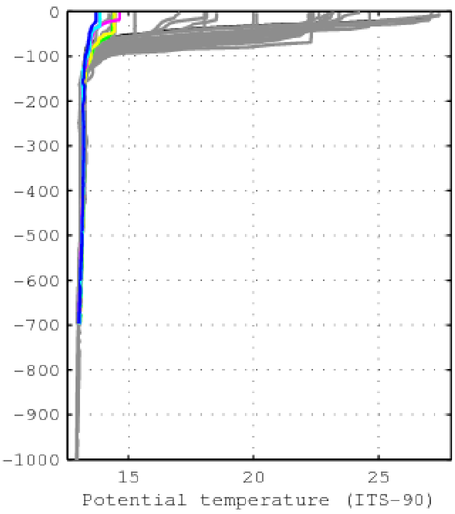


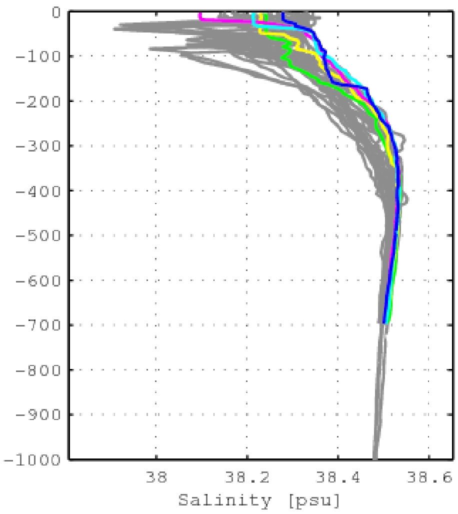
Temperature and Salinity MEDAR Climatology at ~600m depth

SOCIB APEX at N 41.26 E 5.43 in January 2013







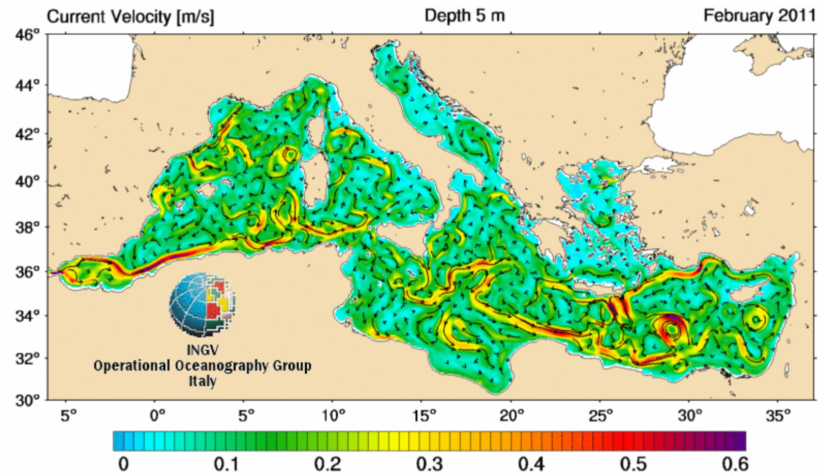


Glider Ballasting

- Glider Average Density: 1029,35 Kg/m3
- Glider Density Range: [1024,35 1034,35] Kg/m3

Note: Seaglider densities must be computed with in-situ temperature and salinity at surface (0 dbar) because of its isopicnal hull (σ_t calculus).

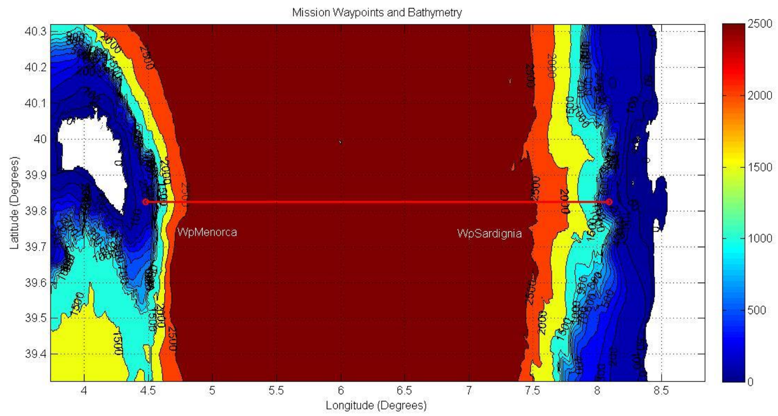
Currents



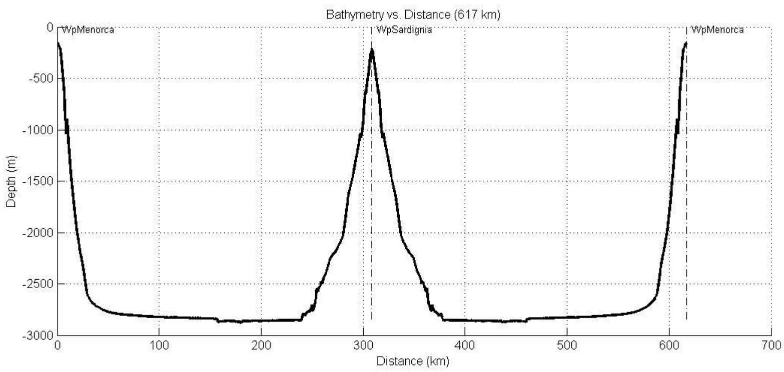
Currents February 2011 from http://gnoo.bo.ingv.it/mfs/analysis_archive.htm

Mission Depth

- Depths: min 150.0 [m], max 2874.4 [m]



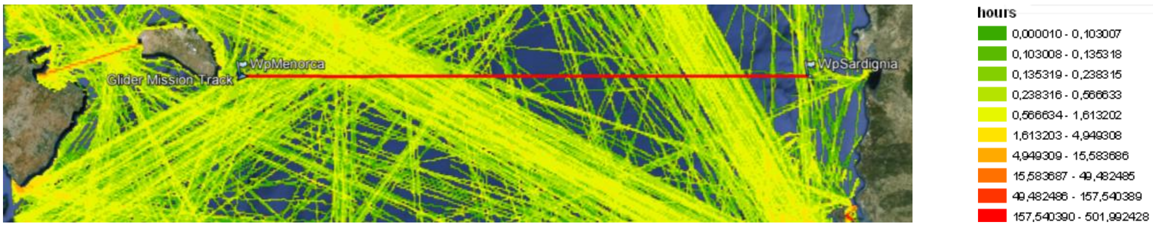
Mission bathymetry map



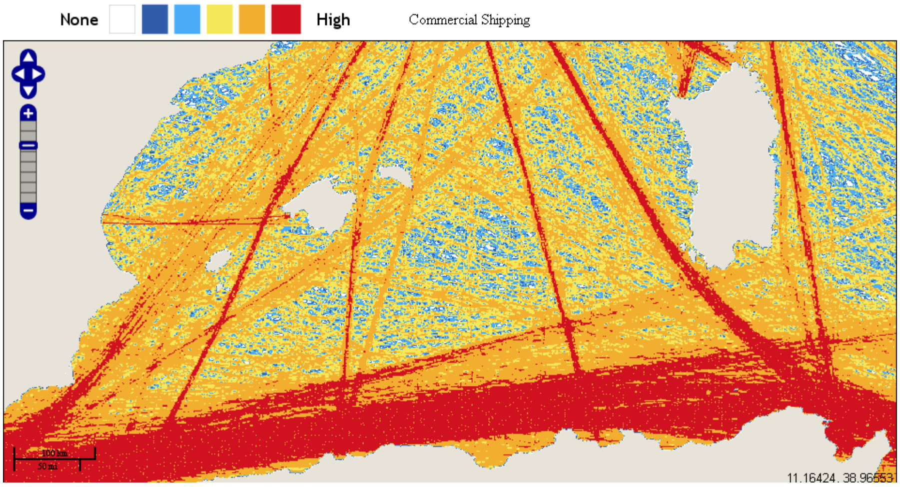
Distance vs Depth plot

IV MARITIME ROUTES AND NAVIGATION SAFETY

Maritime Routes



Marine traffic density (number of hours occupied by ships in every cell of 1km x 1km) between Mallorca and Sardinia (one month of AIS data, August 2012)



Commercial shipping routes (available at: http://globalmarine.nceas.ucsb.edu/)

Navigation Safety

Warnings of glider mission

- Spanish Navy (NATO Member)
- SASEMAR (Spanish Search and Rescue)
- Oristano Coast Guard

Glider insurance

- Company
  - Willis, S&C
- Coverage
  - Glider loss
  - Emergency recovery costs
  - Third party damage

V INSTRUMENTAL SETTINGS

Navigation Behaviour

Surfacing events

-Every inflection
-Mission aborted

Movement

-Distance to seabed: 30.0 m
-Maximum depth: 975.0 m (see Note 1)
-Angle of inclination: 20º (see Note 2)
-Approx. vertical speed: 0.1 m/s (see Note 2)
-Approx. horizontal speed: 0.17 m/s (see Note 2)

Scientific Data Sampling and Transmission

Sensors Sampling (see Note 3)

CTD (conductivity, temperature and pressure)
-Sampling state: diving and climbing
-Sampling frequency: 1/4 Hz (approx. 1 sample/0.4m)
-Sampling depths: [0, 1000]m

Oxygen
-Sampling state: diving and climbing
-Sampling frequency: 1/4 Hz (approx. 1 sample/0.4m)
-Sampling depths: [0, 300]m (see Note 4)
-Sampling frequency: 1/8 Hz (approx. 1 sample/0.8m)
-Sampling depths: [300, 1000]m (see Note 5)

FLNTU (fluorescence and turbidity sensor)
-Sampling state: diving and climbing
-Sampling frequency: 1/8 Hz (approx. 1 sample/0.8m)
-Sampling depths: [0, 300]m (see Note 5)

Sensors Transmission (Real-Time mode)

Data measured will be transmitted through Iridium to verify sensors, sampling and navigation behaviour of the glider. Real time data transmission will be done at least every day (approximately 1 dive transmitted every 4 dives performed) to minimize costs and surface time. All data will be downloaded by cable once mission finishes (delay mode).

Notes

1) During deployment the navigation depth will be increased in consecutive changes (increases of 200m approx.) to ensure correct glider behaviour and navigation minimizing the probability of damage of the glider in case of error.

2) The piston buoyancy and pitch angle will be changed during mission to optimize glider flight, reduce consumption and to adapt the glider velocity to the currents of the mission zone. Those changes will vary the vertical and horizontal velocities.

3) To verify correct sensor measurement and behaviour all sensors will be measured up to 1000m (at least during one dive). The configuration of the sensors sampling will be changed during mission to verify glider and sensors integrity and behaviour.

4) The Oxygen sensor will be measured at a frequency of 1/4Hz up to 300m and at 1/8Hz from 300m to 1000m to reduce power consumption. FLNTU (Wetlabs) sensor will be measuring up to 300m to minimize the power consumption.

