CNR ISMAR - Istituto di
Scienze Marine

TYRRMOUNTS09 Cruise Report

8 May – 3 June 2009

Edited by K. Schroeder and M. Borghini

Consiglio Nazionale delle Ricerche - IAMC

Università degli Studi di Genova

Istituto Nazionale di Geofisica e Vulcanologia

Istituto Nazionale di Fisica Nucleare

Istituto Nazionale di Oceanografia e Geofisica Sperimentale

Contents

Cruise Details

NAME	*TYRRMOUNTS09*
DATE	*8 May – 3 June 2009*
STUDY AREA	*WESTERN IONIAN SEA* *SICILY CHANNEL* *SARDINIA CHANNEL* *TYRRHENIAN SEA*
PROJECT RESPONSIBLE	*G.P. GASPARINI, CNR-ISMAR*
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PARTICIPANT INSTITUTES	*CNR – ISMAR* *CNR – IAMC* *INFN* *INGV* *UNIVERSITY OF GENUA* *OGS*
RESEARCH VESSEL	*URANIA*
DEPARTURE PORT	*RAVENNA*
ARRIVAL PORT	*CIVITAVECCHIA*

Scientific Objectives

This report presents the preliminary results obtained during the TYRRMOUNTS09 cruise, carried out from 8th May – 3rd June 2009, on board of the Italian R/V URANIA in the Western Ionian Sea, in the Central Mediterranean (leg 1) and in the Tyrrhenian Sea (leg 3).

The cruise was addressed to acquire information on physical, biological and geochemical processes of the water column and the sediment in the whole study area. More in detail:

Leg 1 (Ionian Sea & Central Mediterranean): CTD-LADCP stations, recovering and deployment of moorings, box-corers of deep sediments for macrobenthos studies.

Leg 2 (Tyrrhenian Sea): CTD-LADCP stations,gliders,box-corers,

Buckets

The cruise was planned in the framework of three different projects (corresponding to the legs of the cruise):

1. KM3Net: During the last years, the European Commission has approved the funding for the project stage of an enormous astronomic telescope, based on the detection of the neutrino. The Italian collaboration Nemo has the aim to present a competitive solution of the whole detector, called Nemo Km3. There are also other European proposals, like Nestor in Greece and Antares in France, which lay on the same physical principle and has developed for the past ten years the independent project VLVNT (very large volume neutrino telescope). Only recently a European collaboration has started, which is called Km3net, in which the research experiences of the three solution are integrated and which is funded by the EC.

2. SESAME – Southern European Seas: Assessing and Modelling Ecosystem changes: SESAME aims to assess and predict changes in the Southern European Seas (Mediterranean and Black Sea) ecosystems and in their ability to provide key goods and services with high societal importance, such as tourism, fisheries, ecosystem biodiversity and mitigation of climate change through carbon sequestration in water and sediments. In particular we are involved in the workpackages WP2 and WP3, which deal with data collection for model definition and validation along 'WOCE-type' lines and in sub-regional seas. In this particular case the area investigated was the Sicily Strait.

3. MIUR-PRIN 2007 program "*Thyrrhenian Seamounts ecosystems*

In this frameworks, the cruise was planned in order to achieve the following objectives:

1. The physical cruise in the western Ionian is intended to provide updated information on the hydrology in the KM3 area, to recover a mooring, and to deploy another one.

2. The cruise in the Sicily Strait is intended to provide CTD, nutrients, data along transects between Sicily, Sardinia and Tunisia.

3. The cruise in the Tyrrhenian Sea aims to identify and describe the physical forcings acting in seamounts systems. The knowledge of hydrographic processes controlling the circulation, the mixing, and the exchanges of water masses around seamounts is the basis for the understanding of biogeochemical processes. For each seamount it is intended to determine their influence radius on biogeochemical processes and on primary production.

TYRRMOUNTS09 leg 1

8 – 19 May 2009

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Scientific Background

The Ionian Sea

The Ionian Sea is one of the eastern basins. It is bordered by Italy, Greece, Libya and Tunisia and has a volume of 10.8 x 10^4 km^3. The basin is connected to the Cretan Sea through the Straits of Kithira (depth 160 m and width 33 km) and of Antikithira (depth 700 m and width 32 km), to the Levantine Basin through the Cretan Passage, to the Adriatic Sea through the Otranto Strait (depth 780 m and width 75 km) and to the Western Mediterranean through the Sicily Strait.

The thermohaline circulation of the eastern basin is composed of two cells. The first one is an internal cell, deep and vertical, which involves the Ionian and the Levantine Basins. This deep thermohaline cell, the "conveyor belt" of the Eastern Mediterranean, is maintained by a deep water source in the Adriatic Sea, with the Eastern Mediterranean Deep Water (EMDW) reaching the Levantine Basin with a renewal time of 126 years (Roether and Schlitzer 1991; Schlitzer et al., 1991; Roether et al., 1994). During the 90's also another deep water source located in the Aegean Sea was observed (Roether et al. 1996). The external cell comprises water exchanges between the eastern and the western basin and with the North Atlantic. The Atlantic Water (AW), which enters the Mediterranean through the Strait of Gibraltar, moves eastward, spreading through the entire Mediterranean Se, after passing the Sicily Strait, occupying a layer of about 200 m depth. At the same time, the Levantine Intermediate Water (LIW), which forms mainly in the north-eastern Levantine Basin, moves westward, in a layer between 200 and 600 m depth, exiting the Mediterranean towards the North Atlantic, where it constitutes the well-known MOW (Mediterranean Outflow Water). In the Ionian Sea there are water and property exchanges with the Levantine Basin, in the East, and with the Aegean Basin, in the North. It is therefore considered a transition basin for all eastern water masses, where they are subject to important mixing and transformation processes along their pathway.

The main Ionian water masses are the Atlantic Water (AW), which moves eastward from the Sicily Strait, in the surface layer and is normally identified by a subsurface salinity minimum, between 30 m and 200 m depth. Below the AW, there is the Levantine Intermediate Water (LIW), which enters the Ionian Sea through the Cretan Passage, spreading westward from its formation site, the north-eastern Levantine Basin. The LIW is identified by its salinity maximum, between 200 and 600 m depth. The abyssal layer, below 1600 m, is occupied by the Eastern Mediterranean Deep Water (EMDW), colder and less saline, that forms mainly in the Adriatic Sea. In the layer comprised between 700 m and 1600 m, we find a transition water mass, with intermediate properties between the LIW and the EMDW. To these water masses, we have to add the Ionian Surface Water, ISW, which is clearly distinguishable from the AW in summer in the surface layer, being warmer and saltier than the AW.

The deep EMDW has well-defined core properties, because it is less influenced by the transformation processes. On the other hand, the distinguishing properties of the AW and the LIW has modified during their pathway, and depend on the distance from their formation sites. In the table, the AW and LIW properties in the eastern sub-basins are indicated (from literature, Manzella et al., 1988; De Maio et al., 1990; Moretti et al., 1993; Ozsoy et al., 1993; Theocharis et al., 1993; Malanotte-Rizzoli et al., 1997).

The Central Mediterranean Sea

The Central Mediterranean is characterized by a very complicated bottom topography, which directly affects the water exchange between the two Mediterranean basins (western and eastern Mediterranean Sea). The most salient features are the unequal depths of the boundary sections (Astraldi et al., 2002). In the Sardinia Channel (section D13-D21 in Figure 1), the sill depth is at about 1900 m, allowing the free exchange of the deep waters with the WMED, but in the Sicily Strait (section 410-432), the deeper sill is at about 430 m, thus imposing strong constraints on the exchanges with the EMED. In between, a wide area of very shallow waters off Tunisia provides a further obstacle to a direct connection between the two basins. All water masses outflowing at depth, both from the WMED (Krivosheya and Ovchinnikov, 1973; Hopkins, 1988) and from the EMED (Astraldi et al., 1996), are conveyed into the Tyrrhenian Sea, an intermediate basin whose southern part strongly interacts with the central Mediterranean. Section 212-291 is substantially formed by two main channels with a wide plateau in between. The deeper one, in the central part, directly connects the Tyrrhenian Sea with the Sardinia Channel and the WMED, and the other, adjacent to the Sicilian slope, connects, with an increasing depth, the Sicily Strait with the Tyrrhenian Sea.

The Sicily Strait, which represents the connection between western and eastern sub-basins, has a central role in the Mediterranean circulation. The Strait is a topographically complex region consisting of two sill systems separated by an internal deep basin (fig. 1): the eastern sill with a maximum depth of about 540 m connects the Strait with the Ionian Basin, the central basin presents deep trenches deeper than 1700 m, while the western sill is composed of two narrow passages, which have a maximum depth of 530 m. The entire region has a minimum width of 140 km and a total length of 600 km. The width of the Strait, significantly large at the surface, sensibly reduces in depth. Dynamically, the Strait is a two layer system: the surface layer (about 200 m thick) is occupied by the Atlantic Water (AW), moving eastward, while the deep layer, occupied by the Levantine Intermediate Water (LIW), flows in the opposite direction. The dynamics of the Strait is rather complex: the surface layer (AW) is dominated by mesoscale processes, while for the underlying layers the topography plays a key role. The Bernoulli effect associated to the high LIW velocity permits the Ionian deep water, laying at a greater depth, to cross the eastern and the western sills and to reach the western basin (Astraldi et al., 2001). In literature this water mass is called the transitional Eastern Mediterranean Deep Water (tEMDW). The high depth permits the central region to act as an intermediate reservoir between the eastern and the western sills, especially for the subsurface waters. Important mixing is also observed in correspondence of the sills, where high velocities induce significant entrainment effects with the surrounding waters (Iudicone et al., 2003; Stansfield et al., 2003).

Cruise Plan

The following table 1 summarizes the parameters that have been measured and the groups involved in the sampling operations, while table 2 lists the sampling equipment and the methods of analysis.

Parameters/Instruments	Working Group
CTD/O2/Fluorescence/Trasmissometer/rosette	CNR-ISMAR
Salinity	CNR-ISMAR
Dissolved Oxygen	CNR-ISMAR
ADCP	CNR-ISMAR
LADCP	CNR-ISMAR
NO3, PO4, SiO4	ENEA
Meteo station on board	CNR-ISMAR
Attenuation length of light	INFN
Macrobenthos and parameters characterizing the deep sediments	CNR-ISMAR

Table 1 Measured Parameters

Small-Volume Sampling	General Oceanics 24-place rosette with 12-liter bottles
CTD System	CTD SBE 911 plus
Salinometer	GUILDLINE AUTOSAL
Dissolved Oxygen	Winkler titration
ADCP	RDI WH 300 kHz, RDI OS 75 kHz
LADCP	RDI WH 300 kHz
NO3, Po4, SiO4	Samples only, no on board analyses
Meteo station on board	AANDERAA
Sediment sampling	Oceanic Box-corer
Astronomic telescop	Nerone

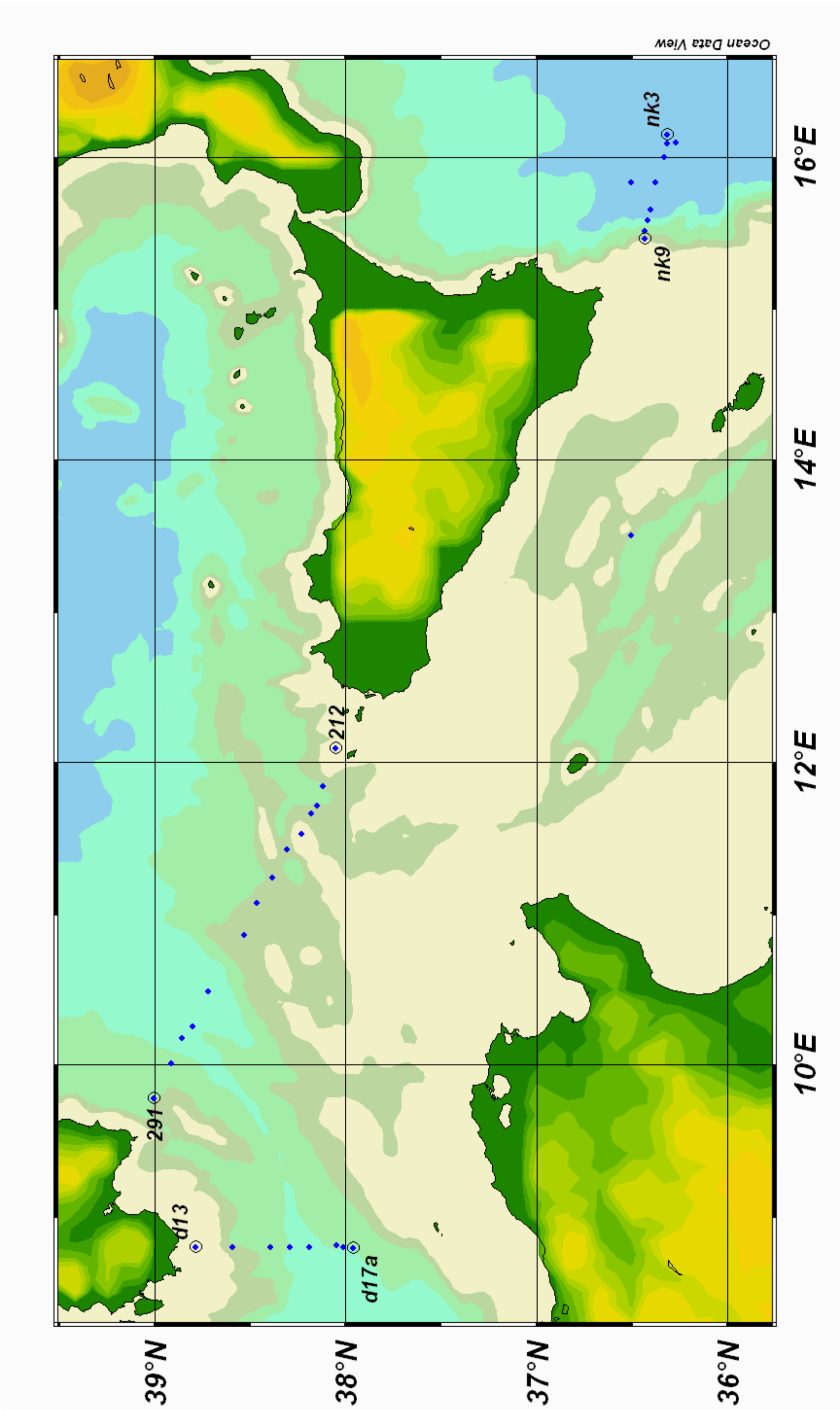
Table 2 Sampling equipment and analysis methods

The track is shown in Figure 2. For this leg we planned to spend 12 days at sea. The geographic boundaries of the survey are 35.0 °N – 39.5 °N latitude and 8 °E - 17 °E longitude.

