SICILY09

- CRUISE REPORT -

30 October – 23 November 2009

CNR IAMC - Istituto per l'Ambiente Marino e Costiero – Oristano

CNR ISMAR – Istituto di Scienze Marine - La Spezia

Consiglio Nazionale delle Ricerche

UNIVERSITÀ DEGLI STUDI DI GENOVA

Università di Genova

STUDIORUM UNIVERSITAS MESSANAE

Università di Messina

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SUMMARY

Cruise details

NAME	*SICILY09*
DATE	*30 OCTOBER – 23 NOVEMBER 2009*
STUDY AREA	*SICILY STRAIT* *TYRRHENIAN SEA* *SARDINIA CHANNEL* *BONIFACIO MOUTH*
PROJECT RESPONSIBLE	*A. PERILLI - CNR-IAMC - ORISTANO*
HEAD OF THE CRUISE	*MIRENO BORGHINI, CNR-ISMAR* *ALBERTO RIBOTTI CNR-IAMC*
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RESEARCH VESSEL	*URANIA*
HARBOUR OF DEPARTURE	*OLBIA*
HARBOUR OF ARRIVAL	*MESSINA*

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1. Scientific objectives

In this report we present all activities realised during the oceanographic cruise named SICILY09, carried out from October 30th November 23rd 2009, on board the R/V URANIA in the central and western Mediterranean basins.

The cruise has been planned to reach the following objectives:

1. **Water masses characteristics and biological structures**

   Several measurements along key sections localised inside and on the board of the basin in order to define the main paths of the circulation and the physical-chemical-biological properties (temperature, salinity, dissolved oxygen, nutrients, chlorophyll, phytoplankton, primary production, etc) of the water upper, intermediate and deep central (Sicily Strait) and western (Tyrrhenian sea, Sardinia Channel) Mediterranean water masses. Check of the diffusion of the new deep waters found during a cruise in 2005 in the same areas.

2. **Validation of numerical models**

   Measurements will be used to validate four numerical circulation models implemented at IAMC-CNR in Oristano (SCRM32, SCRM48, WMRM, BONIFACIO/LA MADDALENA) and at ISMAR-CNR in La Spezia (box model). The three models at IAMC-CNR in Oristano are then operational models as they give daily forecasts for the following 5 days of the main oceanographic parameters (temperature, salinity, water and surface heat fluxes, currents, waves).

3. **Methodological developments**

   - **Measurements of velocity profiles by Lowered ADCP;**
   - **Periodical maintenance of currentmeters moored in the Sicily Strait and Corsica Channel;**
   - **Comparison of different methods for the quantification of Chlorophyll and calibration of the fluorometer coupled with the multiparametric probe through several photochemical techniques.**

2. State of the art

2.1 General description

The Mediterranean sea is a semi-enclosed sea at medium latitudes. Some fundamental processes for the general circulation of the oceans (ex. deep water formation) happen or are given by such sea. The salty waters in the Atlantic, exiting from the Mediterranean, cn influence the water formation processes, the variability and also the equilibrium state of the global thermohaline circulation, a mechanism by which large amounts of heat are exchanged inside and through the basins. The global thermohaline circulation has a fundamental role in contributing in the stabilization of the climatic system. The Mediterranean circulation, in the western basin, is forced by the wind stress, by the general floating forces generated by the heat and fresh water fluxes at the air-sea interface. The geography of the western Mediterranean is really complex with a really complex deep morphology and a distribution of its coasts, a variety of islands, straits, channels and openings. The exchanges through the different basins depend on the morphology of these straits, channels and openings. Due to a complex topography and geometry and of the high external forcing variability, the response time of the water masses and the spatial and temporal variability scales of the currents are really short than the oceanic ones. The recirculation time of the particles, inside the deep water formations areas, is around a hundreds years at Mediterranean scale, a really short climatic scale if compared with the Atlantic temporal scales of millenniums. The general view that grows up is that of a Mediterranean climatic system always interacting with the atmosphere that stores the information of the changes at the air-sea interface and modifies currents at the abyssal depths. This allows the Mediterranean, and then its western basin, to “react” really quickly to the changes of atmospheric forcing and then to be a “sensor” of the Earth climate. The study of the functioning of marine ecosystems and their response to external forcing is then controversial because really complex. The hydrological characteristics of the different water masses behave differently following depth and geographic position with different modifications in act. In the 30’s two different behaviours have been observed, a constant increase in temperature and salinity in the deep and intermediate levels of the western Mediterranean and a more complicated variability of the eastern basin, followed by the climatological transient. What is sure it is then the observation of a phenomenon in the yearly ‘90s that, due to its dimension and speed, is one of those events characterised by a strong discontinuity: the so called climatological transient. This transient shows as the collapse of a system apparently stable can happen suddenly. In a few years the vertical structure of the basin has been completely modified. The possible reasons of the climatological phenomenon in the eastern basin have been widely described in the specialised literature (Malanotte-Rizzoli et al., 1999; Demirov and Pinardi 2002, Rupolo et al, 2003). This anomaly begun to propagate in the western basin (Schroeder et al., 2006; Schroeder et al., 2007, Schroeder et al., 2008). Actually it is difficult to forecast the effects of such an anomaly in the western Mediterranean even if the long times of run of the intermediate waters in the western basin probably will contribute to absorb it decreasing its effects. Vice versa the occurrence of such a phenomenon has underlined once more as the balances of a complex system can be strongly modified also by small variabilities of one of its components.

The temporal analysis of the analysed data does not permits to understand if these oscillations are characteristics of a natural state of the basin or, viceversa, if they represent an anomalous situation.

The cruise is part of a strategy for the periodic monitoring of this new hydrodynamic regime in order to evaluate the hydrodynamic and biogeochemical characteristic trends of the waters along the column and their interannual variabilities. For this reason the cruises have been repeated every year. Furthermore the biogeochemical anomalies N/P and the difference between the variables north and south of the basin, with two different hydrodynamic regimes, have been analysed.

Then in the area three regional hydrodynamic numerical models are operative giving a 5-days forecast of the sea state of the central and western Mediterranean updated daily. These cruises are also organised in order to calibrate and validate the circulation models at basin and coastal scales. Comparative studies with in-situ data, from satellite and models outputs will be used to evaluate the interannual variability of the dynamics at basin scale. Furthermore they will be used to study the mechanisms regulating and modulating the Chlorophyll distribution in mesoscale processes.

The coastal model, named BONIFACIO/LA MADDALENA, works in the Bonifacio Mouths, a strait between Sardinia (Cape Testa and Punta Falcone) and Corsica (Cape Pertusato) of high environmental value for the outstanding importance to the landscape and the wide variety of habitats.

For the legal status of International Strait, every year it is crossed by thousands of ships, particularly ships carrying dangerous or polluting materials such as oil tankers, chemical tankers and gas carriers, many of which are now obsolete or not with the double hull or equivalent technology.

The strong winds from the west and northwest, for the *Venturi* effect, increase their intensity when channeled through the Strait, greatly and influence the weather and sea conditions and therefore the shipping through the Strait.

Navigation is also complicated by the complex morphology of jagged coastline, from the existing shallow waters, the presence of islands of the Archipelago of La Maddalena (Sardinia) and of Lavezzi and Cavallo (Corsica) and the numerous shoals and reefs.

These factors make the Strait of Bonifacio Strait "highly vulnerable", with a high risk of marine pollution by oil and toxic-emissions.

The Strait is included in the plan area of international cooperation Franco-Italian-Monegasque RAMOGEPOL designating the competent authorities to coordinate the joint action of the three countries in the event of accidental pollution in the area RAMOGE (set up following the birth of the *RAMOGE Agreement*); as a function of their high vulnerability of the Strait of Bonifacio was chosen in 2007 as a scenario for the annual exercise and meetings between the authorities of the three countries.

For all the previous region a project named **SOS-Bocche di Bonifacio** (funded by the Italian Ministry for the Environment) wants to implement an innovative system of forecasting and monitoring of marine circulation for the management of environmental emergencies caused by spills into the sea of hydrocarbons (oil spills).

The oil spills are "leakages" of oil from vessels which may be accidental (collisions between ships, ground etc ...) or voluntary (discharge of bilge, ballast and tank waters).

The system provides for the integrated use of:

- analysis/forecast numerical models of the marine circulation "nested" on different spatial scales;
- analysis/forecast numerical models of the mesoscale atmospheric circulation;
- meteorological observations from remote station (weather station of Guardia Vecchia – La Maddalena island);
- Lagrangian measurements of the surface currents field by floating buoys (drifters);
- oil spill modules for the simulation of hydrocarbon spreading and weathering processes.

This system will facilitate the rapid planning and coordination of operations of the marine authorities to tackle pollution, through the knowledge of future estimates of displacement which suffers under the action of wind and sea currents, a patch of oil at sea and the main chemical and physical processes that interest hydrocarbons.

Moreover, the creation of "scenarios and risk maps" will quickly identify the most appropriate intervention strategies, given the high variability of possible events, to be taken during an environmental emergency.

The rapidity of action is essential to avoid a risk of pollution could become real, and if a pollution happens, it could develop into a serious threat to the coastal strip.

The main objective is therefore the prevention and / or limitation of damages, for the conservation of marine resources in coastal waters, especially the most vulnerable areas of high environmental value typical of this area.

This cruise is strictly linked with the previous ones Medgoos (2000-2006), MedOc (2005-2006), MedBio (2006), MedCO07 (2007), SESAME-IT4 and MedCO08 (2008) and Tyrrhmounts (2009) where zonal trends of the hydrodynamic and biogeochemical characteristics of the water masses in the western basin.

The work has been done with CNR-ISMAR in La Spezia to study the hydrodynamics and with the universities of Genova and Messina for the geologicl and biological aspects.

