CRUISE REPORT

SOCIB Canales Autumn 2016

11th to 13th November 2016

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Description:	A repeat seasonal hydrographic survey of the Balearic Sea, monitoring the Ibiza and Mallorca Channels. 25 CTD stations were carried out over 3 days; the stations forming three transects across the Ibiza Channel (IC). Normally a fourth day involves 10 CTD stations across the Mallorca Channel (MC); these stations were skipped and the ship steamed back to Palma de Mallorca during the evening on the 13th November owing to impending weather deterioration. An additional stop was made for maintenance of the Ibiza Channel buoy, where surface samples were taken for comparison with the buoys sensors.
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v1.0.0	2016-11-14	first version document	K. Reeve	E. Alou
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![SOCIB Balearic Islands Coastal Observing and Forecasting System]

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Objectives

1. Complete repeat hydrographic survey of the Ibiza Channel (IC) and Mallorca Channel (MC) through deployment of a CTD instrument frame (SeaBird SBE911*plus*) with extra mounted sensors and rosette equipped with 12 10l Niskin bottles.

2. Discrete water sample collection at various depths for the purpose of:
   a. Sensor field correction with the *in situ* discrete water samples for salinity, dissolved oxygen and chlorophyll a (chl *a*) concentration.
   b. Biogeochemical sampling of nutrients and phytoplankton community (through pigment signatures and microscopic post-cruise analyses).

3. Collection of VM-ADCP (vessel-mounted Acoustic Doppler Current Profiler) data throughout the cruise to gain knowledge about the current structure of the upper 100-400 m of the water column.

4. Maintenance of the Ibiza Channel Buoy.

5. Collection of surface water samples for comparison purposes with the Ibiza Channel buoy, for salinity, dissolved oxygen and chlorophyll a (chl a) concentration.

Onboard personnel

E. Alou	Biochemical
B. Casas	CTD
C. Castilla	CTD
M. Gonzalez	Biochemical/IT
I. Lizarán	CTD
A. Massanet	Biochemical
K. Reeve	ADCP

N. Wirth   CTD

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Station plan

25 CTD stations were carried out over a period of 4 days; all 3 transects in the IC; deteriorating weather conditions meant no stations were carried out in the MC. The ADCP was collecting data throughout the entire duration of the cruise, from the moment the ship left the port to the moment the ship arrives at port. Figure 1 shows the station locations and the order in which stations were carried out.

A ship activity log detailing actions carried out during the cruise is provided in Appendix 1. Note none of the Radmed stations in the Mallorca channel were carried out.
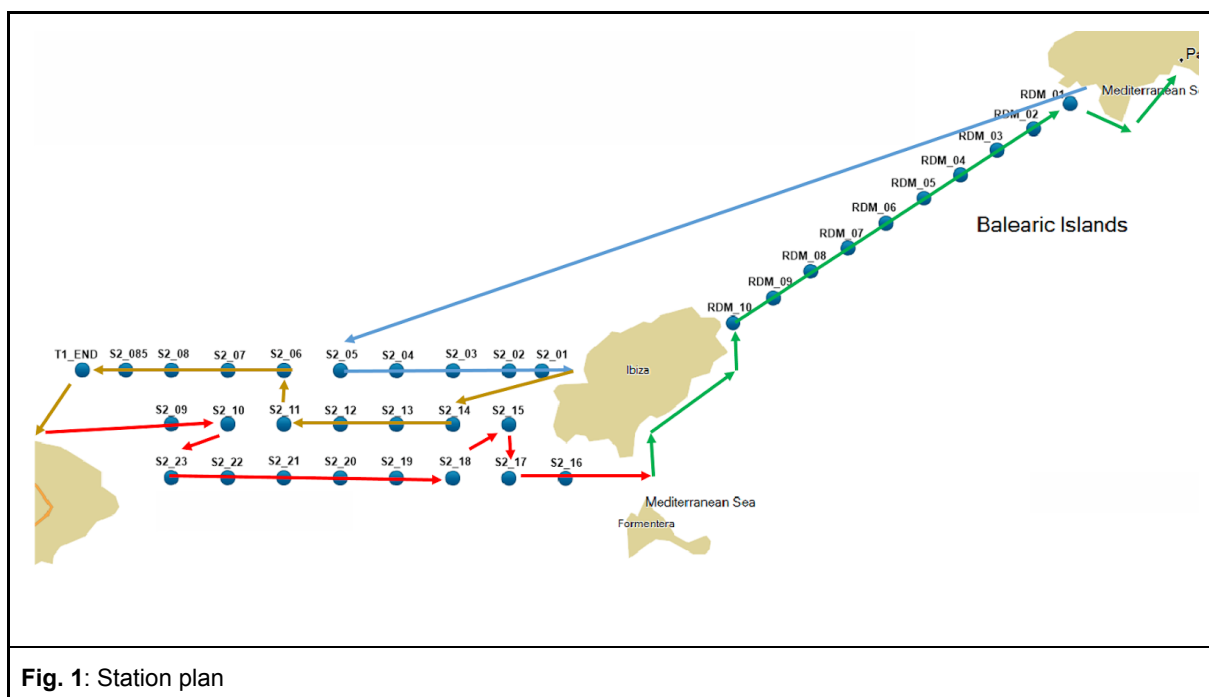
Fig. 1: Station plan

Cruise diary

Day 1 - 11th November 2016

We left the port of Palma at 06:55 UTC, steaming westwards out of Palma Bay. Upon attempting to set up the ADCP configuration files, it was noticed that PCCAMERAS has issues regarding connection to the serial port for navigation. Benja and Miguel ran some tests and were unable to resolve the issue for now. At 09:00 UTC we set the ADCP up on PCLAB2, and had no issues. The first ADCP run was in water tracking mode, as we were just heading off the Mallorca shelf into deeper waters. So far the conditions are nice; apparent wind is <20 knots, the sun is shining and the sea is calm. There was a strong northern flow (30-40+ cm s^{-1}) extending to the sea floor on the eastern side of the Mallorca Channel, and a sharp appearance of a frontal boundary west of which the northern component of flow slackens, and gradually a strong eastward flow (30 cm s-1) could be detected in the upper 60 m. We were steaming at a general speed of 13-14 knots towards the northern coast of Ibiza. After steaming along the northern coast of Ibiza, we entered the Ibiza Channel at 12:40 UTC. The sea state deteriorated slightly upon entering the channel due to wind direction, but it was only temporary. Things had calmed down by the time we had approached the first station of the day, which is in the centre of the Ibiza Channel. Entering the Ibiza channel, we had an eastern flow consistent throughout the top 120 m (to the deepest range for the ADCP at 12-14 knots in these fairly good conditions) in the shallower waters, with a slight northern component- especially in the upper 50 m. As we approached the central channel, a sub-surface western current of about 30 cm s^{-1} appears to dominate (below about 50 m; above 50 m the flow is much weaker). A less well defined, weaker sub-surface southern flow accompanies the western flow. This suggests that the flow is north and eastward hugging the coastline of Ibiza, whereas a southern, western flow dominates in the deeper waters towards the centre of the Channel. We reached the first station of the day (S2_05) at 14:26 UTC, under calm and sunny conditions. This will be the first campaign since the CTD underwent a servicing. After S2_05, the ship steamed eastwards to return to Ibiza - carrying out four more stations before reaching the port of San Antonio. The sun set at 16:40 UTC. At 17:40 UTC the ADCP was switched off for about 2 minutes without stopping the recording on VMdas, and then again a few minutes later for a longer time period. This occurred during file 003, due to issues with PCSONDA - EDT were checking where the problem was. The problem was fixed, and the ADCP file 003 was ended - there may be some noise at the end of the file to remove. The ADCP was started again, in bottom tracking mode (file 004) just as we arrived on station S2_02. Shortly after completing the last station of the day, S2_01, we arrived at the port of San Antonio, Ibiza at 1915 UTC. End of day one!

This cruise campaign is the second time we have used a prototype nutrient sensor SUV51, mounted on the CTD frame and connected to the one serial input port of the SeaBird 9/11 breakout unit. This instrument is a Valeport Ltd derivative of the SUV6 prototype developed in parallel with the University of Southampton (Pidcock et al., 2010). It operates on the basis of the small absorbance of 200-220 nm UV light by dissolved nitrate in seawater.

DAY 2 - 12th November 2016

We left the port of San Antonio, Ibiza, at 06:30 UTC, just as the sun was rising over the horizon. We steamed south westwards at a general speed of 12 knots towards the first station of the day, station S2_14. The ADCP was set up in bottom tracking mode (file 005) over the shallow shelf of Ibiza. It was then switched into water tracking mode (file 006) at 07:53 UTC, just prior to arriving at station S2_14. So far conditions are calm, the ship steaming with the wind. The conditions remained calm throughout the day; although conditions were temporarily slightly less calm as we approached the shelf of the Iberian Peninsula, with the ship starting to head into the wind. The centre of Ibiza Channel shows very weak flow with a mostly northern component. There have been no issues in the morning with the PCs – let's hope it lasts! We also seem to have good depth penetration with the ADCP - consistently to about 160 m, often with some backscatter again below about 250 m. Between stations S2_06; S2_07 and S2_10, the ADCP shows a sub-surface patch, below 50 m, of strong western flow. After this passed, while approaching station S2_10, the westward flow abated and a surface (<50 m) southerly flow appeared, at the edge of the shelf in 500 m water depth. Conditions have remained calm. The day passed with no PC or instrument issues, and nice calm conditions. We finished the last station of the day at 17:50 UTC, before steaming west, arriving at the port of Denía on the Iberian Peninsula at 18:30 UTC.