5) The Oxygen and FLNTU sensor sampling frequency and depth might have to be changed during mission to reduce power consumption depending on battery capacity.

VI LOGISTICS

Deployment: 31 January 2013
Recovery: 17 March 2013 –tentative-
Mission Duration: 45 days
Glider: sdeep03 (Unit 541)
Glider backup: None

Tasks and Calendar

Mission preparation

Task	Personnel	Date
Glider ballasting verification	Simó Cusi, Joaquin Tintoré	20-25 January
Glider verification	Simó Cusi, Miguel Martinez	23-30 January
Navigational Warning	David Roque, Guillermo Vizoso	29 January
Deployment material load	Simó Cusi, David Roque, Benjamin Casas, Miguel Martínez	29 January

Deployment (Menorca)

Task	Personnel	Date
Glider deployment	Carlos Castilla, David Roque, Benjamin Casas, Guillermo Vizoso, Miguel Martínez	31 January
Glider remote control	Simó Cusí, Simón Ruiz, Ananda Pascual	31 January
Vessel	IEO Vessel	31 January
Vessel pilot	David Roque, Benjamín Casas	31 January
Vehicle	SOCIB Mercedes Sprinter	30 January

Mission tracking

Task	Personnel	Date
Glider following, control and mission updates responsible	Simó Cusi, Miguel Martínez, Benjamín Casas, Guillermo Vizoso, Joaquin Tintore	31 January - 17 March
Glider pilot backup	Marc Torner, Simón Ruiz, Ananda	31 January – 17

	Pascual	March

Data Management

Task	Personnel	Date
Real Time Data retrieval	Simó Cusi, Guillermo Vizoso, Miguel Martínez	31 January – 17 March
Real Time Data verification	Marc Torner, Emma Heslop, Simon Ruiz, Ananda Pascual, Joaquin Tintoré	31 January – 17 March
Delay Mode Data retrieval	Simó Cusi, Benjamín Casas, Guillermo Vizoso, Miguel Martínez	18-22 March
Delay Mode Data verification and export	Marc Torner, Emma Heslop, Simon Ruiz, Ananda Pascual, Joaquin Tintoré	18-22 March

Recovery (Menorca)

Task	Personnel	Date
Glider recovery	Marc Torner, David Roque, Benjamin Casas, Guillermo Vizoso, Miguel Martínez	17 March
Glider remote control	Simó Cusí, Simón Ruiz, Ananda Pascual	17 March
Vessel	TMOOS Valiant	17 March
Vessel pilot	David Roque, Benjamín Casas	17 March
Vehicle	SOCIB Mercedes Sprinter	17 March
Calibration CTD Cast - SBE 25	David Roque, Guillermo Vizoso	17 March

Emergency plan

Task	Personnel	Date
Emergency Decision	Miguel Martínez, Benjamin Casas, Joaquin Tintoré, Guillermo Vizoso	31 January – 17 March
Emergency recovery glider pilot	Marc Torner, David Roque, Benjamín Casas,	31 January – 17 March

	Miguel Martínez	
Emergency recovery glider remote control	Simó Cusí, Simón Ruiz	31 January – 17 March
Emergency Vessel and Vehicle	-Depending on availability-	31 January – 17 March

Notes

1) Deployment:

The deployment will be carried out by Benjamín Casas, Miguel Martínez, Guillermo Vizoso, David Roque and Carlos Castilla at East Menorca to reduce the consumption of the glider and minimize the scientific mission start-up time. This deployment will be done using the vessel IEO on date 31 January. The glider (541) is already in the Menorca facility. The material to carry from IMEDEA is: argos tag, communication cable, magnets, tool box, Benthos pinger, spare wings, rudder, weights, foams and laptop.

2) Recovery:

The recovery will be done at Menorca (WP1) approximately on the 17th of March. The vessel TMOOS Valiant must be available for recovery during these dates and also SOCIB's Mercedes Sprinter.
Vehicles and vessels needed for an emergency recovery will be available. A CTD cast will be done during recovery for calibration and verification purposes.

VII DATA MANAGEMENT

Communications

Basestation Primary:	67.207.130.126
Basestation Secondary:	67.207.130.126
Primary Iridium Phone:	881600005201 (Rudics)
Secondary Iridium Phone:	881600005201 (Rudics)

The data from this mission will be available in Real Time and Delay Mode.

Real Time

The data will be received at the iRobot Basestation through Iridium satellite communications every glider surface. The log and binary data obtained will be then transferred to SOCIB Data Center for mission tracking. Pre-processing of log files will be carried out creating NetCDF files and images that will be available for public download at SOCIB thredds data discovery portal. The scientific sensors data will be processed by glider technicians that will represent the scientific variables and generate images for verification.

All files from basestation will be synchronized according to the following properties:

-Origin: ftp://67.207.130.126/../sg541
-Target: /home/glider_public/deployments/sg541/20130131/basestation_01
-Download frequency: every 60 minutes.

The data will be accessible for the general public at the following location with read only access:

-Host: ftp://ftp.socib.es
-User: glider_public
-Password: **** (hidden)

The data files will be transmitted in the future to EGO server, Coriolis, and MyOcean2 portal (when available). Attention will be given for all theses data to be available to the GTS (Global Telecomunication System, WMO).

Delay Mode

Once the mission is finished, the data will be downloaded to the SOCIB Data Center where pre-processing and Quality Control and Validation will be carried out and NetCDF files and images will be created.

The data files will be finally included in JERICO portal.

VIII GLIDER SETUP

Sensors

The glider is equipped with the following sensors:

- CTD:
  SeaBird unpumped CT-Sail,
  S/N: 0173, Last calibrated: 2011-03-28
  Paine pressure sensor,
  S/N: 264065, Last calibrated: 2011-02-01

- FLUOROMETER:
  WetLabs Triplet,
  S/N: BBFL2VMT-777, Last calibrated: 2010-10-13

- OXYGEN:
  Aanderaa Oxygen Optode 4330F,
  S/N: 470, Last calibrated: 2010-12-15

Batteries

Battery endurance is calculated with the Excel Spreadsheet provided by iRobot (SG Endurance). Mission settings have been introduced in the spreadsheet and consumption per dive for both batteries is obtained and used in the next table:

Depth in meters	50	100	150	300	500	1000	
24V Amp-hr /dive	0,036717	0,048664	0,072644	0,088447	0,109457	0,161981	
10V Amp-hr/dive	0,025062	0,045587	0,067424	0,130997	0,185789	0,244455	
Mission Dives	12	4	8	16	12	144	**TOTAL Ahr**
Consumption 24V	0,440602	0,194655	0,581149	1,41515	1,31348	23,32527	**27,270309**
Consumption 10V	0,300743	0,182346	0,539389	2,095957	2,229462	35,20158	**40,549476**

The current and post-mission expected battery state are:

	24V Energy	**10V Energy**	**24V Voltage**	**10V Voltage**
Current	133,4 Ahr (92%)	87,1 Ahr (92%)	24,8 V	10,8 V
Post-mission	106,1 Ahr (73%)	46,6 Ahr (49%)	-	-

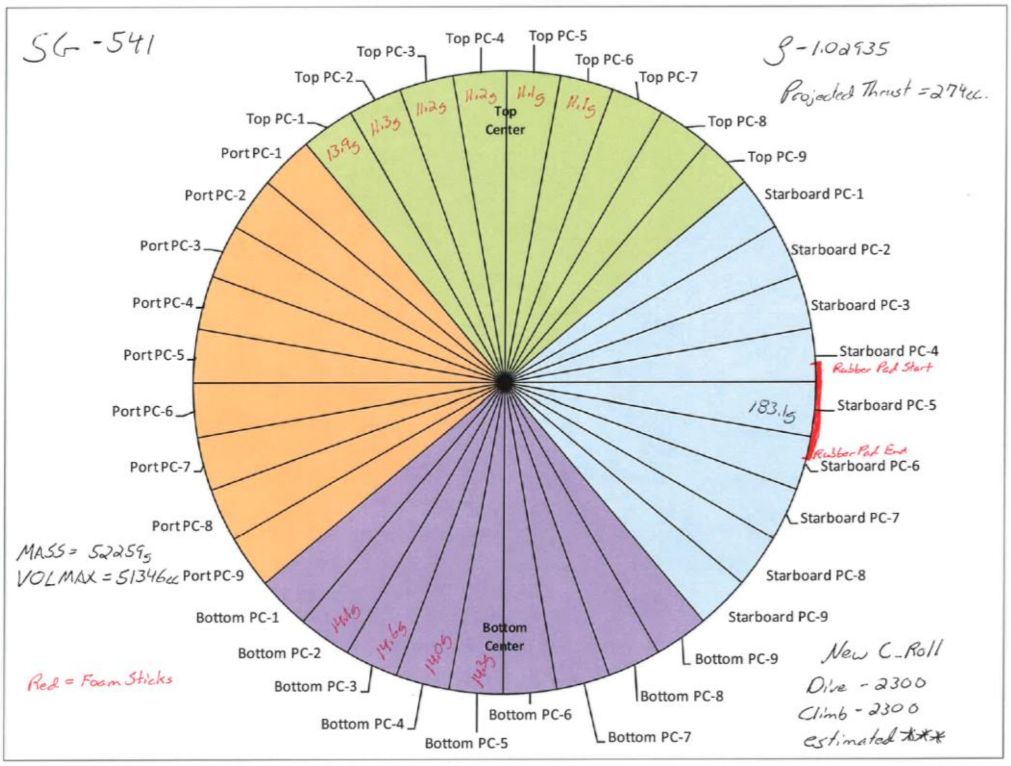
Previous missions (GF-MR-0005, GF-MR-0006, GF-MR-0012) performed with sdeep02 (sg538) showed that this sensor configuration was consuming the 10V battery pack at the same rate as the 24V battery pack so that the 40,5 Ahr hour estimation seems too conservative. For the mentioned missions the glider was just estimating the consumption as it is not equipped with a coulomb counter. Therefore, there is a conflict between the glider estimations and those of the endurance model spreadsheet provided by iRobot (19% vs 43%). The current battery capacity allows for both estimations so that the mission can be safely performed.

The mission allows flexibility in sampling frequencies and depths for both WetLabs and Aanderaa sensors (the most consuming ones). This gives a margin to correct excessive 10V battery consumption during the mission.

Ballasting

The expected average density for the waters the glider will dive in is 1028,55 kg/m^3 and current glider's density is 1029,35 kg/m^3. Therefore, there is no need to reballast the glider. The minimum expected surface density is 1027,7 kg/m3 so that glider will have no problems to surface and communicate.

In the next figure it can be seen the pinwheel diagram done by iRobot showing where the weights and foams are placed on the pupa. Also it shows the glider's total mass (52259 g) and the glider's maximum volume, with oil bladder inflated (51,346 l), that gives a minimum density for the glider equal to 1017,78 kg/m^3. The final glider density range having into account its 10σ capability is from 1024,35 kg/m^3 to 1033,3 kg/m^3. All glider weights and their distribution are shown in sdeep03's trimsheet.