2.1.1 Main hydrodynamic characteristics in the study areas

The **central Mediterranean** (Sardinia and Sicily channels) is characterised by a really complicated bottom topography directly influencing on the water exchanges between the two Mediterranean basins (eastern and western). In the Sardinia channel the threshold depth is about 1900 m. This allows the Exchange of deep waters in the western Mediterranean. The Sicily Strait is instead characterised by two strict passages with the deepest one about 430 m depth giving strong limits to the exchanges with the eastern Mediterranean. Over these two thresholds, a wide and shallow area far off Tunisia (Skerki bank) is another obstacle to a direct link between the water masses in the two basins.

The **Tyrrhenian sea** is linked both with the western Mediterranean as the eastern and is an intermediate basin whose southern part is linked to the central Mediterranean through a shallow channel permitting the passage of the LIW (*Levantine Intermediate Water*) and of the tEMDW (*transitional Eastern Mediterranean Deep Water*) that, sinking at the entrance of the Tyrrhenian sea, .origins the TDW that will move over the WMDW. The Opening Sicily-Sardinia is mainly formed by two channels with a wide intermediate plain. The deepest, in its central part, directly links the Tyrrhenian sea to the Sardinia channel and to the rest of the western Mediterranean. All the water masses composing the water column from the surface to the bottom pass through it.

Resuming, the study area is a very complex system with an almost sub-tropical climate. Furthermore in the central Mediterranean area is present the widest community of marine mammals and fishes of the whole Mediterranean basin.

Other interesting aspects regards the hydrological properties (temperature and salinity) of the deep and intermediate layers, that show a positive trend for some decades. The reasons of this trend are still unknown.

An increase of the knowledge of all these aspects will contribute to a better comprehension of the role and functioning of the Mediterranean sea.

3. Cruise plan

The following table shows all the measured parameters and the working groups involved in the operations. Table 2 lists the instrumentation and analysis methods used.

Parameters/Instruments	Working Groups
CTD/O2/rosette	CNR-ISMAR/ IAMC
Dissolved oxygen	CNR-ISMAR
Marine microbic microbiology	Messina University
	Genova University

Table 1 Measured parameters

Small sampling volume	Rosette General Oceanics 24-bottles of 10 l
CTD System	CTD SBE 911 plus
Oxygen	Winkler titration
Box Corer System	Box Corer & filter

Table 2 Instrumentation for the sampling and analysis methods

The geographical limits of the study area are 32.00°N - 42.00°N of latitude and 8°E – 16°E of longitude. Due to bad sea conditions, the expected sampling plan has been partially reorganised (see pictures).

4. Cruise maps

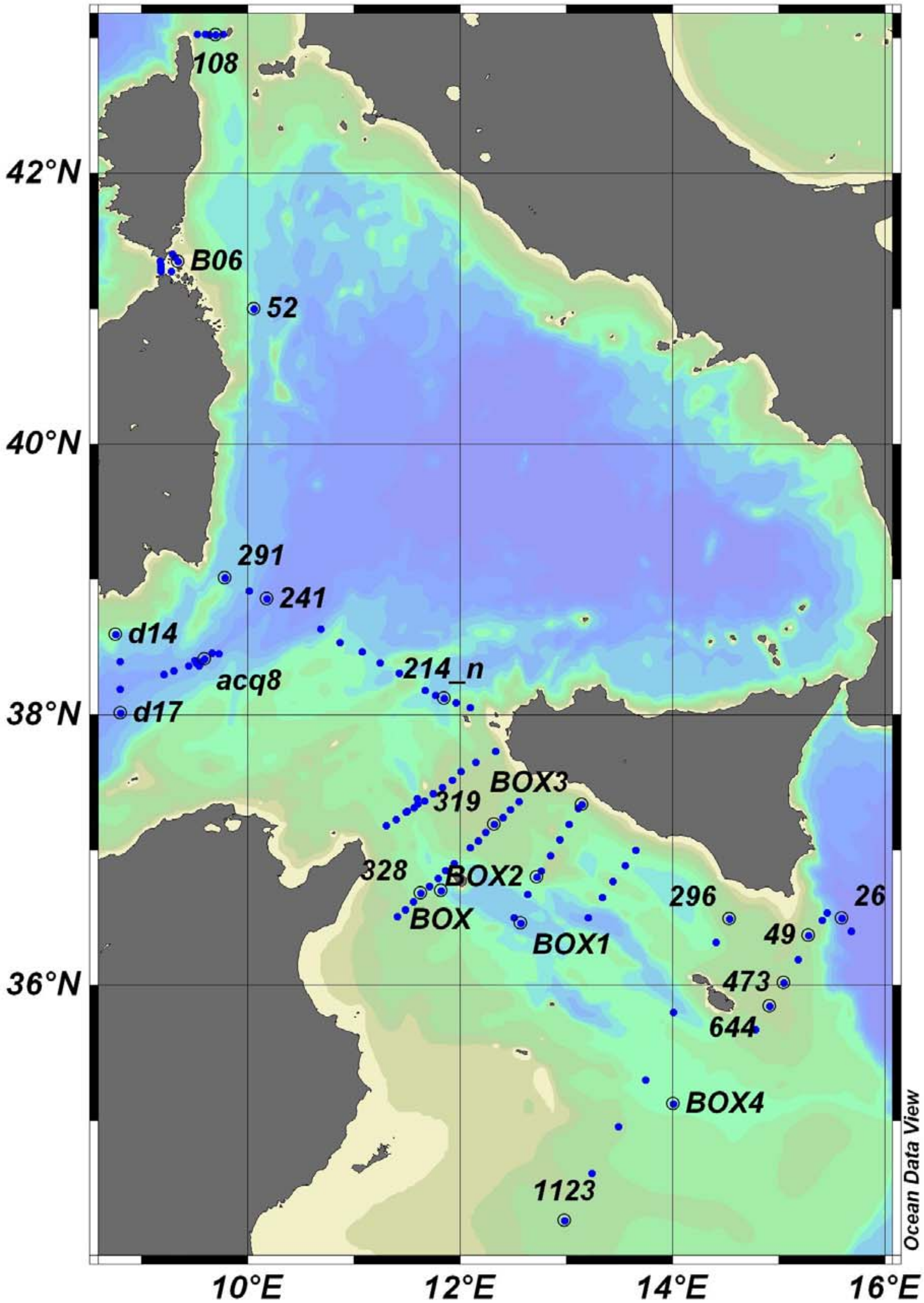


Figure. Maps of the CTD/Box Corer casts

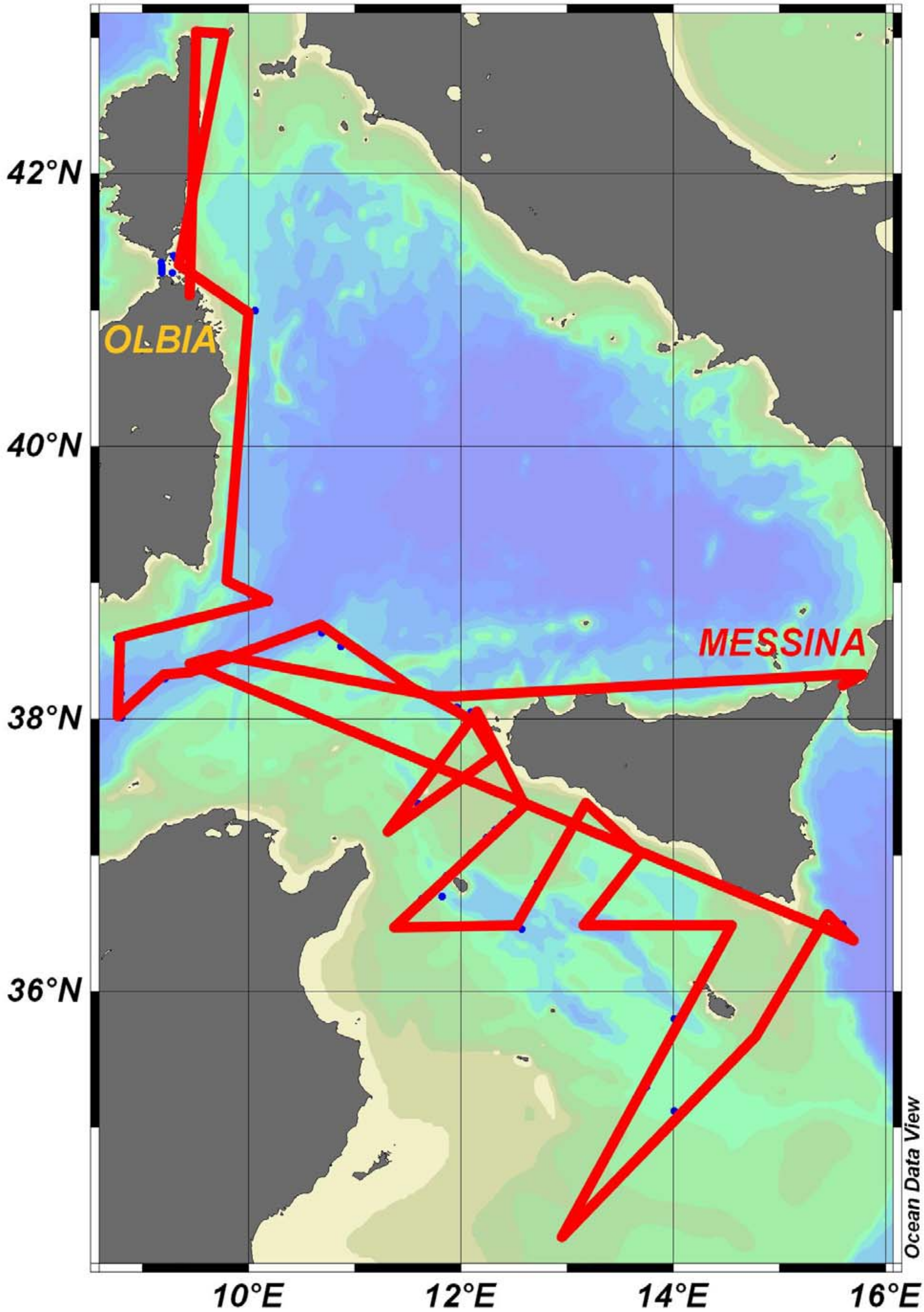


Figure. Map of the cruise path

Table CTD casts list

Sampling type and institute: N = Nutrients (Genova Univ)); C = Box Corer (Genova Univ); O = dissolved oxygen (CNR); E = marine microbic ecology (Messina Univ).

