Ichnussa 2015 Cruise Report

25 November 2015 - 14 December 2015

CNR-ISMAR

CNR-IAMC

Dublin City University

Communication Tecnhology

Cruise Details

NAME	Ichnussa 2015
DATE	2015-11-25 - 2015-12-14
STUDY AREA	Central Mediterranean Sea
PROJECT RESPONSIBLE	Paolo Magni
HEAD OF MISSION	Mireno Borghini
CHIEF SCIENTIST	Alberto Ribotti
PARTICIPANT INSTITUTES	ISMAR, IAMC
RESEARCH VESSEL	Minerva Uno
DEPARTURE PORT	Messina
ARRIVAL PORT	Napoli

Scientific Staff

CNR-ISMAR Sede di La Spezia Forte Santa Teresa 19032 Pozzuolo di Lerici Italia	Mireno Borghini	Technician
CNR-IAMC Sede di Oristano Località Sa Mardini	Alberto Ribotti	Researcher
	Andrea Satta	Technician
	Marco Torri	Researcher

Torregrande Oristano	
Dublin City University	Margaret McCaul — Researcher Anthony Grey — Researcher Eoghan Mc Namara — Researcher Pamela Cardillo — Researcher
	Cira Bonocore — Researcher Lara Codognotto — Researcher Peter Moles — Researcher
Communication Tecnhology	Alessandro Giordano — Communication Technician

Scientific Objectives

Oceanographic cruises: the sampling plan of the ICHNUSSA2015 proposes the route already covered in previous cruises since 2000 to acquire data for the activities of Cal/Val of oceanographic ecosystem or forecasting numerical models at different scales. Then the aim is also to study the inter-annual variability of biogeochemical and physical properties of the water masses in crucial areas for understanding the circulation and exchange between basins, in particular the transport of heat and salt in the western Mediterranean. In particular, we want to study the exchange between the western and eastern Mediterranean and the waters recirculating or formed in the Algerian-Provençal basin (like the new deep water in the Gulf of Lions) and along the transect Sardinia-Balearic islands. Then we want to monitor characteristics and distribution of the new western Mediterranean deep water and its possible effects on the general circulation of the Mediterranean.The ICHNUSSA2015 is designed to approximately replicate the stations of previous cruises MedGOOS, MedCO or MedOc and ICHNUSSA2012 and 2013.Objective: the oceanographic cruise is planned in order to collect an oceanographic dataset in areas of interest (Algerian-Provencal sub-basin, the area between Sardinia-Sicily-Tunisia and along the western Sardinian platform) to: i) monitor the physical characteristics of the new deep water recently formed in the western Mediterranean; ii) evaluate the transport of water, salt and heat in the western Mediterranean and analyze whether the interannual variability of water mass properties are due to climate change; iii) ordinary maintenance of deep water currentmeters chains for the inclusion of the data in a 20 years old CNR dataset; iv) initialize, calibrate and validate ecosystem or operational hydrodynamic models at different scales with in situ and satellite data; v) evaluate innovative oceanographic sensors mounted on moorings, Lagrangian instruments or CTDs.

Scientific Background

Cruise Plan

On board there were several groups working together, with different instruments. Both are listed below.

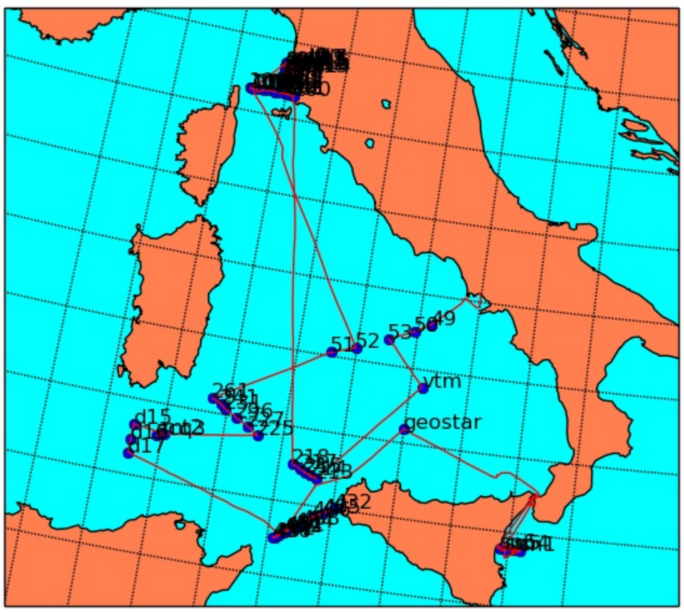
Parameters	Working Group

CTD/O2/Fluorescence/Transmissiometer/Rosette	CNR-ISMAR
Dissolved Oxygen	CNR-ISMAR, CNRS
Lowered ADCP	CNR-ISMAR
Nutrients	CNR-ISMAR
Salinity	CNR-ISMAR

Instruments	
CTD System	SBE 911 plus
Dissolved Oxygen	Winkler titration with Titrino SBE 43
Fluorimeter	AQUAtraka MK III
Lowered ADCP	RDI WH 300 kHz
Nutrients	Only samples frozen on board
Salinometer	Portasal Guideline
Small-Volume Sampling	General Oceanic 24-place rosette with 12 L bottles

---

Cruise Map



Cruise track and measurement sites.

Cruise Stations

Station	Date	Latitude	Longitude	Bottom Depth	Activity
437	2015-12-03 10:29:30	37.233833 N	11.433166 E	82 m	
c01	2015-12-02 14:14:40	37.379166 N	11.590666 E	459 m	
geostar	2015-12-01 20:55:45	38.9165 N	13.299 E	3441 m	
sn6	2015-11-30 01:28:26	37.5 N	15.164833 E	295 m	
sn4	2015-11-29 20:44:41	37.500166 N	15.390166 E	2087 m	
sn5	2015-11-29 23:20:45	37.5 N	15.247833 E	1151 m	
sn1	2015-11-29 17:55:30	37.5 N	15.5 E	1984 m	
436	2015-12-03 11:19:40	37.226833 N	11.396 E	412 m	
438	2015-12-02 18:19:44	37.458666 N	11.829333 E	74 m	
451	2015-12-02 15:09:01	37.340166 N	11.597833 E	545 m	
432	2015-12-02 22:19:29	37.728833 N	12.335 E	166 m	
406	2015-12-02 19:57:24	37.587333 N	12.005833 E	162 m	
c02	2015-12-03 08:22:20	37.285 N	11.499666 E	535 m	
462	2015-12-03 09:25:56	37.314333 N	11.5625 E	87 m	
405	2015-12-02 21:02:48	37.648 N	12.1445 E	91 m	
434	2015-12-02 17:14:28	37.4155 N	11.7425 E	81 m	
d17	2015-12-04 05:07:16	38.01 N	8.8 E	1617 m	
d16	2015-12-04 07:59:14	38.191833 N	8.800666 E	2245 m	
d15	2015-12-04 10:52:57	38.3935 N	8.800666 E	1378 m	
mt2	2015-12-04 15:40:11	38.334166 N	9.3325 E	1923 m	
acq3	2015-12-04 17:53:52	38.299333 N	9.211166 E	2036 m	
225	2015-12-05 05:35:29	38.533666 N	10.8685 E	736 m	
227	2015-12-05 07:41:57	38.632166 N	10.6835 E	1534 m	
296	2015-12-05 10:02:03	38.711 N	10.47 E	2430 m	
231	2015-12-05 12:55:55	38.805 N	10.258 E	2306 m	
241	2015-12-05 15:11:50	38.856833 N	10.183166 E	2306 m	
261	2015-12-05 18:09:03	38.913333 N	10.015166 E	1477 m	
51	2015-12-06 06:13:29	39.780833 N	11.883333 E	3420 m	
52	2015-12-06 10:52:29	39.889333 N	12.277166 E	3430 m	
109	2015-12-07 14:07:13	43.025 N	9.641166 E	360 m	
cors01	2015-12-07 14:43:38	43.029666 N	9.683666 E	435 m	
108	2015-12-07 15:27:45	43.024833 N	9.699666 E	441 m	
107	2015-12-07 16:29:46	43.029666 N	9.769833 E	82 m	
106	2015-12-07 17:37:04	43.034833 N	9.882666 E	100 m	
105	2015-12-07 18:28:41	43.038166 N	9.980666 E	100 m	
104	2015-12-07 19:33:37	43.034833 N	10.094166 E	152 m	
102	2015-12-07 21:09:51	43.034833 N	10.270166 E	116 m	
103	2015-12-07 20:23:06	43.0385 N	10.1885 E	121 m	
101	2015-12-07 21:50:38	43.031666 N	10.348 E	106 m	
100	2015-12-07 22:32:41	43.031833 N	10.437833 E	72 m	
sol2	2015-12-08 00:06:04	43.087666 N	10.190666 E	124 m	
sol3	2015-12-08 00:42:44	43.138 N	10.190833 E	125 m	
sol4	2015-12-08 01:18:29	43.188 N	10.190833 E	125 m	
sol5	2015-12-08 01:54:00	43.238 N	10.191166 E	124 m	
sol6	2015-12-08 02:27:58	43.287833 N	10.1905 E	120 m	
sol7	2015-12-08 03:02:21	43.337833 N	10.190833 E	115 m	
sol8	2015-12-08 03:48:22	43.388 N	10.190833 E	108 m	
sol9	2015-12-08 04:30:17	43.437833 N	10.191 E	92 m	
sol17	2015-12-08 15:31:19	43.450166 N	10.3165 E	52 m	

sol16	2015-12-08 15:59:35	43.416833 N	10.349833 E	53 m	
sol15	2015-12-08 16:31:07	43.3835 N	10.383333 E	39 m	
sol14	2015-12-08 17:21:18	43.337833 N	10.410166 E	10 m	
sol13	2015-12-08 17:44:16	43.333333 N	10.366666 E	16 m	
sol12	2015-12-08 18:18:11	43.366666 N	10.316 E	64 m	
sol11	2015-12-08 18:52:44	43.399833 N	10.267 E	79 m	
sol18	2015-12-08 19:19:38	43.416666 N	10.3 E	70 m	
sol10	2015-12-08 19:56:21	43.433333 N	10.216666 E	83 m	
218	2015-12-11 01:15:50	38.233833 N	11.5305 E	225 m	
217	2015-12-11 02:33:28	38.181166 N	11.666666 E	762 m	
215	2015-12-11 03:53:28	38.146 N	11.7665 E	1192 m	
214	2015-12-11 08:35:59	38.120833 N	11.846833 E	1146 m	
213	2015-12-11 10:15:37	38.086333 N	11.9575 E	408 m	
vtm	2015-12-11 23:02:26	39.499 N	13.499666 E	3428 m	
53	2015-12-12 07:18:46	40.07 N	12.813 E	3558 m	
50	2015-12-12 11:59:34	40.214833 N	13.234 E	2504 m	
49	2015-12-12 15:09:45	40.336666 N	13.500166 E	1956 m	