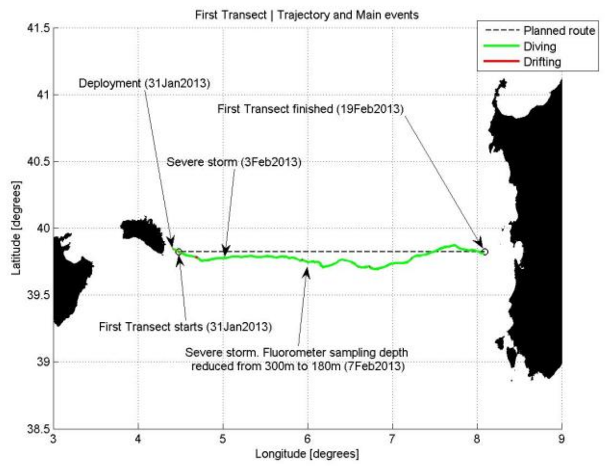


Pinwheel diagram of ballasting for determining the weights and foams and their location

IX MISSION SUMMARY BY TRANSECT

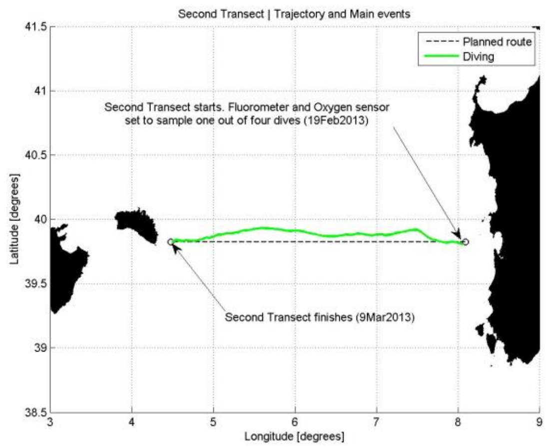
First Transect

Two severe storms (+6m wave height) predicted by Puertos del Estado. Reduced sampling depth of Fluorometer to save 10V battery energy.	
Glider	sdeep03
Start WP	39º 49.457' N 4º 28.855' E
End WP	39º 49.457' N 8º 05.486' E
Distance	167 NM
Dates	31/Jan/2013 - 19/Feb/2013
Total Days	19,5 days
Navigated Distance	188,4 NM
Number of Profiles	198
Iridium Connections	207 (547 min)
Data through Iridium	2,3 MB
Total raw data	13,4 MB
Initial Batt. Voltage	25,2 V / 10,1 V
Final Batt. Voltage	23,9 V / 10,1 V
Battery Consumption	11,88 Ahr (8,2%) / 22,32 Ahr (23,5%)
Sensors	CTD, Fluorometer, Oxygen



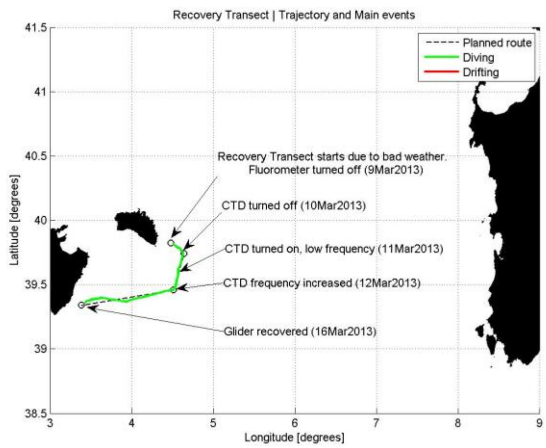
Second Transect

Fluorometer and Oxygen sensor sampling one out of four dives.	
Glider	sdeep03
Start WP	39º 49.457' N 8º 05.486' E
End WP	39º 49.457' N 4º 28.855' E
Distance	167 NM
Dates	19/Feb/2013 - 09/Mar/2013
Total Days	18,0 days
Navigated Distance	175,8 NM
Number of Profiles	152
Iridium Connections	117 (339 min)
Data through Iridium	1,4 MB
Total raw data	10,6 MB
Initial Batt. Voltage	23,9 V / 10,1 V
Final Batt. Voltage	24,0 V / 9,9 V
Battery Consumption	6,55 Ahr (4,5%) / 14,79 Ahr (15,6%)
Sensors	CTD, Fluorometer, Oxygen



Recovery Transect

CTD Data at low frequency are not valid.	
Glider	sdeep03
Start WP	39º 49.457' N 4º 28.855' E
End WP	39º 20.456' N 3º 23.056' E
Distance	79,9 NM
Dates	09/Mar/2013 - 16/Mar/2013
Total Days	6,5 days
Navigated Distance	80,8 NM
Number of Profiles	102
Iridium Connections	56 (80 min)
Data through Iridium	0,2 MB
Total raw data	4,1 MB
Initial Batt. Voltage	24,0 V / 10,2 V
Final Batt. Voltage	24,8 V / 10,2 V
Battery Consumption	5,75 Ahr (4,0%) / 4,42 Ahr (4,7%)
Sensors	CTD



X MISSION SCIENTIFIC DATA

Data Filtering

Data coming from the sensors are filtered using low and high limits to avoid spikes and non-realistic values (i.e. negative values) in visualization plots. The following table indicates the outside bands that are dismissed (including the discarded percentage of data).

Potential temperature, salinity and σt are obtained from the NetCDF files generated by the University of Washington's python scripts (2010), contained in the Basestation. CTD data filtering is needed mostly to avoid salinity spikes. It has been decided to apply a band pass filter with reasonable boundaries. Another possibility would be to discard data of the first 5 meters as most of the spikes happen to be there due to the Seaglider's nature.

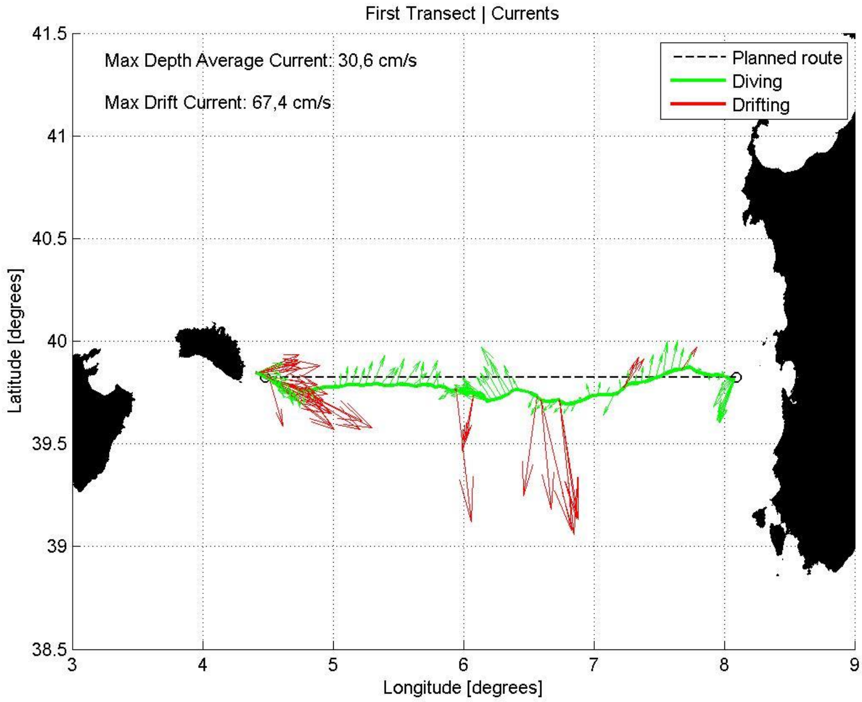
Oxygen with wetlabs=noise?

Fluorometer variables's calibration curves… ref DA11

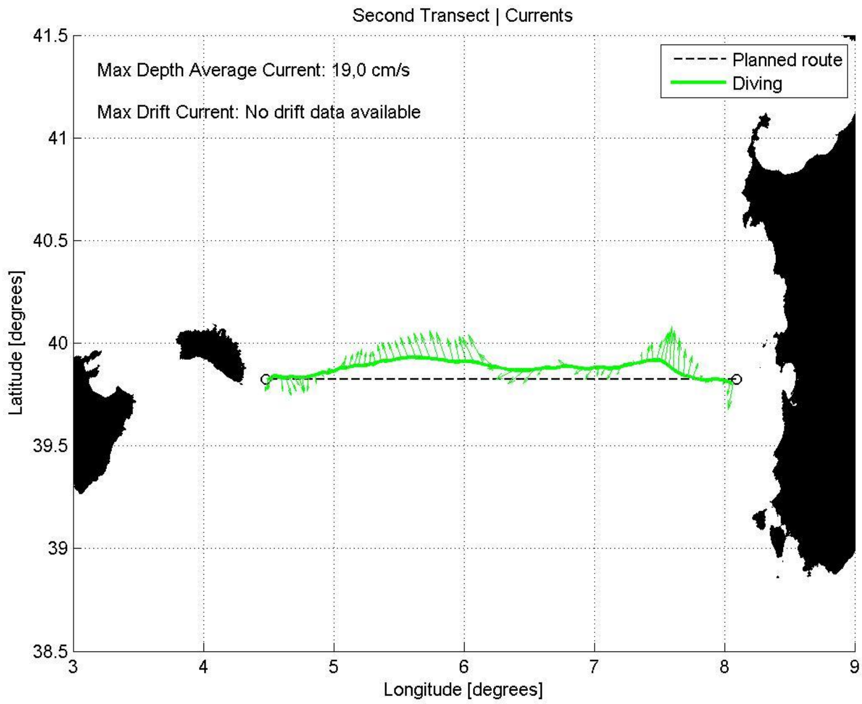
Transect	Sensor	Variable	Low filter	Too low	High filter	Too high	% Discarded
First	CTD	Pot. Temp.	10,0 ºC	2	-	-	0,001 %
		Depth	0 m	0	975 m	1846	0,544 %
		Salinity	37,0 PSU	277	39,0 PSU	55	0,098 %
		σ_t	27,5 kg/m3	264	29,5 kg/ m3	53	0,093 %
	Fluoro meter	Chlorophyll	0,0 µg/l		1,0 µg/l		%
		CDOM	0,0 ppb		3,0 ppb		%
		Scatter 650	0,0 m-1sr-1		3*10-4 m-1sr-1		%
	Oxygen	Oxygen	3,5 ml/l	23	6,5 ml/l	1697	0,830 %
Second	CTD	Pot. Temp.	10,0 ºC	0	-	-	0,000 %
		Depth	0 m	0	975 m	269	0,082 %
		Salinity	37,0 PSU	244	39,0 PSU	70	0,096 %
		σt	27,5 kg/m3	234	29,5 kg/ m3	71	0,093 %
	Fluoro meter	Chlorophyll	0,0 µg/l		1,0 µg/l		%
		CDOM	0,0 ppb		3,0 ppb		%
		Scatter 650	0,0 m-1sr-1		3*10-4 m-1sr-1		%
	Oxygen	Oxygen	3,5 ml/l	3	6,5 ml/l	433	0,786 %
Recovery	CTD	Pot. Temp.	10,0 ºC	0	-	-	0,0 %
		Depth	0 m	0	975 m	1924	1,686 %
		Salinity	37,0 PSU	82	39,0 PSU	19	0,118 %
		σt	27,5 kg/m3	80	29,5 kg/ m3	18	0,115 %