Data inizio calata	Stazione	Lat (°N)	Long (°E)	Fondale	Attività
31/10/2009	107	43.029	9.767667	86	E
31/10/2009	108	43.025	9.7	445	
31/10/2009	109	43.025167	9.641667	364	E
31/10/2009	110	43.026	9.599667	364	
31/10/2009	111	43.026167	9.525333	65	E
01/11/2009	B01	41.354333	9.1785	72	E
01/11/2009	B02	41.324167	9.1805	72	E
01/11/2009	B03	41.301167	9.181	74	E
01/11/2009	B04	41.275333	9.181167	72	E
01/11/2009	B05	41.273667	9.279167	60	E
01/11/2009	B06	41.346167	9.345333	86	E
01/11/2009	B07	41.379167	9.313167	47	E
01/11/2009	B08	41.402	9.289333	85	E
02/11/2009	52	41.000167	10.059833	987	E
04/11/2009	241	38.856667	10.1835	2521	E
04/11/2009	261	38.913333	10.014833	1466	E
04/11/2009	291	39.012333	9.788333	1006	E
05/11/2009	acq3	38.299333	9.211	2030	E
05/11/2009	acq3b	38.324333	9.302667	1928	
05/11/2009	acq4	38.361	9.441	1989	
05/11/2009	acq5	38.3795	9.5215	2011	E
05/11/2009	d14	38.5935	8.758667	633	E
05/11/2009	d15	38.392833	8.800333	1392	
05/11/2009	d16	38.1905	8.799667	2233	E; O
05/11/2009	d17	38.009667	8.801667	1619	E
06/11/2009	212	38.051833	12.094	137	
06/11/2009	213	38.087333	11.957	410	E
06/11/2009	214	38.12	11.847667	1131	
06/11/2009	215	38.145333	11.765667	1199	E
06/11/2009	217	38.180333	11.667333	766	
06/11/2009	219	38.308	11.426333	857	E
06/11/2009	221	38.384333	11.244833	702	E
06/11/2009	223	38.467667	11.0765	848	
06/11/2009	225	38.535	10.868833	738	E
06/11/2009	227	38.632	10.683833	1506	
07/11/2009	405	37.647667	12.144333	96	E
07/11/2009	406	37.581	12.0045	146	E
07/11/2009	410	37.180333	11.305333	249	E
07/11/2009	432	37.730167	12.333333	137	E

07/11/2009	433	37.514833	11.922	105	E
07/11/2009	434	37.415	11.742667	85	E
07/11/2009	436	37.2265	11.396833	413	
07/11/2009	438	37.460167	11.828833	74	E
07/11/2009	451	37.339	11.6	538	
07/11/2009	460	37.278833	11.486833	544	E
07/11/2009	462	37.314	11.563167	90	
07/11/2009	463	37.364	11.660833	93	E
12/11/2009	BOX	36.69988	11.8168	620	B
12/11/2009	328	36.680133	11.630067	350	B
12/11/2009	317	37.299833	12.4695	148	E
12/11/2009	318	37.239833	12.401	130	E; N
12/11/2009	319	37.19	12.319833	84	E; N; B
12/11/2009	320	37.13	12.24	89	
12/11/2009	321	37.0695	12.1695	93	E; N
12/11/2009	322	37.019333	12.091167	124	
12/11/2009	316	37.36	12.550667	163	E; N
13/11/2009	324	36.8995	11.939667	579	E; N
13/11/2009	325	36.849667	11.860667	482	E; N
13/11/2009	326	36.789833	11.789667	697	E; N
14/11/2009	167	37.306167	13.106833	287	E
14/11/2009	327	36.729833	11.710167	350	E; N
14/11/2009	328	36.679333	11.630333	355	
14/11/2009	329	36.619667	11.560833	297	E; N
14/11/2009	330	36.56	11.48	238	
14/11/2009	331	36.509833	11.409667	151	E; N
14/11/2009	614	36.844833	12.762	133	
14/11/2009	781	36.672167	12.634	739	E
14/11/2009	948	36.499833	12.506167	1310	E
14/11/2009	BOX 1	36.458233	12.56665	1278	B
14/11/2009	BOX 2	36.8	12.72	487	B
14/11/2009	BOX 3	37.335933	13.144433	88	B
15/11/2009	275	37.191333	13.021	484	E
15/11/2009	296	36.4905	14.536167	157	E; B
15/11/2009	386	37.076333	12.934833	369	
15/11/2009	464	36.317	14.403	463	E
15/11/2009	500	36.959833	12.849	94	E
15/11/2009	601	36.999	13.648167	461	E; N
15/11/2009	602	36.883667	13.550833	739	E
15/11/2009	603	36.768167	13.435167	324	E
15/11/2009	604	36.649833	13.333833	606	E
15/11/2009	605	36.501833	13.2035	1711	E
16/11/2009	11105	35.3025	13.741	575	E
16/11/2009	11111	34.956167	13.487667	122	E

16/11/2009	11117	34.609833	13.236333	252	E
16/11/2009	969	35.799	14.007333	1043	E
16/11/2009	1123	34.2641	12.984067	125	E; B
16/11/2009	BOX 4	35.125633	14.002383	598	B
17/11/2009	809	35.67185	14.779933	134	E
17/11/2009	644	35.8448	14.912933	94	E; B
17/11/2009	473	36.01765	15.046633	96	E; B
17/11/2009	305	36.190583	15.181167	129	E
17/11/2009	49	36.369767	15.279817	143	E; B
17/11/2009	48	36.479833	15.405083	136	E
17/11/2009	25	36.536533	15.449867	1079	E; B
17/11/2009	KC2	36.399467	15.678983	3384	E; O
18/11/2009	26	36.494433	15.588817	1909	E
18/11/2009	KC2up	36.400167	15.678333	3383	E
20/11/2009	acq6_2	38.450667	9.726333	2056	E
20/11/2009	acq7	38.455667	9.6625	2034	
20/11/2009	acq8	38.411833	9.591667	2044	
20/11/2009	acq9	38.3875	9.5585	2033	
20/11/2009	acq10	38.359833	9.541833	2012	
20/11/2009	acq11	38.403833	9.503	2013	
20-21/11/2009	214_n	38.12	11.847667	1136	
20-21/11/2009	215_n	38.145333	11.765667	1211	O; N

5. On board operations

5.1 CTD casts

At all the 114 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, 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, IAMC-CNR

5.3 Nutrients

Seawater samples for nutrient measurements were collected at different depths at a few stations, when the system CTD /rosette was going up, according to the vertical profiles of salinity, potential temperature and dissolved oxygen, recorded in real time. Samples of 100 ml of seawater were collected at different depths and immediately filtered through a polycarbonate filter (0.47 µm Ø and pore size 0.4 µm) under slight vacuum. The filtered samples were transferred in 20 ml polyethylene vials and frozen at -20°C. The analysis of inorganic nutrients will be performed in the laboratory on land by the AutoAnalyser AAIII Bran+Luebbe (Grasshoff,1999).

Laboratory: Genova University

5.4 LADCP

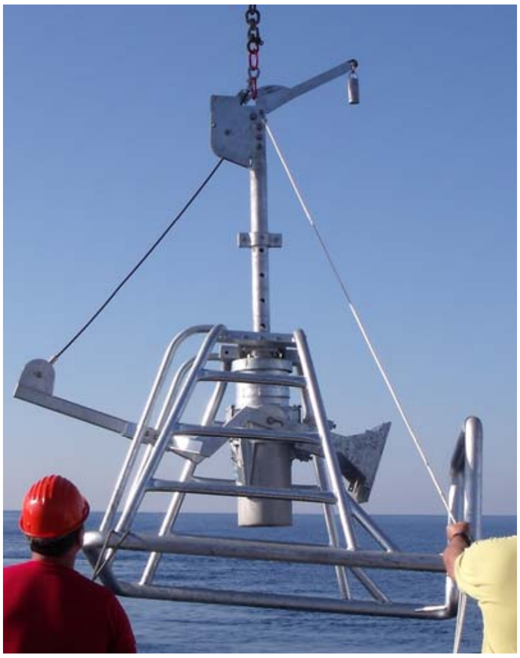
Two Lowered Acustic Doppler Current Profilers (LADCP) were used to measure velocity profiles. We used two RDI Workhorse 300 kHz ADCP. For data post-processing we used the LDEO LADCP (versione 8.1) software.

Laboratory: CNR-ISMAR

5.5 Macrobenthos and sediment analysis

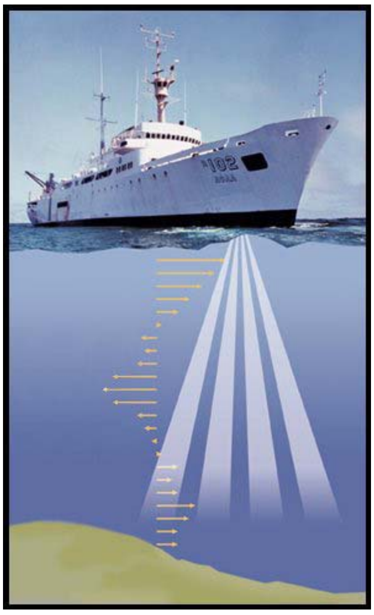
The primary goal was to investigate the deep macrobenthic communities (in terms of abundance, biomass, distribution and diversity) in the Ionian sea, along the Maltese continental slope. Sediment samples were taken for biological and biochemical analyses, in order to characterize the deep macrofauna 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: Genova University

5.6 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

5.7 Turtles and other cetaceans sightings

A table to be filled by the ship crew with all sightings of turtles and other cetaceans (dolphins, wales, etc.) has been left on the bridge of the ship. In the following table type of sighting, date, time and number of animals are resumed.

date (dd/mm/yyyy) time (GMT+1)	**latitude**	**38° 11.06' N**	**Turtle**	n°1
21/11/09	**longitude**	**012° 12.8' E**	**Wale**	n°/
14:20	**Dist. stimata**	**20 m**	**Dolphin**	n°20 (stenelle), 1 delfino
	latitude	**38° 15.10'N**	**Turtle**	n°/
	longitude	**012° 37.0' E**	**Wale**	n°/
	Dist. stimata	**10 m**	**Dolphin**	n° 3 stenelle, 2 delfini

Laboratory: CNR-IAMC

5.8 Marine midrobic microbiology

Almost all stations, at depths along the water column, have been filtered with different sea water volumes to study microbial biodiversity using CARD-FISH technique. Then the sea water samples from Niskin bottles have been processed on board to perform viable counts and isolation of Heterotrophic Bacteria on Marine Agar medium (MA) and Luminescent Bacteria on SWC (Sea Water Complete) medium (fgure belowey will be characterized in laboratory using morpho-physiological and tassonomic approaches.