DAY 3 - 13th November 2016

We left the port of Denía at 06:44 UTC, steaming south eastwards towards the first station of the day. Conditions are still calm and pleasant, with increased cloud cover. We set up the ADCP on PCLAB3 once again, and started running it in bottom tracking mode (file 008) while we were still leaving the port, to check that everything was functioning ok. It was then switched into water tracking mode (file 009) just off the shelf, while on station S2_22. It was noted while on the subsequent station, S2_21, that WinADCP doesn't appear to be working, although the ADCP, navigation and VMdas all seem to be working fine. We approached the Ibiza Channel Buoy at 11:30 UTC, where divers carried out maintenance of the buoy while water samples were taken at the surface in order to carry out salinity, oxygen and chlorophyll comparisons with the buoy. While stationary, we stopped the ADCP and set things up once again on PCLAB2, so that we can have live monitoring of the ADCP with WinADCP (file

010). Conditions are perfect, almost glassy, with virtually no wind (1-2 knots when on station in a generally eastward direction. The beginning of ADCP file 010 may have to be cleaned as the ship was turning 180º a few times when retrieving the divers. When the divers were back on board, we steamed south eastwards to return to the southern-most transect, towards station S2_19. At 14:36 UTC, we switched the ADCP back to PCLAB02 (hopefully for the last time!), in bottom tracking mode. The issue with WinADCP was that the processing velocity reference level was not allocated; the velocity reference level should be set to navigation (VMdas). The rest of the stations went smoothly, with beautiful glassy conditions. We're now steaming around the southern coast of Ibiza at 20 knots in the hope that we make it back to Mallorca before the weather turns too bad - no stations in the Mallorca Channel this time. The ADCP was running in one file for the entirety of the Mallorca Channel. For the first 1.2 hours of the ADCP-transect, the ship was steaming at 20 knots, after which we slowed to 11-12 knots. The ship-transect is a straight line and good conditions at night time meant that the ADCP was able to penetrate as far down as 300 m. To the western side of the Mallorca channel there is a northern flow in the upper 80-100 m. Towards the eastern side of the channel, the flow becomes more eastward, with the strongest flow occurring both at the surface and at 100 m. The ADCP was stopped at 21:06 UTC as we headed towards the port of Palma, where we arrived at 21:30 UTC.

Instrumentation description and configuration

In this section are described the instrumentation and the configuration used during the cruise

CTD-Probe

Manufacturer:	SeaBird
Model:	SBE9+
S/N:	1031
SOCIB Inventory:	SCB-SBE9002
Deck Unit:	SBE11
SOCIB Inventory:	SCB-SBE11+001

Sensor	Model	S/N	Calibration date
Temperature	SBE 3P	03P5427	2013/12/19
Temperature 2	SBE 3P	03P5449	2013/12/19
Conductivity	SBE4C	043872	2014/01/14
Conductivity 2	SBE4C	043877	2014/01/14
Pressure		119076	2014/02/03
Oxygen	SBE 43	432117	2014/01/18
Transmissometer	WET Labs C-Star 25-650	CST-1413DR	2014/03/05
Turbidity	STM Sea Point	12181	2014/01/23
Fluorometer	Seapoint 6000m	3258	2014/01/23
Irradiance	PAR Biospherical QCP-2300L-HP	70363	2011/03/25

Surface Irradiance	SPAR Superficie Biospherical QCR2200	20395	2011/03/28
Altimeter	Datasonics PSA-916D	52712	
SUV51 (via serial port)	Valeport Ltd	-	-

Configuration

For controlling the CTD the following file was used: S2_01.xmlcon. The information contained in that file is located in Appendix 2: CTD Configuration File.

Acoustic doppler profiler

Manufacturer:	RDI
Model:	Ocean Surveyor 150 kHz
S/N:	1878
SOCIB Inventory:	SCB-RDi001

Configuration

Thermo-salinometer

Manufacturer:	SeaBird	
Model:	SBE21	
S/N:	3370	
SOCIB Inventory:	SCB-TSL001	
Calibration date:	2011/12/21	

Configuration

The data are collected using the UTM - Termosal.exe software. The data are stored directly in the main desktop and are processed through the SOCIB-DC system.

Fluorometer

The instrument was not installed therefore data from this instrument were not collected during this cruise.

Manufacturer:	Turner	
Model:	10 - AU	
S/N:	1100195	
SOCIB Inventory:		
Calibration date:	2015/09/17	

Weather Station

Manufacturer:	Geonica
Model:	Meteodata 2000
S/N:	
SOCIB Inventory:	SCB-MET009
Calibration date:	2011

Configuration

The data are collected using the UTM - SADO System. The data are stored directly in the main desktop and are processed through the SOCIB-DC system.

SUV-51 - prototype nutrient sensor (Valeport limited)

This cruise campaign is the second time we have used a prototype nutrient sensor SUV51 (manufactured by Valeport limited). This instrument was connected to the serial input port of the seabird 911 breakout box, and provided a serial data stream to be viewed at the deck unit. It appears to be working fine, although there is no visualization of the data - a method of data processing will need to be established. Seeing as the instrument has only been tested for 500 m profiling work, the SUV51 was only attached to the rosette frame for stations less than 500 m depth.

Scientific Reports

Physical data report

The following contains an overview of the physical data collected from the CTD and the VM-ADCP on board the R/V SOCIB catamaran from the 11th to the 13th November 2016. The first section is a technical description of the VM-ADCP data processing and visualization, and a calibration report, while the second section briefly outlines the steps followed in order to process the CTD data. The next section provides a brief biogeochemical

data report, after which some results are presented from both the VM-ADCP and CTD, drawing attention to any particularly interesting features.

VM-ADCP

Throughout the entire cruise (i.e. both during sections and during transits), a VM-ADCP was recording data about the movement of the upper 100-400 m of the water column. Generally penetration range was less than 200 m, resulting from a combination of rough weather, and low abundance of scattering particles at this depth possibly resulting from diel vertical migration of zooplankton. The R/V SOCIB is equipped with a 150 kHz, RDI Ocean Surveyor, VM-ADCP (vessel-mounted Acoustic Doppler Current Profiler) transducer located in the port hull just forward of the accommodation bulkhead in front of the fuel tanks. Data is recorded and displayed real-time using the RDI developed software VmDas (RDI's data acquisition and playback software) and WinADCP (RDI's visualisation software). Log sheets detailing the ADCP files can be found in here.

Data processing: The basic data processing was carried out to SOCIB's VM-ADCP standard operating procedures (SOPs) within VM-DAS and WinADCP (refer to these documents for further details).

The initiation files for both bottom-tracking and water-tracking mode included the following settings:

- Transducer depth = 2 m
- Blank distance = 8 m
- Number of Bins = 50
- Bin thickness = 8 m
- Max range for bottom tracking = 400 m
- STA files (short term averaging) = 120 s
- LTA files (long term averaging) = 600 s

Calibration: The EA Heading alignment was set to -45.5° while the velocity scale factor for profile velocities was initially set to 1.010, in accordance with previous cruises. These values correct for misalignment between the VM-ADCP instrument and the ship. Throughout the cruise, a total of 6 transects were carried out in bottom-tracking mode for the purpose of misalignment calibration checks (as described in the SOPs). Due to the issues with the PC (see cruise diary for further information), these bottom-tracking mode files were short and choppy and two files lacked the number of consistent ensemble data points (consistent in terms of bottom depth, velocity and direction) for calibration purposes and were therefore discarded. The bottom track STA files were read into excel and sections of data were then copied into a VM-ADCP calibration spreadsheet. These data sections were subjectively

chosen on the basis of relatively constant ship velocity, heading and bottom depth. The calibration spreadsheet follows the standard theory for VM-ADCP installation calibration from bottom track information as described in Joyce (1989) and Pollard and Reed (1989). The resulting calibrations of the four bottom-track sections are provided in table 1a. The mean misalignment angle varies from about 0.05º to 0.2º, with no statistical significance (on average standard deviation: SD ± 0.37).

The velocity scale factor was set as 1.01. Across all 4 bottom tracking files, the amplitude factor ranged from 1.00645 to 1.012, with an average of 1.00992 ± 0.004 (SD). This leads to suggested new velocity scale factors ranging from 1.0165 to 1.0223, with a mean of 1.020, and between 1.012 and 1.0276 when one looks at extremes using the standard deviation. Just one out of the four files suggests a new velocity scale factor that is less than 1.02. This is quite a sudden change from calibrations from previous ship campaigns, where the amplitude factor has consistently led to suggested velocity scale factors of typically close to 1.01. The change may be a result of a thorough servicing of the ship that took place prior to the cruise. The data were reprocessed with a new velocity scale factor of 1.02 (alignment offset was unchanged) and were then recalibrated, the results of which are shown in table 1b. The new amplitude factors are considerably closer to 1.0, ranging from 0.9998 to 1.00035, with a mean of 1.00004 ± 0.0037. This results in new velocity scale factors ranging from 1.0198 to 1.0204 (mean: 1.02005 ± 0.00381). This suggests that 1.02 is now the better choice for velocity scale factor. In future ship campaigns this should be monitored carefully, for further sudden changes in the calibration of the ADCP.