Sampling Strategy

Level	Standard depths [m]
01	0
02	25
03	50
04	75
05	100
06	200
07	300
08	400
09	500
10	750
11	1000
12	1250
13	1500
14	1750
15	2000
16	2250
17	2500
18	2750
19	3000
20	3250
21	3500

Onboard Operations

CTD Casts

At every station, pressure (P), salinity (S), potential temperature (θ) dissolved oxygen concentration (DO) and fluorescence were measured with a CTD-rosette system consisting of a CTD SBE 911 plus, and a General Oceanics rosette with 24 Niskin Bottles (12 liters each). Temperature measurements were performed with a SBE-3/F thermometer, with a resolution of 0.00015 °C/bit at -1 °C or 0.00018 °C/bit at 31 °C, and conductivity measurements were performed with a SBE-4C sensor, with a resolution of 3 x 10-4 S/m. Dissolved oxygen was measured with a SBE-43 sensor (resolution 4.3 µM). The vertical profiles of all parameters were obtained by sampling the signals at 24 Hz, with the CTD/rosette going down at a speed of 1 m/s. The data were processed on board, and the coarse errors were corrected thanks to the sampling and analyzing on board o f oxygen and salinity of the deepest station. The rosette is equipped with a sonar altimeter which intercept the bottom 70-50 meters before getting to it. The altimeter is used just for safety, to avoid the rosette to touch the bottom, and for more precision in measuring depth.

Oxygen and Salinity Determination

Salinity samples were collected, stored and analyzed with a Guildline Portasal Salinometer, standardized with IPSO standard 34.999 PSu Water and at controlled temperature. Also dissolved oxygen samples were collected and analyzed with the Winkler method,using a computer controlledpotentiometric end-point titrationprocedure. Samples were taken from theNiskins bottle with the recommendedprecautions and following the Winkler procedure. For example oxygen was sampled before everything else, paying attention not to make the water gurgle, to prevent any biological activityand gas exchange with the

---

LADCP

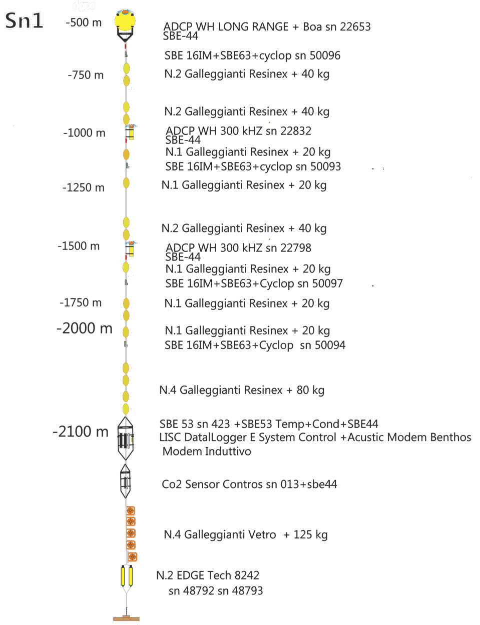
Two Lowered Acoustic Doppler Current Profilers (LADCP) are used to measure velocity and magnitude of the currents during the CTD cast. They are two RDI Workhorse 300 kHz ADCP, a master facing down and a slave facing up. For data post-processing we used the LDEO LADCP (version 10.16) software.

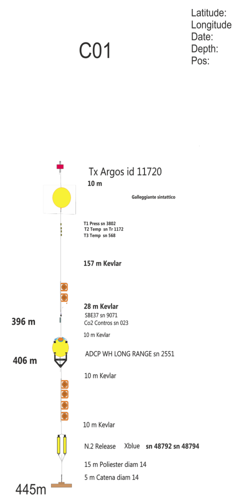
Inorganic Nutrients

Seawater samples for nutrient measurements were collected at standard depths of every cast, within oxygen and salinity samples. Nutrient samples were stored at –20°C and nitrate, orthosilicate and ortophosphate concentrations will be determined later in the laboratory, using a hybrid Brän–Luebbe AutoAnalyzer following classical methods (Grasshoff et al., 1983) with slight modifications.

Recovery and Deployment of Moorings

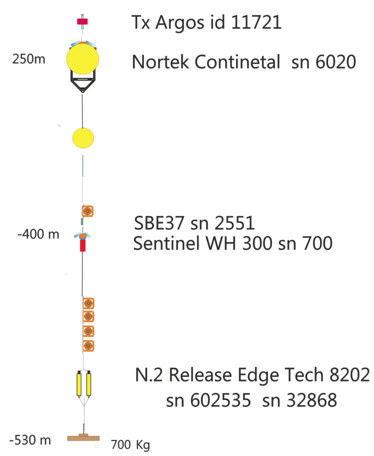
During the cruise five moorings were recovered and deployed again in their original position and a new one is deployed.