Currents Plots

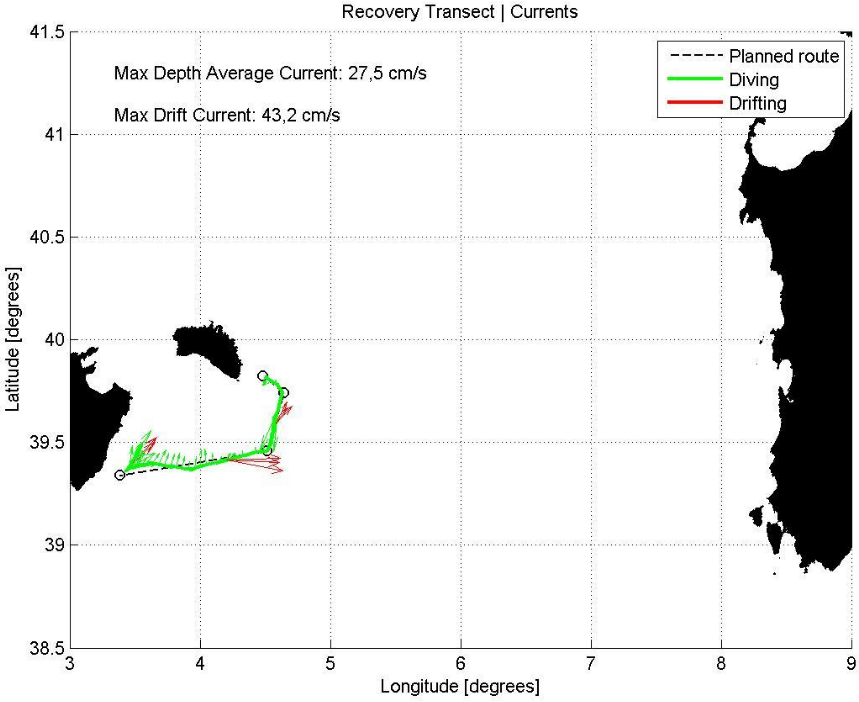
First Transect



Second Transect



Recovery Transect

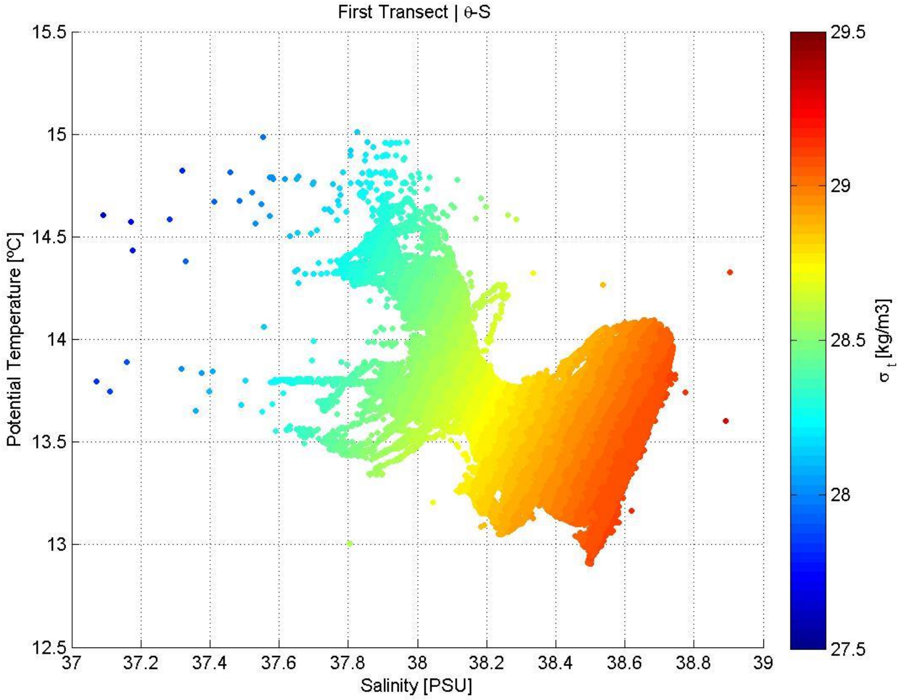


Depth Average Currents (DAC) are calculated using Seaglider's hydrodynamic model. The glider dead reckons its position while underwater and compares it against GPS fixes once it is at surface. The difference encountered is assumed to be due to currents.
During the entire mission, DAC mostly point North with magnitudes reaching 30,6 cm/s.
It should be noted that the Seaglider relies on its compass for navigation and DAC calculation. This device gives high erros (DR10). Therefore, if precise DAC want to be obtained, the currents plotted here need to be corrected.

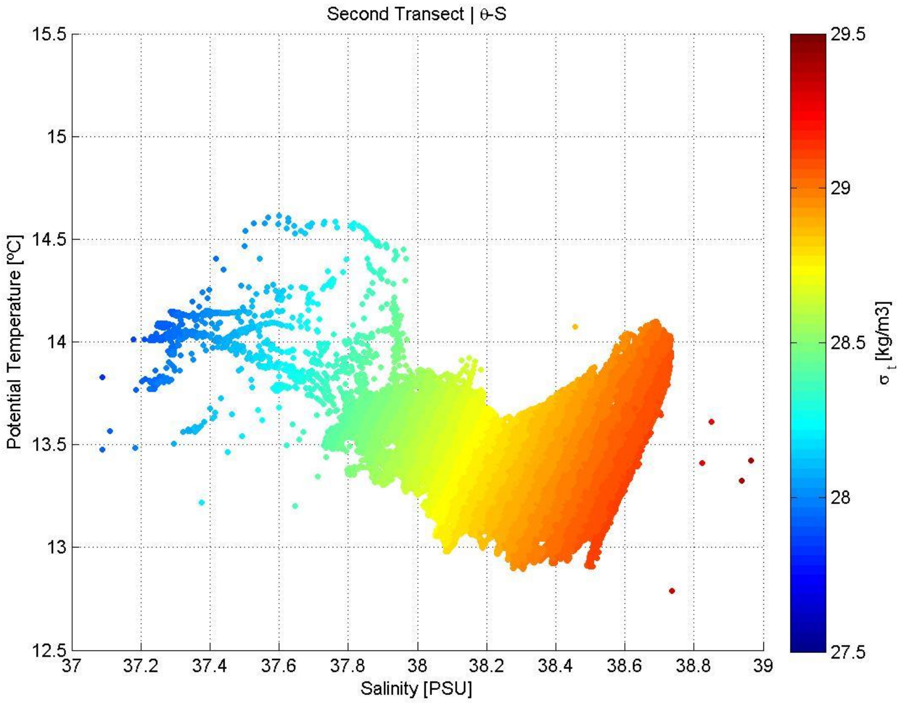
Drift currents are extracted from the movement of the glider when at surface. Two different GPS fixes with their related timestamps are used to extract the surface displacement in a straight line and, from it, velocity and direction are calculated. During this mission, there were not long periods of time drifting so that drift may be due to real surface currents or oscillations.
During the first transect, the glider drifted E-SE off Menorca and South in the center of the channel, reaching speeds up to 67,4 cm/s. During the recovery transect, the drifting took the E-NE direction.