Date	File	No. bins	Bin size (m)	Max range (m)	Alignment offset	Velocity Scale Factor	No. data points	Mean Phi	std mean Phi	Mean Amplitude Factor	std Amplitude Factor	New Velocity Scale Factor	min New Velocity Scale Factor	max New Velocity Scale Factor
16/11/11	2	50	8	400	-45.5	1.01	38	0.0466	0.4742	-1.01213	0.00534	1.02225	1.01686	1.02765
16/11/12	5	50	8	400	-45.5	1.01	8	0.1990	0.4897	-1.00645	0.00450	1.01651	1.01196	1.02106
16/11/13	8	50	8	400	-45.5	1.01	14	0.0752	0.2936	-1.01009	0.00386	1.02019	1.0163	1.02409
16/11/13	11	50	8	400	-45.5	1.01	10	0.1586	0.2049	-1.011	0.00221	1.02111	1.01887	1.02334

Table 1a. Calibration records for Canales Autumn 2016, before reprocessing (i.e. with velocity scale factor of 1.01).

Date	File	No. bins	Bin size (m)	Max range (m)	Alignment offset	Velocity Scale Factor	No. data points	Mean Phi	std mean Phi	Mean Amplitude Factor	std Amplitude Factor	New Velocity Scale Factor	min New Velocity Scale Factor	max New Velocity Scale Factor
16/11/11	2	50	8	400	-45.5	1.02	24	-0.0363	0.4738	-0.99998	0.00384	1.01998	1.01607	1.0239
16/11/12	5	50	8	400	-45.5	1.02	14	-0.079	0.4556	-0.99983	0.00439	1.01983	1.01535	1.02431

16/11/12	7	50	8	400	-45.5	1.02	10	0.0229	0.3313	-1.00035	0.00254	1.02036	1.01777	1.02295
16/11/13	8	50	8	400	-45.5	1.02	18	0.0510	0.2831	-1.00001	0.00417	1.02001	1.01576	1.02426
16/11/13	11*	50	8	400	-45.5	1.02	9	0.2194	0.1494	-1.00278	0.00254	1.02283	1.02025	1.02542

Table 1b. Calibration records for Canales Autumn 2016, after reprocessing (i.e. with velocity scale factor of 1.02). *File with highly variable ship direction and bottom depth.

CTD and water bottle sampling

Data acquisition: CTD casts were carried out at 25 stations encompassing 3 transects across the IC; no stations were carried out in the MC. At each station, water samples were collected with the rosette at various depths for measuring *in situ* salinity, dissolved oxygen and fluorescence in order to apply corrections to the conductivity, oxygen and fluorescence sensors. Refer to the available logbook generated during the cruise for more details on sampling depths, replicates and parameters sampled at each station ( )

Data preprocessing and visualization: The sensor data were processed using SBE (Sea-Bird Electronics) Data Processing Version V7 23.2 (for details refer to SBE Web site). The resulting data are then processed in Matlab in order to provide the figures in the following section. Post cruise processing will involve the correction of the salinity data based on calibration with in situ water samples analysed in the lab with a Guildline Portasal model 8410A salinometer. The biogeochemical sampling will be discussed in the next section: the biogeochemical report.

Biogeochemical data report

As mentioned in the general objectives, the primary objective of the biogeochemical data collection during this cruise is to compare the CTD oxygen (SBE-43) and fluorescence (Seapoint) sensors against the *in situ* discrete water samples of these parameters.

Secondary field objectives are:

1. To estimate chl *a* concentration and distribution (as a proxy for phytoplankton biomass).
2. To assess nutrient concentration distribution: Nitrate (NO_3-), nitrite (NO_2-), silicate (SiO_4^{2-}) and phosphate (PO_4^{3-}).
3. To study phytoplankton community composition.

The sampling was carried out on 3 days from the 11th November to the 13th November 2016 and followed the established R/V SOCIB protocols.

Dissolved oxygen

Discrete water samples (Winkler's method, Langdon 2010, see protocols) for comparison were taken at each station along each transect at a maximum of 3 depths. We chose depths of varying oxygen concentrations (in order to sample the full spectrum of oxygen concentrations). Refer to the available logbook generated during the cruise for more details on sampling depths, replicates and parameters sampled at each station.

Samples were analyzed on board after an 8-12 h period in darkness with a titration procedure with potentiometric endpoint detection (Metrohm 888 Titrator).

The final dissolved oxygen dataset will be produced post-cruise following the analysis of the data.

Chl _a_ concentration

Samples for chl _a_ concentration were taken at all stations at 4 depths (see logbook for details). Post-cruise chl _a_ determination will be carried out at the IMEDEA by fluorometry (Turner Trilogy fluorometer, see available protocol).

Nutrients

Samples for inorganic nutrient concentrations were taken at all stations at a maximum of 9 depths. Additional nutrient samples were taken at certain stations and depths to check the new nutrient sensor, SUV51 (see logbook for detailed information on sampling depths and protocols). Samples will be kept frozen at -20ºC at the IMEDEA until analysis.

Phytoplankton community composition

Samples were taken on each station at the deep chlorophyll maximum (DCM) for general cell identification (cells fixed in Lugol's solution, Utermöhl 1958). Samples for microscopy will be analyzed post-cruise at the IMEDEA. Additionally surface samples were taken at a few selected stations (see logbook).

Samples for High Performance Liquid Chromatography (HPLC) analyses were taken on each station at 2 depths (surface and DCM). The total fraction was collected and a volume of 2 L filtered through a GF/F filter (retaining microorganisms larger than the nominal pore size of 0.7 µm). Samples are stored at the IMEDEA (-80ºC) until analysis.

Preliminary results

Preliminary physical results

1. Velocity Vector Maps: 24 and 72 m

Figure 2 shows 2 km averaged VM-ADCP velocity at 24 (a) and 72 m (b); these depths were chosen to represent the current structure above and below the thermocline. ..TBC