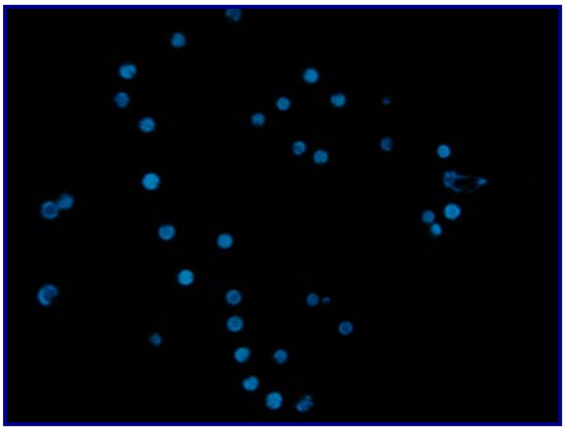


Figure 5.10.1.Luminous Bacteria Strains

Some samples are filtered on Millipore filters 0,22 µm and stored in "RNAlater" for a taxonomic study by molecular approach. As a consequence, DNA-RNA extraction was carried out to compare active and inactive microbial communities, coming from different water masses. Filters are stored at -20 °C after incubation in "RNAlater" storage solution.

Laboratory: Messina University

5.9 Other operations on board

DATASONIC DSP-661 Chirp 2 Profiler 4SBP at 3.5 kHz, with positions recorded on the XTF trace headers as lat/long of the DGPS antenna

Laboratory: CNR-IAMC

RESON Seabat 8160 (50 kHz, 3X, 126 beams at 0.5° covering at 150° installed on the keel through bulb protruding of about 1.5m)

Laboratory: CNR-IAMC

Recovering and maintenance of moorings

Three moorings, deployed in the first half of 2009 in the COR (Cosica Channel), C01 and C02 (Sicily Strait) were recovered and redeployed.

Laboratory: CNR-ISMAR

Chlorophylls

Laboratory: Genova University

6. Preliminary Results

6.1 Meteo-marine conditions and problems on board

The meteo-marine conditions during the cruise have been characterised by a strong variability but, usually, by a medium-high atmospheric pressure and very low pressure at the end of the first half of the cruise. This has permitted to do all planned activities, with only 4 ays of inactivity in Favignana island (TP).

6.2 Hydrology

In the following pages the maps with the stations for the different areas are presented (Corsica Channel, Bonifacio Mouths, Tyrrhenian Sea, Sicily Strait, Sardinia Channel, Ionian Sea).

6.2.1 Corsica Channel

In the Corsica Channel the mooring has been recovered and then re-deployed (COR, see in the following section). Then four CTD stations have been done. Map and table follow.

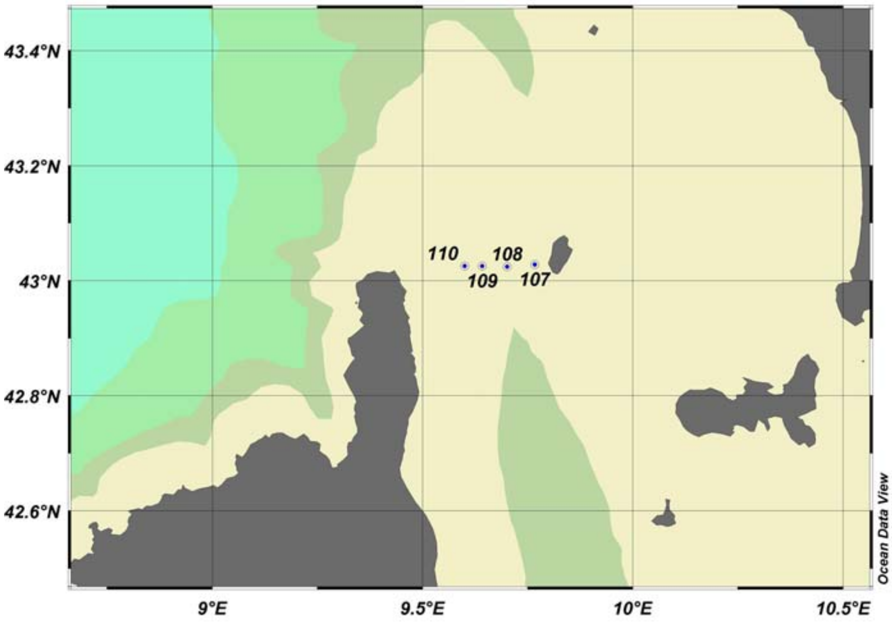


Figure. The CTD casts in the Corsica Channel

Data inizio calata	Stazione	Lat (°N)	Long (°E)	Fondale	Attività
31/10/2009	107	43.029	9.767667	86	E
31/10/2009	108	43.025	9.7	445	
31/10/2009	109	43.025167	9.641667	364	E
31/10/2009	110	43.026	9.599667	364	
31/10/2009	111	43.026167	9.525333	65	E

6.2.2 Bonifacio Mouths and La Maddalena Archipelago

In the Bonfacio Mouths and La Maddalena Archipelago some CTDs casts have been done and, furthermore ADCP, CHIRP and Multibeam.

The data have been acquired in the framework of the "SOS-Bonifacio" project, to improve local bathymetry (Chrip and Multibeam) and the knowledge on current in the area of the Bonifacio area and La Maddalena Archipelago. Furthermore data will be used to validate local numerical circulation models.

In the following maps and tables the ADCP, Chirp and Multibeam route and the CTD casts.

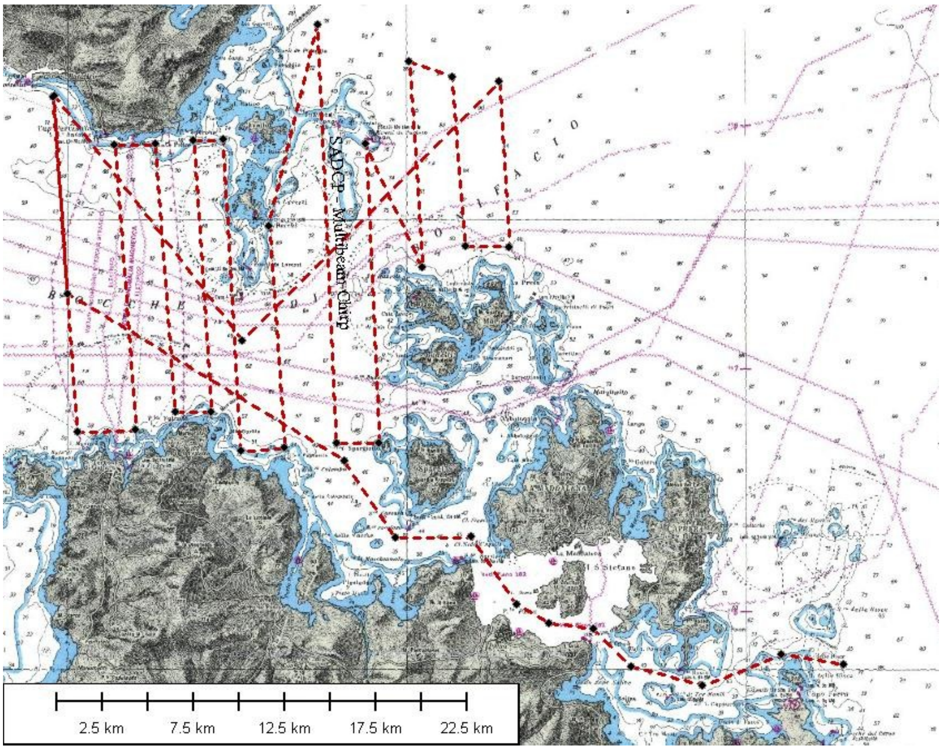


Figure. The tracks for ADCP, Chirp & Multibeam

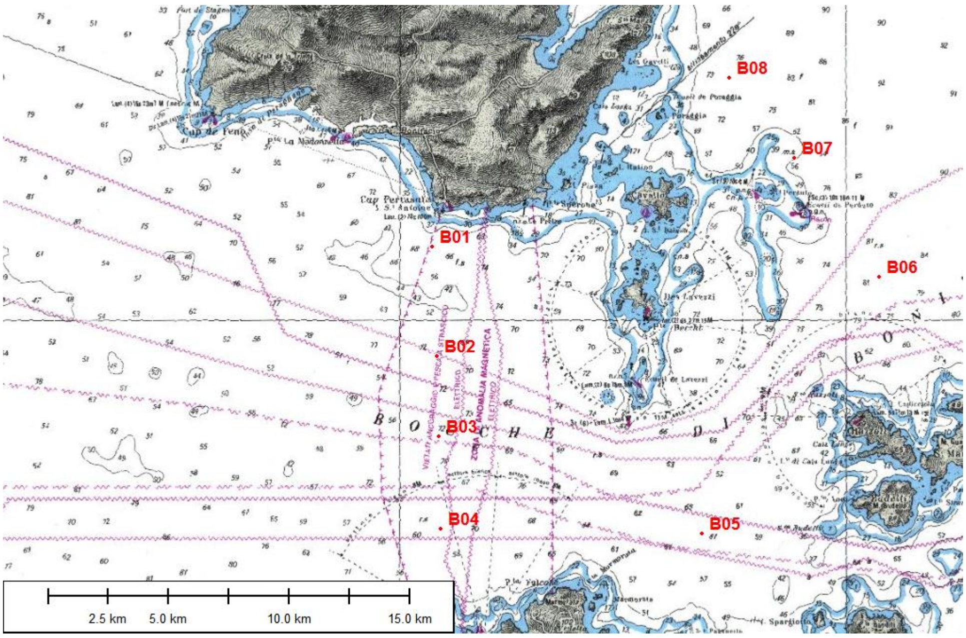


Figure. The CTD casts in the Bonifacio Mouths

Data inizio calata	Stazione	Lat (°N)	Long (°E)	Fondale	Attività
01/11/2009	B01	41.354333	9.1785	72	E
01/11/2009	B02	41.324167	9.1805	72	E
01/11/2009	B03	41.301167	9.181	74	E
01/11/2009	B04	41.275333	9.181167	72	E
01/11/2009	B05	41.273667	9.279167	60	E
01/11/2009	B06	41.346167	9.345333	86	E
01/11/2009	B07	41.379167	9.313167	47	E
01/11/2009	B08	41.402	9.289333	85	E