θ-S Plots

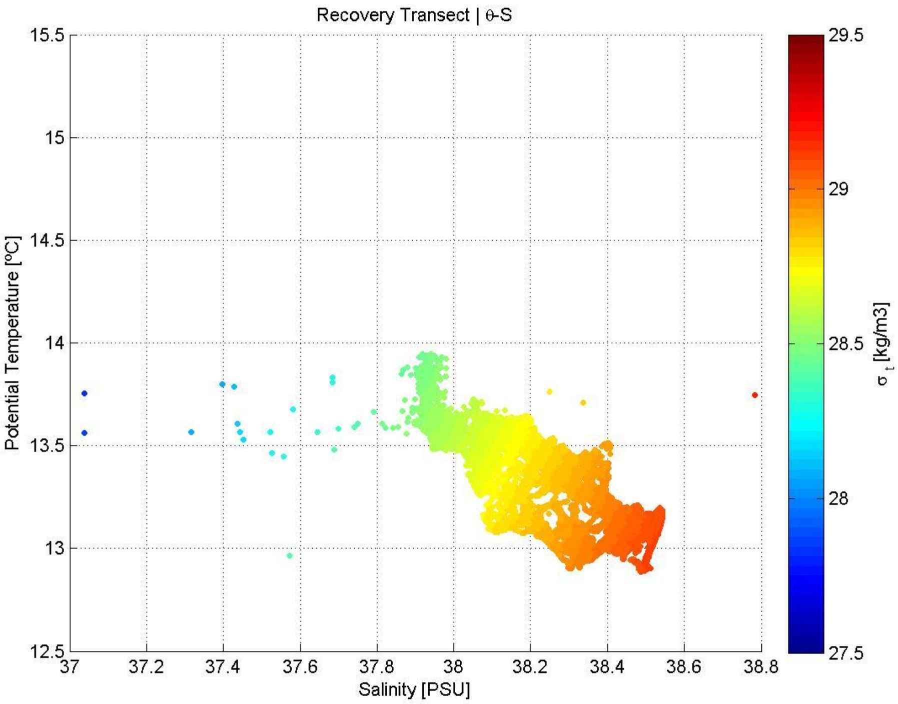
First Transect



Second Transect

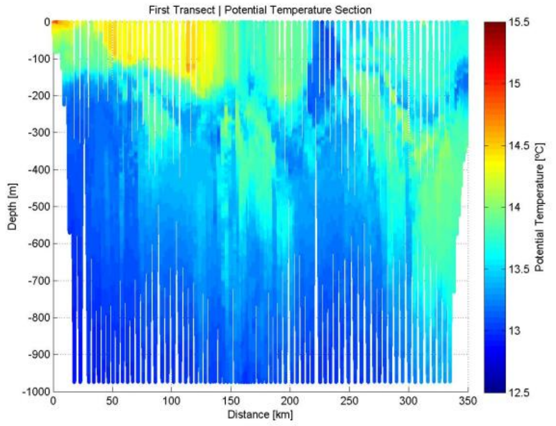


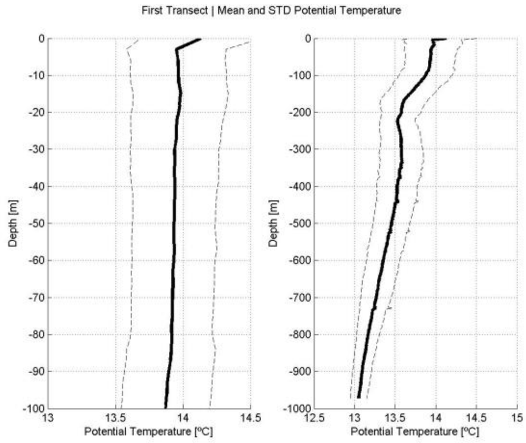
Recovery Transect



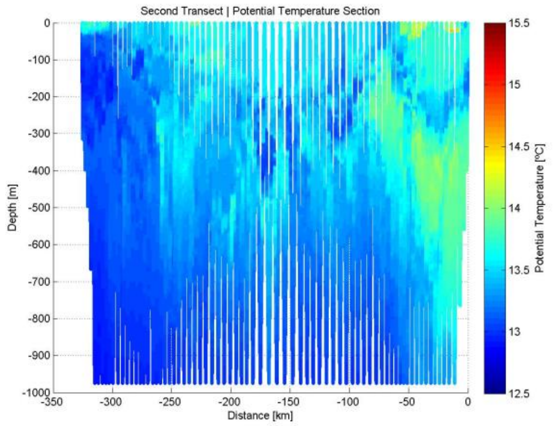
Potential Temperature Sections

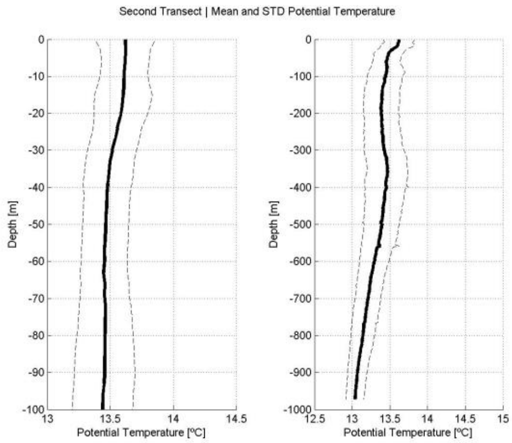
First Transect



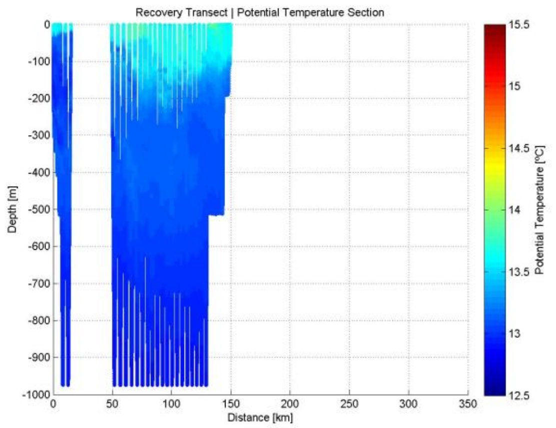


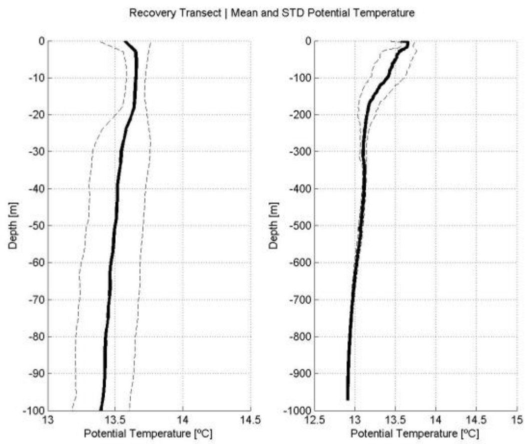
Second Transect





Recovery Transect

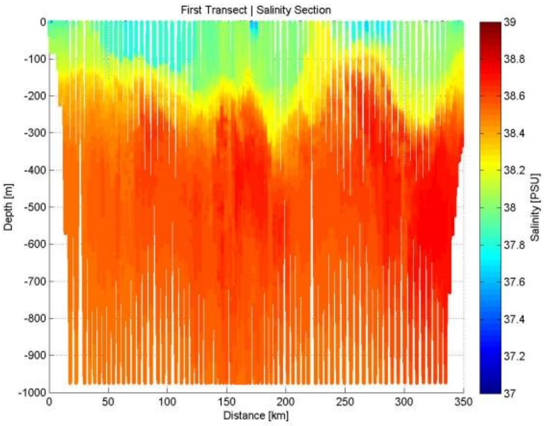


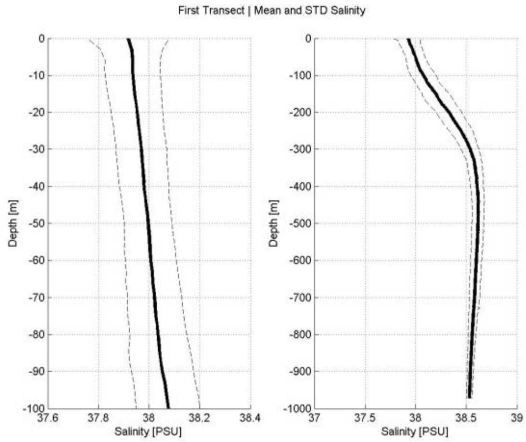


Max, min

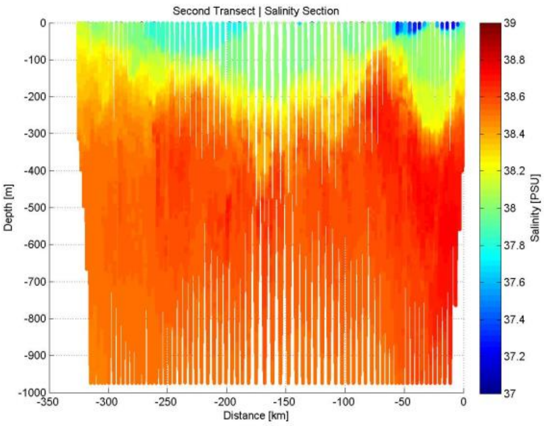
Salinity Sections

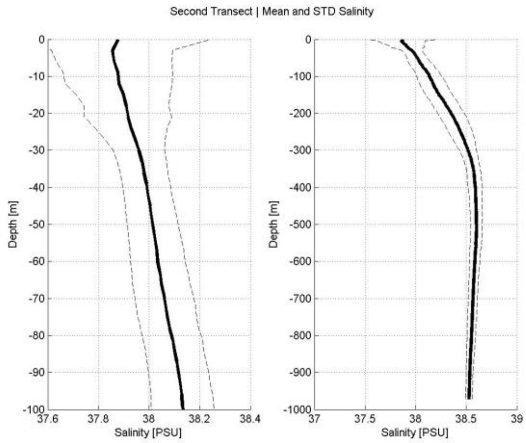
First Transect



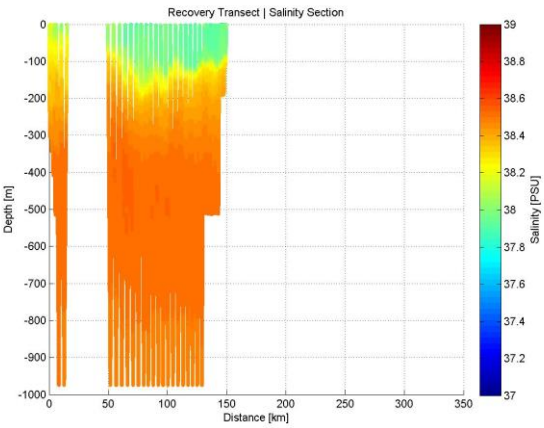


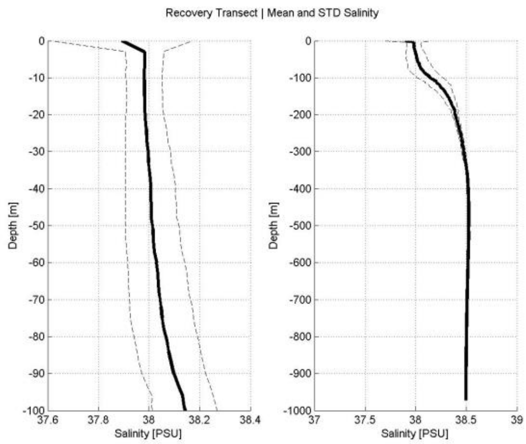
Second Transect





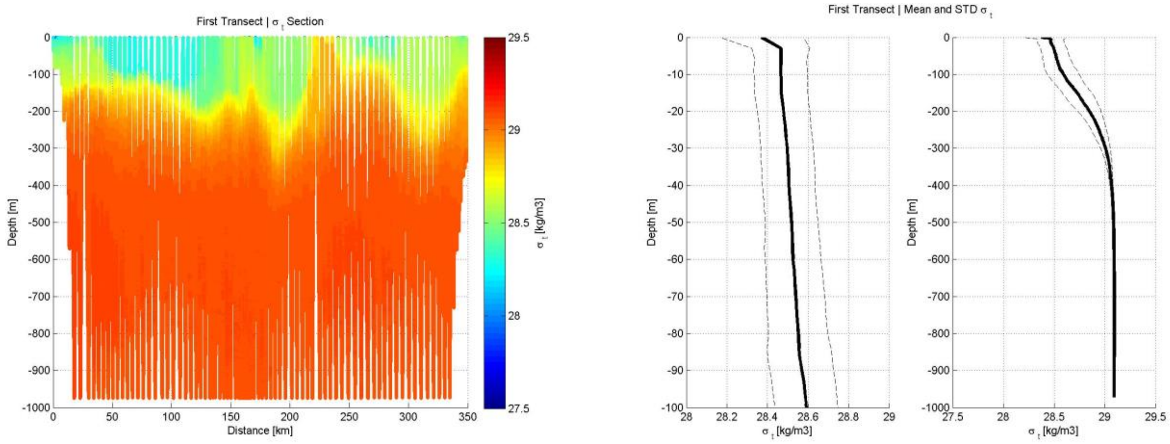
Recovery Transect



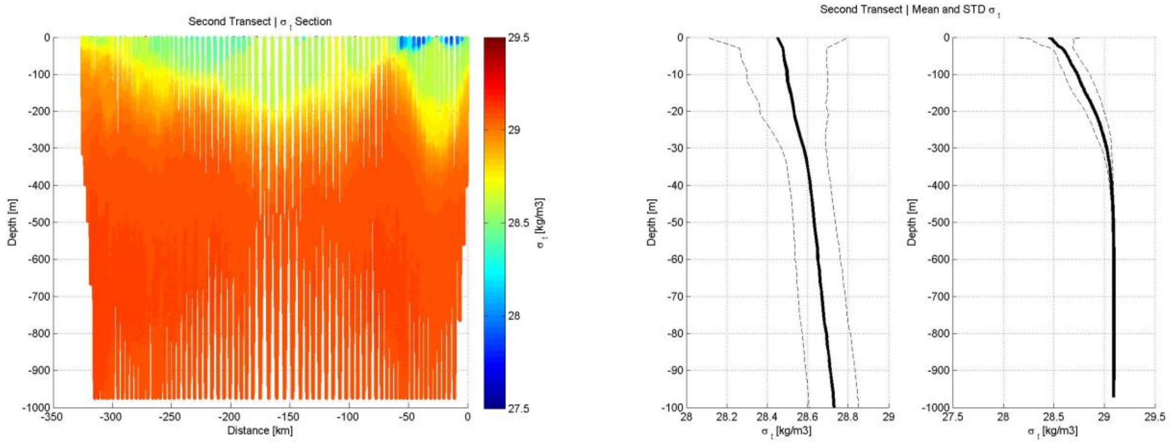


σ_t Sections

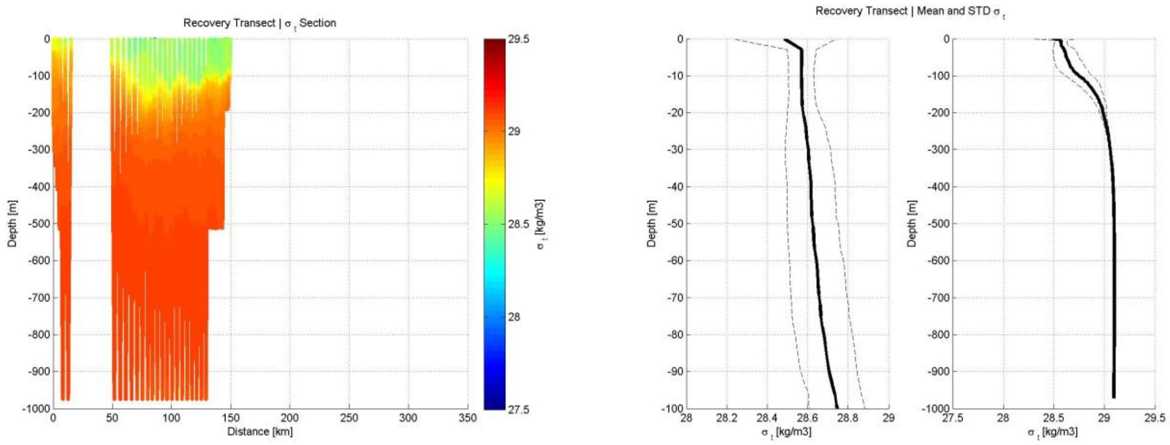