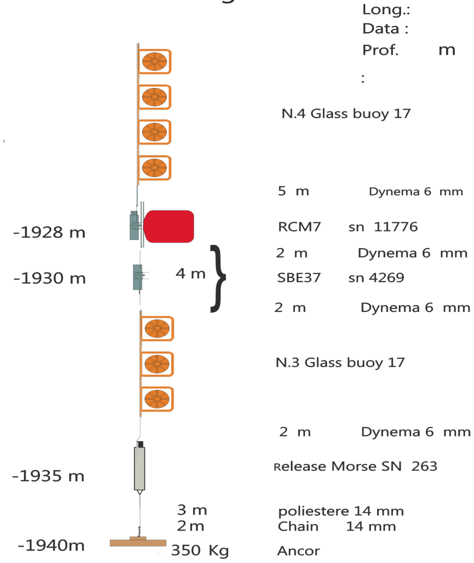


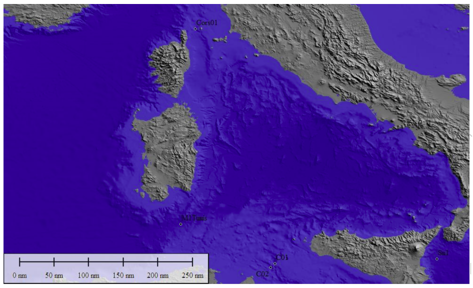
C02 Mooring

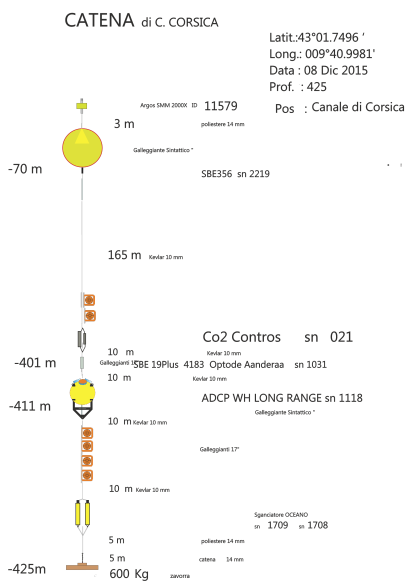
Lat 37°17.097´ Long 011°29.9791´



Tunisian Mooring





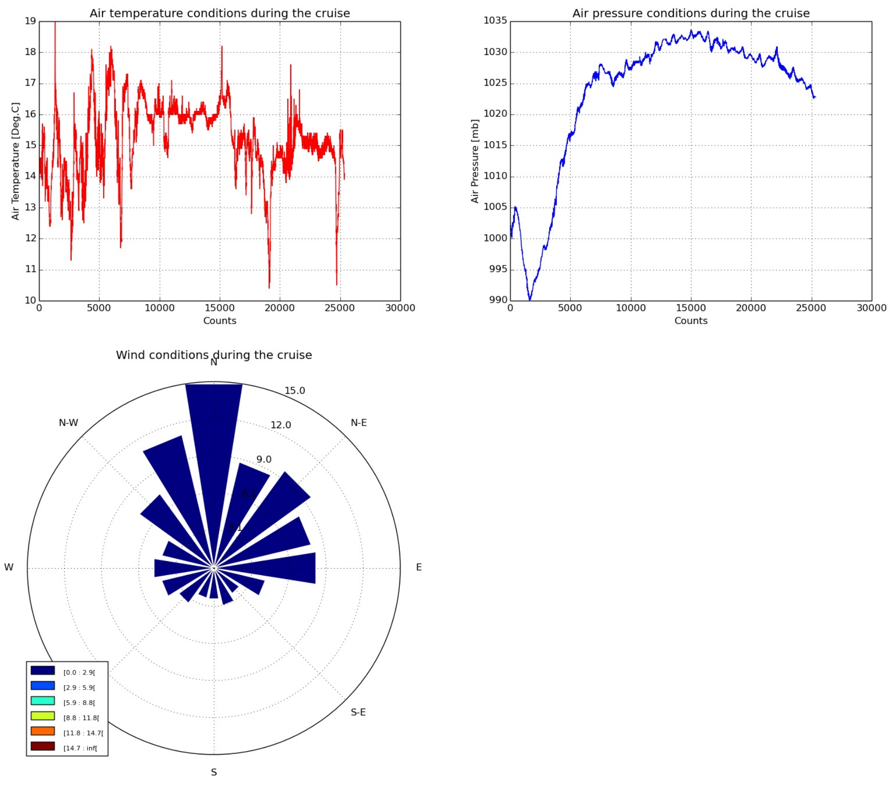


DCU university activity

DCU researchers Dr Margaret McCaul, Eoghan McNamara and Anthony Grey embarked on the Ichnussa 2015 research cruise to field test the pre-competitive prototypes sensors developed at DCU for Eutrophication and Heavy Metals as part of the COMMONSENSE FP7 project. The COMMON SENSE nutrient sensor is based on a similar approach to the systems previously developed at DCU for autonomous detection of phosphate and other parameters. The system is based on a combination of microfluidic analytical systems, colorimetric reagent chemistry, and low-cost LED-based optical detection. The CS autonomous sensor was tested on-board the RV Minerva Uno for the detection of nutrients by utilising colorimetric chemistries nitrite, nitrate and phosphate. Samples were collected using the rosette sampler at varying locations outlined in the cruise plan. 10 litres of water was sampled at each station at varying depths, the water was filtered through a 0.45uM glass fibre filter paper prior to analysis. Filter papers were stored at -22 degrees celsius for subsequent analysis of suspended solids back in DCU. Over 80 samples were analysed on board for nitrite and nitrate, limitations with the system encountered on-board did not allow for the determination of phosphate. Briefly; the optical system was tested on-board regarding the control of light intensity, via an LED, through a standard voltage resistance circuit as well as through pulse width modulation (PWM) in a constant current circuit. During testing it was apparent the the LED was too intense when driven at its optimal constant current, even with the pulse width of the LED set as low as possible. To further reduce the intensity of the LED large resistors (from 1 kOhm up to 1 MOhm) were placed in series, however this only proved to push the LED outside of its optimal operation envelope and the stability of the light intensity was found to decrease. Some success was had by placing a pin hole between the LED and the sample thereby physically reducing the quantity of light as opposed to electronically. It is this physical method of light reduction that will be explored further during the development of the system. In order to achieve lower light intensities in the short term the circuit was changed from the constant current set up to a standard voltage resistance set up with no PWM. Here LED intensity was controlled via a 1 kOhm potentiometer. This set up had produced linear results in the laboratory, however this circuit type does suffer from a drift in the sensor signal. On-board testing relieved a substantial increase in sensor drift and a reduction in signal stability. This is partially believed to be due to the power source available. The detection of phosphate is dependent on PWM functionality in order to drive the Ultra Violet (UV) LEDs correctly and so once the circuit was altered to the the voltage resistance set up, the system was no longer capable of phosphate detection. The testing period proved invaluable to the further development of the sensor system as opportunities for improvement were highlighted throughout. In order to test the heavy metals sensor, water samples have been acquired at two-three different depths (bottom, 25 m and 1.5 m) in three very shallow stations along Tuscany coast (stations SOL15, SOL16, SOL17; see figure 2 and the list in Annex 1). The heavy metal sensor system prototype was tested on-board. The system uses a buffer and a sample/standard mixed on a microfluidic chip and passed across a screen printed electrode (Carbon-Bismuth) from which the potentiometer takes a reading. On-board testing was an invaluable opportunity to test the mixing rates and fluidic system. Fluidic issues were encountered on-board regarding flow rates, residence time of sample/buffer on the screen printed electrode and the seal in which the electrode is held. These issues encountered will be resolved on return to DCU to ruggedize the sensing system for use on such vessels and research cruises.

Preliminary Results

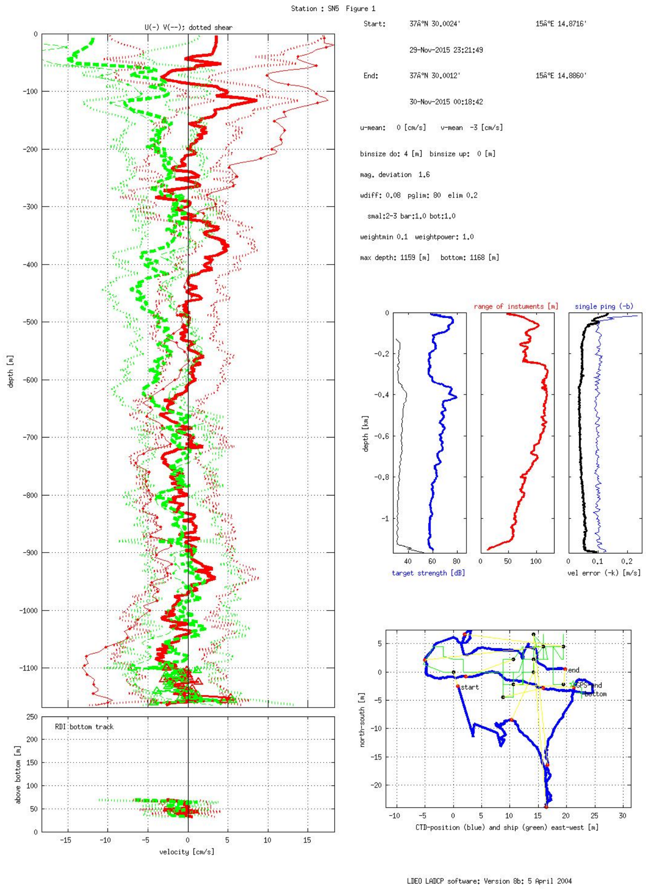
Weather conditions



Evolution of the weather conditions during the cruise (air temperature, air pressure, wind rose).

Currents from LADCP

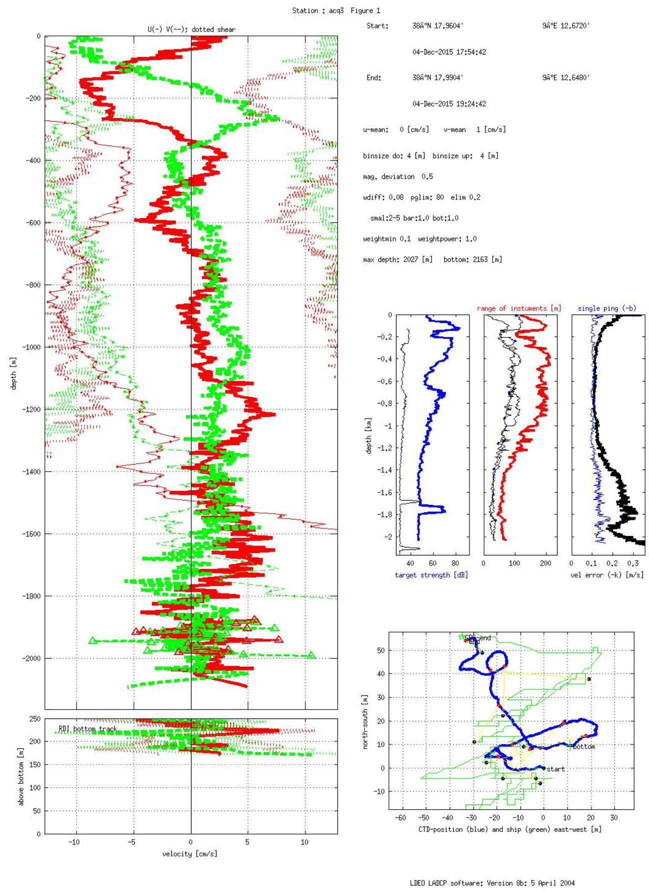
Station sn5



Profiles of the measured velocities in cm/s at the station.

Currents from LADCP

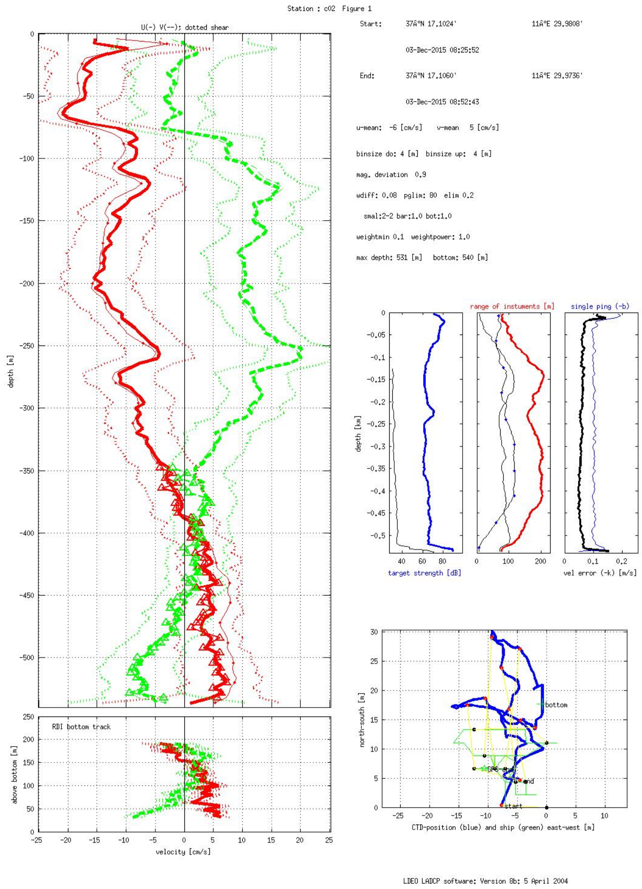
Station acq3



Profiles of the measured velocities in cm/s at the station.