Note there are significant outliers at 72 m on the shelf regions; an accurate outlier removal process is still a work in progress.
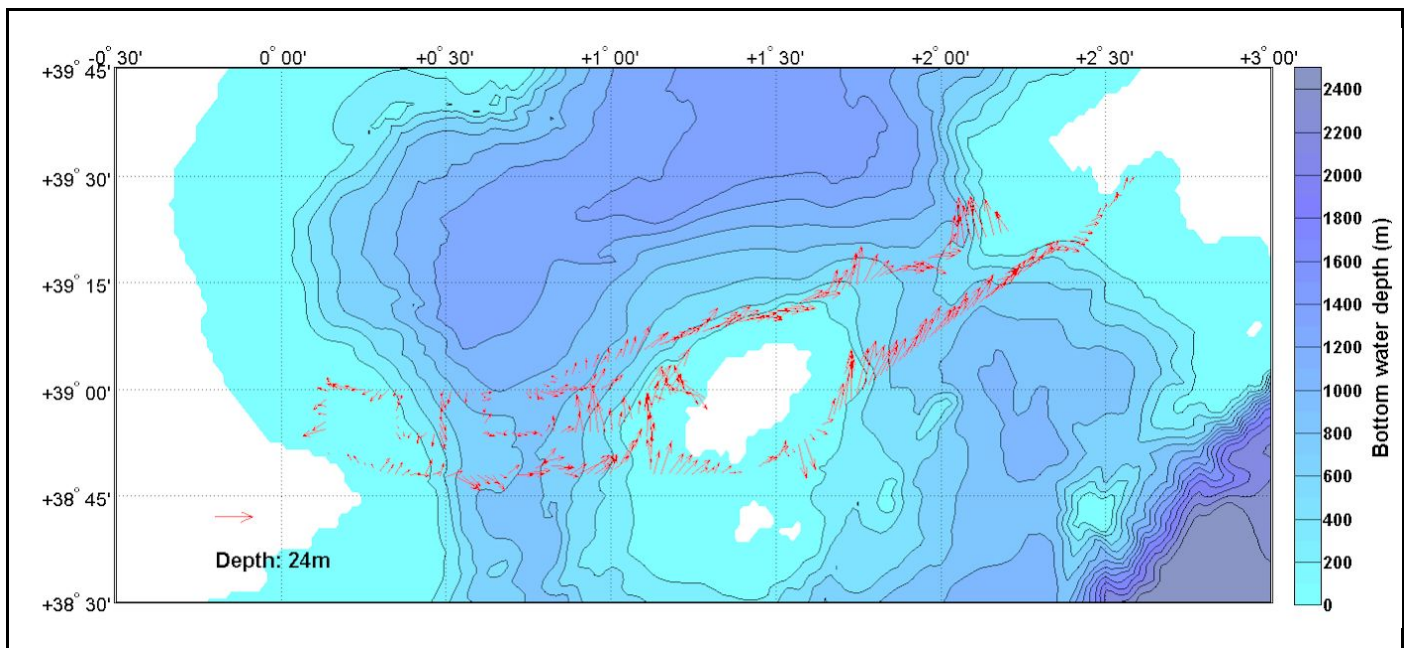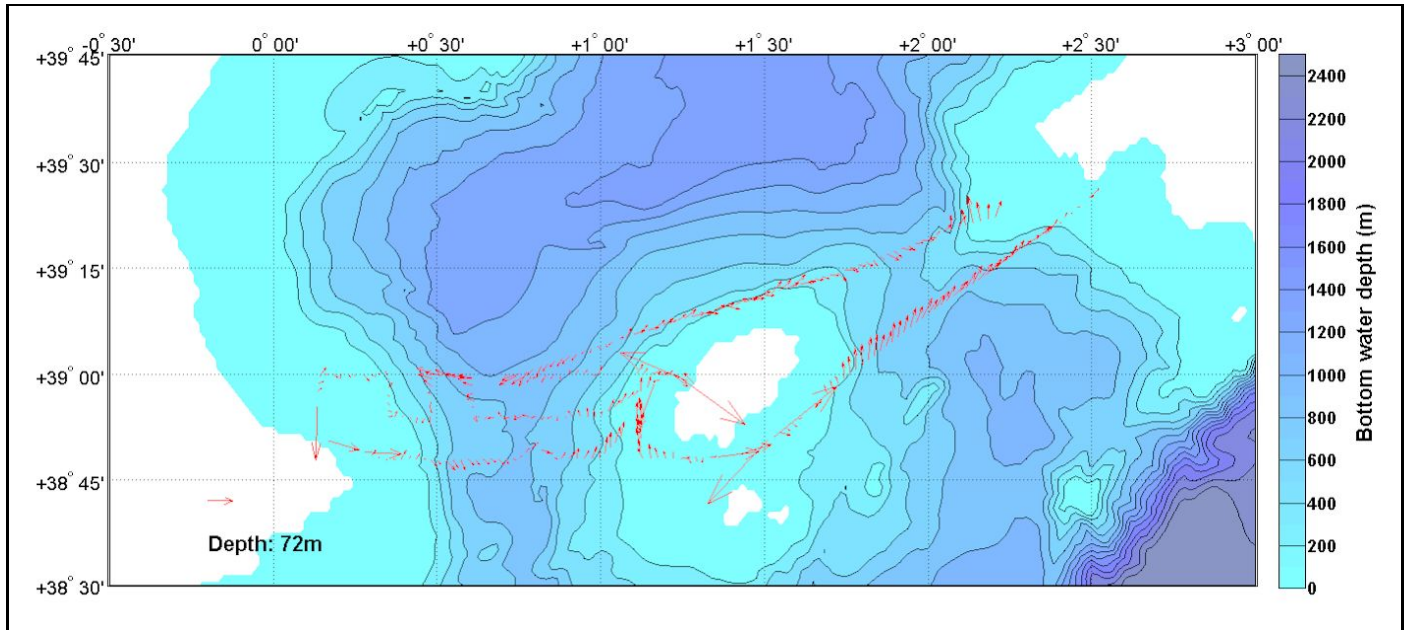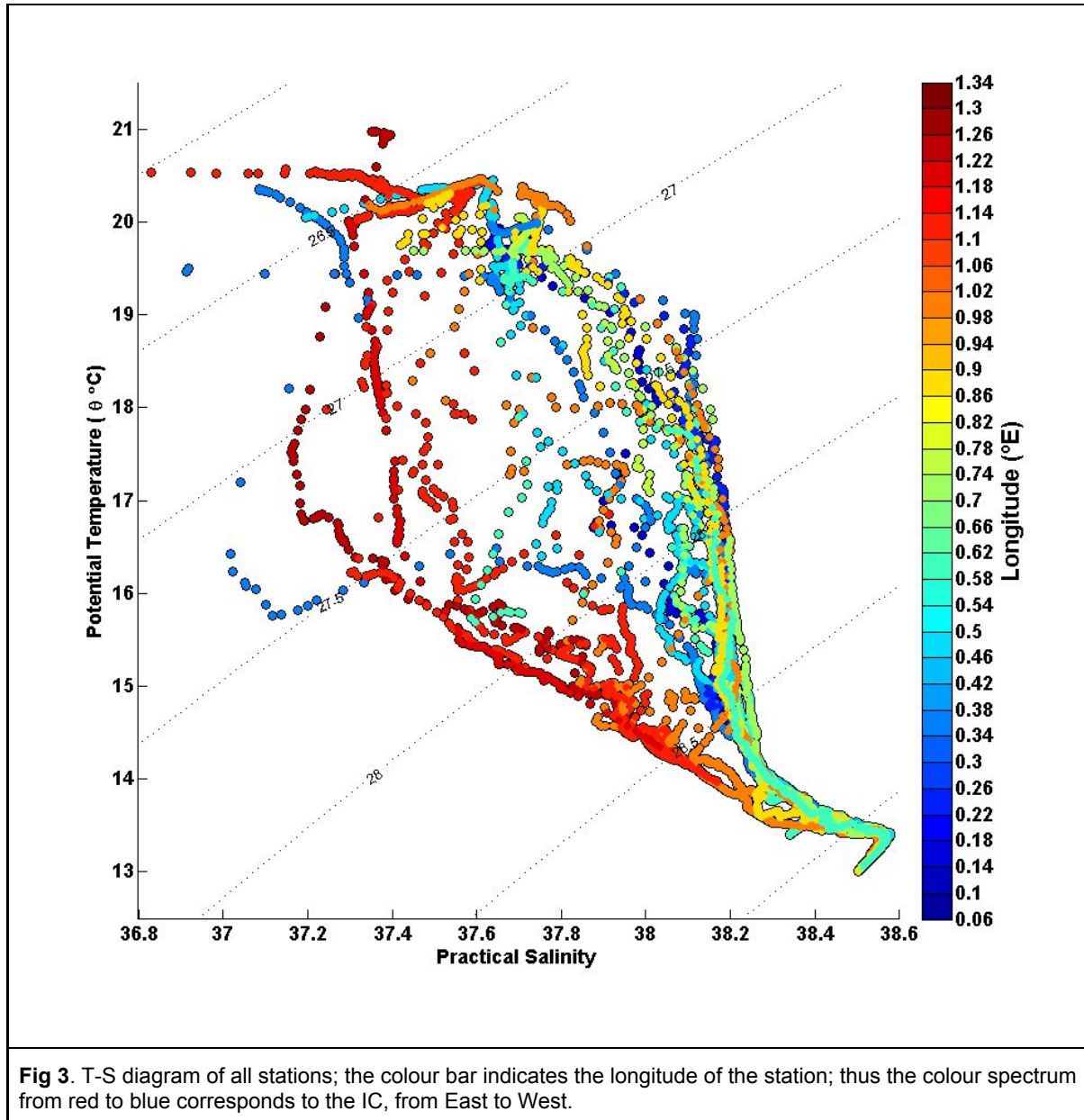
Fig. 2: 2 km averaged velocity at (a) 24 and (b) 72 m from VM-ADCP data. These depth bins were used to represent above and below the thermocline respectively

2. Hydrography: T-S diagram

Figure 3 shows the potential temperature – salinity distribution of all stations of the entire water column, where colour indicates the longitude of the corresponding station. The most saline surface water is typically found in the western part of the Ibiza Channel, where flow is southward on the shelf of the Iberian Peninsula (fig. 2). In contrast the eastern part of the Ibiza Channel shows some of the freshest surface water signals. In the Mallorca Channel, the freshest profiles can be found at the two easternmost stations RADMED_01 and RADMED_02, as well as the within the deepest section of the channel, between about 1.7º and 1.9º E.

Fig 3. T-S diagram of all stations; the colour bar indicates the longitude of the station; thus the colour spectrum from red to blue corresponds to the IC, from East to West.

3. Ibiza Channel: North

The figures presented in this section are showing the third, most southerly transect of the IC. Figure 4 shows the velocities u and v from the ADCP, of the off-shelf region of the IC (note the ship remained more or less at the same latitude throughout this transect; at about 38° 48.0 N). The subplot c shows a plot of the distance covered by the ship against the distance between each ensemble ping; where the distance between each ensemble ping reduces to