First Transect



Second Transect

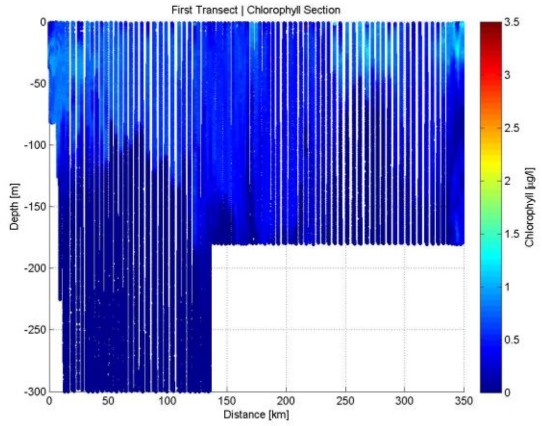


Recovery Transect

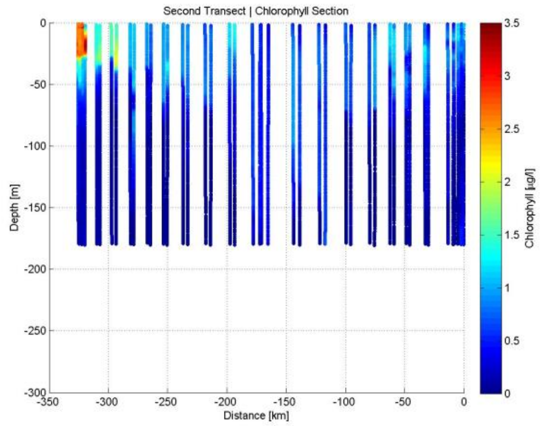


Chlorophyll Sections

First Transect (not valid, need calibration)



Second Transect (not valid, need calibration)



CDOM Sections (need calibration)

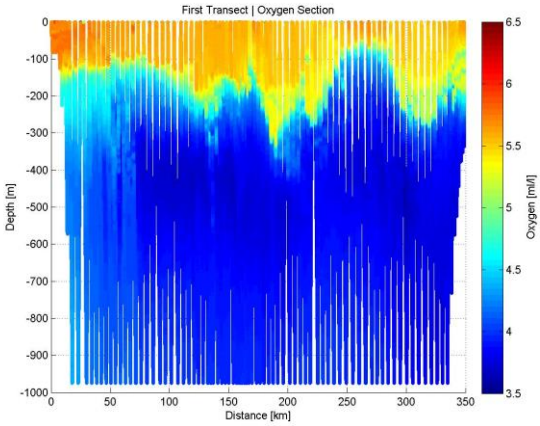
First Transect	
Second Transect	
Recovery Transect	

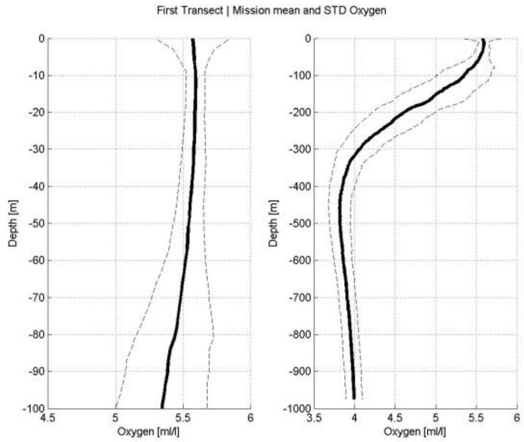
Backscatter 650nm Sections (need calibration)

First Transect	
Second Transect	
Recovery Transect	

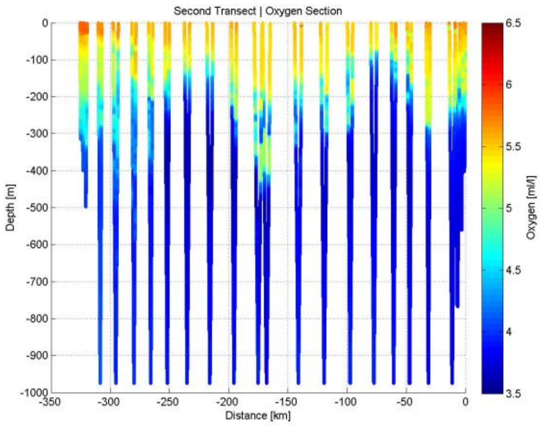
Oxygen Sections

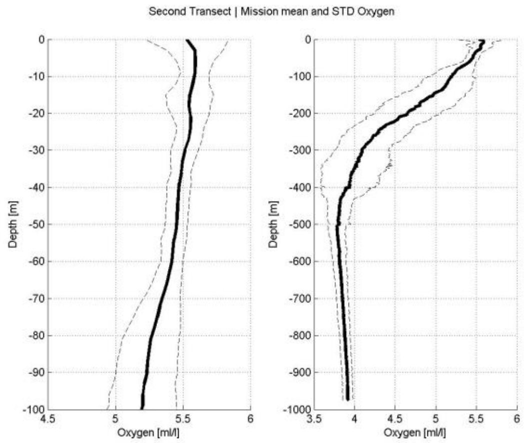
First Transect





Second Transect



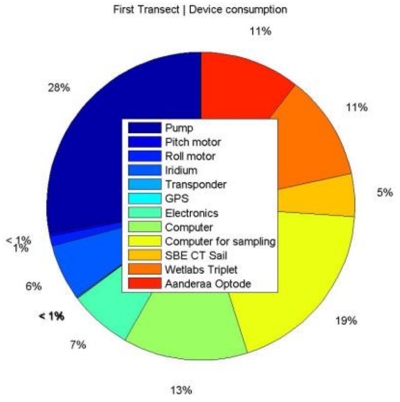


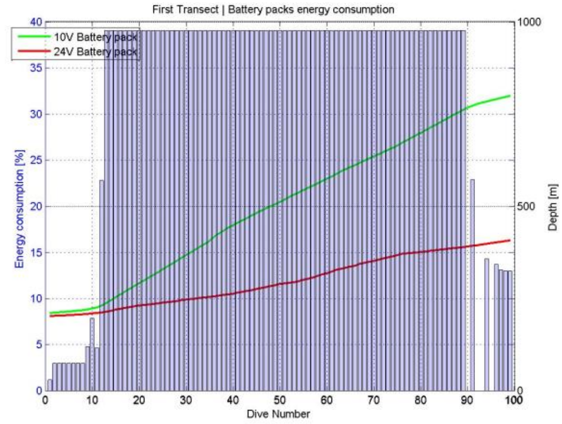
Oxygen varies from about 5,5 ml/l on the surface to about 4 ml/l at 400 meters depth. From this depth down to 975m it remains almost constant.