Currents from LADCP

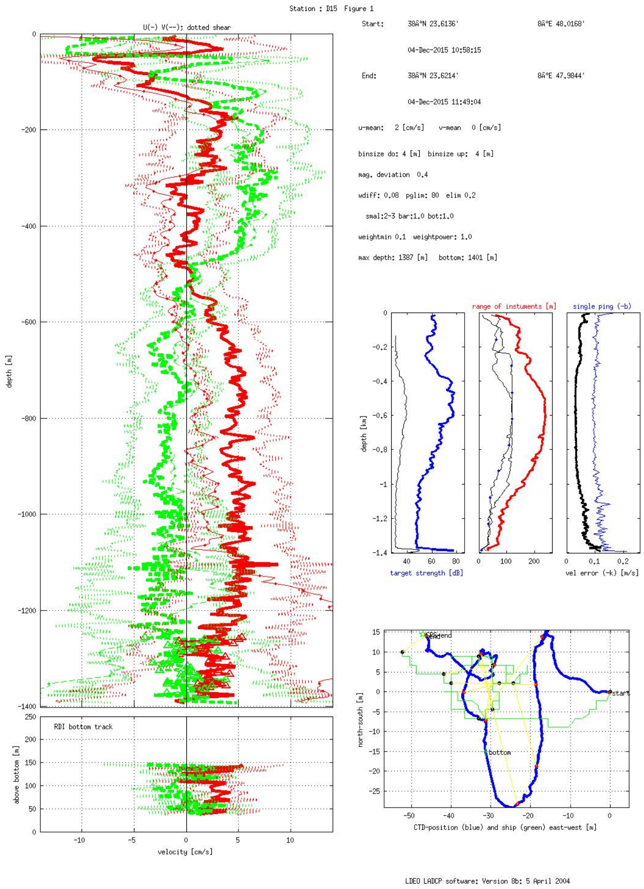
Station c02



Profiles of the measured velocities in cm/s at the station.

Currents from LADCP

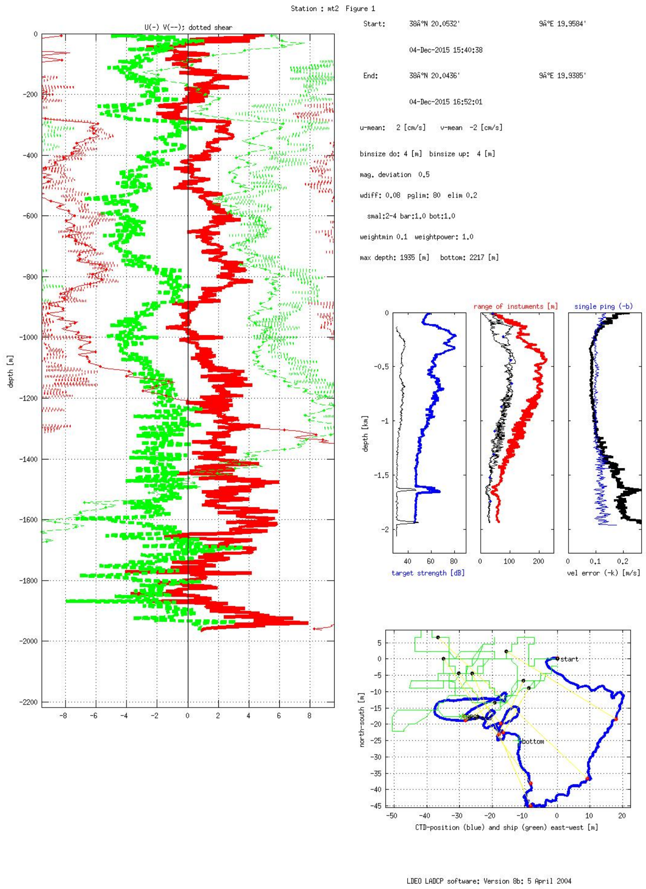
Station d15



Profiles of the measured velocities in cm/s at the station.

Currents from LADCP

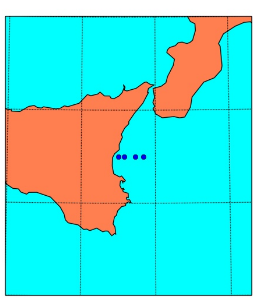
Station mt2

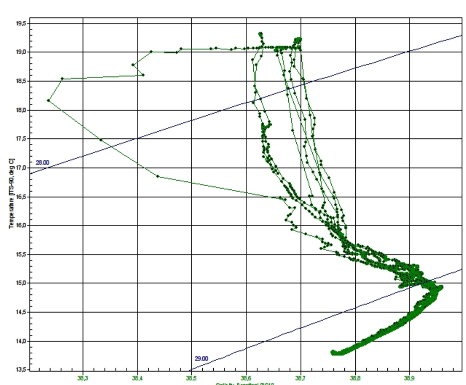


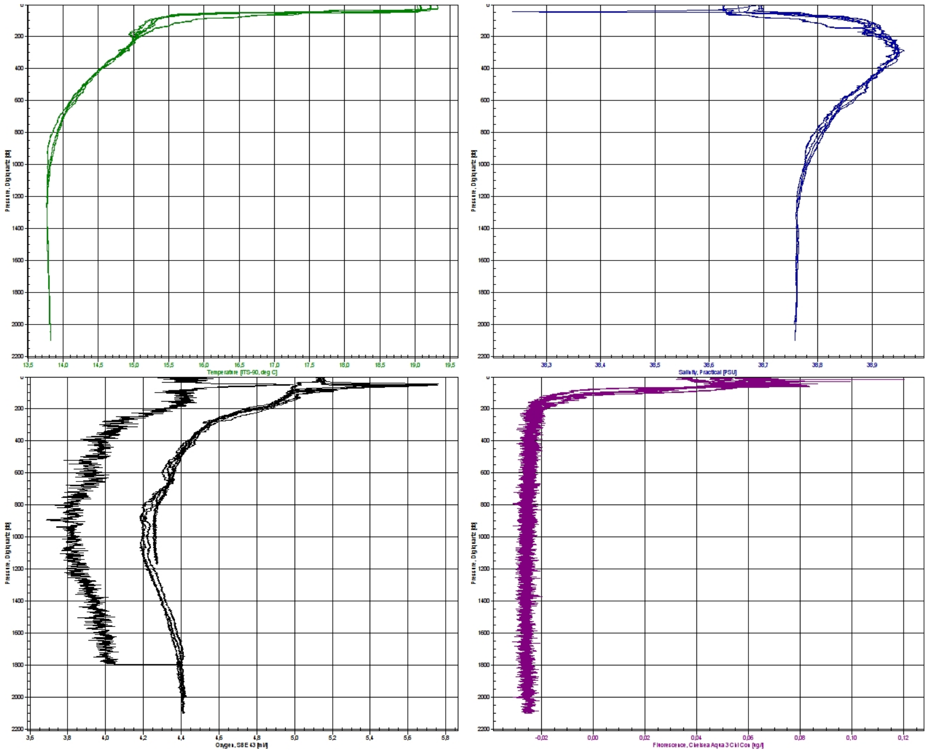
Profiles of the measured velocities in cm/s at the station.