6.2.3 Tyrrhenian Sea

In Figure below the unique CTD station realised in the Tyrrhenian Sea.

Two transects were planned in the area, but bad weather conditions obliged the vessel to move southward along Sardinia.

Below figure and table:.

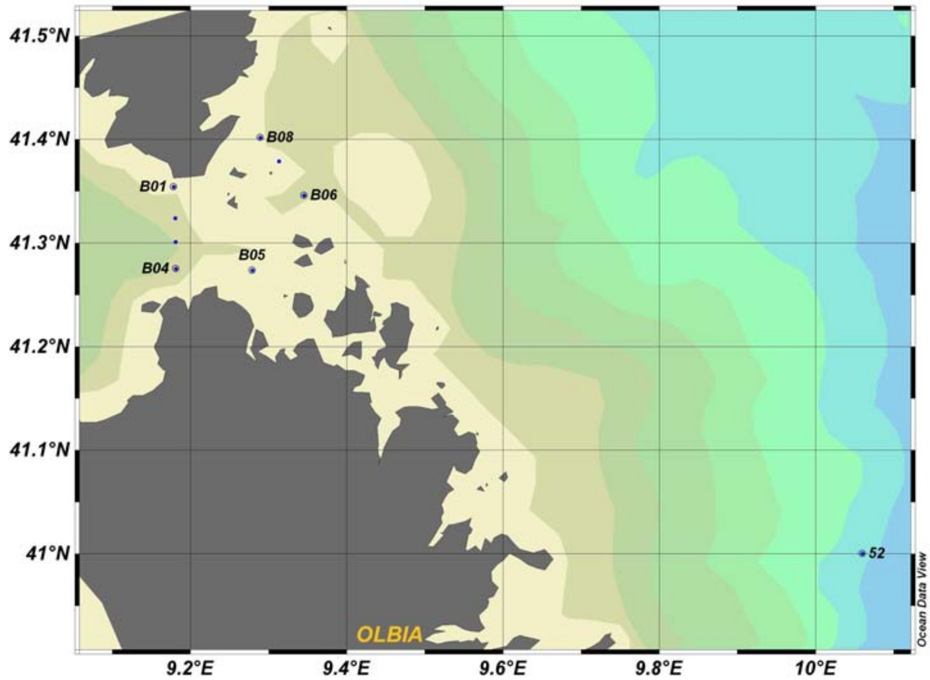


Figure. The CTD cast in the Tyrrhenian Sea

Data inizio calata	Stazione	Lat (°N)	Long (°E)	Fondale	Attività
02/11/2009	52	41.000167	10.059833	987	E

6.2.4 Central Mediterranean sea

In the figure below three transects between Sardinia and Sicily, across the Sardinia Channel and trasversal to the Sardinia Channel are visible.

The importance of these three transects is given by their central position in the whole Mediterranean basin and obliged passage for the waters coming from west to east and vice versa. Here the diffusion of the nWMDW from the Algerian to the Tyrrhenian Sea has been verified.

The station ACQ6 has been stopped on November 5th due to bad weather conditions and re-made on November 20th followed by other stations in the area in order to define the limit of the nWMDW over the sill dividing the Algerian Basin from the Tyrrhenian Sea.

On November 20th -21st stations 214 and 215 have been repeated 6 times in order to verify fluctuations in the water masses from the Esastern Mediterranean.

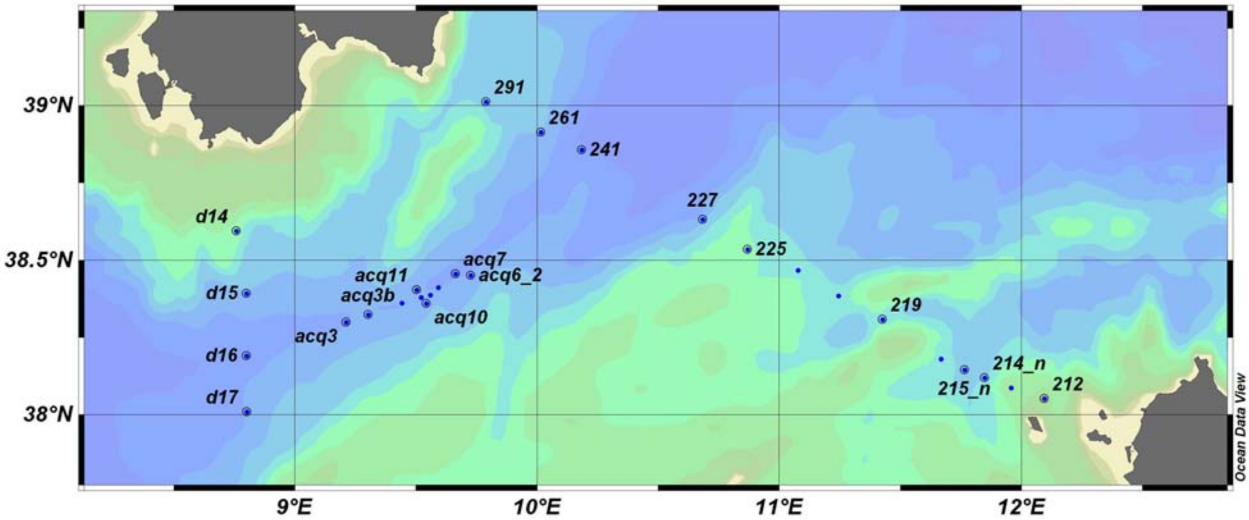


Figure The three CTD transects in the Sardinia channel and Sicily-Sardinia passage

Data inizio calata	Stazione	Lat (°N)	Long (°E)	Fondale	Attività
04/11/2009	241	38.856667	10.1835	2521	E
04/11/2009	261	38.913333	10.014833	1466	E
04/11/2009	291	39.012333	9.788333	1006	E
05/11/2009	acq3	38.299333	9.211	2030	E
05/11/2009	acq3b	38.324333	9.302667	1928	
05/11/2009	acq4	38.361	9.441	1989	
05/11/2009	acq5	38.3795	9.5215	2011	E
05/11/2009	acq6	38.450667	9.726333	2056	interrotta
05/11/2009	d14	38.5935	8.758667	633	E
05/11/2009	d15	38.392833	8.800333	1392	
05/11/2009	d16	38.1905	8.799667	2233	E; O
05/11/2009	d17	38.009667	8.801667	1619	E
06/11/2009	212	38.051833	12.094	137	
06/11/2009	213	38.087333	11.957	410	E
06/11/2009	214	38.12	11.847667	1131	
06/11/2009	215	38.145333	11.765667	1199	E

06/11/2009	217	38.180333	11.667333	766	
06/11/2009	219	38.308	11.426333	857	E
06/11/2009	221	38.384333	11.244833	702	E
06/11/2009	223	38.467667	11.0765	848	
06/11/2009	225	38.535	10.868833	738	E
06/11/2009	227	38.632	10.683833	1506	
20/11/2009	acq6_2	38.450667	9.726333	2056	E
20/11/2009	acq7	38.455667	9.6625	2034	
20/11/2009	acq8	38.411833	9.591667	2044	
20/11/2009	acq9	38.3875	9.5585	2033	
20/11/2009	acq10	38.359833	9.541833	2012	
20/11/2009	acq11	38.403833	9.503	2013	
20-21/11/2009	214_n	38.12	11.847667	1136	
20-21/11/2009	215_n	38.145333	11.765667	1211	O; N

6.2.5 Sicily Strait

CTD casts, ADCP routes and box corer casts have been acquired in the area of the Sicily Strait and two moorings recovered and re-deployed (C01 and C02, see the following section). The data have been used to verify the forecast circulation numerical model in the Sicily Strait in the framework of several projects and for climatologicl studies.

Unfortunately the planned Lybian transects have been cancelled as the expected permissions from Lybia were not available in time.