XI MISSION TECHNICAL DATA

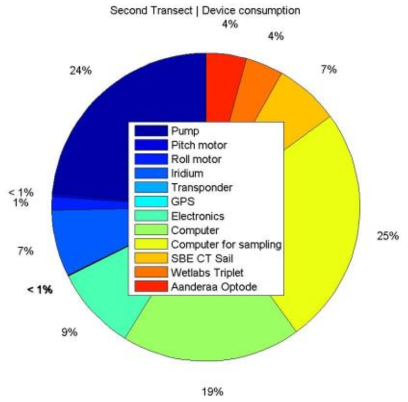
Energy Consumption

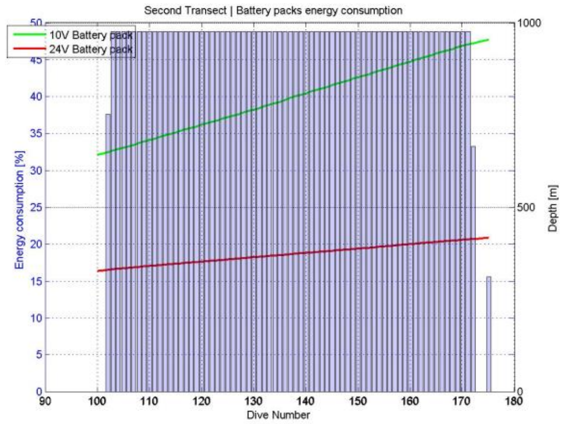
First Transect



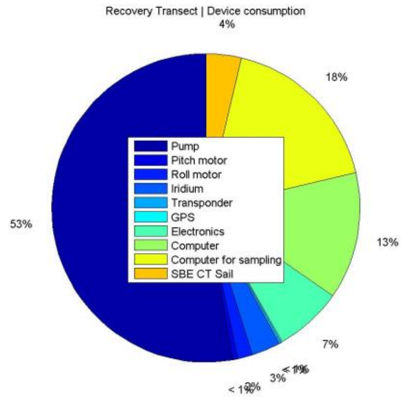


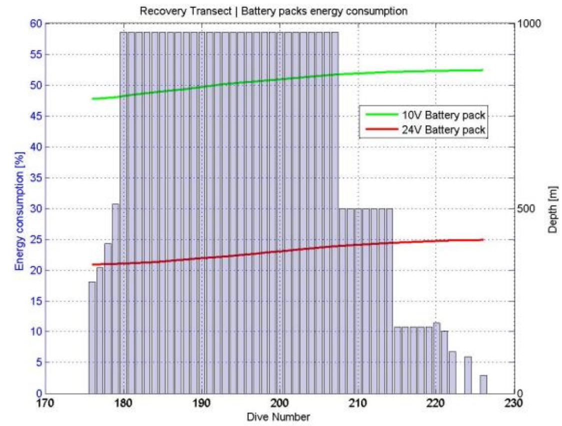
Second Transect





Recovery Transect





During the first transect, the 10V battery was consuming much faster than the 24V one. It was decided to reduce the sampling depth of the fluorometer from 300m to 180m but the consumption rates of both batteries were still very different. The consumption ratio for the 10V battery pack vs the 24V one was 2,87 for the whole transect. The most consuming device was the pump with a 28% of the total energy.

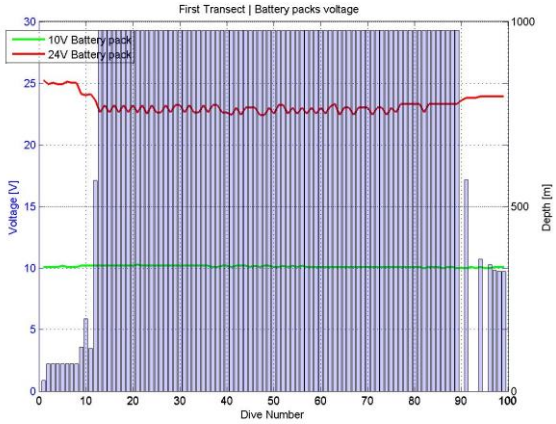
When the second transect started, it was decided to sample with the Fluorometer and the Oxygen sensor only one out of four dives, the CTD was kept as before (maximum frequency). The mostly favourable currents allowed to use minimum buoyancy change (100cc) for most of the transect, this made the 24V battery consume very few energy, almost half of the first transect's. The 10V energy consumption was also reduced considerably but not as it was expected. The computer time dedicated to sampling was the most consuming, 25%, even more than the pump, 24%.

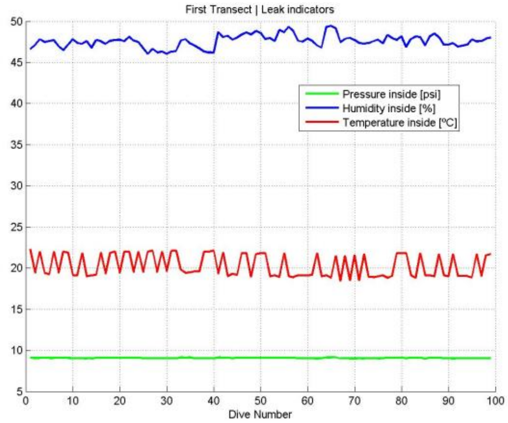
During the recovery transect, only the CTD was used. During this transect, the consumption ratios of both battery packs were well balanced. This indicates that for missions where the glider mostly dives to full depth, 975m, the 10V battery pack will greatly limit the mission duration if the optical sensors are on. With only CTD at maximum frequency, and taking an average of the first and second transects consumption of the 24V battery, a mission could last about 71 days diving to 975m. Another option would be using higher thrust (ie 270 cc), which would bring the 24V battery consumption closer to the 10V one.

Regarding the consumption estimation (DA2, DR9), it was predicted that 27,3 Ahr would be used from the 24V pack and 40,5 Ahr from the 10V pack. This prediction was for the two channel transects and did not count the recovery transect. The actual consumption of the two channel transects was 18,4 Ahr from the 24V pack (67% of predicted) and 37,1 Ahr from the 10V pack (92% of predicted). The endurance estimator provided by iRobot can be considered quite accurate and valid for predicting Seaglider consumption.

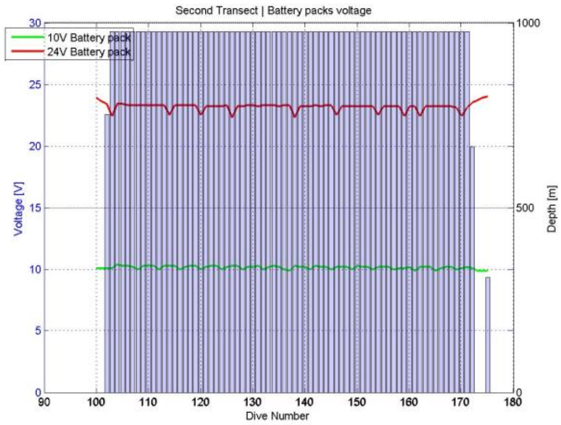
Battery voltage and Leak indicators

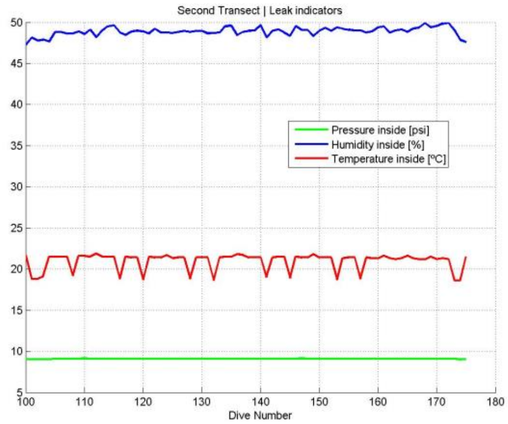
First Transect



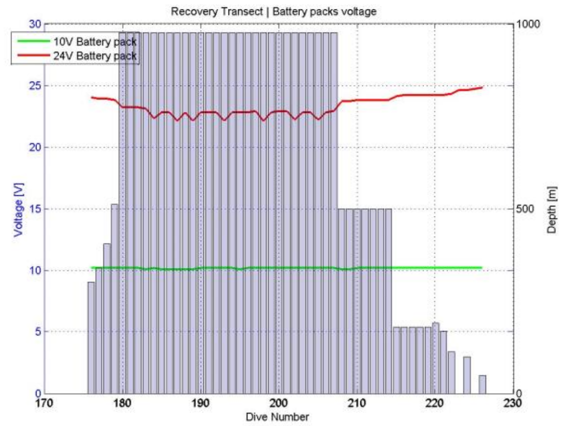


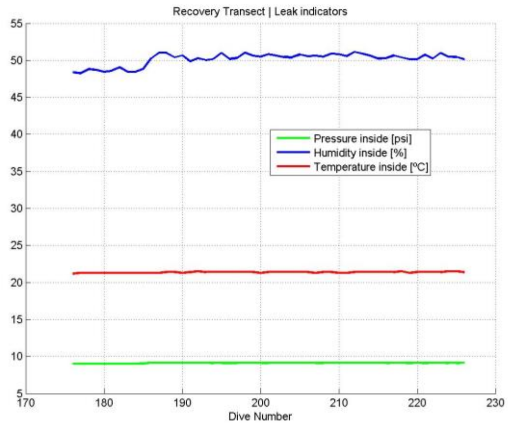
Second Transect





Recovery Transect

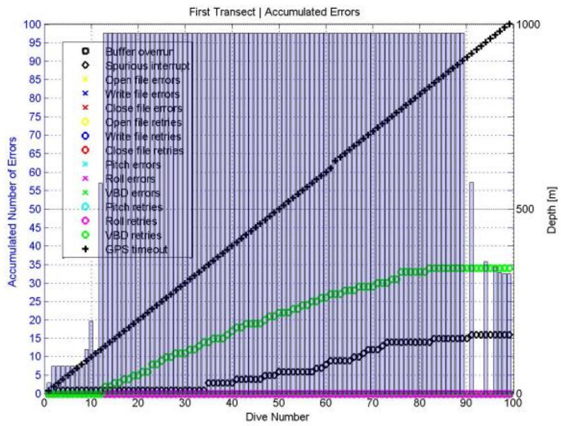




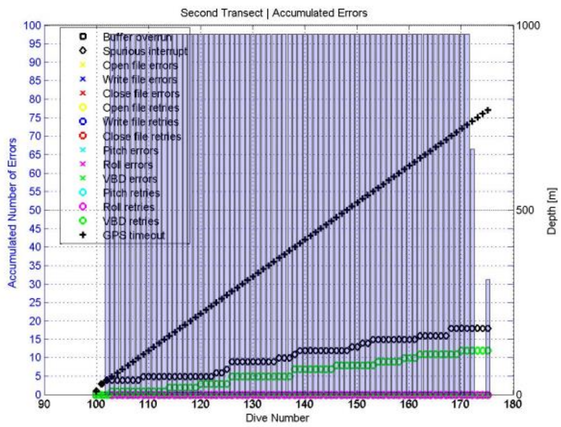
No incidents regarding leaks or sudden battery voltage drop. During deeper dives, 24 V battery voltage drops as required power increases. Diving shallower again recovers the voltage.