Hydrology

Transect sn

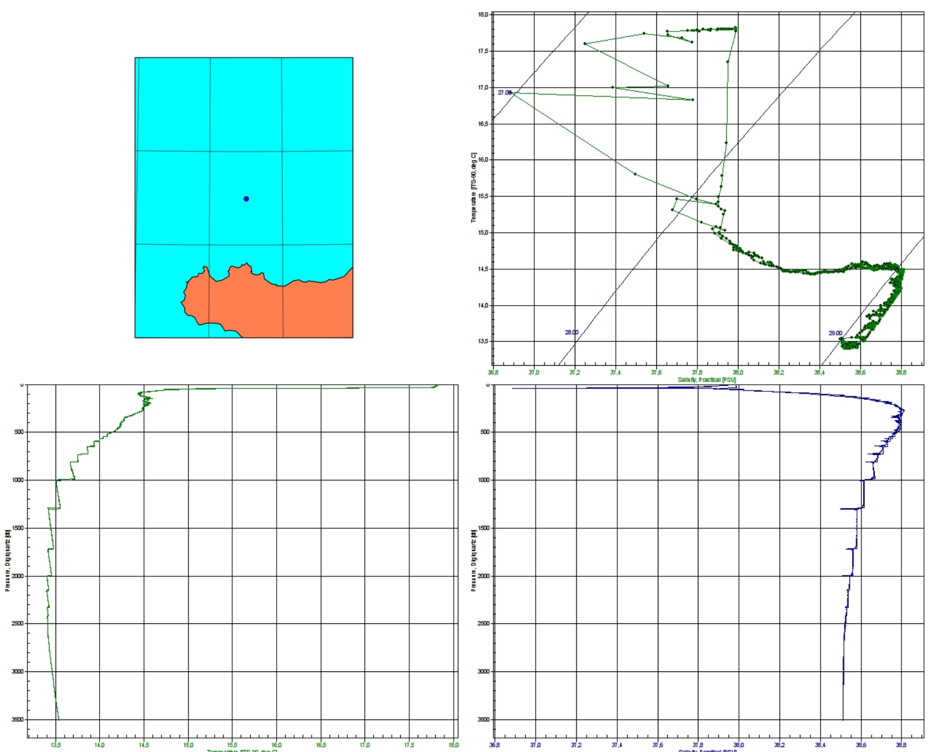


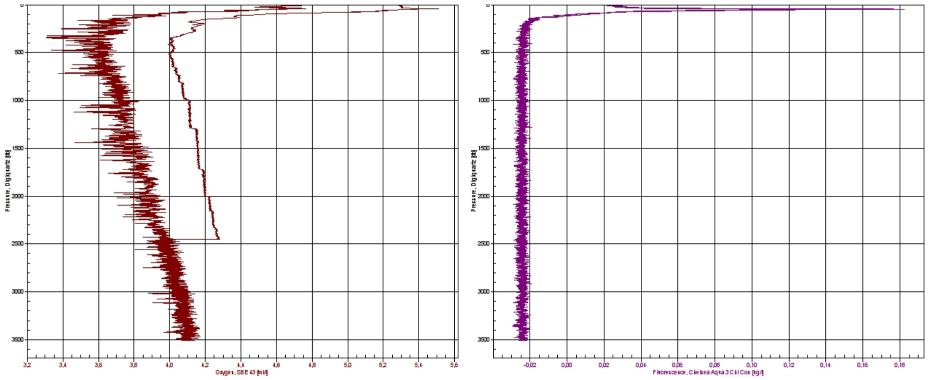




Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

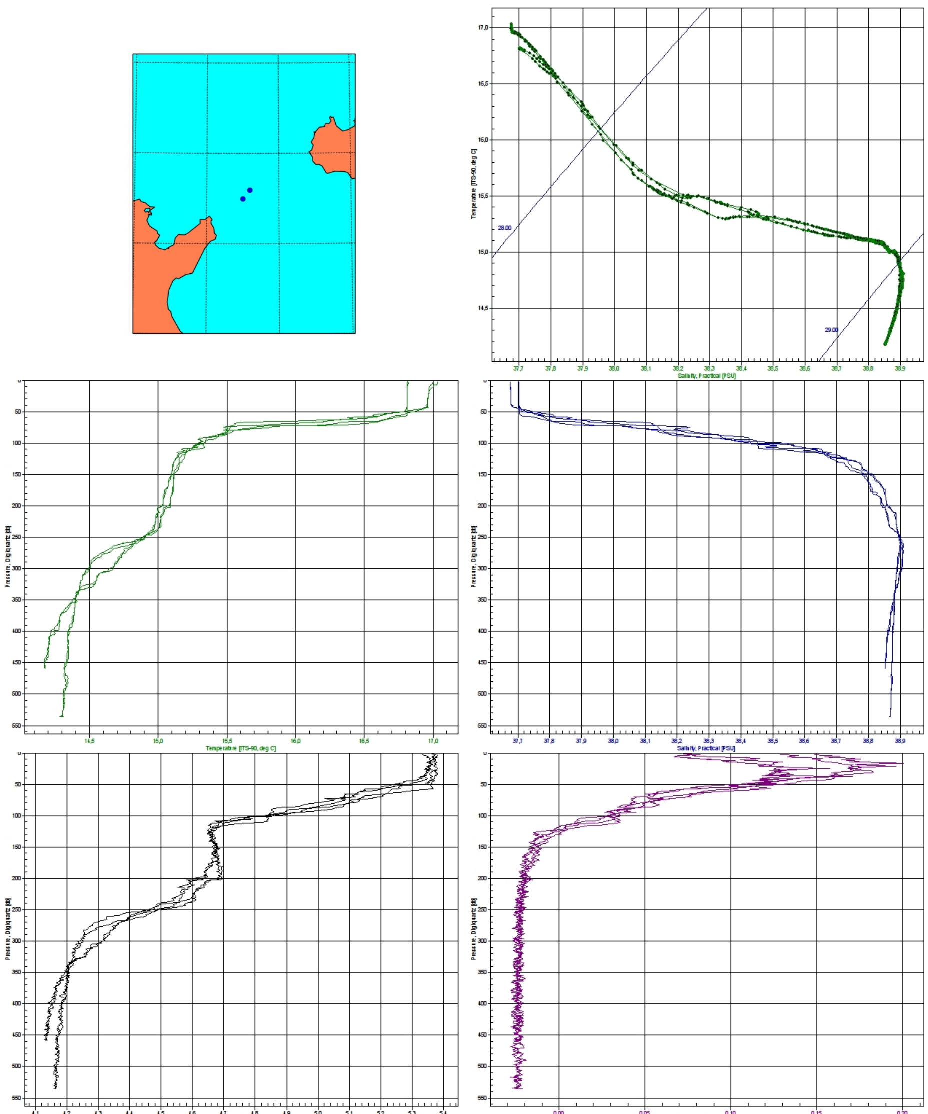
Station geostar





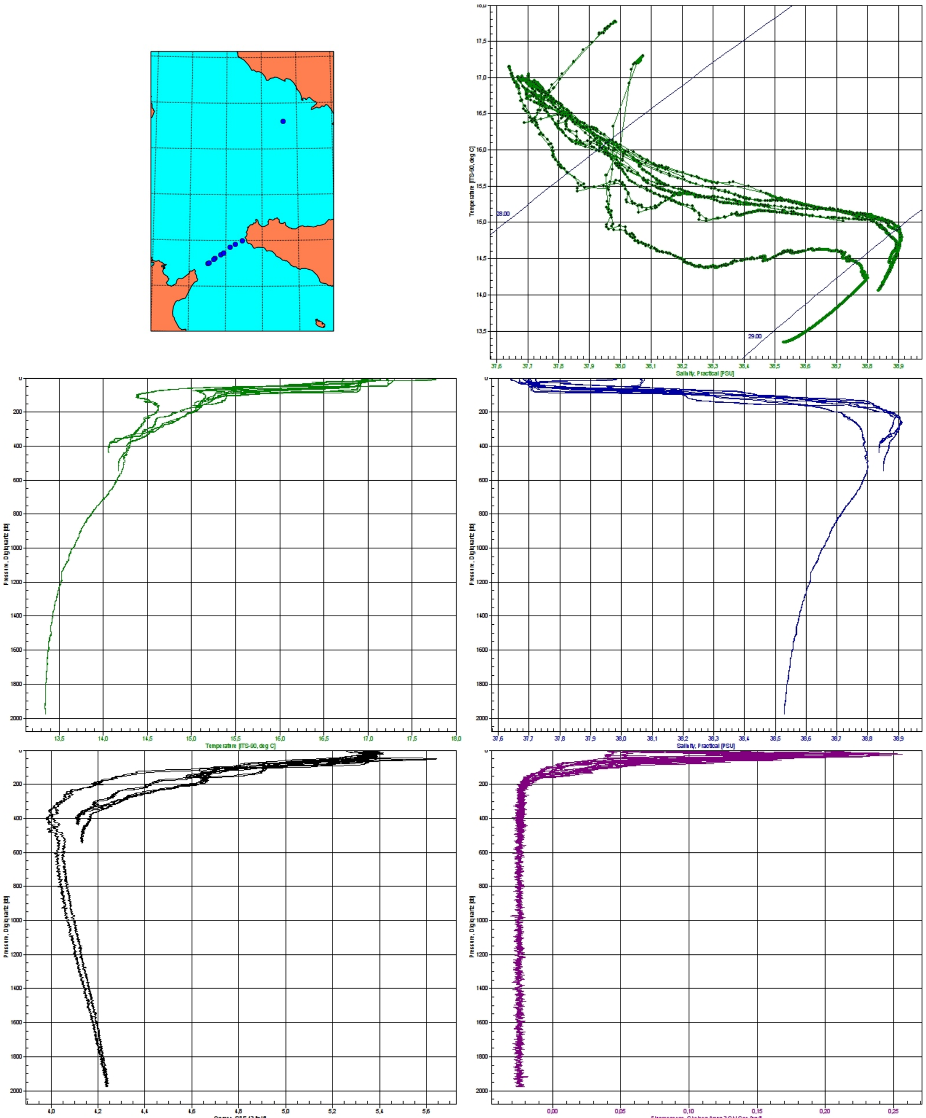
Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

Transect c



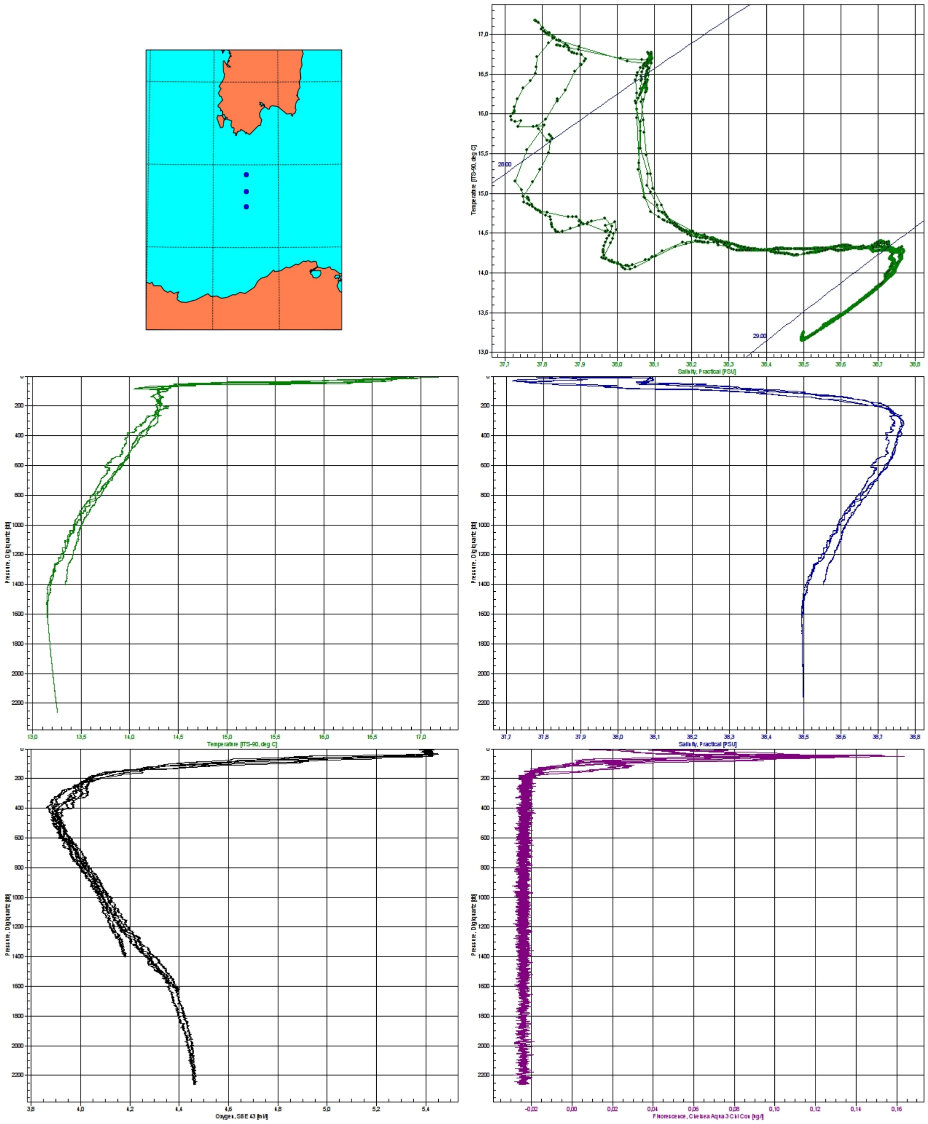
Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