The station list is shown in table 3.

Cruise Maps

Figure 2 Station map



Cruise Stations

Station	Lon (°E)	Lat (°N)	Depth (m)	ACTIVITY
Nk3	36.317	16.149	3385	CTD – LADCP – Oxygen
KC1	36.316	16.092	3437	CTD – LADCP – Oxygen – Salinity
KM4	36.267	16.101	3463	CTD – LADCP – Oxygen
Nk4	36.332	16..000	3437	CTD – LADCP
Nk5	36.375	15.833	3508	CTD – LADCP
Km3	36.501	15.834	3419	CTD – LADCP – Oxygen
Nk6	36.402	15.657	3383	CTD – LADCP
Nk8	36.434	15.517	1181	CTD – LADCP – Oxygen
Nk9	36.433	15.467	341	CTD – LADCP
Nk7	36.417	15.583	2228	CTD – LADCP
605	36.501	13.502	806	CTD – LADCP – Oxygen
D13	38.7861	8.8000	130	CTD – LADCP – Nutrients
D14	38.5943	8.8000	900	CTD – LADCP – Nutrients
D15	38.3936	8.8000	1600	CTD – LADCP – Nutrients – Oxygen
D16	38.1917	8.8000	2500	CTD – LADCP – Nutrients – Oxygen
D16A	38.2910	8.8000	2208	CTD – LADCP
D16B	38.0460	8.8110	1993	CTD – LADCP
D17	38.0101	8.8000	1800	CTD – LADCP – Nutrients – Oxygen – Salinity
D17B	38.0101	8.8000	1800	CTD – LADCP
218	38.2320	11.5310	229	CTD – LADCP – Nutrients
261	38.9140	10.0150	1500	CTD – LADCP – Nutrients
291	39.0080	9.7830	1004	CTD – LADCP
241	38.8560	10.1830	2560	CTD – LADCP – Nutrients – Oxygen
231	38.8050	10.2570	2345	CTD – LADCP – Nutrients

225	38.5330	10.8680	730	CTD – LADCP – Nutrients
227	38.6320	10.6820	1575	CTD – LADCP – Nutrients
229	38.7220	10.4940	2460	CTD – LADCP – Nutrients – Oxygen
212	38.0500	12.0900	220	CTD – LADCP – Nutrients
214	38.1200	11.8460	1160	CTD – LADCP
216	38.1480	11.7170	951	CTD – LADCP – Nutrients
217	38.1810	11.6660	762	CTD – LADCP – Nutrients – Oxygen
219	38.3060	11.4280	890	CTD – LADCP – Nutrients – Oxygen – Salinity
221	38.4340	11.2467	686	CTD – LADCP – Nutrients
223	38.4670	11.0770	840	CTD – LADCP – Nutrients – Oxygen - Salinity

Table 3 List of stations

Sampling Strategy

The stations have been selected mainly based on previous knowledge and available literature. The hydrological characteristics of the study area have been determined by CTD cast. In order to achieve information about the spatial variability of nutrients a high-resolution sampling has been applied, at the standard depths (table 4). For a better sampling of the biological and chemical parameters, extra sampling depths were defined in the water column by analyzing the CTD profile during the acquisition. The same standard depths have been sampled for the probe calibration against Winkler titration (for dissolved oxygen) and salinity determination.

Level	Standard depths (m)
1	0
2	25
3	50
4	75
5	100
6	200
7	300
8	400
9	500
10	750
11	1000
12	1250
13	1500
14	1750
15	2000
16	2500
17	3000
18	3250
19	3500

Table 4 Standard depths

Onboard Operations

CTD Casts

At all the hydrological stations, pressure (P), salinity (S), potential temperature (θ) and dissolved oxygen concentration (DO) were measured with a CTD-rosette system consisting of a CTD SBE 911 plus, and a General Oceanics rosette with 24 12-l Niskin Bottles. Temperature measurements were performed with a SBE-3/F thermometer, with a resolution of 10^{-3} °C, and conductivity measurements were performed with a SBE-4 sensor, with a resolution of 3×10^{-4} S/m. In addition, salinities of water samples were analyzed on board using a Guildline Autosal salinometer. Dissolved oxygen was measured with a SBE-13 sensor (resolution 4.3 µM), and data were checked against Winkler titration. 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.

Laboratory: ISMAR-CNR

LADCP

Two Lowered Acoustic Doppler Current Profilers (LADCP) were used to measure velocity profiles. We used two RDI Workhorse 300 kHz ADCP. For data post-processing we used the LDEO LADCP (versione 8.1) software.

Laboratory: CNR-ISMAR

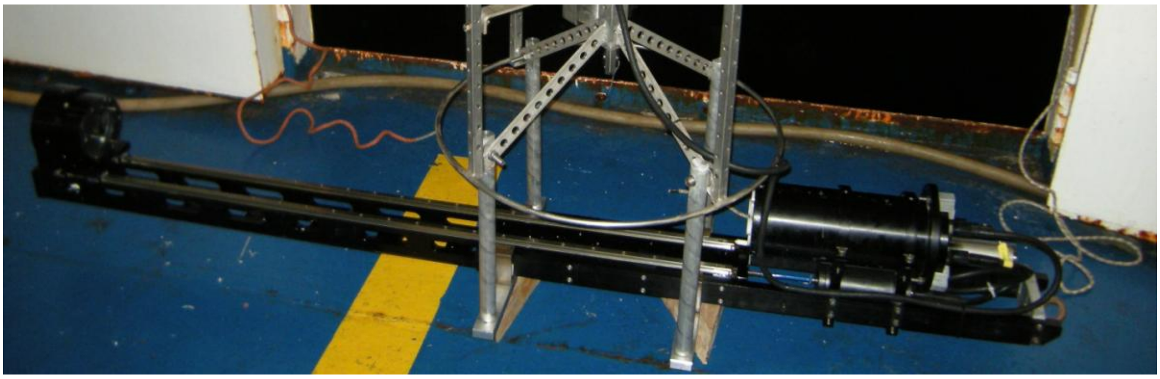
Inorganic Nutrients

Seawater samples for nutrient measurements were collected at different depths, when the system CTD/rosette was going up, according to the vertical profiles of salinity, potential temperature and dissolved oxygen, recorded in real time. No filtration was employed, 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.

Laboratory: CNR-ISMAR in collaboration with ENEA

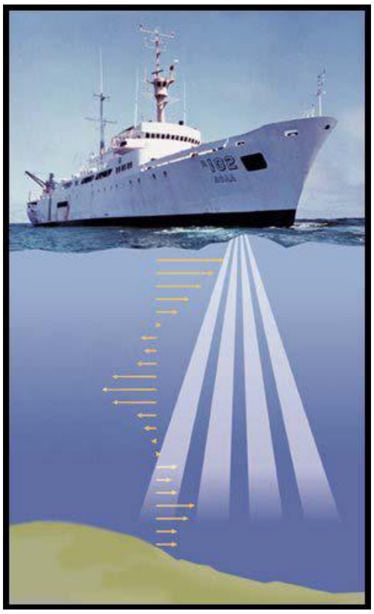
NERONE

NERONE is an instrument designed and built at INFN to measure the attenuation length of light in water. This project has been developed in the framework of the environmental studies for the NEMO group and the km3net European project for a 1 km3 Cerenkov neutrino detector in the Mediterranean sea. NERONE measures the attenuation length of light in water by changing the light path with the movement of a reflector along a rail. The measurement is thus independent of calibrations and comparisons with pure water. During the cruise several deployments have been performed to varying depths, with a final deployment to 2500m which has finally proven the functionality of the instrument.



NERONE before deployment GEMS mounted in mooring cage, with its power supply

Vessel-mounted ADCPs



The hydrographic data set has been integrated with direct current measurements. During the whole campaign two VM-ADCPs (RDI Ocean Surveyor, 75 KHz, and RDI Workhorse, 300 KHz) which operated during the whole campaign, along the whole ship track. The depth range of the two current profilers is about 700 m (OS75) and 150 m (WH300). Data acquisition is carried out using the RDI VMDAS software vers. 1.44. The ADCP data will be submitted to a post-processing with the CODAS3 Software System, which allows to extract data, assign coordinates, edit and correct velocity data. Data will be corrected for errors in the value of sound velocity in water, and misalignment of the instrument with respect to the axis of the ship.

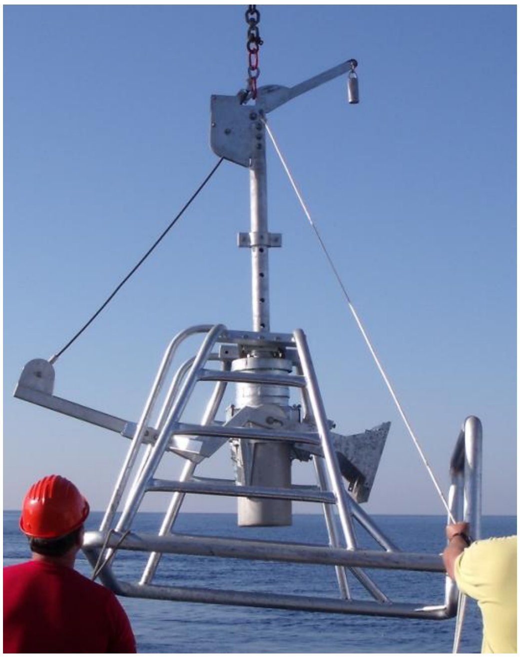
Laboratory: CNR-ISMAR

Recovering and deployment of moorings

One mooring, deployed in November 2008 in the NEMO position (KC1), was recovered and not redeployed. A mooring specifically designed for the assessment of biofouling has been deployed almost in the same position.

Laboratory: CNR-ISMAR and INFN

Macrobenthos and sediment analysis



The primary goal was to investigate the deep macrobenthic communities (in terms of abundance, biomass, distribution and diversity) in the Ionian sea, along the Maltese continental slope. Sediment samples were taken for biological and biochemical analyses, in order to characterize the deep macrofauna associations in relation to the main environmental characteristics of the area. Three different depths along the slope were selected: 1200 m, 1700 m and 2000 m, performing three deployments in each station. Sediment samples were collected with a box-corer (size: 32 cm diameter, 52 cm height) and subsamples were collected using Plexiglass liners of 5,5 cm and 3,6 cm internal diameter. Sediment subsamples were collected to analyze the biochemical composition of organic matter (chlorophyll a, phaeopigments, carbohydrates, lipids and proteins), heterotrophic prokaryote production, protozoa abundance, meiofaunal abundance, biomass and diversity, granulometry. All the sediment in the box corer have been collected for macrofauna.

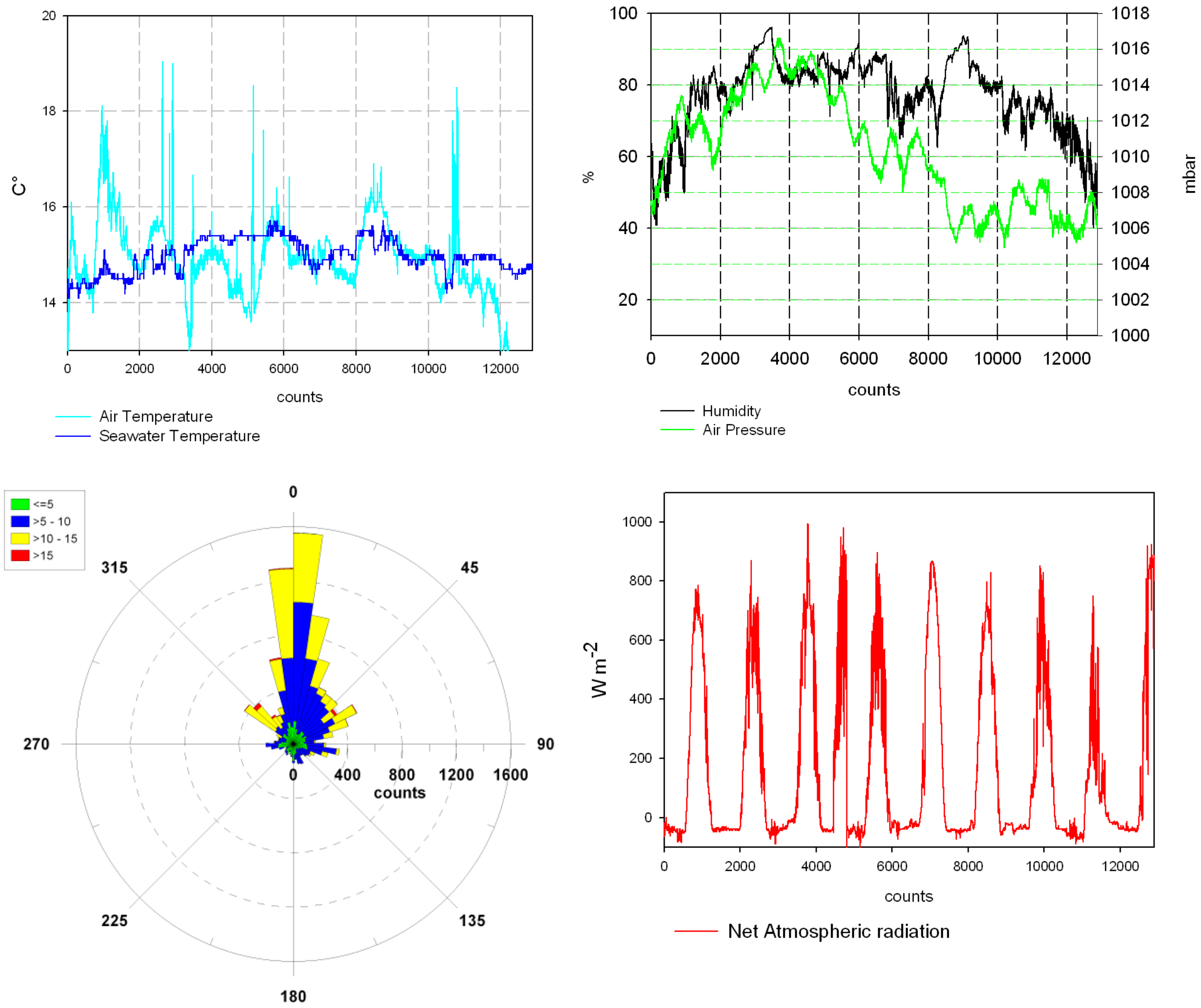
Laboratory: CNR-ISMAR

Preliminary Results

Weather conditions

The diagrams in figure 3 show the sea and weather conditions during the cruise.