almost 0 we can identify periods where the ship is on station. By plotting against distance covered instead of ensemble number, the pixels where the ship is stationary have been compressed, providing a more uniform picture of the spatial structure of the Ibiza Channel. Flow is predominantly northward throughout with the exception of the easternmost part of Fig. 4.b, over the shelf edge of the Iberian Peninsula. The flow here is southward. The east-west component of velocity is less well defined; in general there is a weak net eastward component over the shelf edge, and a peak westward component between 30 and 35 km, which occurs at the deepest section of the Ibiza Channel. The flow is generally uniform throughout the upper 200 m of the water column, with the exception of the region over the Iberian Peninsula shelf edge; here there appears to be a slight northern flow in the upper ~30-40 m and predominantly southern flow below that depth, which incidentally coincides with the base of the thermocline (Fig. 5a). There is a distinct horizontal gradient in potential density where the density contours "bulge" towards the surface at 0.6º E (at the base of the shelf edge; station S2_21), and deepen to both sides of 0.6º E (Fig. 5c). Just to the east of this point, at the deepest section of the channel (station S2_20), there is some suggestion of vertical interleaving stratification in salinity and to a lesser extent potential temperature, particularly between 20 and 50 m (Figs. 5b and 5a respectively).
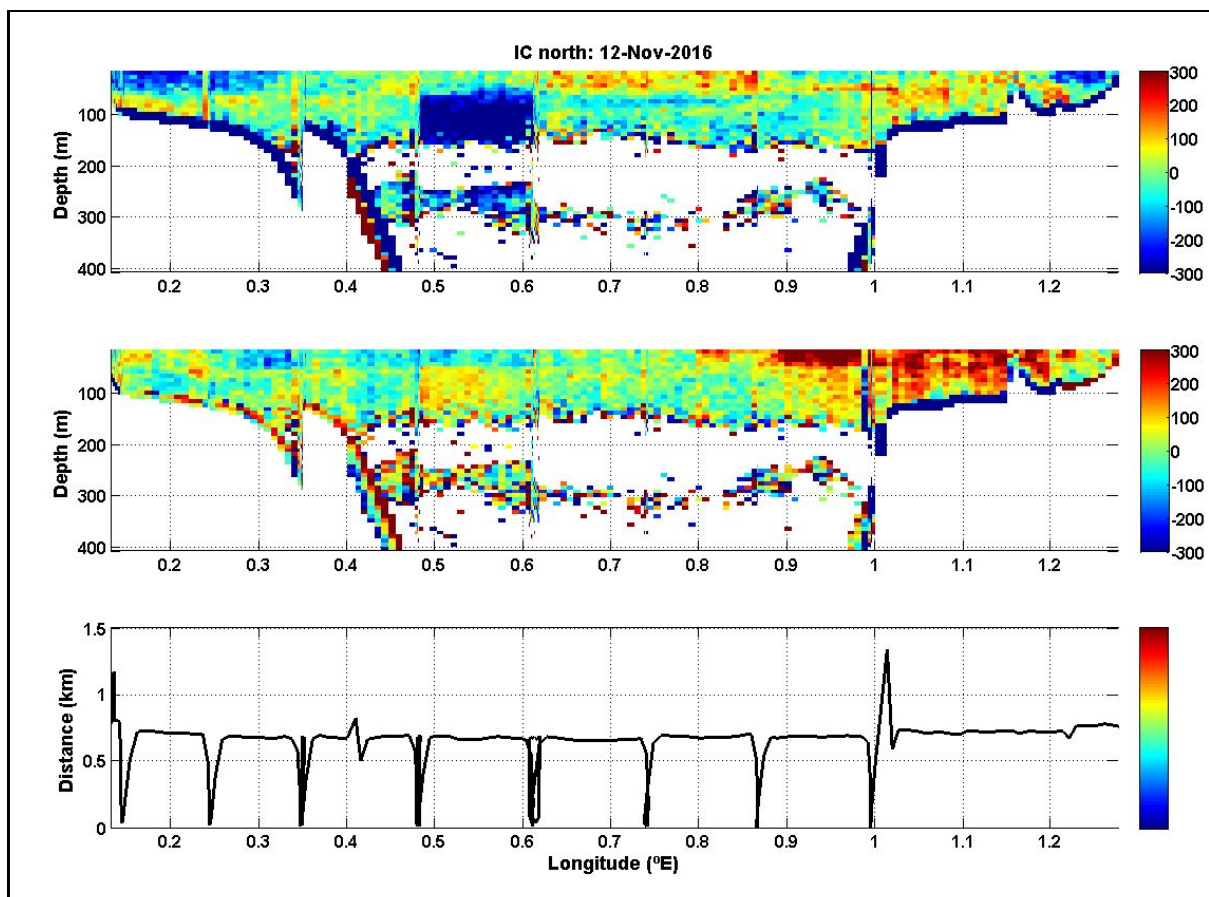
Fig. 4. east (a) and north (b) components of velocity (mm s⁻¹) plotted over longitude along the northern, east to west transit of the IC during day 2: 2016/11/12. The last plot (c) shows the distance between neighboring ensemble pings plotted over longitude in order to highlight where the ship is on station (these regions have close to 0 km between ensemble pings, whereas the distance between pings is larger than 0 km when the ship is in transit.
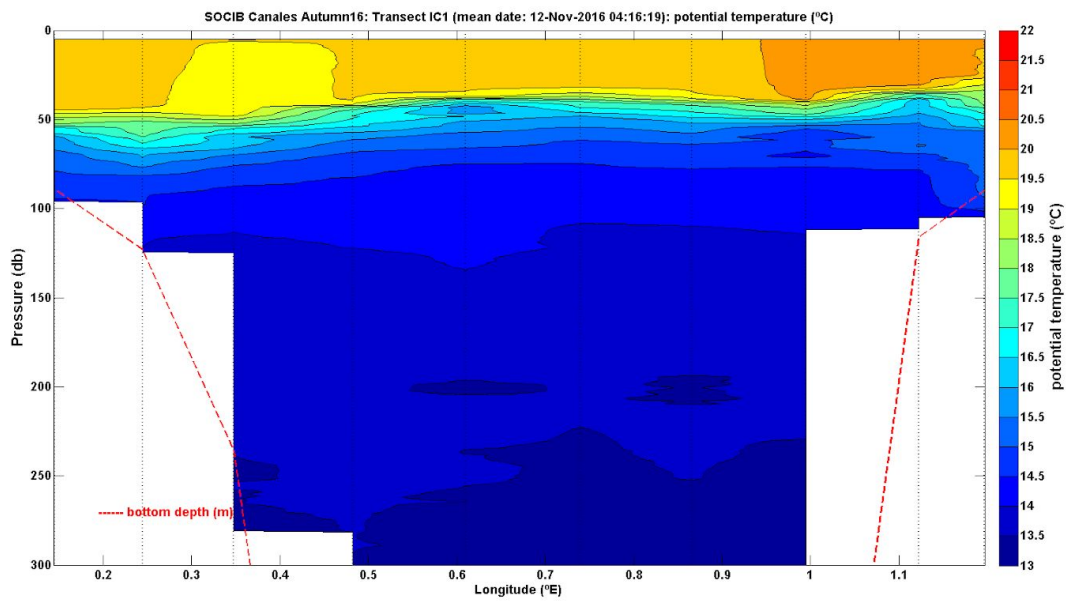
Fig. 5a. Potential temperature (°C) of the first (most northerly) transect of the IC (only the upper 300 m of the water column is shown in order to highlight the subsurface lense centred at 0.6° E).
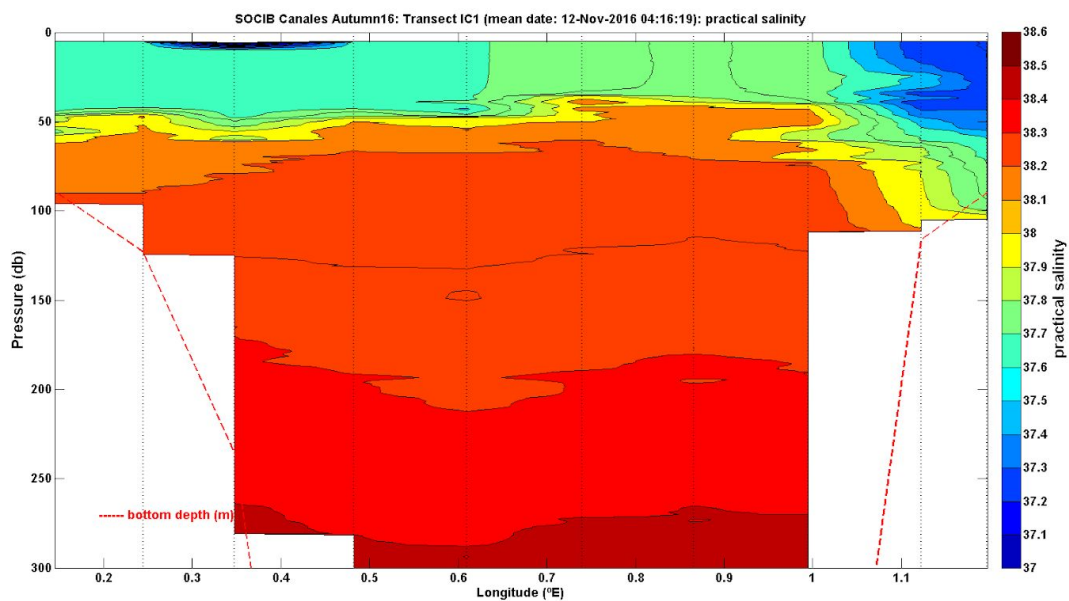
Fig. 5b. Salinity of the first (most northerly) transect of the IC (only the upper 300 m of the water column is shown in order to highlight the subsurface lense centred at 0.6º E, most pertinent in density in fig. 5c).
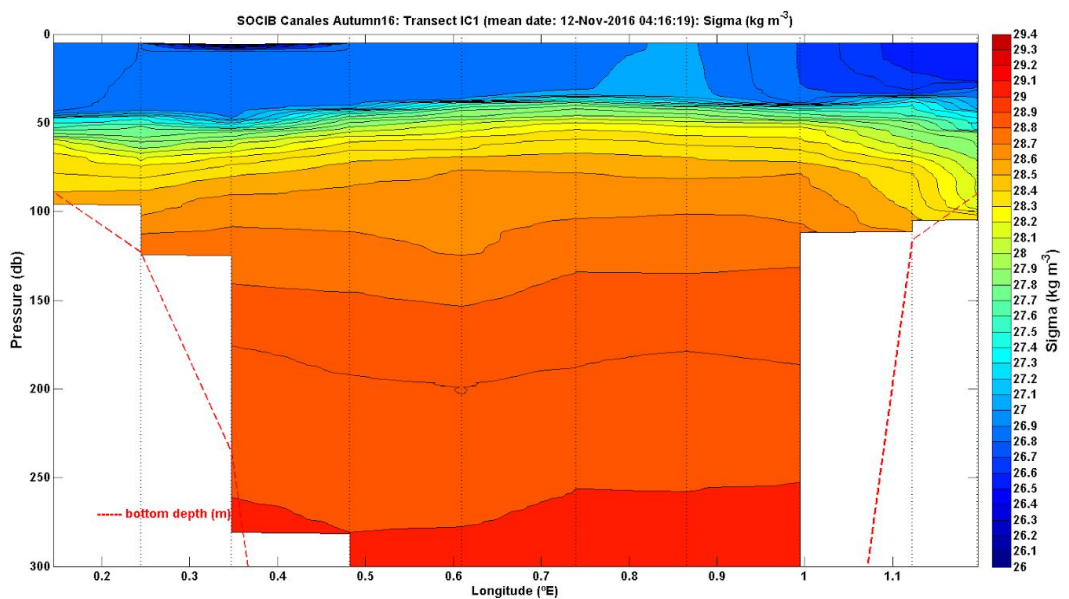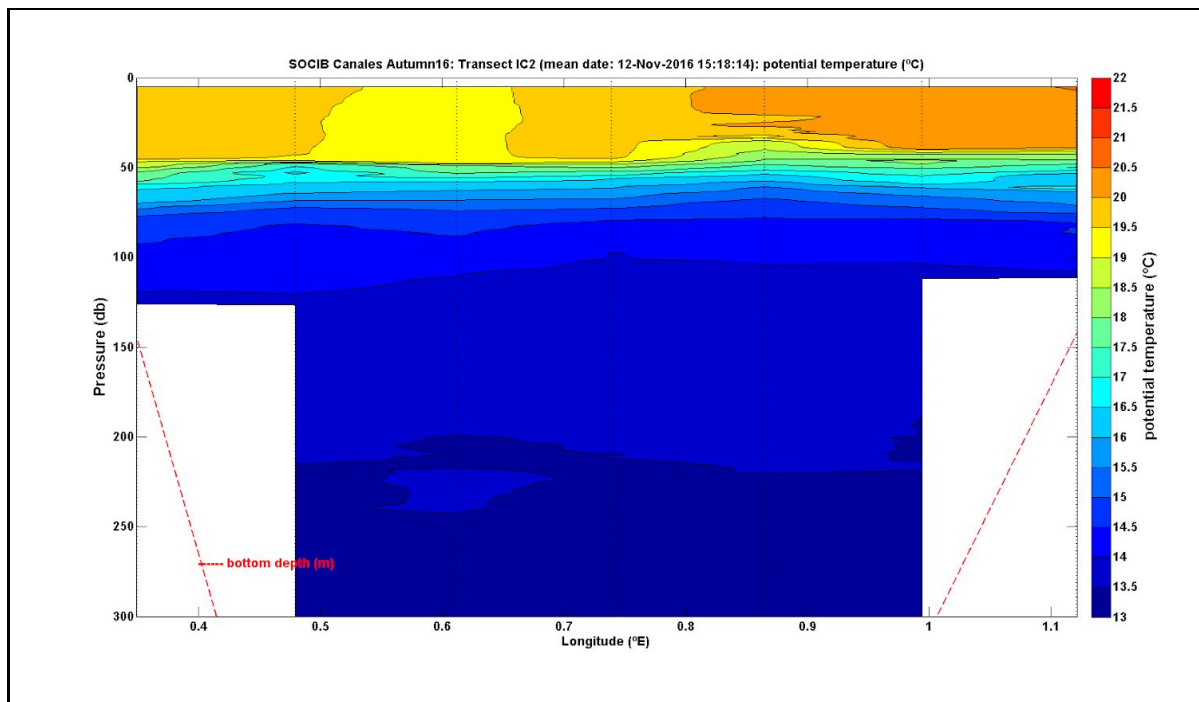
Fig. 5c. Potential density (kg m^{-3}) of the first (most northerly) transect of the IC (only the upper 300 m of the water column is shown in order to highlight the subsurface lense centred at 0.6º E).