Transect 4



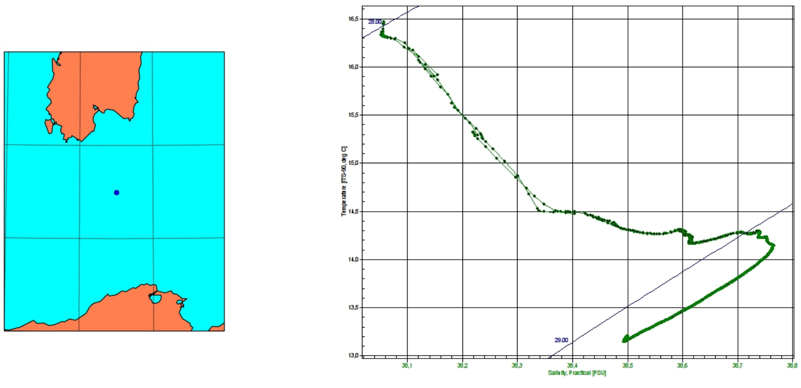
Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

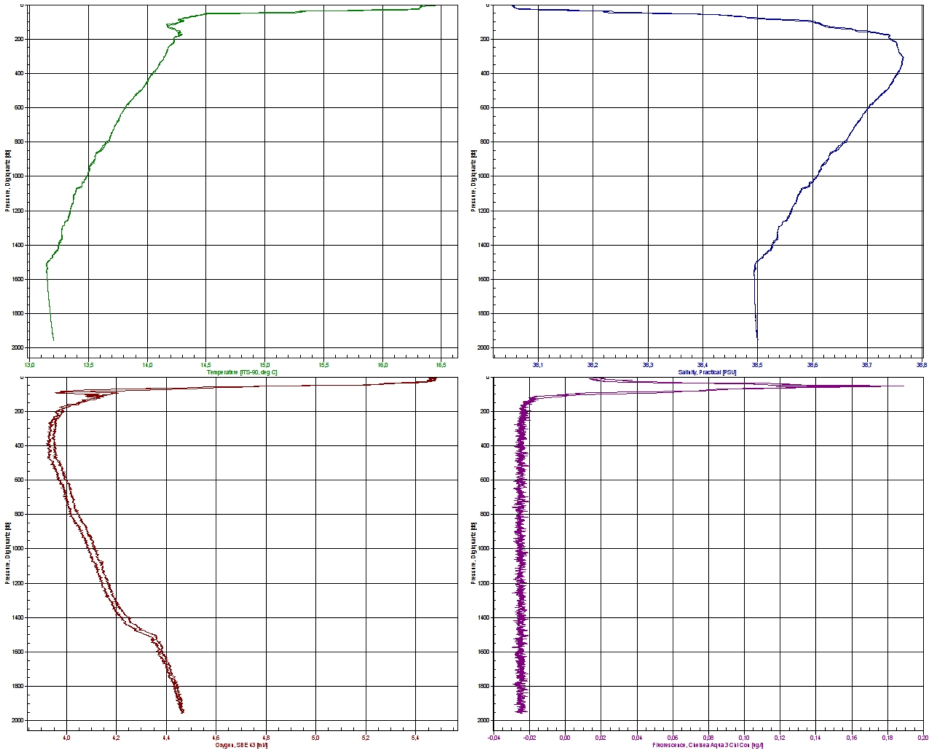
Transect d



Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

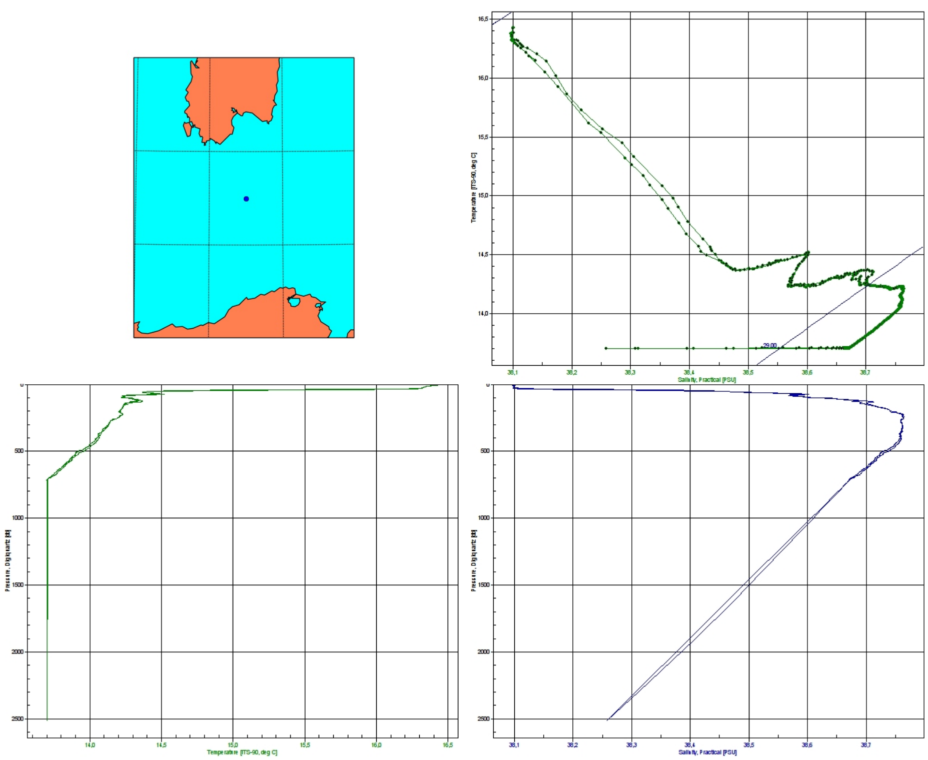
Station mt2

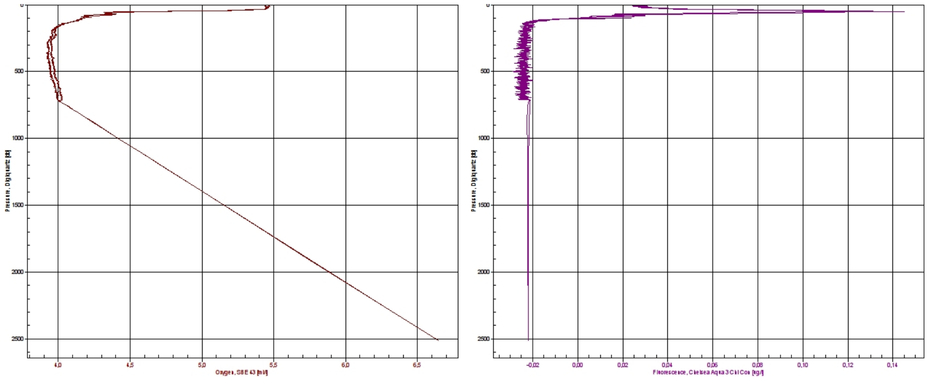




Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