Figure 3 Evolution of the weather conditions between 11th and 21th March 2008 (air temperature, sea temperature, relative humidity, air pressure, wind rose, irradiance)

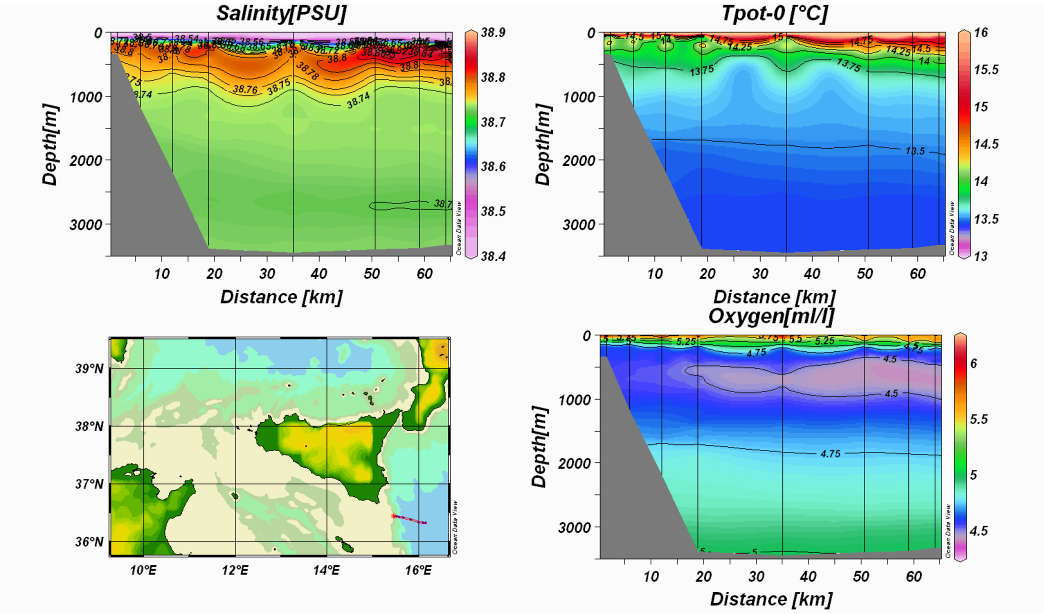


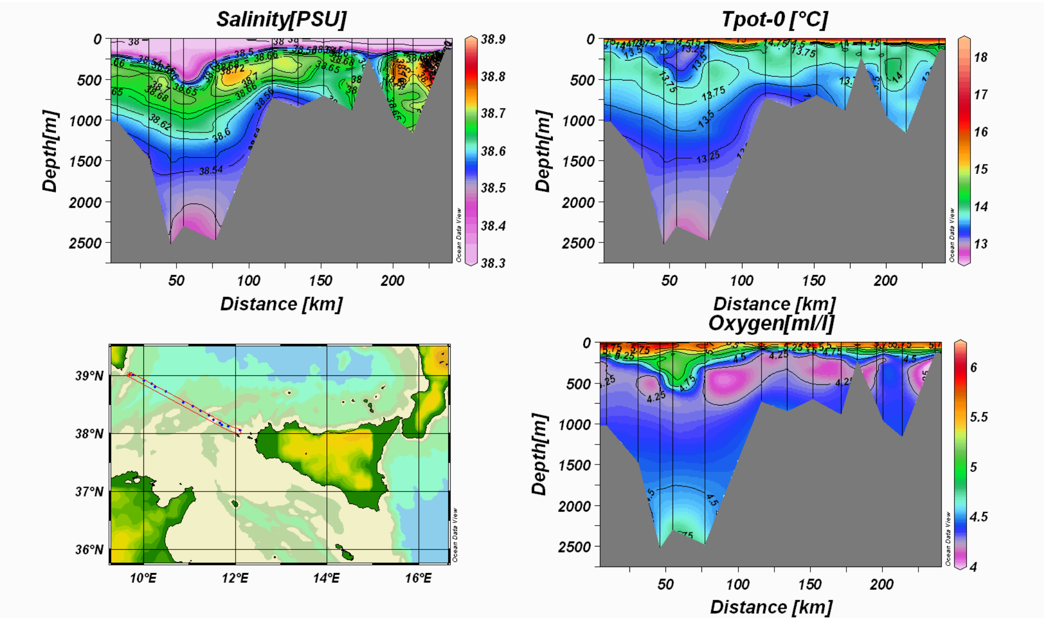
Hydrology

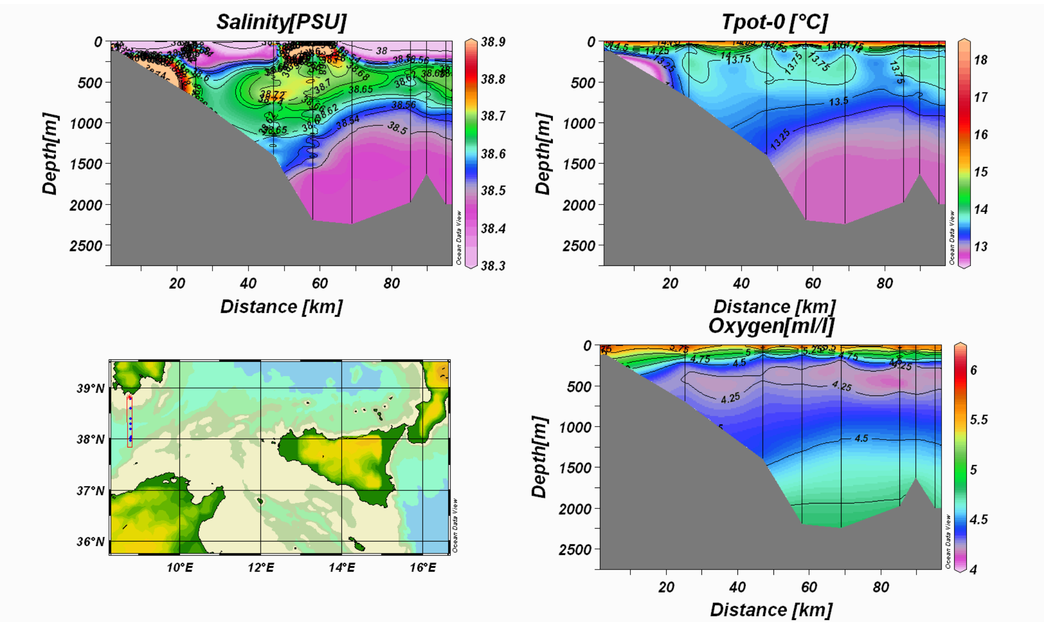
In the following some preliminary hydrological data and current measurements (LADCP data) of the western Ionian Sea are presented.

Hydrographic sections

Figure 4 Distribution of potential temperature, salinity and oxygen along the transect nk9-nk3, transect 291-212 and transect d13-d17

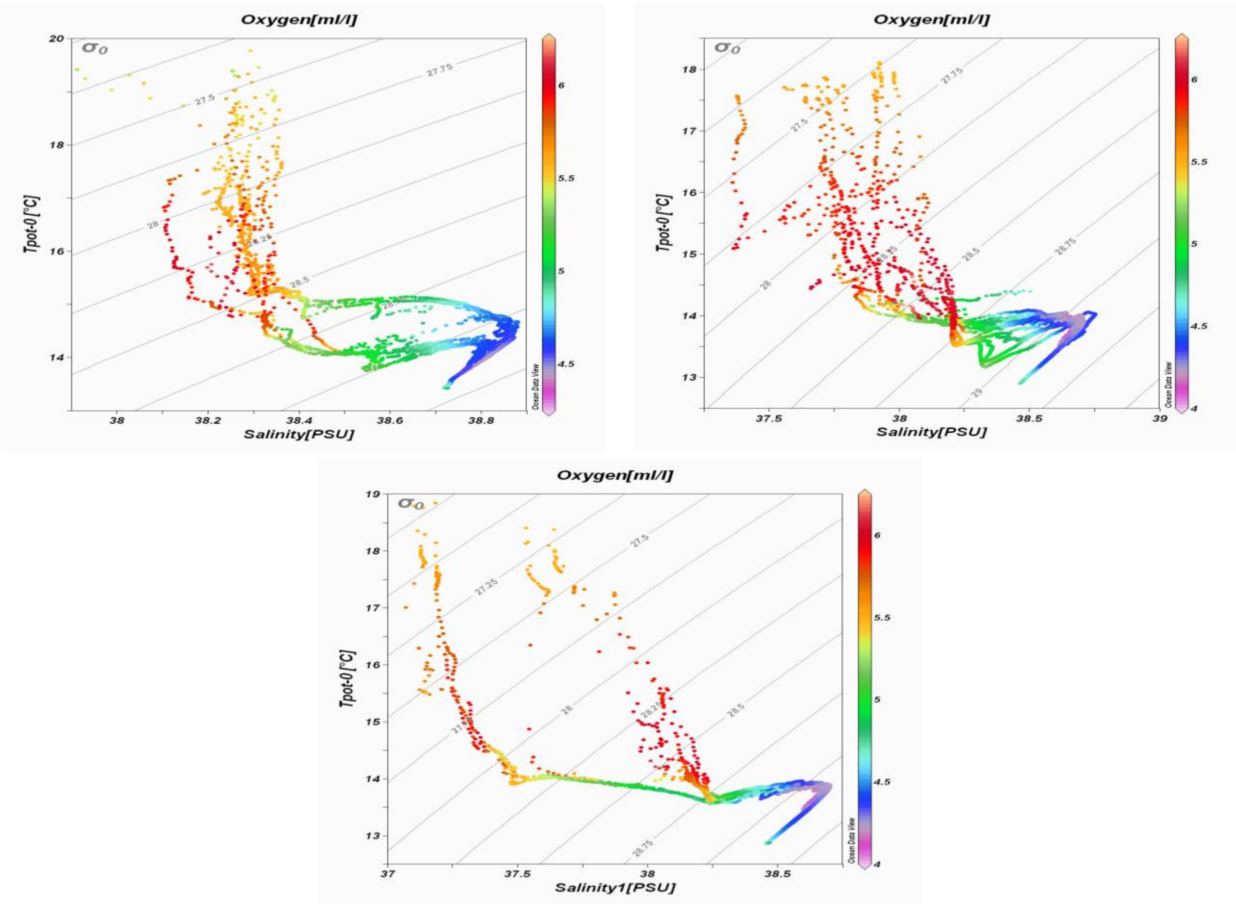






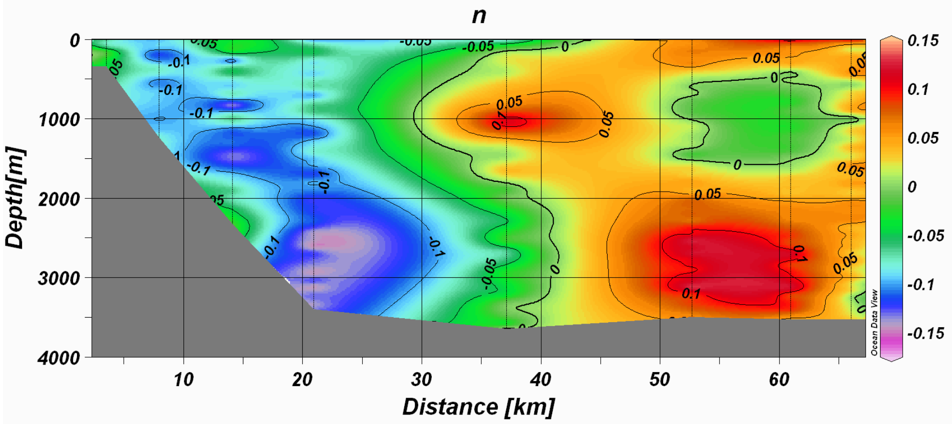
Potential Temperature vs Salinity Diagrams

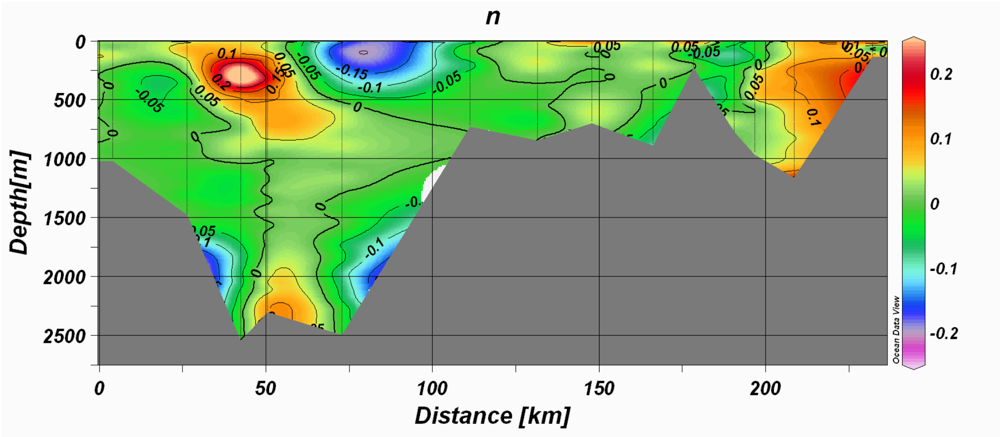
Figure 6 Theta-S diagram of the whole water column along the transect nk9-nk3 (left) and transect 291-212 (right), transect d13-d17 (below)



Currents from LADCP

Figure 7 Distribution of the measured velocity (normal component) in m/s along transect nk3-nk9 (above), 212-291 (centre), d13-d17 (below). Positive values are northeastward.