Maps and table follow:

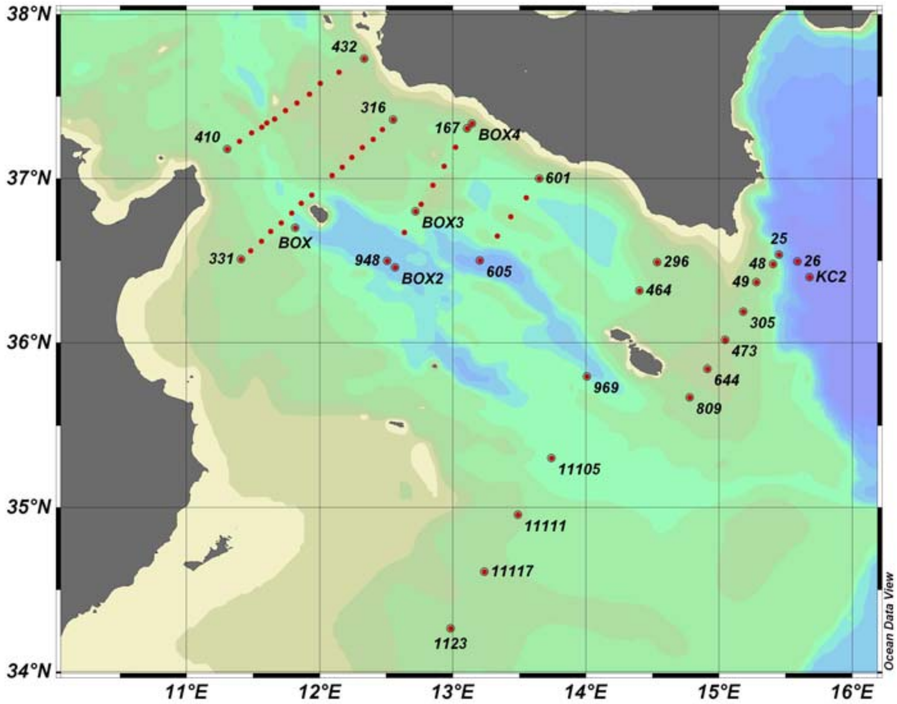


Figure. The CTD and BOX stations in the Sicily Channel

Data inizio calata	Stazione	Lat (°N)	Long (°E)	Fondale	Attività
07/11/2009	405	37.647667	12.144333	96	E
07/11/2009	406	37.581	12.0045	146	E
07/11/2009	410	37.180333	11.305333	249	E
07/11/2009	432	37.730167	12.333333	137	E
07/11/2009	433	37.514833	11.922	105	E
07/11/2009	434	37.415	11.742667	85	E
07/11/2009	436	37.2265	11.396833	413	
07/11/2009	438	37.460167	11.828833	74	E
07/11/2009	451	37.339	11.6	538	
07/11/2009	460	37.278833	11.486833	544	E
07/11/2009	462	37.314	11.563167	90	
07/11/2009	463	37.364	11.660833	93	E
12/11/2009	BOX	36.69988	11.8168	620	B
12/11/2009	328	36.680133	11.630067	350	B
12/11/2009	317	37.299833	12.4695	148	E
12/11/2009	318	37.239833	12.401	130	E; N
12/11/2009	319	37.19	12.319833	84	E; N; B
12/11/2009	320	37.13	12.24	89	
12/11/2009	321	37.0695	12.1695	93	E; N
12/11/2009	322	37.019333	12.091167	124	
12/11/2009	316	37.36	12.550667	163	E; N
13/11/2009	324	36.8995	11.939667	579	E; N
13/11/2009	325	36.849667	11.860667	482	E; N
13/11/2009	326	36.789833	11.789667	697	E; N
14/11/2009	167	37.306167	13.106833	287	E
14/11/2009	327	36.729833	11.710167	350	E; N
14/11/2009	328	36.679333	11.630333	355	
14/11/2009	329	36.619667	11.560833	297	E; N
14/11/2009	330	36.56	11.48	238	
14/11/2009	331	36.509833	11.409667	151	E; N
14/11/2009	614	36.844833	12.762	133	
14/11/2009	781	36.672167	12.634	739	E
14/11/2009	948	36.499833	12.506167	1310	E
14/11/2009	BOX 1	36.458233	12.56665	1278	B
14/11/2009	BOX 2	36.8	12.72	487	B
14/11/2009	BOX 3	37.335933	13.144433	88	B
15/11/2009	275	37.191333	13.021	484	E
15/11/2009	296	36.4905	14.536167	157	E; B
15/11/2009	386	37.076333	12.934833	369	
15/11/2009	464	36.317	14.403	463	E
15/11/2009	500	36.959833	12.849	94	E
15/11/2009	601	36.999	13.648167	461	E; N

15/11/2009	602	36.883667	13.550833	739	E
15/11/2009	603	36.768167	13.435167	324	E
15/11/2009	604	36.649833	13.333833	606	E
15/11/2009	605	36.501833	13.2035	1711	E
16/11/2009	11105	35.3025	13.741	575	E
16/11/2009	11111	34.956167	13.487667	122	E
16/11/2009	11117	34.609833	13.236333	252	E
16/11/2009	969	35.799	14.007333	1043	E
16/11/2009	1123	34.2641	12.984067	125	E; B
16/11/2009	BOX 4	35.125633	14.002383	598	B
17/11/2009	809	35.67185	14.779933	134	E
17/11/2009	644	35.8448	14.912933	94	E; B
17/11/2009	473	36.01765	15.046633	96	E; B
17/11/2009	305	36.190583	15.181167	129	E
17/11/2009	49	36.369767	15.279817	143	E; B
17/11/2009	48	36.479833	15.405083	136	E

6.2.6 Ionian Sea

Three CTD casts (KC" have been repeated twice), ADCP routes and the attempt to recover some instruments from the station KC2 have been realised.

The three CTD casts have been realised as extension in the Ionian Sea of the transect 809-48 in order to verify the numerical model response at the across a front.

The instruments were moored in a previous crusie at the point named KC2, but problems incurred and have been never recovered. Now the attempt have failed.

Maps and table follow:

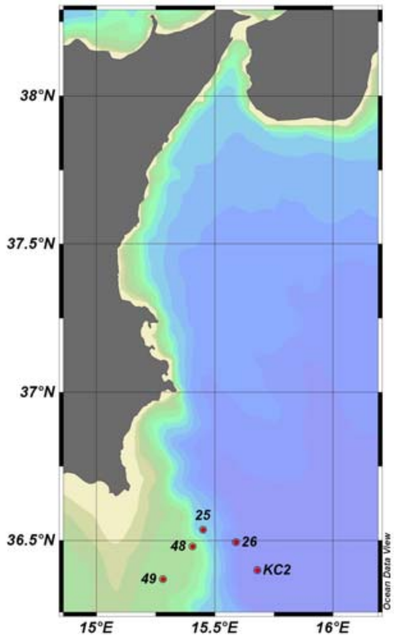


Figure. The CTD and BOX stations in the Sicily Channel

Data inizio calata	Stazione	Lat (°N)	Long (°E)	Fondale	Attività
17/11/2009	25	36.536533	15.449867	1079	E; B
17/11/2009	KC2	36.399467	15.678983	3384	E; O
18/11/2009	KC2up	36.400167	15.678333	3383	E
18/11/2009	26	36.494433	15.588817	1909	E

6.3 Moorings

6.3.1 Corsica Channel

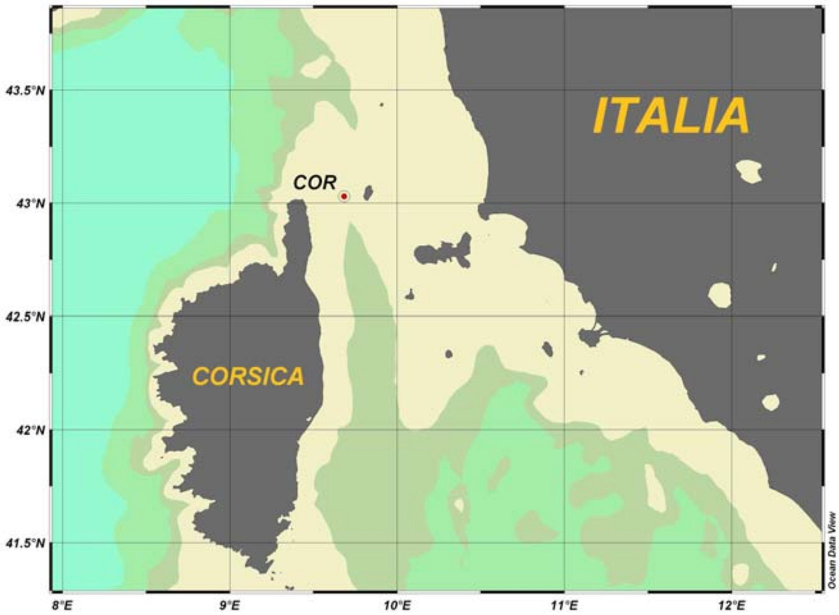


Figure. Location of the COR mooring in the Corsica Channel

In the following table the coordinates of the mooring are shown:

mooring	Longitude [° ‘E]	Latitude [° ’N]	Bottom [m]	Date [dd/mm/yy]	Mooring length [m]
COR	009 41.123	43 01.766	447	31/10/2009	378

The mooring was structured (see figure), from the top to the bottom, with a buoy with satellite Argos SMM 2000X ID transmitter.

Then these instruments follow (figure below): a floating buoy Billing <37 inches in diameter, two mechanical correntmeters RCM7, two acoustics currentmeters RCM9, one CTD SBE37, 7 floating buoys of 17 inches in diameter, one double underwater acoustic release Edge Tech 8202. Instruments and floats are then kept together by a 10 mm Kevlar or a 14 mm poliester cable, by a 14 mm chain moored to the bottom through two 300 kg train wheels.

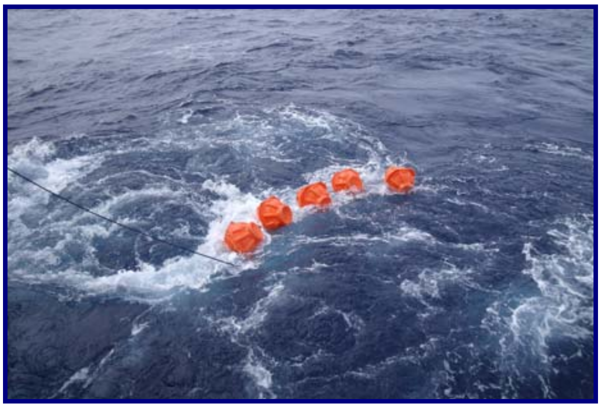


Figure. Two images of the mooring: acoustic releases (left), five orange underwater floats (right).