Errors and Bottom detection

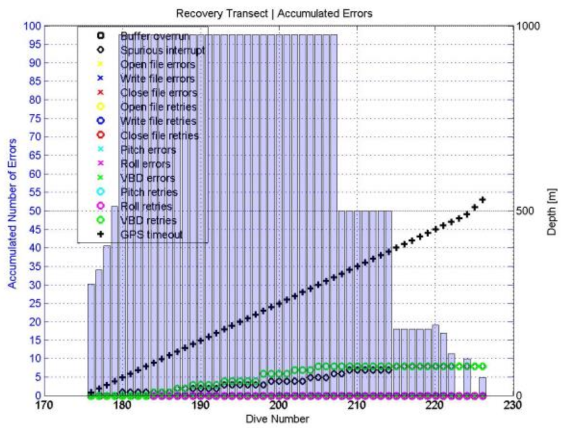
First Transect



Second Transect

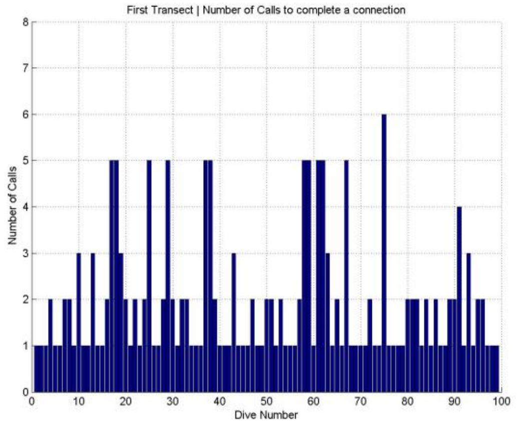


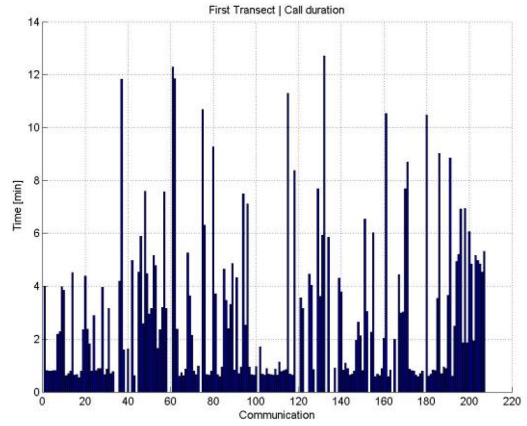
Recovery Transect



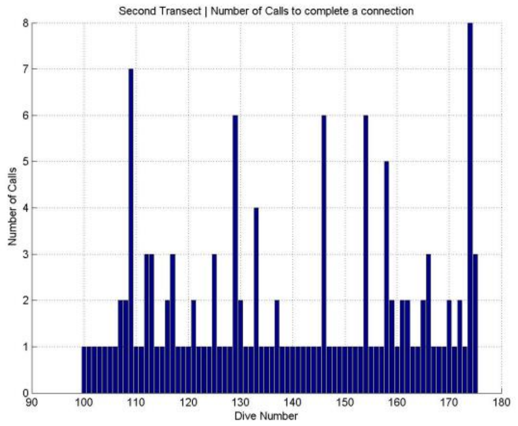
Iridium Communications

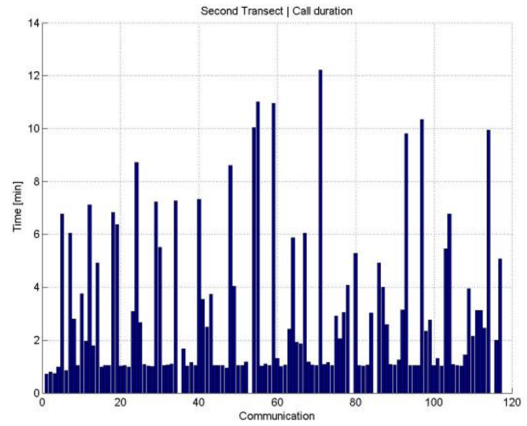
First Transect



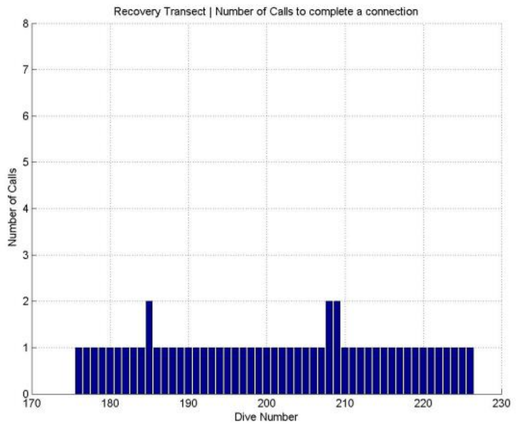


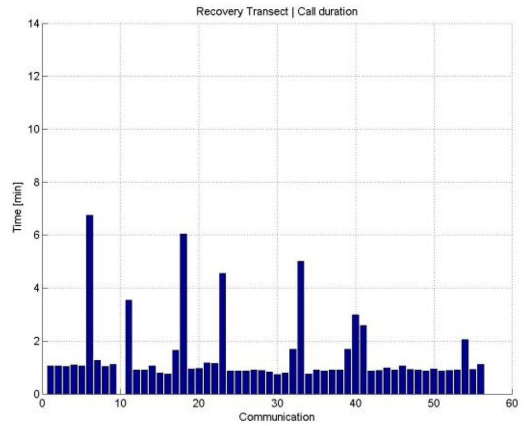
Second Transect





Recovery Transect





By the end of the first transect (dive 70) it was decided to increase $CALL_TRIES from 5 to 8 as many dives could not be transmitted completely in 5 calls; the result was very satisfactory. Also, from dive 66 the size of the data packages the glider sends (N_FILEKB) was increased from 4kb to 8kb. This reduced the handshaking between glider and basestation and reduced communication errors and cuts.

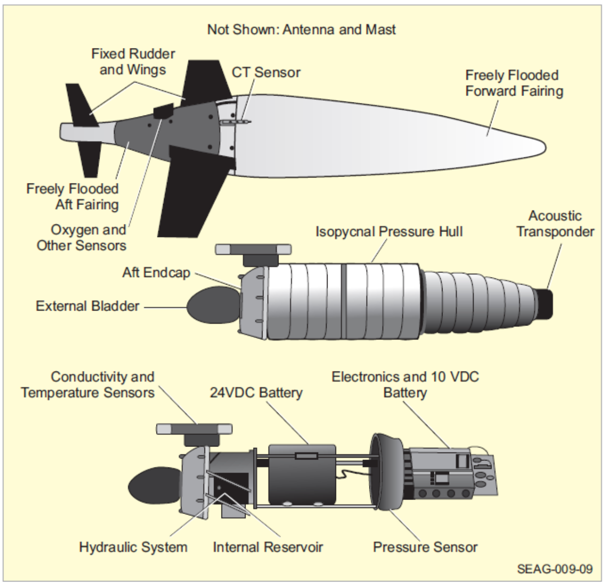
ANNEX I: GLIDER TECHNICAL INFORMATION

iRobot Seaglider 1KA

The Seaglider is neutral in water when the external bladder has a certain amount of oil inside. When the glider wants to dive, the bladder deflates (oil moves into a reservoir) and the glider becomes denser than water. While diving, the wings give the glider lift and forward propulsion. As the glider goes deeper, the pressure on the hull increases making the hull smaller and therefore increasing the glider's density. This change in glider density is similar to the change in density the water experiments thanks to the isopycnal hull design. This way, vertical velocity remains stable.

To climb, the glider uses the hydraulic system to inflate the external bladder and thus gain buoyancy. This is done during the apogee phase and it is the most energy consuming manoeuver.

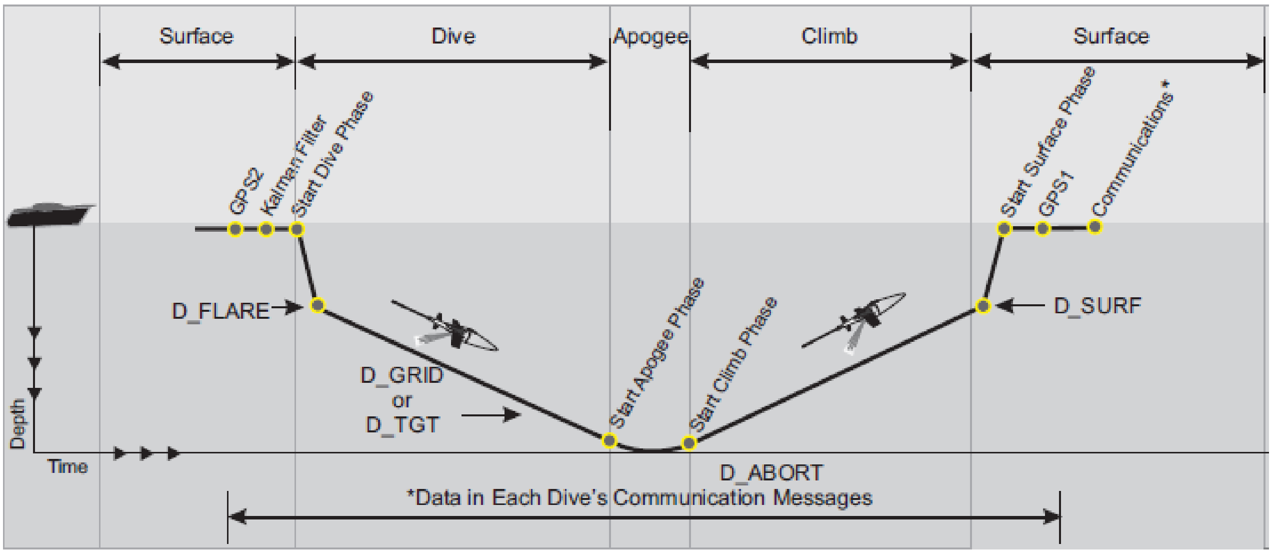
Once on the surface, the glider gets a GPS fix and calls via Iridium satellite into the basestation to receive new orders (navigation, sampling, waypoints) and upload data (scientific and technical). With the new instructions, the glider gets another GPS fix, makes some calculations to find the direction to the next waypoint and dives again.



Seaglider parts. Source: iRobot (DA 1)

iRobot Seaglider 1KA Specifications	
Weight in air	52 Kg
Weight in water	Neutrally buoyant
Hull Diameter	Max 30 cm
Hull material	Aluminium
Width including Wings	1 m
Vehicle Length	1,8 m
Depth Range	0-1000 m
Speed, projected	0,25 m/s horizontal
Energy	Lithium Sulfuryl Chloride primary batteries, 17 MJ
Endurance	Dependent on navigation and sampling. Typically 4 months
Range	3000 km
Navigation	GPS, internal dead reckoning, altimeter
Sensor Package	Conductivity, Temperature, Depth, Clorophyll, CDOM, backscatter 650nm and oxygen
Communications	Iridium satellite, external ARGOS transmitter, Serial cable, Pinger for recovery

Glider Behaviour



Seaglider dive phases. Source: iRobot (DA 1)

- Distance travelled:

Vertical speed = w_d = (2 * $D_TGT * 100cm/m) / ($T_DIVE * 60s/min)

Distance = $D_TGT * (1 / tan (Down Angle) + 1 / tan (Up Angle))

If Up Angle = Down Angle= 20º

1 / tan (20º) = 2,75

Then **Distance = Depth * 5,5**

- Horizontal Speed (theoretical - without currents):

Speed = **0,25 [meter/sec]** * (1 mile / 1852 meter) * (3600 sec / 1 hour) =

0,486 [miles / hour]

- Inflection Time (Up and Down)

Time = Distance / Speed = Depth * 5,5 / 0,25 = **Depth * 22 [sec]**

For example:

Depth= 1000 meter

Distance = 5500 meter

Time = Distance/Speed = 5500 [m] / 0,25 [m/sec] = 22000 [sec] =

366 [min] = 6 [h] + 6 [min]

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