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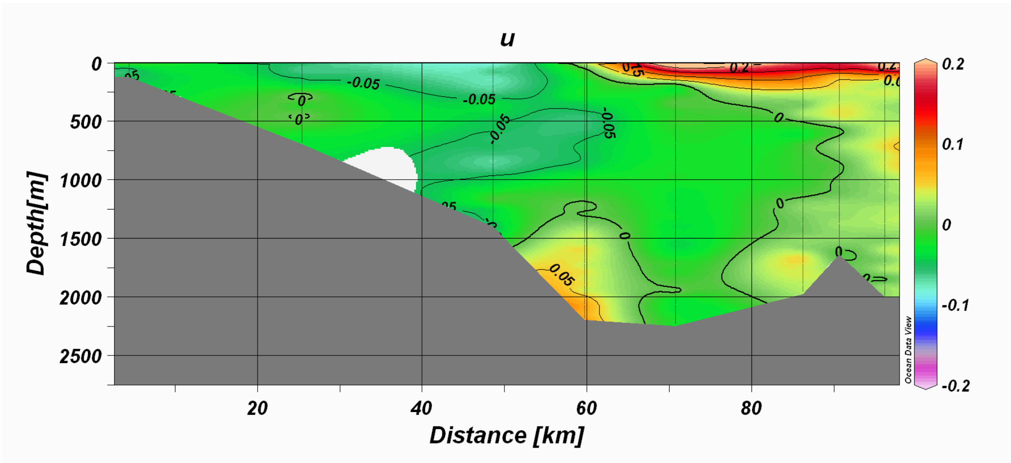
Depth[m]
Distance [km]
Ocean Data View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Distance [km]
Ocean Data View

Eulerian measurements

A moorings was recovered after its deployment in November 2008, in the NEMO position (KC1). It was not redeployed. The data were downloaded from the internal memories. In the following graphs we show some preliminary data elaborations.

Figure 12 Scheme of the KC1 mooring, recovered at 36°18.97' N and 16°05.48' E

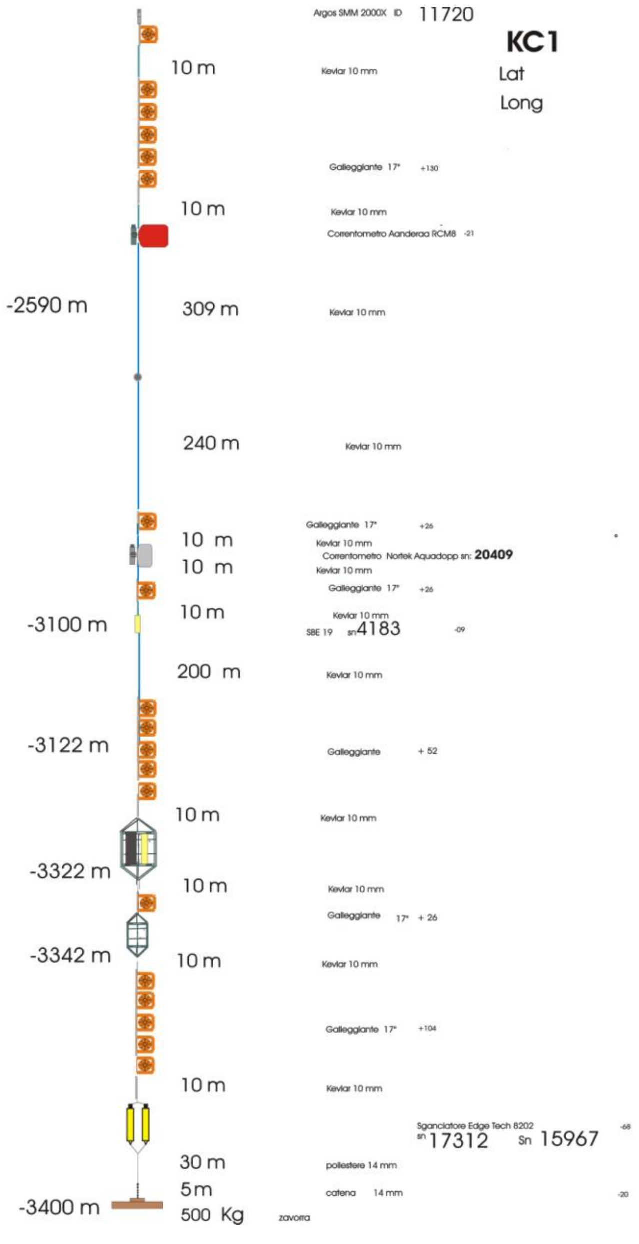


Figure 13 Scheme of the Biofouling mooring, deployed at 36°18.97' N and 16°05.48' E

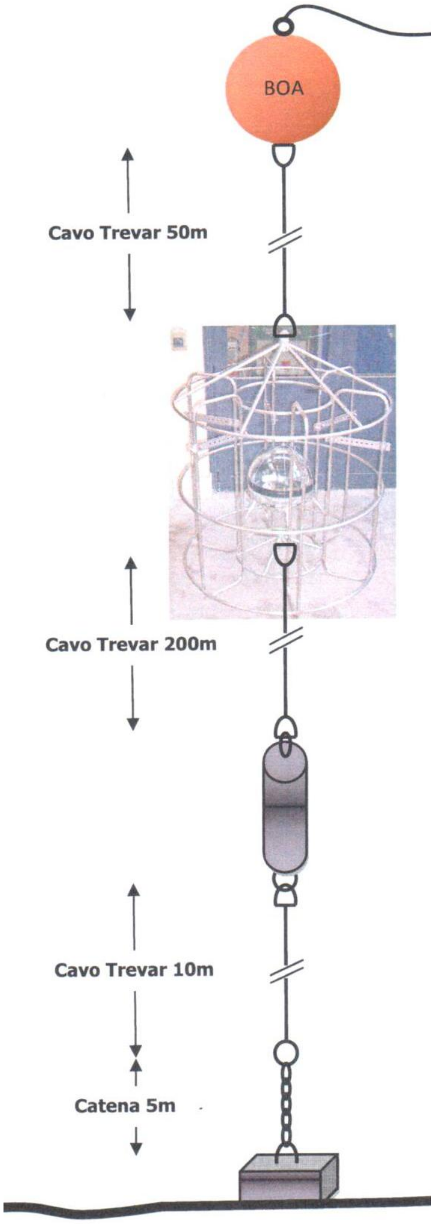


Figure 17 Temporal evolution of potential temperature and salinity measured by an SBE19 at 3150 m depth in the KC1 mooring

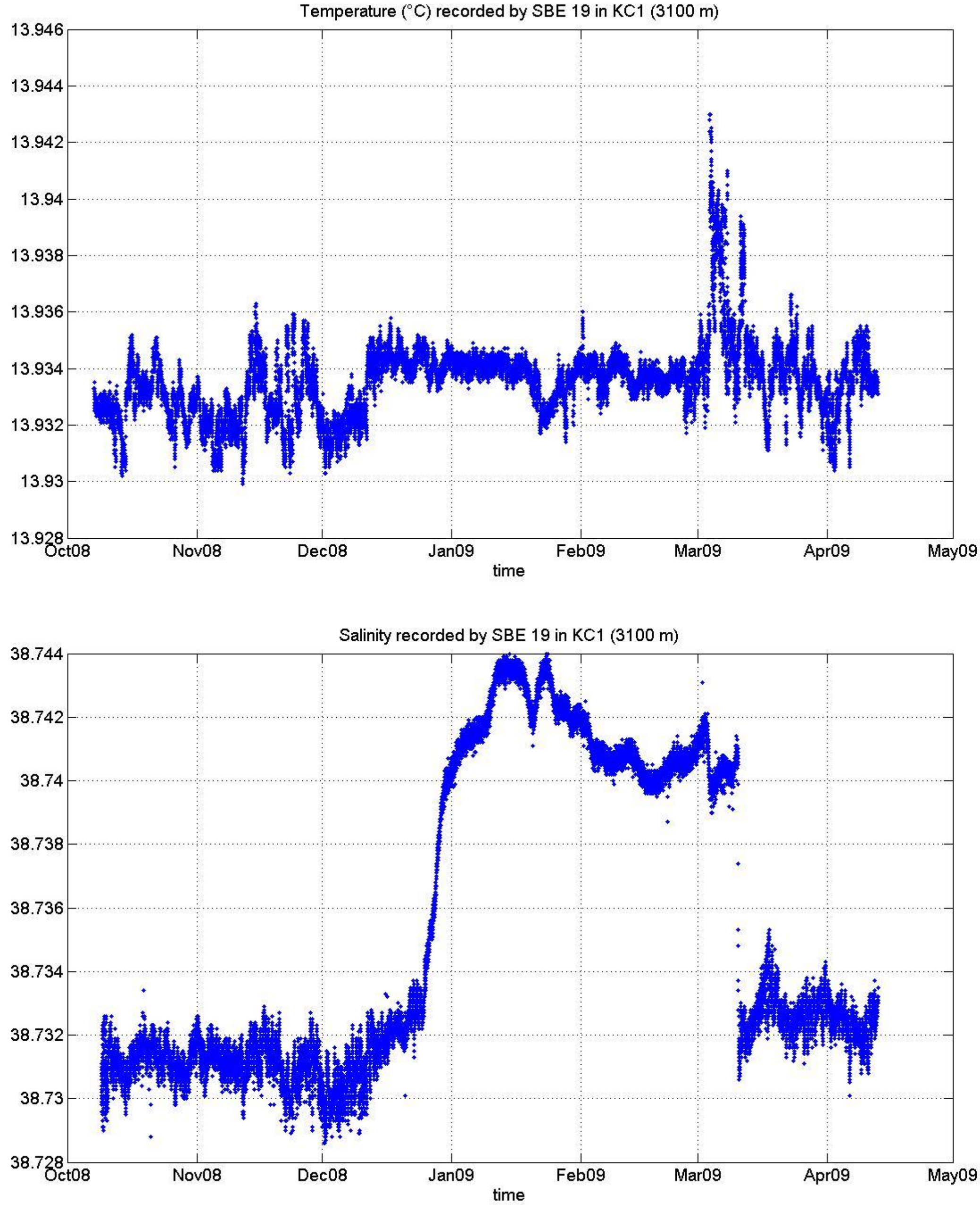
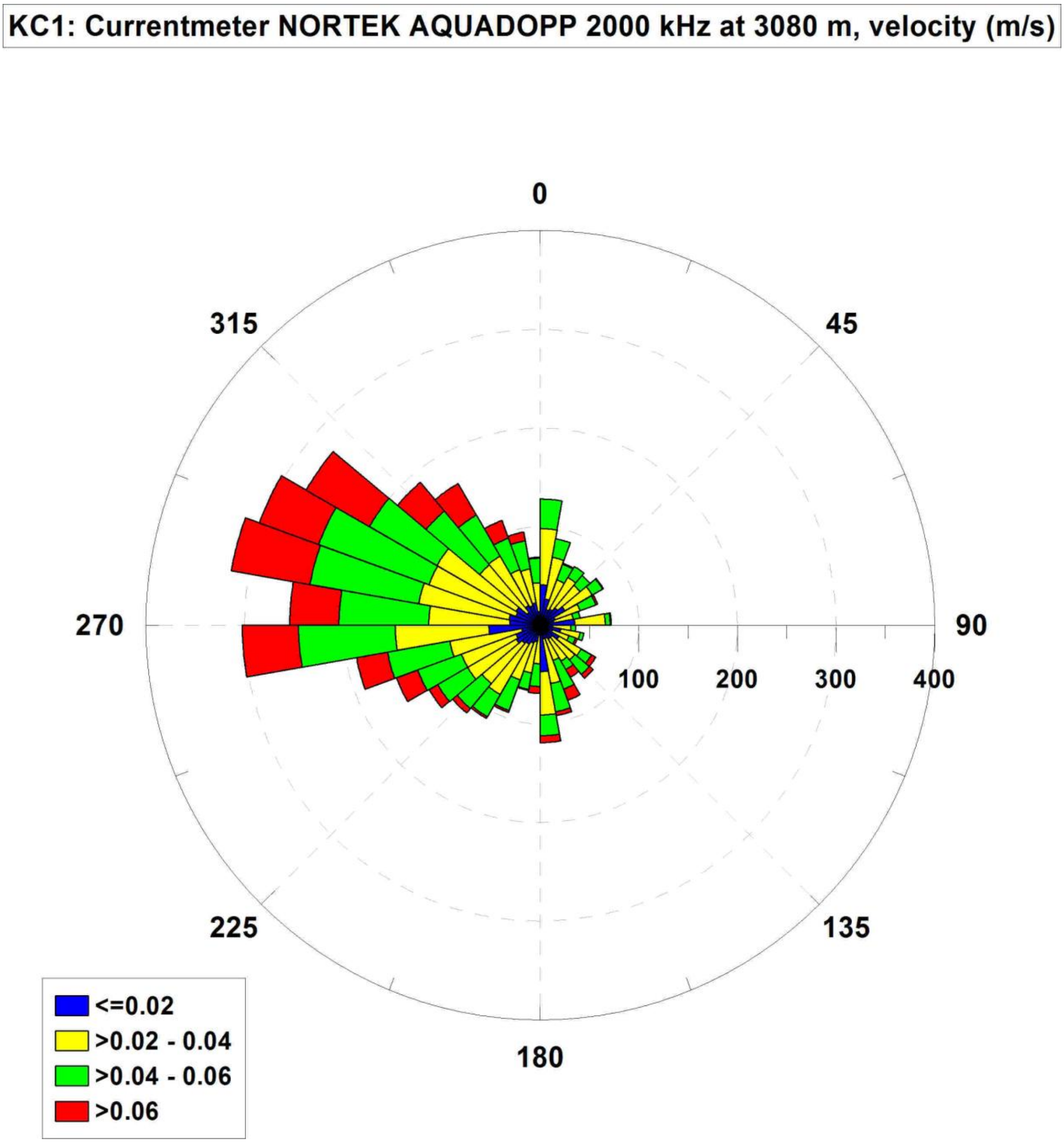