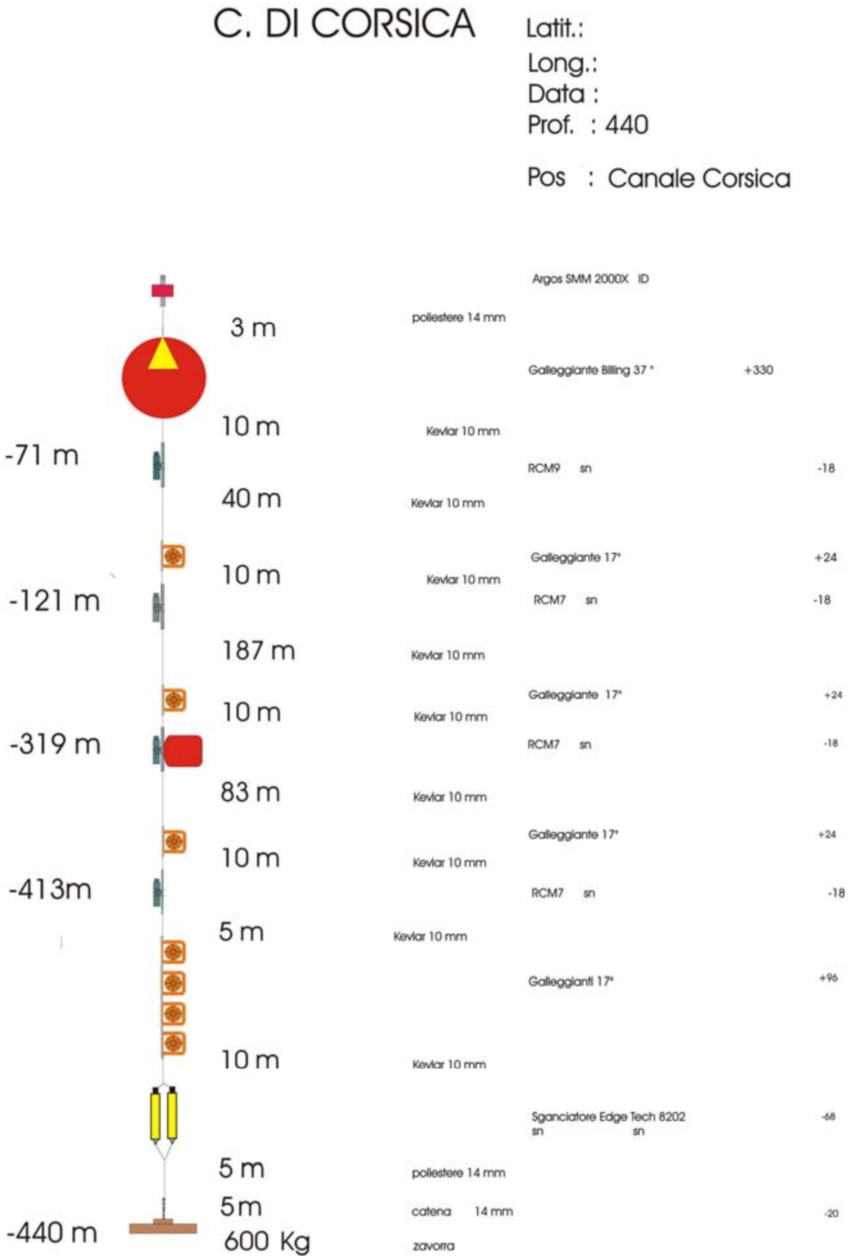


Figure 6.3.2.2. Structure of the mooring COR in the Corsica Channel

6.3.2 Sicily Strait

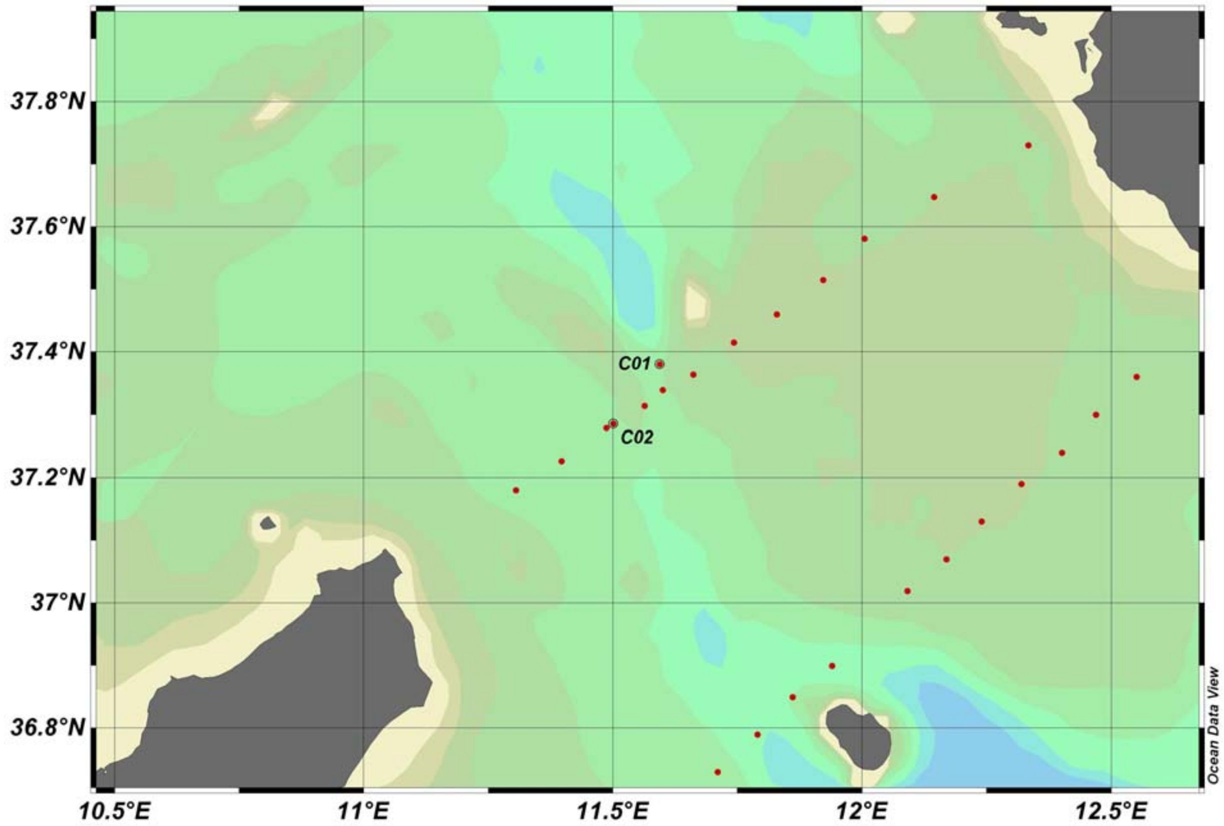


Figure. Location of the C01 and C02 moorings in the Sicily Strait

In the following table the coordinates of the moorings are shown:

mooring	Longitude [° ‘E]	Latitude [° ’N]	Bottom [m]	Date [dd/mm/yy]	Mooring length [m]
C01	011 35.636	37 22.836	457	13/11/2009	383
C02	011 30.019	37 17.120	536	13/11/2009	287

The two moorings were structured (see figure 6.3.2.) with:

- C01: a buoy with satellite Argos SMM 2000X ID transmitter, a syntathic floating buoy with RDI ADCP Workhorse Long Ranger 75kHz, a syntathic floating buoy, a mechanical correntmeters RCM7, one CTD SBE19 plus and one SBE37 MicroCat, 6 floating buoys of 17 inches in diameter, two underwater acoustic releases Edge Tech 8202.
- C02: a syntathic floating buoy with ADCP Nortek 6020, a syntathic floating buoy, a buoy with satellite Argos SMM 2000X ID transmitter, a mechanical correntmeters RCM7, a Nortek Aquadop 20409 currentmeter, one CTD SBE37, 5 floating buoys of 17 inches in diameter, one underwater acoustic release Edge Tech 8202.

Instruments and floats are then kept together by a 10 mm Kevlar or a 14 mm poliester cable, by a 14 mm chain moored to the bottom through two 350 kg train wheels.