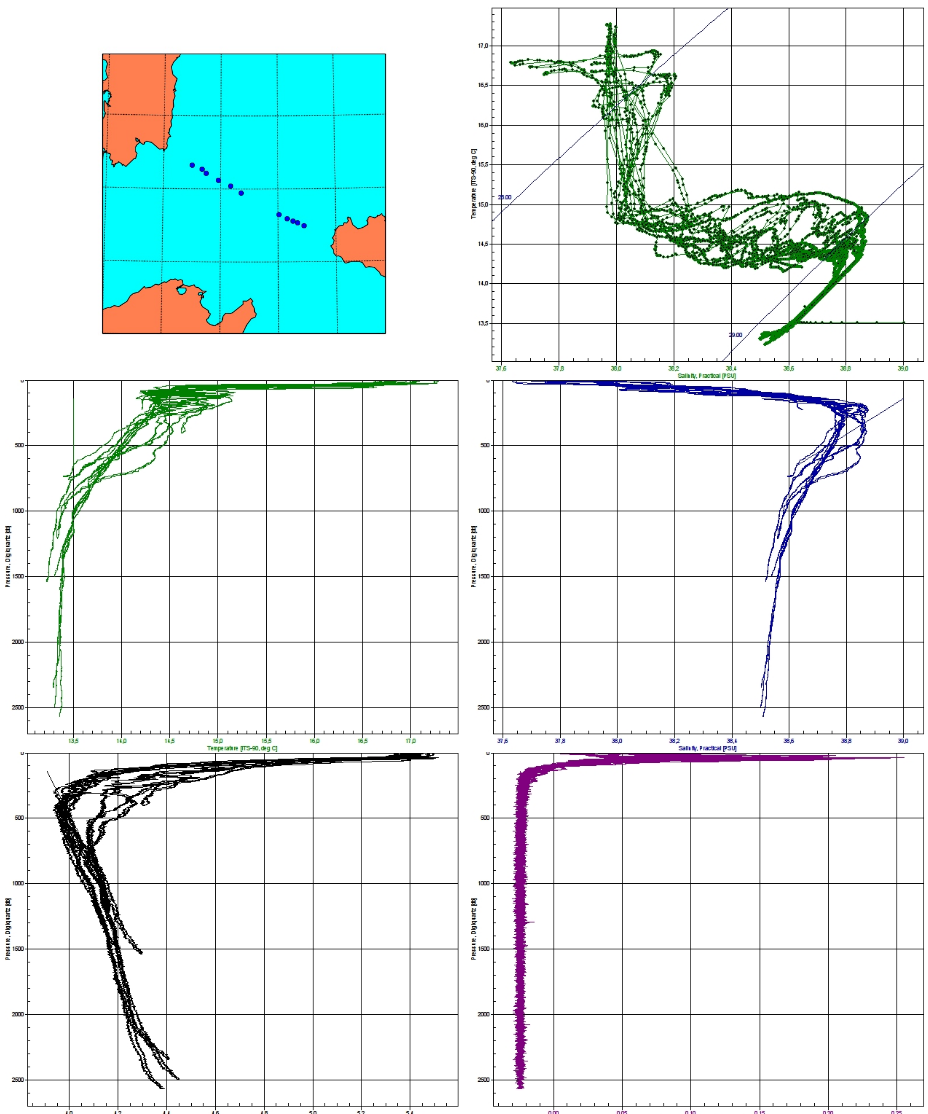
Station acq3





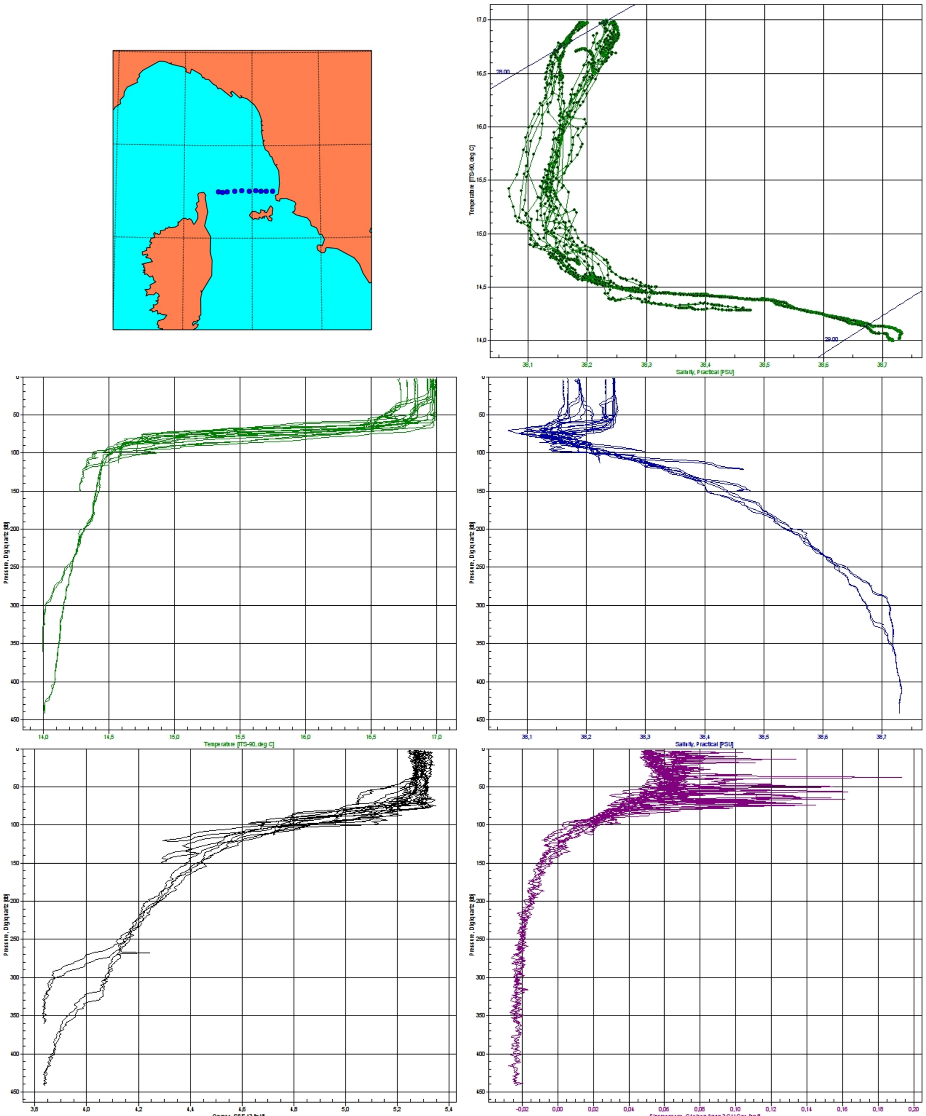
Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

Transect 2



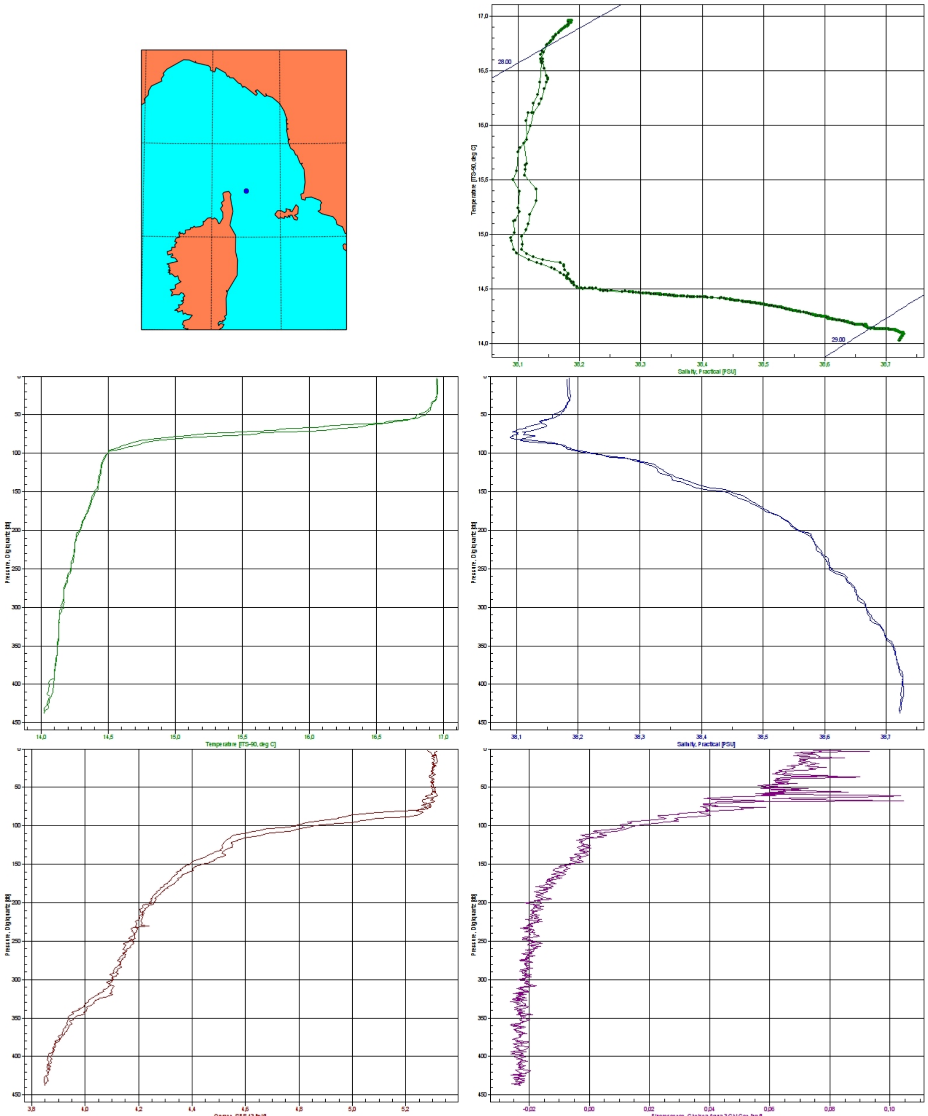
Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

Transect 1



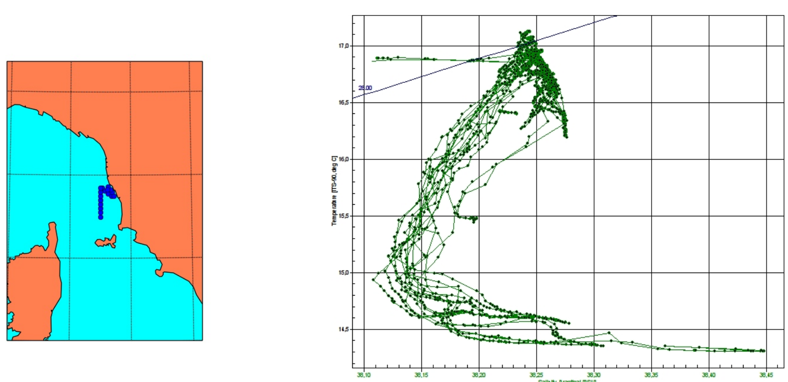
Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