Figure 20 Currentmeter AQUADOPP at 3400 m depth in the KC3 mooring: velocity and angle histogram



Characterization of bathyal macrofauna

The first 20-30 centimeters of the sediment in the box-corer were sieved using a 0,5 mm and 0,3 mm sieving in order to collect all macrobenthic organisms. Before sieving a visual observations of the surface cores was regularly performed and the organisms were immediately picked. All the macrofauna was preserved in 10% buffered formalin with Bengal Rose and then transferred to 80% alcohol. After a preliminary and quick sorting, all macrofauna found seemed to be mainly polychaetes, scaphopods and foraminifera; few molluscs and pteropodes shells. A huge quantity of white filter feeding polychaetes characterised the superficial sediment in station 2 and in station 3. A detailed sorting and identification of the organisms will be subsequently made in the laboratory, to estimate the abundance and diversity of the macrobenthic communities.
Each box-corer was sub-sampled using two Plexiglas liners of 5.5 cm for organic matter, prokaryote production and meiofauna and one Plexiglas liners of 3.6 cm for granulometry. Chemical and biological analyses were carried out on three replicates (from independent deployments) at each sampling station. For the heterotrophic prokaryote production the 0-1, 3-5 and 10-15 cm of three liners were immediately used to perform these analyses on board. For the organic matter and prokaryote diversity, sediment corers were sliced into different layers: 0-1, 1-3, 3-5, 5-10 and 10-15 cm and were immediately frozen at -20°C and stored until the analysis. For meiofauna three corers were immediately frozen at -20°C and stored until the analysis. For granulometry three small liners were sliced into different layers: 0-1, 1-3, 3-5, 5-10 and 10-15 cm and stored in plastic jars until the analysis.

Station	Lon (°E)	Lat (°N)	Depth (m)	Activity
St.1_NK8 R1	15°31.044'	36°25.959	1206	CTD, BOX-CORER: 1' deployment
St.1 R2	15°31.049'	36°25.849'	1246	BOX-CORER: 2' deployment
St.1 R3	15°31.160'	36°25.835'	1264	BOX-CORER: 3' deployment
St.2_NK7 R1	15°34.980'	36°25.021'	2071	CTD, BOX-CORER: 1' deployment
St.2 R2	15°35.046'	36°24.976'	2087	BOX-CORER: 2' deployment
St.2 R3	15°35.013'	36°25.006'	2120	BOX-CORER: 3' deployment
St.3 R1	15°32.781'	36°25.322'	1780	BOX-CORER: 1' deployment
St.3 R2	15°32.747'	36°25.330'	1779	BOX-CORER: 2' deployment
St.3 R3	15°32.793'	36°25.301'	1768	BOX-CORER: 3' deployment

Table 5 List of all sites with positions, depth and description of the activity

TYRRMOUNTS09 leg 2

19 May – 03 June 2009

Scientific Staff

CNR-ISMAR

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Scientific Background

The Tyrrhenian Sea

The Tyrrhenian Sea is one of the most deep and isolated basins of the Mediterranean Sea. It exchanges through the Corsica Channel and the large passage between Sardinia and Sicily. The topography of its seafloor is characterized by the presence of numerous mountain and volcano systems (ridges and isolated seamounts), some of them reaching considerable heights, thus penetrating even the photic zone. It has been suggested that the hydrodynamic conditions around a seamount could be able to support an enhanced productivity, especially in the case of the superficial seamounts, because of the upwelling of deeper water masses. These water masses are characterized by higher nutrient concentrations, that may be used if other conditions, like light and the stability of the water column, are favourable. In order to verify these factors in the Tyrrhenian Sea we propose to conduct an in-depth investigation of five Tyrrhenian seamounts, two of them reaching even the photic layer: Vercelli (41°06' N/10°54'E, depth of the summit 55 m), Magnaghi (39°54.5' N/11°48'E, depth of the summit 1470 m), Vavilov (39°51.5' N/12°37'E, depth of the summit 750 m), Marsili (39°16' N/14°24'E, depth of the summit 505 m) and Palinuro (39°29' N/14°49'E, depth of the summit 70 m).

The other regions we intend to investigate during the cruise play a key role, since they are directly involved in the exchanges between the two Mediterranean basins: the Sicily Channel, the Ionian basin and the Tyrrhenian basin. The spatial coverage will permit to verify to which extent, with which transformations and ways a signal present in the Ionian basin is able to cross the Sicily Channel and reach the Tyrrhenian Sea. In order to completely characterize the water masses and the interbasin exchange, nutrient concentrations along the whole water column will be measured as well.

Studies about the interannual variability of processes like the formation of dense water are going to assume a central role, both in the western Mediterranean and in the eastern Mediterranean. The discovery of the so-called Eastern Mediterranean Transient (EMT) has definitively shown that the thermohaline cells of the Mediterranean are far from stationarity, with basin-scale consequences. The punctual monitoring for more than 15 years in the Sicily Channel has permitted to follow the evolution of the EMT from east to west. In the Sicily Channel and in the Sardinia-Sicily passage we will carry out hydrological measurements along transects that have already been monitored in the previous years. In the Channels of Sicily and Corsica we will recover and redeploy three moorings, equipped with currentmeters and CTD probes. The work in the Ionian Sea includes hydrological measurements and recovery/redeployment of two moorings, equipped with currentmeters, CTD probes and cages containing different metallic alloys for the study of corrosion in the deep layers. In the same area we will carry out current measurements along the whole water column with two LADCPs.

Cruise Plan

The following table 1 summarizes the parameters that have been measured and the groups involved in the sampling operations, while table 2 lists the sampling equipment and the methods of analysis.

Parameters/Instruments	Working Group
CTD/O2/Fluorescence/Trasmissometer/rosette	CNR-ISMAR
Salinity	CNR-ISMAR
Dissolved Oxygen	CNR-ISMAR
ADCP	CNR-ISMAR
LADCP	CNR-ISMAR
Meteo station on board	CNR-ISMAR
Attenuation length of light	INFN

Table 1 Measured Parameters

Small-Volume Sampling	General Oceanics 24-place rosette with 12-liter bottles
CTD System	CTD SBE 911 plus
Salinometer	GUILDLINE AUTOSAL
Dissolved Oxygen	Winkler titration
ADCP	RDI WH 300 kHz, RDI OS 75 kHz
LADCP	RDI WH 300 kHz
Meteo station on board	AANDERAA
Sediment sampling	Oceanic Box-corer
Astronomic telescop	Nerone

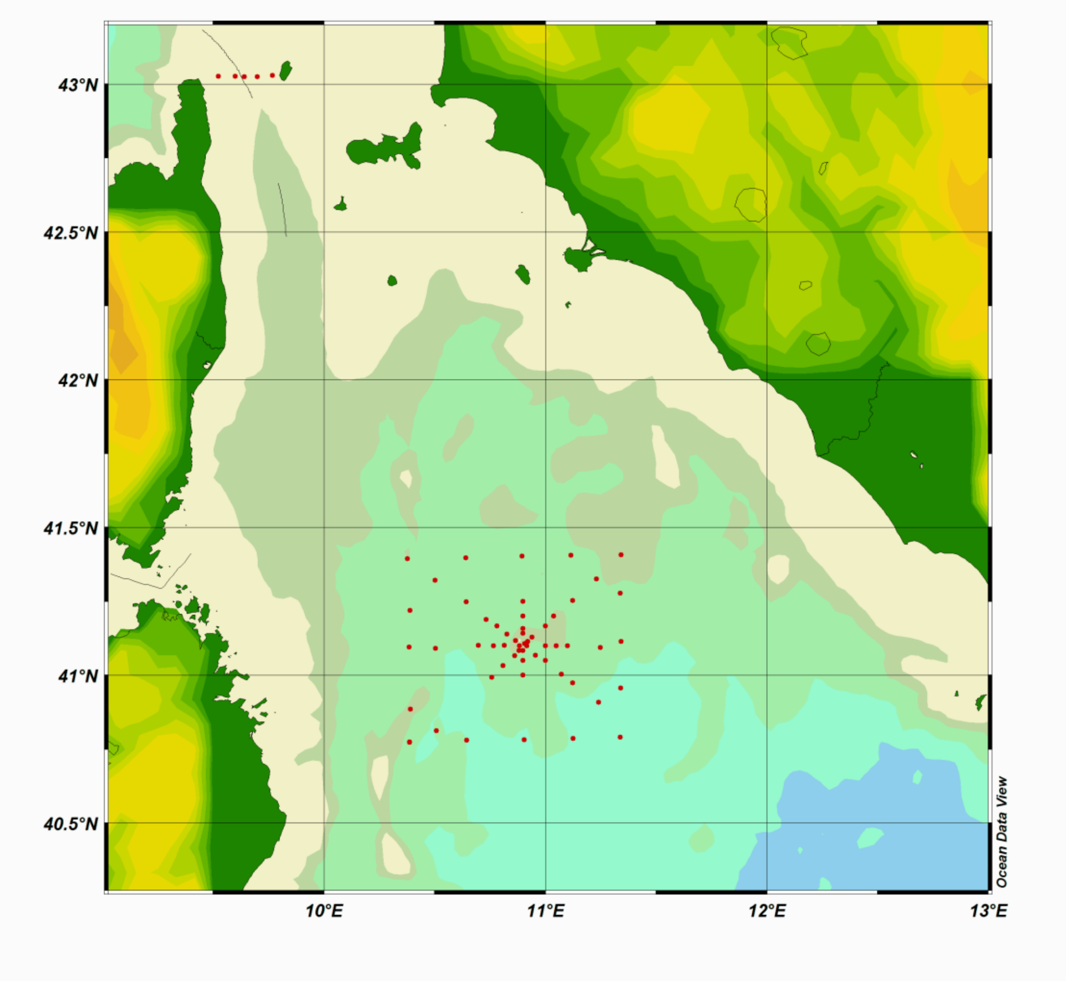
Table 2 Sampling equipment and analysis methods

The track is shown in Figure 2. For this leg we planned to spend 5 days at sea. The geographic boundaries of the survey are 35.00 °N - 38 °N latitude and 15 °E - 17 °E longitude.

The station list is shown in table 3.

Cruise Maps

Figure 2 Station map



Cruise Stations

Station	File name	LAT (° N)	LONG (°E)	Depth m	Activity
1	d001.cnv	41.2502	10.8997	1293	CTD- LADCP
2	d02.cnv	41.2000	10.9002	1163	CTD- LADCP
3	d03.cnv	41.1582	10.8998	1240	CTD- LADCP
4	d04.cnv	41.1418	10.9002	1020	CTD- LADCP
5	d05.cnv	41.0837	10.9000	449	CTD- LADCP

6	d06.cnv	41.0502	10.9002	1370	CTD- LADCP
7	d07.cnv	41.0002	10.8993	1971	CTD- LADCP
9	d09.cnv	40.9932	10.7590	1222	CTD- LADCP
10	d10.cnv	41.0330	10.8085	1114	CTD- LADCP
107	d107.cnv	43.0287	9.7683	85	CTD- LADCP
108	d108.cnv	43.0248	9.7000	445	CTD- LADCP
109	d109.cnv	43.0250	9.6418	365	CTD- LADCP
11	d11.cnv	41.0667	10.8618	575	CTD- LADCP
110	d110.cnv	43.0252	9.5995	239	CTD- LADCP
111	d111.cnv	43.0260	9.5250	66	CTD- LADCP
12	d12.cnv	41.0832	10.8825	235	CTD- LADCP
13	d13.cnv	41.1142	10.9217	183	CTD- LADCP
14	d14.cnv	41.1280	10.9403	390	CTD- LADCP
15	d15.cnv	41.1665	11.0000	1182	CTD- LADCP
16	d16.cnv	41.1998	11.0377	1159	CTD- LADCP
17	d17.cnv	41.0998	11.0997	1480	CTD- LADCP
18	d18.cnv	41.0988	11.0500	946	CTD- LADCP
19	d19.cnv	41.1000	11.0007	978	CTD- LADCP
20	d20.cnv	41.0998	10.9165	258	CTD- LADCP
21	d21.cnv	41.0997	10.8833	190	CTD- LADCP
22	d22.cnv	41.1003	10.8152	1063	CTD- LADCP
23	d23.cnv	41.1000	10.7662	1650	CTD- LADCP
24	d24.cnv	41.1003	10.6985	1848	CTD- LADCP
25	d25.cnv	41.1880	10.7333	1833	CTD- LADCP
26	d26.cnv	41.1670	10.7823	1787	CTD- LADCP
27	d27.cnv	41.1390	10.8275	1568	CTD- LADCP
28	d28.cnv	41.1165	10.8665	877	CTD- LADCP
30	d30.cnv	41.0680	10.9567	1506	CTD- LADCP
31	d31.cnv	41.0500	11.0000	1599	CTD- LADCP
32	d32.cnv	41.0030	11.0735	1728	CTD- LADCP
33	d33.cnv	41.4027	10.8957	1384	CTD- LADCP
34	d34.cnv	41.4053	11.1170	1296	CTD- LADCP
35	d35.cnv	41.4073	11.3425	756	CTD- LADCP
36	d36.cnv	41.3257	11.2318	1350	CTD- LADCP
37	d37.cnv	41.2528	11.1232	1522	CTD- LADCP
38	d38.cnv	41.2775	11.3380	1250	CTD- LADCP
39	d39.cnv	41.1137	11.3425	1722	CTD- LADCP
40	d40.cnv	40.9567	11.3410	2222	CTD- LADCP
41	d41.cnv	40.7898	11.3390	2646	CTD- LADCP
42	d42.cnv	40.9083	11.2403	2365	CTD- LADCP
43	d43.cnv	40.9745	11.1233	1167	CTD- LADCP
44	d44.cnv	40.7862	11.1260	2474	CTD- LADCP
45	d45.cnv	40.7813	10.9050	1992	CTD- LADCP
46	d46.cnv	40.7808	10.6448	2163	CTD- LADCP
48	d48.cnv	40.8128	10.5088	1436	CTD- LADCP
49	d49.cnv	40.7743	10.3870	1436	CTD- LADCP