4. Ibiza Channel: South

Figure 6 Shows the east and north components of velocity across the MC (start point at 0 km is the western shelf edge of Ibiza, during station RADMED_09, while the end point is just on the Mallorca shelf at 2.15º E, just as we were arriving at station RADMED_04). Of particular interest is the appearance of a divide in flow between the upper ~50 m and the underlying water column. At the eastern shelf of Ibiza this pattern is less well defined (between 0 and 10 km in fig. 6). At the surface, the flow is generally north-eastwards throughout the transect. Below the upper 50 m the flow varies. In the eastern part of the channel until about 30-35 km into the transect, below 100 m the flow is westward. Between 0 and about 25 km, there is a weak (about 5 0-7 cm s^{-1}) northward component to the flow. After 25 km, the flow has a weaker western-component (more or less 0), and a general southward direction, peaking at the shelf edge, at 40 km (~25 cm s^{-1}). The peak horizontal gradient in both u and v occurs at about 25 km, which is between stations RADMED_07 and -06, in the deepest part of the Mallorca Channel. The water column appears to be fairly interleaving stratified, with both temperature and salinity inversions with increasing depth; this is most pronounced between 20 and 100 m, in the deepest section of the channel as well as the shelf edge of Mallorca (Figs. 7a-c respectively).
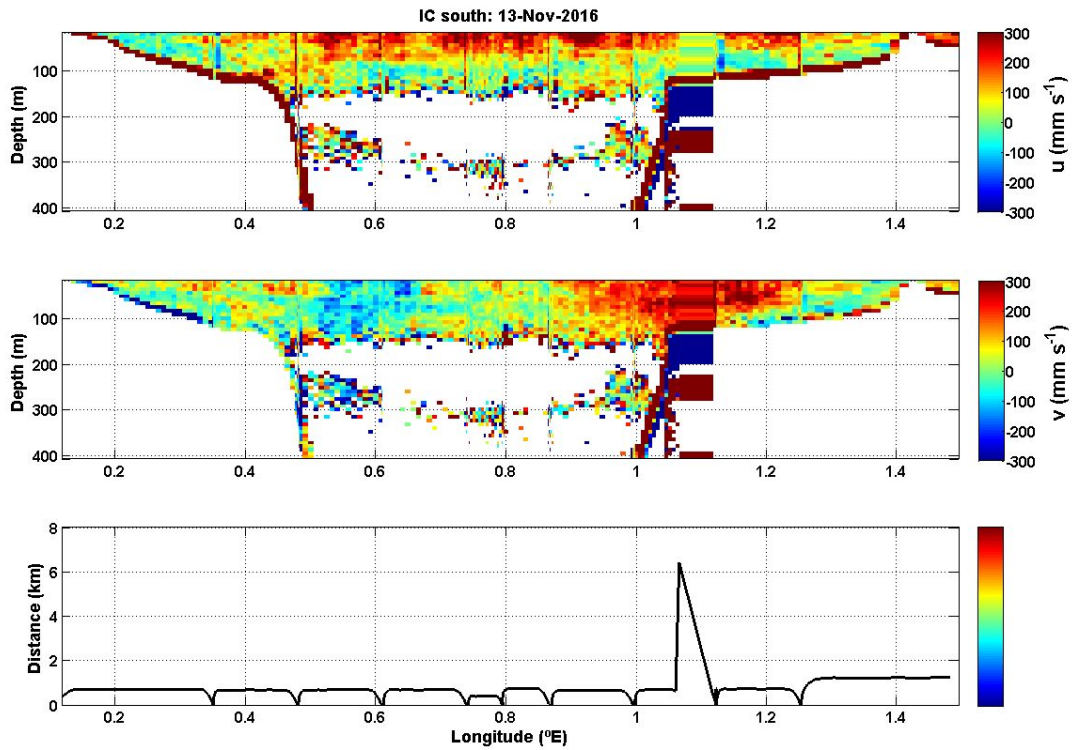
Fig. 6. east (a) and north (b) components of velocity (mm s⁻¹) plotted over longitude along the southern, west to east transit of the IC during day 3: 2016/11/13. The last plot (c) shows the distance between neighboring ensemble pings plotted over longitude in order to highlight where the ship is on station (these regions have close to 0 km between ensemble pings, whereas the distance between pings is larger than 0 km when the ship is in transit.