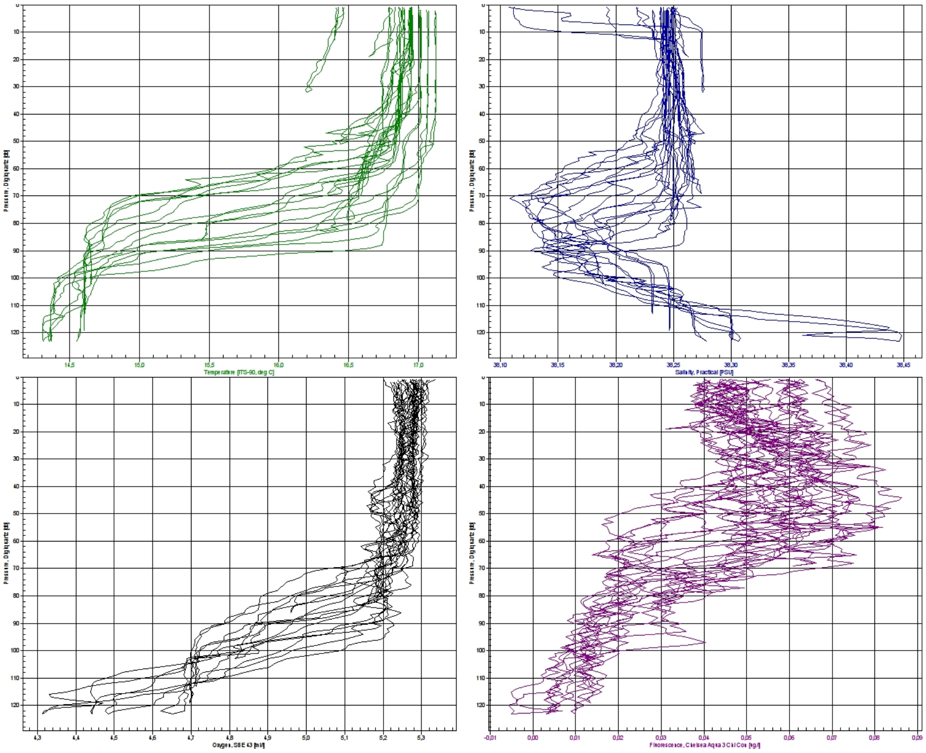
Station cors01



Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

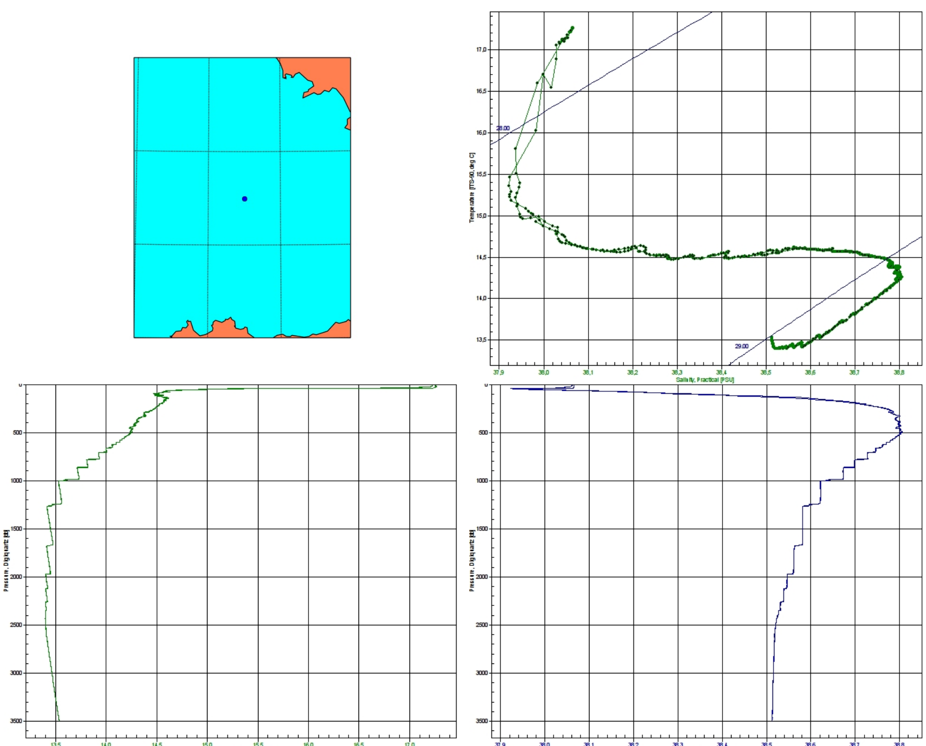
Transect sol

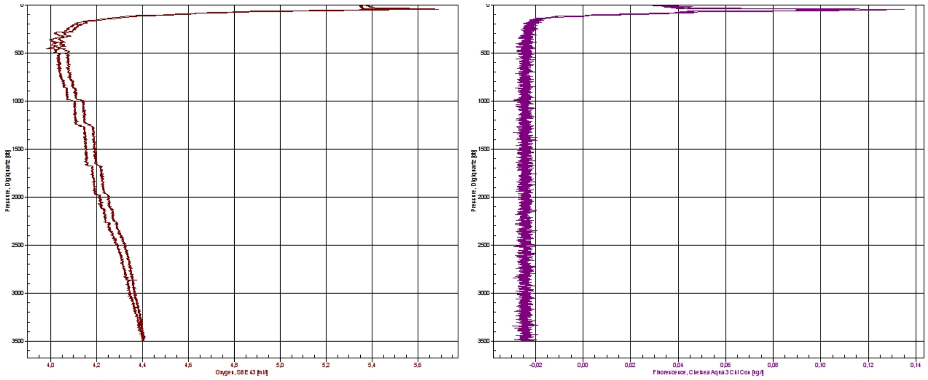




Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

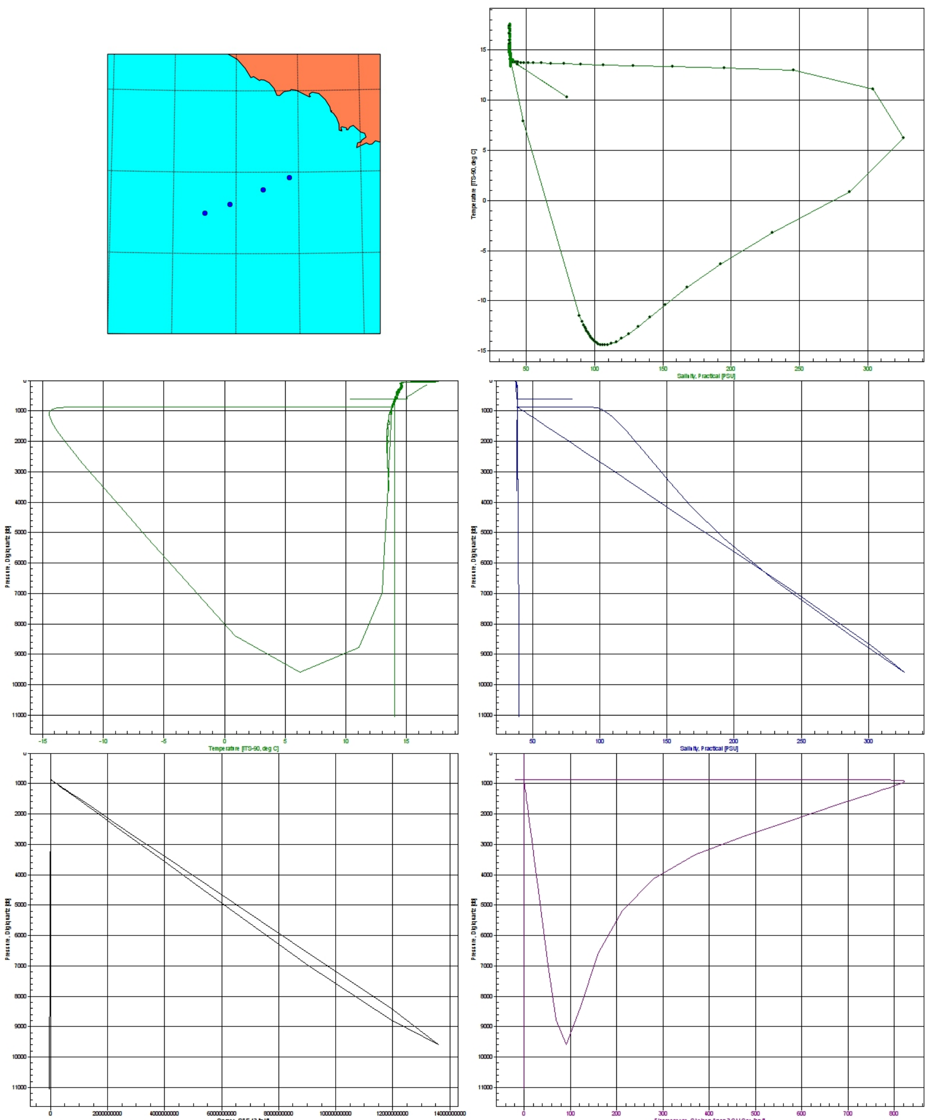
Station vtm





Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

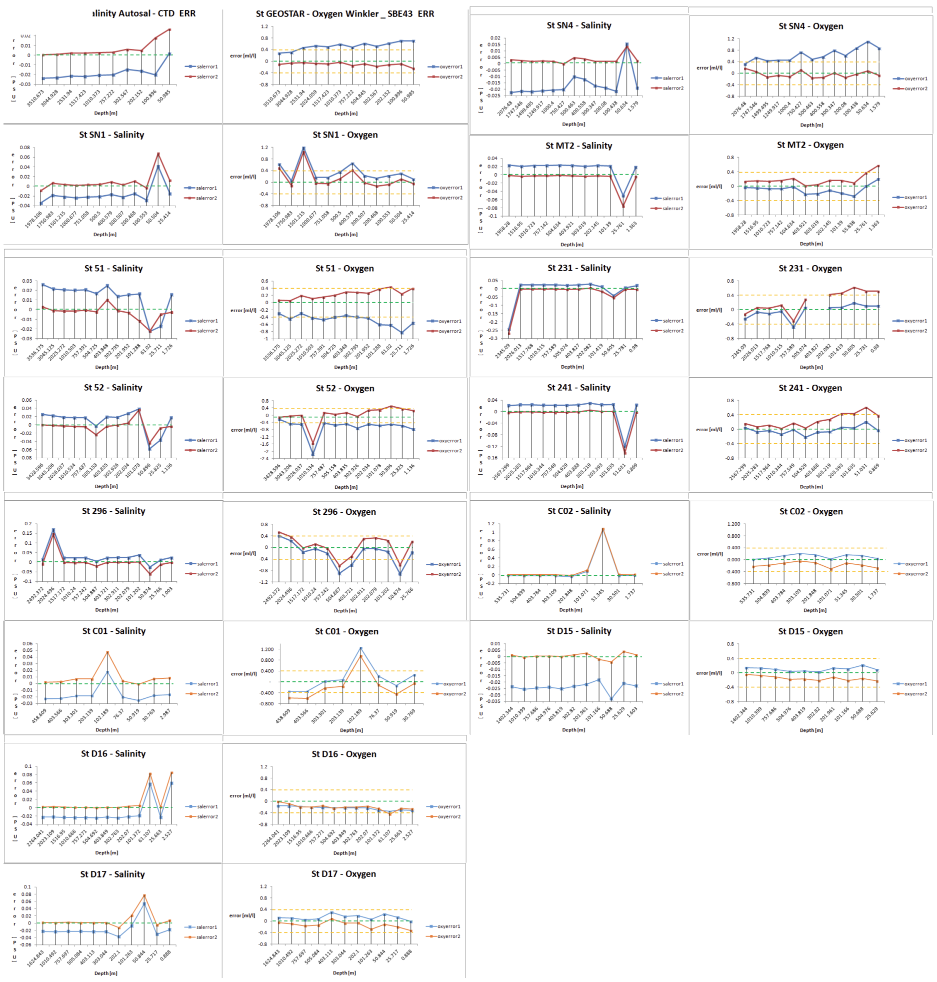
Transect 5



Hydrological parameters along the transect: T-S, temperature, salinity, oxygen, fluorescence.

Onboard Calibration of Sensors

calibration check on board with the use salinometer Portal Guildeline for the determination of salinity, and the Winkler method for the dissolved oxygen concentration



Acknowledgements

The authors are deeply indebted to the Captain and the crew of the CNR R/V Minervauno for continuous support during the whole measurement phase

---