50	d50.cnv	40.8857	10.3913	843	CTD- LADCP
51	d51.cnv	41.0957	10.3852	1597	CTD- LADCP
52	d52.cnv	41.2185	10.3892	936	CTD- LADCP
53	d53.cnv	41.3938	10.3777	887	CTD- LADCP
54	d54.cnv	41.3212	10.5027	1945	CTD- LADCP
55	d55.cnv	41.2480	10.6440	1258	CTD- LADCP
56	d56.cnv	41.3963	10.6410	1945	CTD- LADCP
57	d57.cnv	41.0903	10.5042	1775	CTD- LADCP
58	d58.cnv	41.0943	11.2490	1593	CTD- LADCP
Top	dtop.cnv	41.1075	10.9072	66	CTD- LADCP

Table 3 List of stations

Onboard Operations

CTD Casts

At all the hydrological stations, pressure (P), salinity (S), potential temperature (θ) and dissolved oxygen concentration (DO) were measured with a CTD-rosette system consisting of a CTD SBE 911 plus, and a General Oceanics rosette with 24 12-l Niskin Bottles. Temperature measurements were performed with a SBE-3/F thermometer, with a resolution of 10^{-3} °C, and conductivity measurements were performed with a SBE-4 sensor, with a resolution of 3 x 10^{-4} S/m. In addition, salinities of water samples were analysed on board using a Guildline Autosal salinometer. Dissolved oxygen was measured with a SBE-13 sensor (resolution 4.3 µM), and data were checked against Winkler titration. 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.

Laboratory: ISMAR-CNR

LADCP

Two Lowered Acoustic Doppler Current Profilers (LADCP) were used to measure velocity profiles. We used two RDI Workhorse 300 kHz ADCP. For data post-processing we used the LDEO LADCP (versione 8.1) software.

Laboratory: CNR-ISMAR

Vessel-mounted ADCPs

The hydrographic data set has been integrated with direct current measurements. During the whole campaign two VM-ADCPs (RDI Ocean Surveyor, 75 KHz, and RDI Workhorse, 300 KHz) which operated during the whole campaign, along the whole ship track. The depth range of the two current profilers is about 700 m (OS75) and 150 m (WH300). Data acquisition is carried out using the RDI VMDAS software vers. 1.44. The ADCP data will be submitted to a post-processing with the CODAS3 Software System, which allows to extract data, assign coordinates, edit and correct velocity data. Data will be corrected for errors in the value of sound velocity in water, and misalignment of the instrument with respect to the axis of the ship.

Laboratory: CNR-ISMAR

Report Drifter

On May 24th 2009 at 14.15 UTC, the drifter # 94658 (named "Rimedia") has been deployed south of the seamount "Vercelli" in the central Tyrrhenian Sea (west sector; see figure 1), then being monitored for a week until its rescue (see table 1). Over 540 kb of data have been acquired.

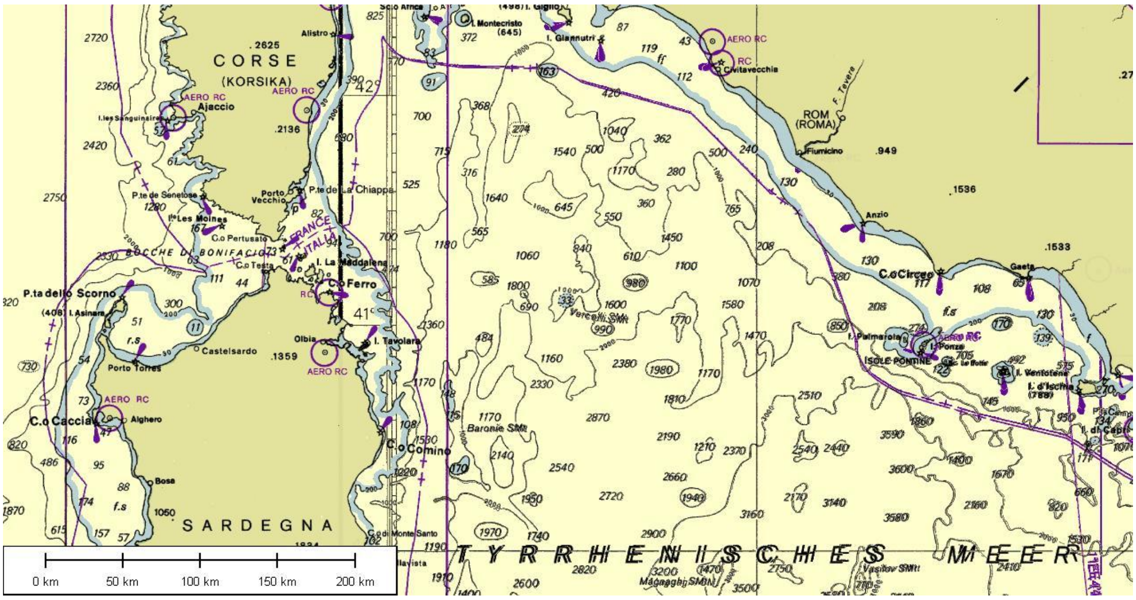


Figure 1

Table 1

Experiment #: 1		**Experiment name:** TYRRMOUNTS09	
Data accensione: 23.05.2009		**Ora UTC di accensione:** 09:00	
Deployment			
Date 24.05.2009	**Time (UTC)** 08:37	**Depth (m)** 1527	**Area** central Tyrrhenian Sea
Latitude: 41° 04.071' N (41.06785° N)		**Longitude:** 010° 57.574' E (010.959567° E)	
Rescue			

Date 30.05.2009	Time (UTC) 14:15	Depth (m) 750	Area central Tyrrhenian Sea
Latitude 41° 07.790' N (41.129833° N)		**Longitude** 011° 03.130' E (011.052167° E)	

The experiment has permitted to verify how the drifter works with an acquisition frequency of 20', the Argos transmission of the data (and their downloading on the IAMC server) and the rescue of the drifter.

Data analysis

During the experiment the sea conditions changed a lot from calm in its first part (A; in figure 2) to rough and northern winds at the end (C) with very rough sea and mistral wind at half experiment (B).

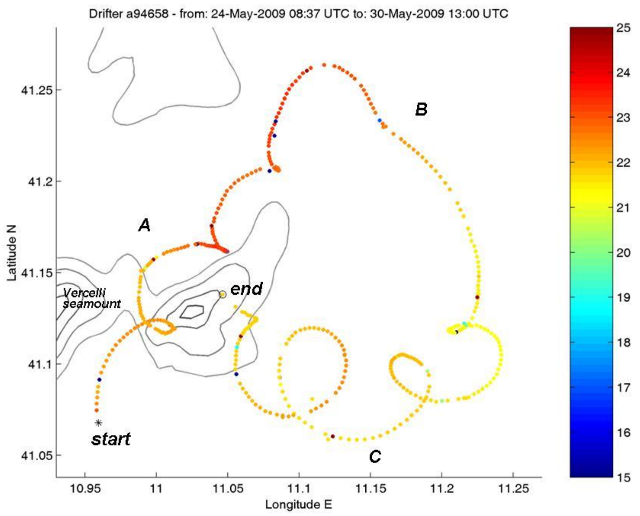


figura 2

The deployment position of the drifter, indicated in figure with a black star (and with "start"), ha been chosen due to an analysis of bibliographic and old drifter data in the area. It was close to the seamount Vercelli, visible on the left down of figure 2. The different colours of the points, surface temperature data, from the yellow or the red are due to spikes, then temporary malfunctioning of the temperature sensor that, actually, was not possible to delete.

In figure 2 the path of the drifter is shown tank to GPS data.

Temperature has passed, in the three periods from a heating due to a low wind circulation in the early days of the experiment to a quick cooling at half due to northern winds.

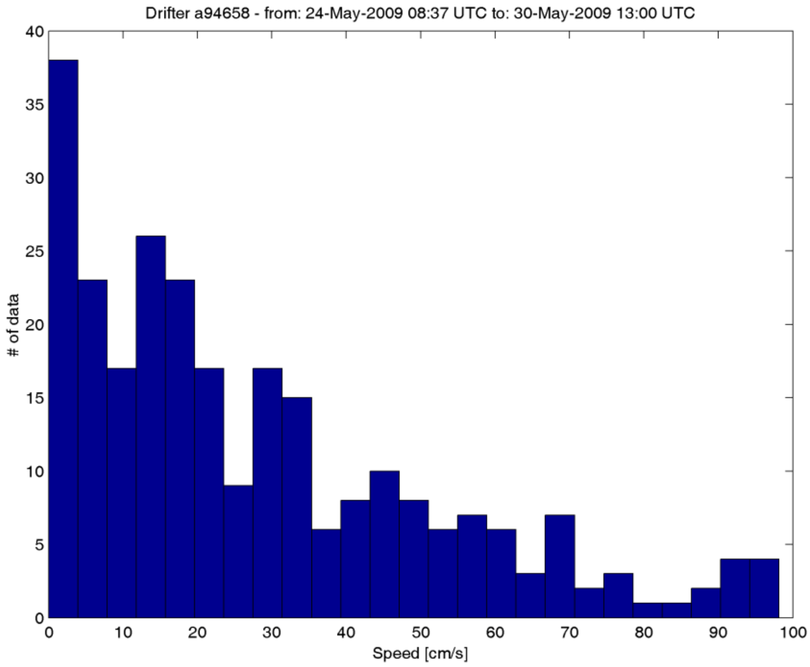


figura 3

The path of the drifter is influenced by the wind, too, that temporary drives the surface current.

Its initial and final paths (A and C) are characterised by calm of wind (A) and low wind (B) with a following inertial movement of the buoy with “locks” with a period of about 17-18 hours mainly given by the Coriolis force. During the phase (B) of its path, with strong northerly winds, the locks disappear and the path is more rectilinear.

The speed of the drifter calculated during the experiment show values mainly between 0-20 cm/s. The values over 60 cm/s are probably due to spikes still present in the data.

REPORT PROJECT TYRRMOUNTS 09

R/V URANIA 19.05.09-03.06.09
OU ANCONA, UNIVPM: Prof. G. Bavestrello, M. Bo
MACROBENTHOS

The work was conducted in order to assess the biodiversity of the benthic communities of the Vercelli seamount. The result is a preliminary list of macro invertebrates species which will be used for further explorations with the ROV to characterize the population structure of the benthic assemblages through the visual census. The main taxa that are going to be investigated are: sponges, hydrozoans, gorgonians, zoanthids, antipatharians and scleractinian corals. The identified species will be used also to assess, through the count of broken or dead colonies in the ROV video sequences, the impact of fishing gears (long lines and bottom trawls).

Investigation

The investigation was carried out through the use of an oceanographic dredge in a bathymetric range comprehended between 500 m and 90 m depth along all sides of the seamount. In total 7 operations were made between the 29th and 31st of May 2009:

Dredge N°	Position	Start Coordinates	Substrate	Depth (m)	Collection
1	South	41°05.697' N 10°54.224' E	Rock	300-430	Rocks and *Panopea* sp.
2	West	41°06.151' N 10°52.910' E	Mud and sand	300-150	Dead branches of *Dendrophyllia* sp. corals
3	West	41°06.107' N 10°52.884' E	Mud and sand	320-150	Dead branches of *Dendrophyllia* sp. Corals covered by encrusting sponges and bryozoans; Rocks
4	East	41°06.681' N 10°56.462' E	Mud	420-400	Dead branches of *Dendrophyllia* sp. corals
5	North	41°07.942' N 10°44.125' E	Rock	700-250	Rocks
6	Plane	41°07.538' N 10°54.106' E	Rock	220-170	Dead branches of *Dendrophyllia* sp. corals

7	Plane	41°07.042’ N 10°54.145’ E	Rock	180-90	Fishing net entrapped in the dredge: bottom trawling. Collection of a great amount of macro invertebrates: sponges, gorgonians, tunicates, bryozoans, crustaceans, mollusks, polychaetes, echinoderms

A total of 31 samples were collected in the dredged sites. Branched colonies and carbonate organisms were preserved dried, while portions of them were kept in buffered Formaldehyde 4% or Ethanol 70° for further laboratory morphological investigations on the living tissues. Some samples (sponges) were preserved in Ethanol 95° for DNA analyses. Rocks were kept dried in separated boxes for further geological studies.