Fig. 7a. Potential temperature (°C) of the southernmost IC cross-section.
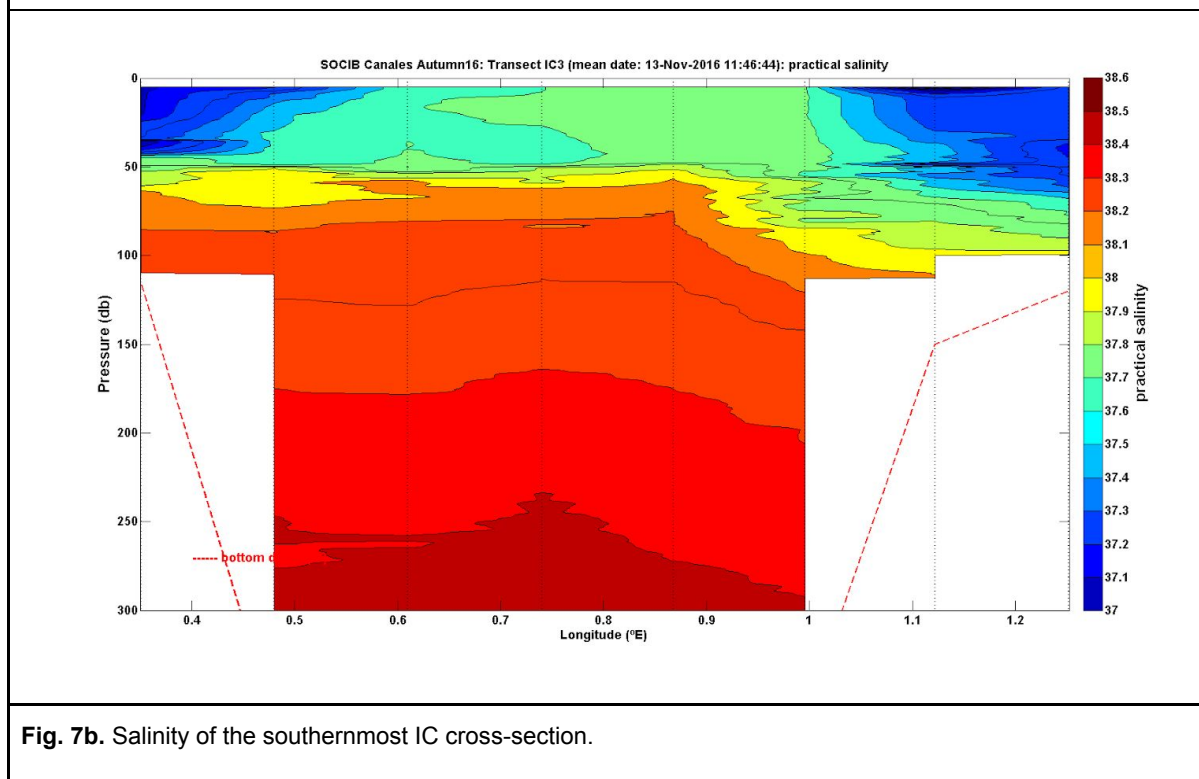
**Fig. 7b.** Salinity of the southernmost IC cross-section.
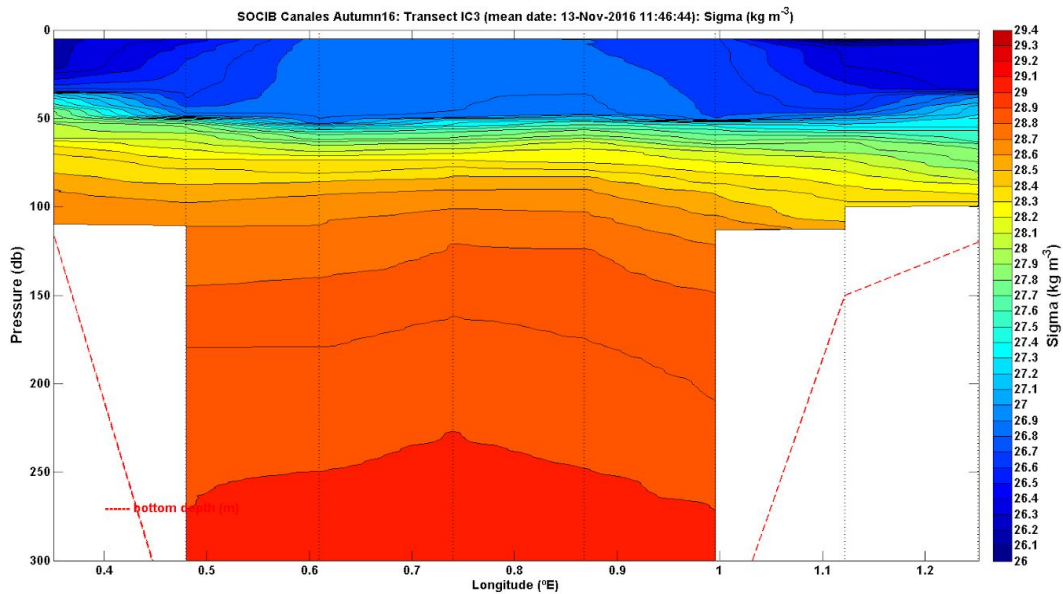
0…..

Fig. 7c. Potential density (kg m^{-3}) of the southernmost IC cross-section.

Preliminary biogeochemical results

The final biogeochemical dataset will be produced in due course following post-cruise analysis of the data.