- Porifera: various massive and encrusting demosponges found both on primary (rocks) and secondary substrates (dead corals and net).
- Cnidarians: dozens of gorgonians (*Paramuricea clavata*, *Paramuricea macrospina*, *Eunicella cavolinii*, *Corallium rubrum*), soft corals (*Paralcionium coralloides*) and sea anemones (dredged by the net on the most superficial part of the mount). Tanatocoenosis of the scleractinian *Dendrophyllia* sp. found along all sides of the mountain, in the deepest investigated ranges.
- Polychaetes: hundreds of sabellid tubes (family Paraonidae) with biological encrustations
- Mollusks: Bivalve *Pteria hirundo* as epibiont of several gorgonian colonies and small specimens, to be identified, in the sandy substrate
- Crustaceans: one specimen a Majide decapod and a *Parthenope* crab
- Bryozoans: encrusting and erect specimens found only on secondary substrates (dead corals and net)
- Tunicates: Numerous specimens of encrusting (Didemnids) and massive (*Clavelina* sp., *Microcosmus* sp.) ascidians
- Echinoderms: crinoids *Antedon mediterranea*, sea urchins (*Cidaris* sp., *Echinus melo*)

Work and specimens. **A.** Collection of corals with the dredge. **B.** *Corallium rubrum*. **C.** Colonies of the gorgonians *Paramuricea clavata* and *Eunicella cavolinii*. **D.** Rocky substrate. **E.** *Eunicella cavolinii* colony. **F.** Dead branches of the scleractinian *Dendrophyllia* sp. **G.** Mixed macrofauna sample.

Activity report

Tyrrmounts 2009 cruise

r/v URANIA

May-20 - June 2 2009

U.O Dip.Te.Ris. - Università degli Studi di Genova

(Michela Castellano, Anabella Covazzi, Francesco Massa, Cristina Misic, Paolo Povero)

Corso di Laurea in Scienze Ambientali Marine - Università degli Studi di Genova

(Cecilia Baggini, Cristian Falcone, Enrico Grosso, Luca Tixi)

U.O. Dip.Te.Ris. conducted research activities during the Tyrrmount 2009 cruise in the framework of MIUR-PRIN 2007 program "*Thyrrhenian Seamounts ecosystems: an Integrated Study –TySEc".* TySEc research activity involves different italian institutions: Università Politecnica delle Marche, Università degli Studi di Genova, CNR ISMAR La Spezia, INGV.

The goal of the research project is to study the hydrological features around the seamount and their influence on the ecosystem, focusing on the relationship between water column and sediments (pelagic-benthic coupling). The research activities were conducted on a Tyrrhenian seamount, the Vercelli Ridge (41°05'00 N / 10°53'00 E; summit depth: 55 m).

This study will constitute a preliminary work experience in order to define an investigating protocol useful to study many other Thyrrhenian seamount. Seamounts are major topographic features of the ocean floor. Extending over a considerable depth range from base to summit, and according a variety of substrate types and habitats, they constitute unique ecosystems for biota in the open ocean.

The principal objectives of U.O. Dip.Te.Ris are:

- to assess the origin, the quantity and the dynamics of the organic material within the water column and the surface sediments at the seamount, in order to estimate the degree of influence of the seamounts on the biogeochemical processes, focusing on the pelagic-benthic coupling relationship. These issues are pivotal for understanding the energy supply and transfer in ecosystems potentially controlled by topographic elevations and they are linked to the study of the benthic communities;
- to define structure and composition of the plankton community around the seamount, focusing on the temporal and spatial variability, to investigate whether the origin is autochthonous or allochthonous;
- to define and model the trophic ecology of the seamount ecosystem.

Field activities

Samplings activities were carried out on board of the R/V URANIA (CNR) between May 20 and June 2 2009 (Tyrrmount 2009 cruise) (tab. 1)

Water samples were collected using Niskin bottles, in order to perform further chemical and biological analyses, to determine the concentrations of the principal inorganic nutrients, the elemental and biochemical characterization of the dissolved and particulate organic matter, the phytoplanktonic biomass (chlorophyll-a and phaeopigments). Zooplankton samples were collected along two transects perpendicular to the seamount using a Bongo net (200 µm).

Box-corer and grabs were use to collect the sediments and the benthos communities. In each station of the grid sediment samples will be collected by means of box-corer to obtain a quantitative description of the infaunal communities and a characterization of the sediments (granulometry, elemental and biochemical content of the organic fraction, pigments content).

	station	*water samples*	*sediment samples*	*zooplankton samples*
1	41	x	3 box-corer	x
3	32	x	2 box-corer	
2	30	x	-	-
4	0	x	1 grab	x
5	28	x	1 box-corer	x
6	25	x	4 box-corer	x
7	9	x	4 box-corer	x
8	11	x	-	-
9	53	x	4 box-corer	x
10	14	x	4 box-corer	x
11	16	x	4 box-corer	x
12	49	x	-	-
13	48	x	-	-
14	45	x	-	-
15	42	x	-	-
16	27	x	-	-
17	2	x	-	-
18	7	x	-	-
19	23	x	-	-
20	51	x	-	-
21	54	x	-	-
22	33	x	-	-
23	36	x	-	-
24	35	x	-	-
25	17	x	-	-

26	19	x	-	-
27	39	x	-	-

Tab. 1 sampling stations U.O Dip.Te.Ris - Università degli Studi di Genova

Laboratory activities

The analyses of seawater, sediments and benthos will be carried out at the laboratories of Dip.Te.Ris. (Università degli Studi di Genova).

Marino Vacchi and Ugo Briozzo

In the framework of field activities of the “Tyrrmounts 09” cruise (May 2009, N/O “Urania”), fish samplings were conducted in order to test the performances of different types of fishing gears and to collect preliminary information on the fish assemblage of the Vercelli seamount (Central Tyrrhenian).

We adopted the three following different kinds of long-lines designed to operate along the rocky and steep sea-beds of the Vercelli seamount: oblique long-line with 60 hooks; vertical long-line with 30 hooks; bottom long-line 160 hooks.

The fishing activities were performed between 60 m (the top of the seamount) and 450 m with long-lines baited with frozen pilchard.

In total we made three fishing operations; The long-lines were hauled by a 24-volts electric winch. The steepness and the high rugosity of the sea bottoms created difficulties during the hauling of the gears; in particular the bottom long-line was severely damaged by the presence of numerous obstacles on the sea-beds (possibly white coral banks) and several branch lines were lost.

Better results were obtained with semi-vertical (oblique) and vertical long-lines.

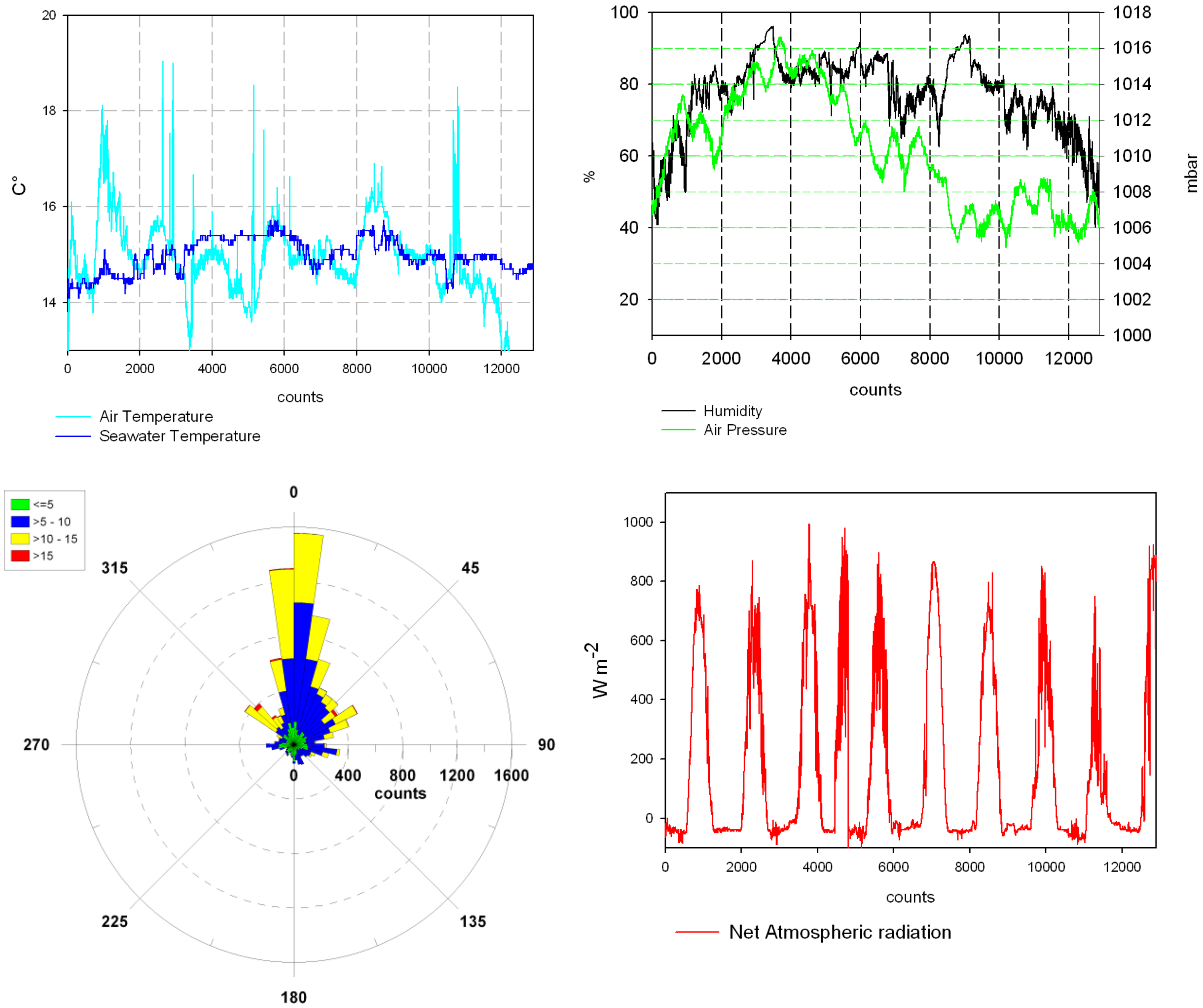
The catches were in general poor; we found in the long-lines only some specimens of three different species of teleosts (*Lepidopus caudatus*, *Muraena helena* and *Serranus cabrilla*) and two cartilaginous fishes (*Centrophorus granulosus* and *Pteroplatytrygon violacea*).

Preliminary Results

Weather conditions

The diagrams in figure 3 show the sea and weather conditions during the cruise.

Figure 3 Evolution of the weather conditions between 11th and 21th March 2008 (air temperature, sea temperature, relative humidity, air pressure, wind rose, irradiance)

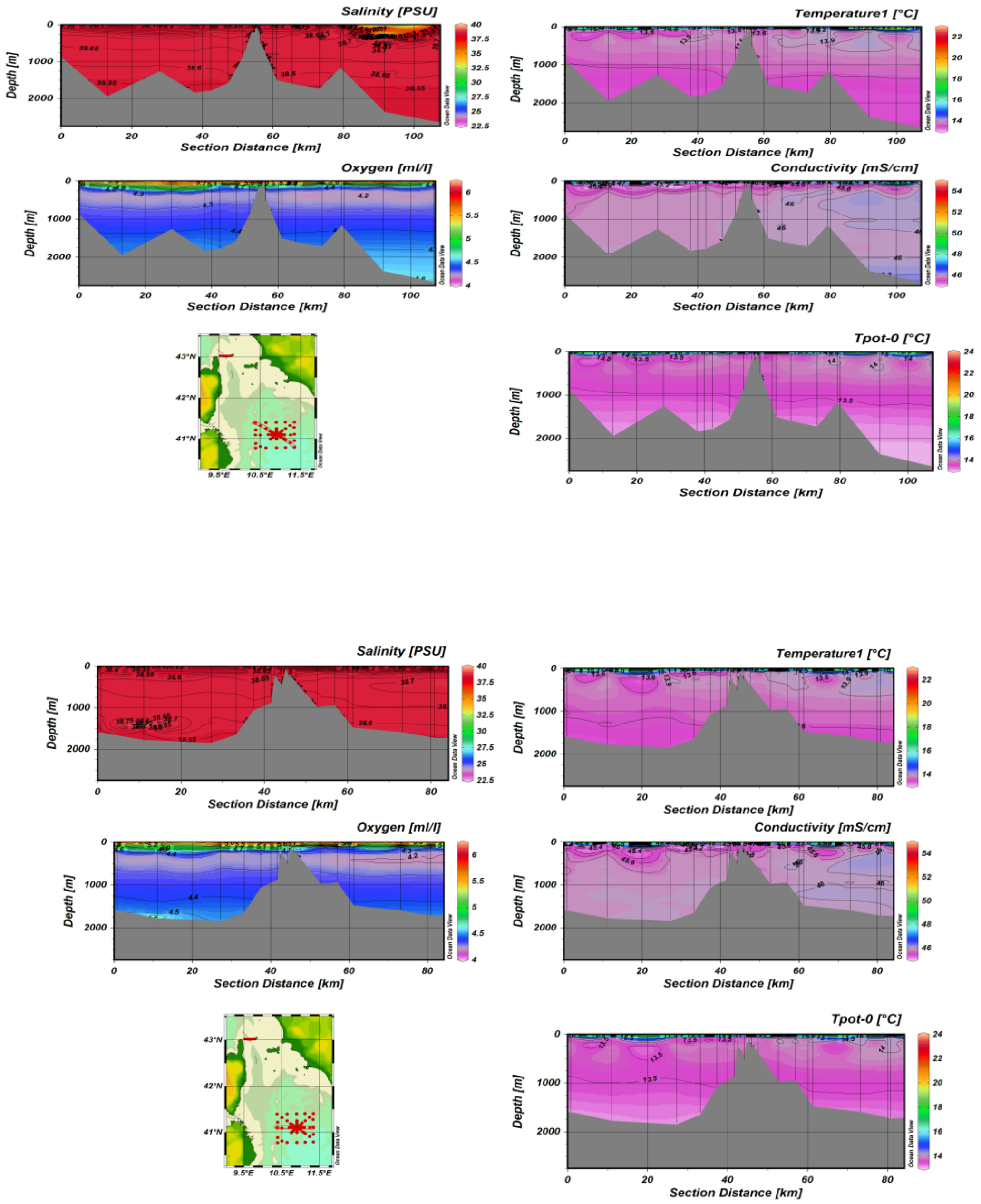


Hydrology

In the following some preliminary hydrological data and current measurements (LADCP data) of the western Ionian Sea are presented.