Below we present some preliminary results obtained with the CTD sensors for dissolved oxygen (Fig. 8a, 9a) and *in vivo* fluorescence (Fig. 8b, 9b) of northernmost and southernmost transects of the IC respectively.
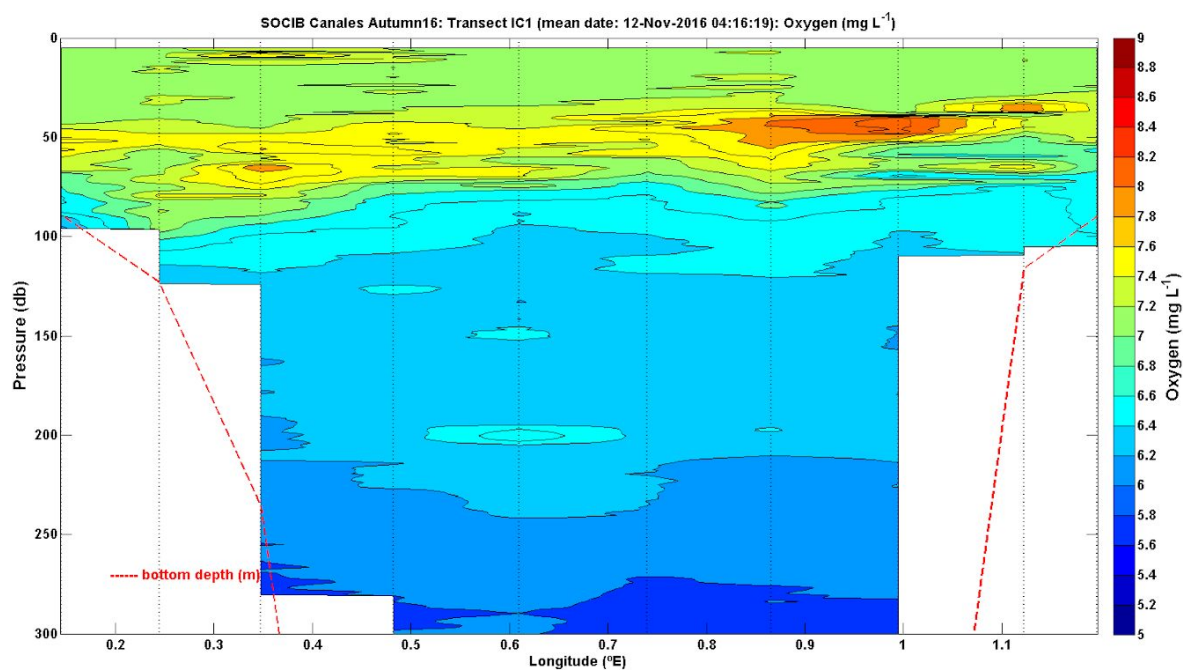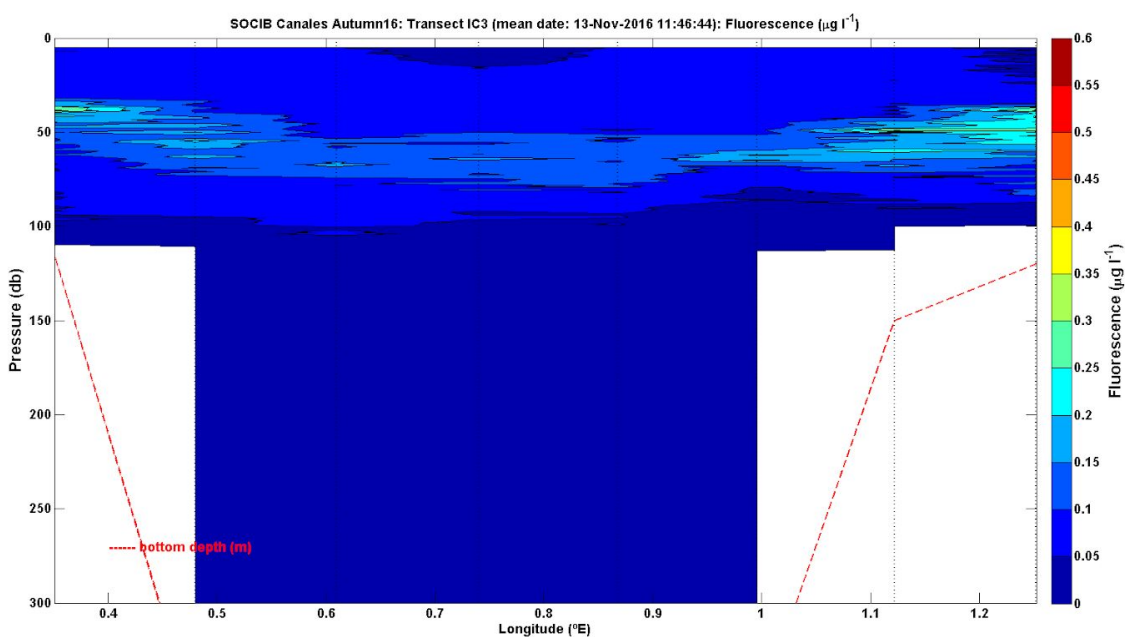
Fig. 8a: Initial figure for dissolved oxygen distribution obtained during the northern transect of the IC
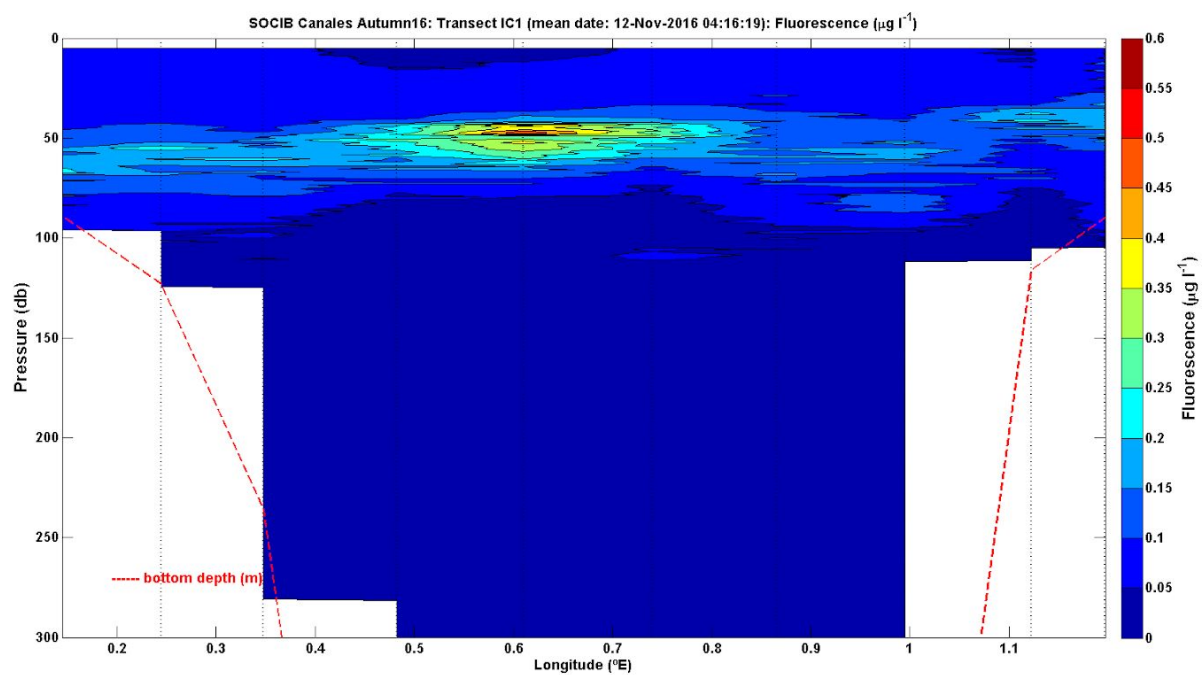
Fig. 8b: Initial figure for fluorescence distribution obtained during the northern transect of the IC
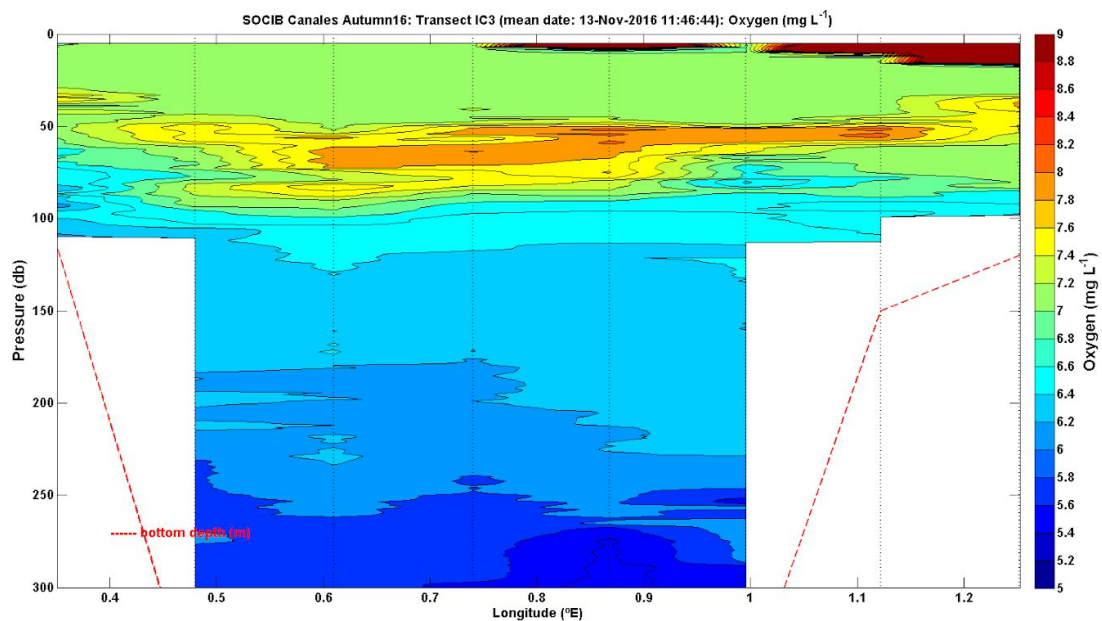
Fig. 9a: Initial figure for dissolved oxygen concentration distribution obtained on the southernmost IC cross-section.

Fig. 9b: Initial figure for fluorescence distribution obtained on the the southernmost IC cross-section.	

Problems encountered

No additional problems to be highlighted.

Seadatanet Cruise Summary Report Link

The SDN-ICES Cruise Summary Report that references to this cruise is available through the following link:

http://seadata.bsh.de/Cgi-csr/retrieve_sdn2/csrreport.pl?project=SDN&session=96292&v1=10&v2=12&pcode=

Processed Data Repository

Data Source	Thredds URL
Position	
Thermosal	
Meteo Station	
CTD	
VM-ADCP	

References

Joyce T.M. (1989). On in situ "calibration" of shipboard ADCPs. Journal of Atmospheric and Oceanic Technology 6:169–172.

Langdon C. (2010). Determination of dissolved oxygen in seawater by Winkler titration using the amperometric technique. In: Sloyan B.M., Sabine C. (Eds). GO–SHIP repeat hydrography manual: A Collection of Expert Reports and guidelines. IOC/IOCCP. Paris.

Pidcock R., Srokosz M., Allen J., Harman M., Painter S., Mowlem M., Hydes D., Martin A. (2010). Integration of an ultra-violet spectrophotometer on-board a towed vehicle for 3-D mapping of submesoscale nitrate variabililty. Journal of Ocean and Atmospheric Technology 27:1410–1416.

Pollard R., Read J. (1989). A method for calibrating shipmounted acoustic Doppler profilers and the limitations of gyro compasses. Journal of Atmospheric and Oceanic Technology 6:859–865.

Utermöhl H. (1958). Zur Vervollkomnung der quantitativen Phytoplankton-Methodik. Mitteilungen der internationale Vereinigung für theorische und angewandte Limnologie 9:1–38.

APPENDIX 1: Activities through Canales Autumn 2016 Cruise

For a table of all ship activities logged during the Summer campaign, refer to the excel file, SHIP_LOG_OF_ACTIVITIES.

APPENDIX 2: CTD configuration files in Canales Spring 2019

S2_01.XMLCON

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<?xml version="1.0" encoding="UTF-8"?>
<SBE_InstrumentConfiguration SB_ConfigCTD_FileVersion="7.23.0.2" >
  <Instrument Type="8" >
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        <FrequencyChannelsSuppressed>0</FrequencyChannelsSuppressed>
        <VoltageWordsSuppressed>0</VoltageWordsSuppressed>
        <ComputerInterface>0</ComputerInterface>
        <!-- 0 == SBE11plus Firmware Version >= 5.0 -->
        <!-- 1 == SBE11plus Firmware Version < 5.0 -->
        <!-- 2 == SBE 17plus SEARAM -->
        <!-- 3 == None -->
        <DeckUnitVersion>0</DeckUnitVersion>
        <ScansToAverage>1</ScansToAverage>
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<NmeaDepthDataAdded>0</NmeaDepthDataAdded>
<NmeaTimeAdded>0</NmeaTimeAdded>
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<D>0.00000000e+000</D>
<F0_Old>0.000</F0_Old>
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<F0>1000.000</F0>
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</TemperatureSensor>
</Sensor>
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<CellConst>2000.0000</CellConst>
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<CPcor>-9.57000000e-008</CPcor>
</Coefficients>
<Coefficients equation="1" >
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<Offset>0.00000</Offset>
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<C2>5.430216e-001</C2>
<C3>1.292780e-002</C3>
<D1>3.845500e-002</D1>
<D2>0.000000e+000</D2>
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<CTcor>3.2500e-006</CTcor>
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<!-- Coefficients for Sea-Bird equation - SBE calibration in 2007 and later. -->
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<B> 2.4724e-004</B>
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</WET_LabsCStar>
</Sensor>
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<SerialNumber>12181</SerialNumber>
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<!-- The following is an array index, not the actual gain setting. -->
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</Sensor>
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