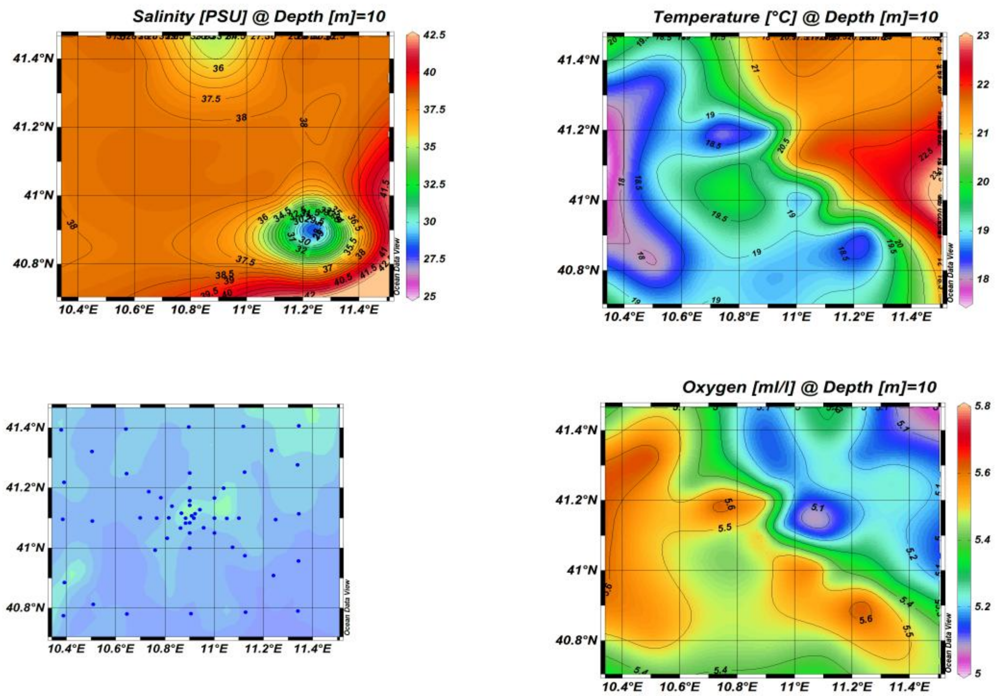
Hydrographic sections

Figure 4 Distribution of potential temperature, salinity and oxygen along the transect NW-SE transect W-E



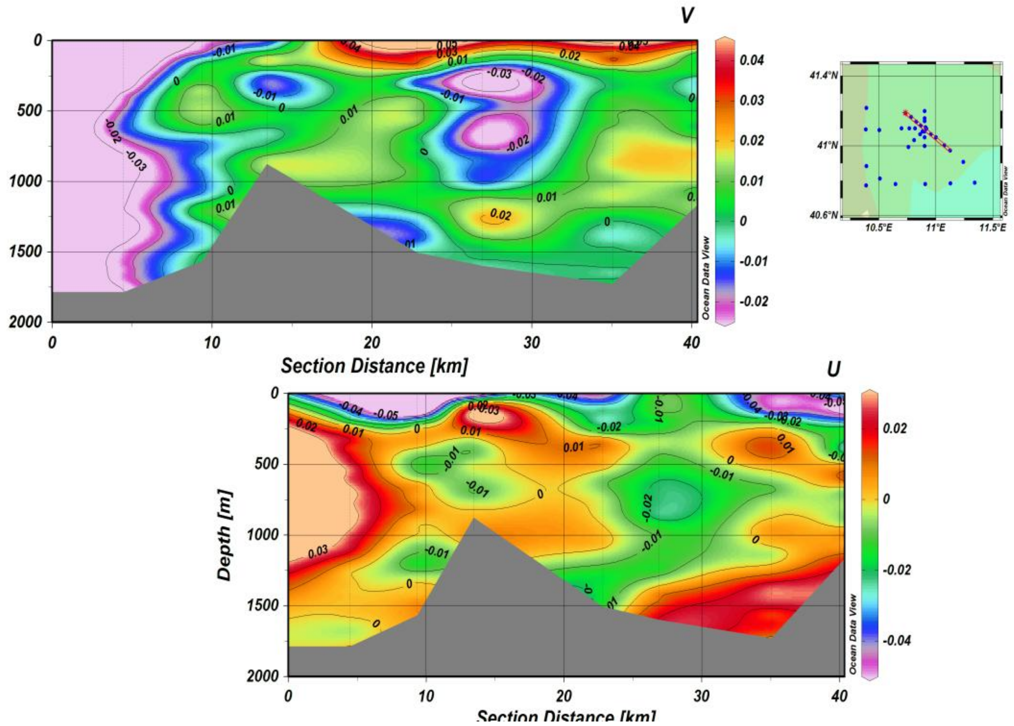
Temperature , Salinity Oxygen Contour 10 m

Figure 6 Surface Contour 10 m.



Currents from LADCP

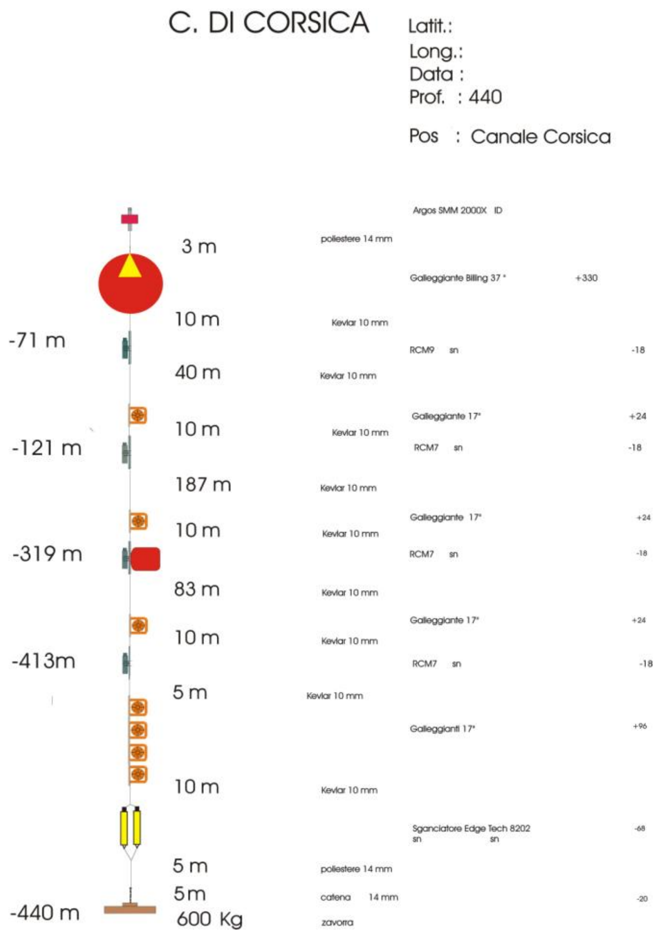
Figure 7 Distribution of the measured velocity

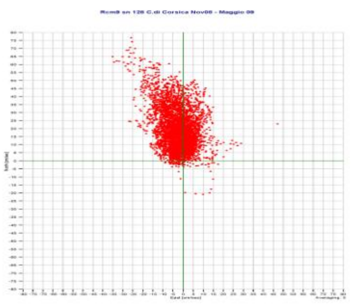
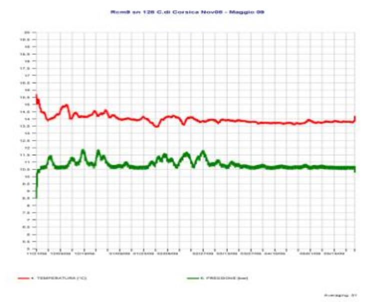
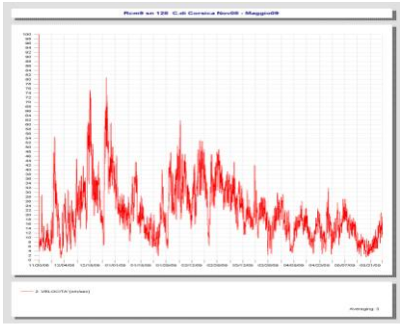
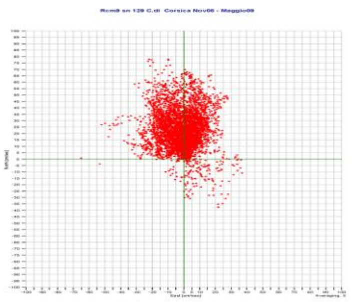
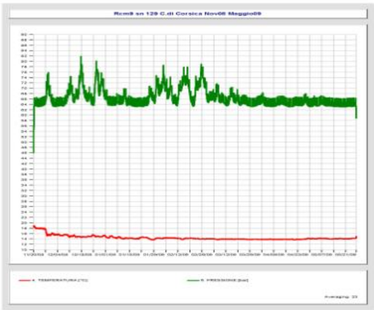
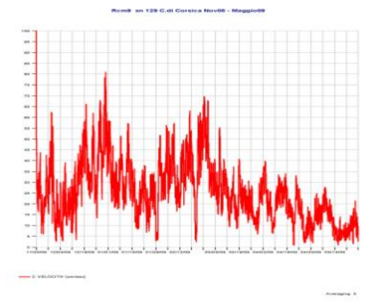
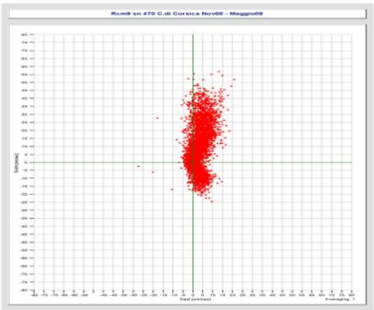
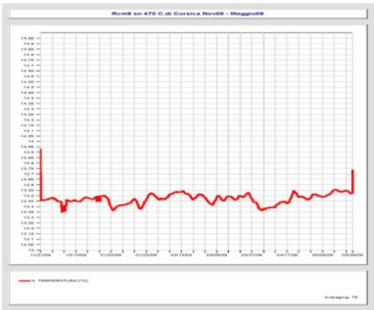
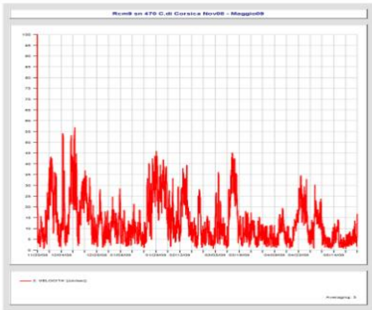
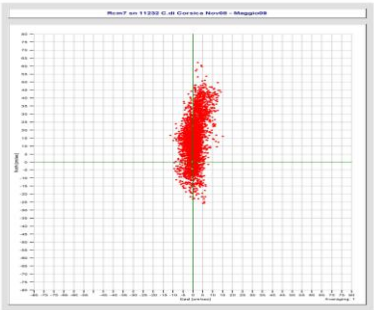
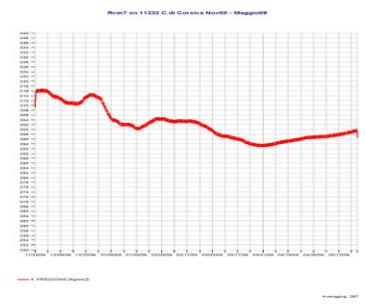
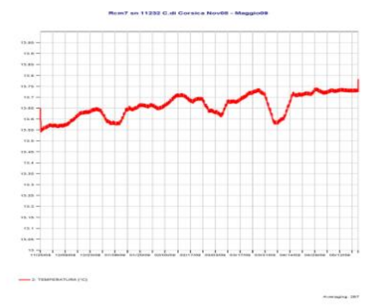


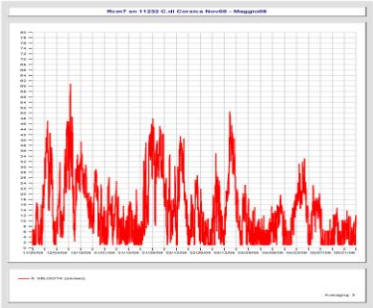
Eulerian measurements

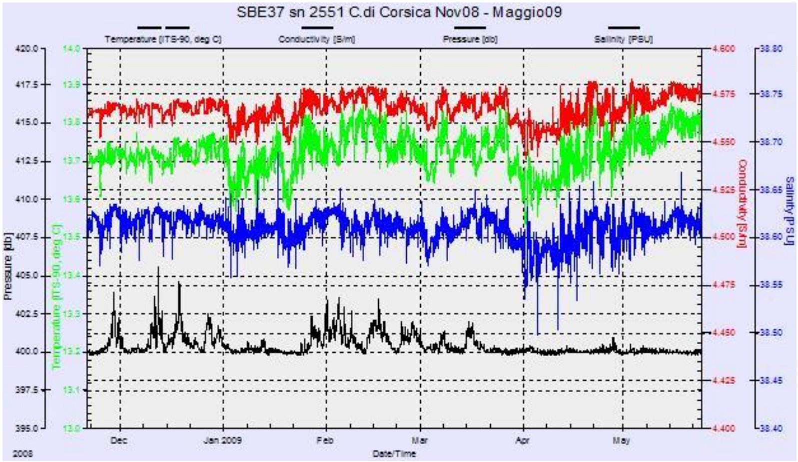
A moorings was recovered after its it was redeployed. The data were downloaded from the internal memories. In the following graphs we show some preliminary data elaborations.

Figure 12 Scheme of the C. Channel mooring, in position 43°02.00' N and 009°415.00' E







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