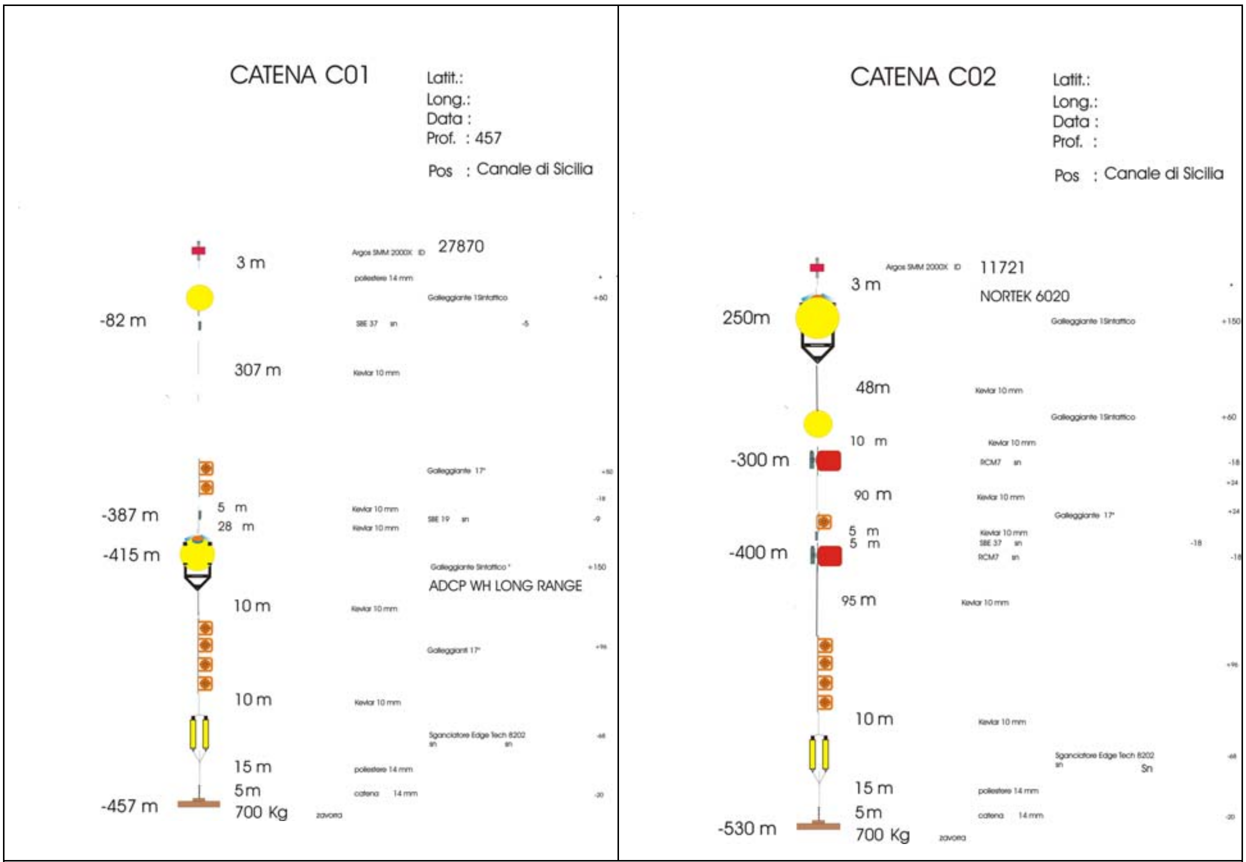
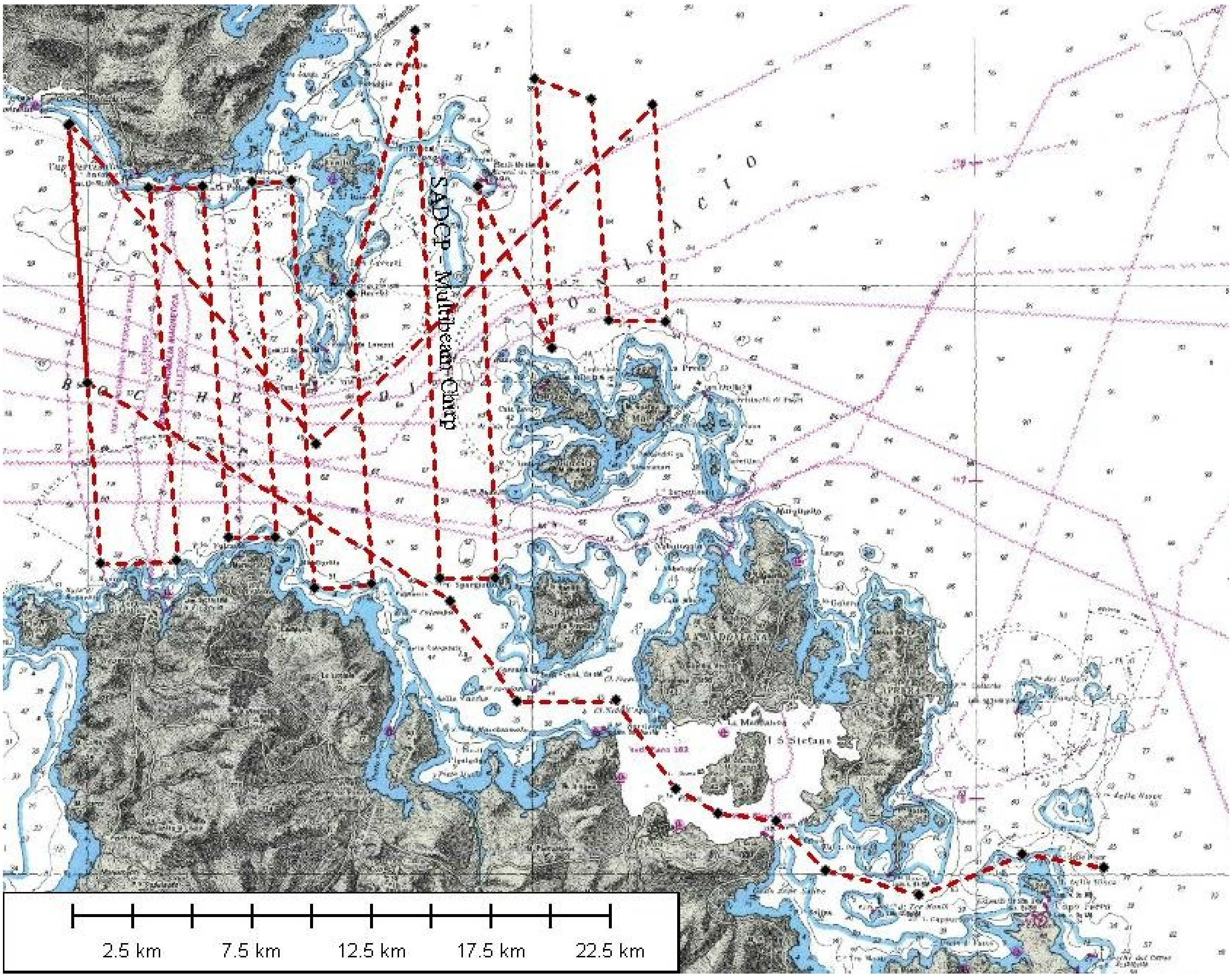


Figure. Structure of the moorings C01 (left) and C02 (right) in the Sicily Strait

6.4 Chirp and Multibeam in the Bonifacio Mouth

During the whole cruise SADCP data have been recorded by using an RDI Workhorse 300 kilohertz and an RDI Ocean Surveyor 75 kilohertz. Inside the Bonifacio Mouths and La Maddalena Archipelago multibeam and chirp data have been recorded as visibile in the picture below.

The vessel speed was about 5-6 knodes. The acquisition started in the Tyrrhenian Sea to the Corsica Sea.



Figure– SADCP (RDI Workhorse 300 kilohertz), multibeam and chirp lines of acquisition

6.5 Characterization of bathyal macrofauna

On 12 stations (see table and figure below), each repeated at least 5 times, box corer operations have been realized in order to acquire the superficial sediment to be anlysed for 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.

Data inizio calata	Stazione	Lat (°N)	Long (°E)	Fondale	Attività
12/11/2009	BOX	36.69988	11.8168	620	B
12/11/2009	328	36.680133	11.630067	350	B
12/11/2009	319	37.19	12.319833	84	E; N; B
14/11/2009	BOX 1	36.458233	12.56665	1278	B
14/11/2009	BOX 2	36.8	12.72	487	B
14/11/2009	BOX 3	37.335933	13.144433	88	B
15/11/2009	296	36.4905	14.536167	157	E; B
16/11/2009	1123	34.2641	12.984067	125	E; B
16/11/2009	BOX 4	35.125633	14.002383	598	B
17/11/2009	644	35.8448	14.912933	94	E; B
17/11/2009	473	36.01765	15.046633	96	E; B
17/11/2009	49	36.369767	15.279817	143	E; B

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.

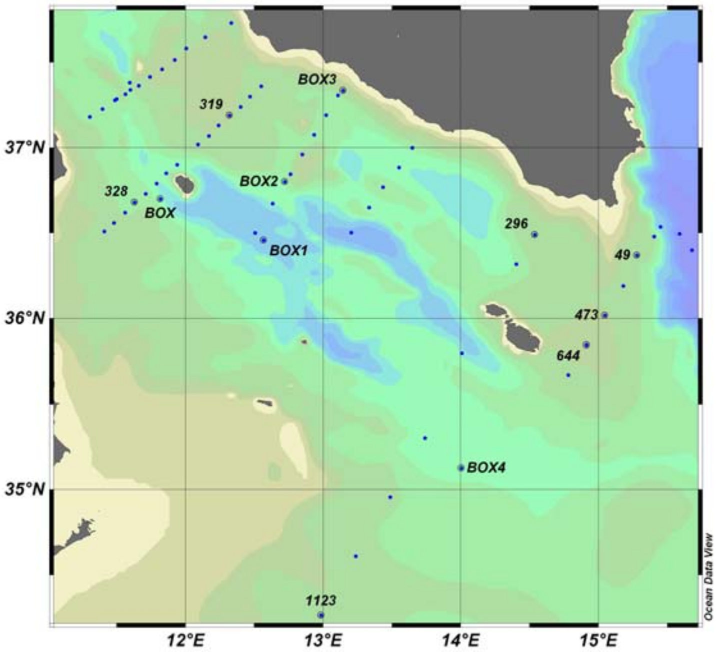


Figure. The Box Corer stations in the Sicily Strait

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.

6.6 Marine midrobic microbiology

In almost all CTD casts water samples (see CTD casts list above) have been realised in order to obtain a water for microbic analyses. Microbes are believed to play a large role in marine environments. Microbial community in deep-sea and along water column has poorly been studied. Exactly there are insufficient information about a possible correlation among water mass, depth, and bacterial community composition (Giovannoni, et al. 2000). This approach is essential to study the role of bacteria in marine ecology and their contribution in nutrient and element cycles.

The aim of this research is the quantitative and qualitative analysis of heterotrophic bacteria distribution in western Mediterranean pelagic waters. Heterotrophic bacteria utilize organic compounds. Most of marine bacteria belongs to this kind of bacteria, such as luminous bacteria.

One of the most important factor in heterotrophic microbial distribution in different sea water is organic compounds concentration, particularly sugars and proteins concentration (Rheinheimer, 1977). Therefore, higher values of microbial density are characteristic of the photic layer.

Another important objective of this study was to characterize microbial communities diversity focusing on the metabolically active fraction of the bacterial populations that occurs in some representative layers of the water column (Surface, 200 m, 500 m, 700 m, 800 m, 1000 m, 1500, 2000 m, Bottom) in the same areas. Pure-culture approach to study microbial world, seriously constrained microbial diversity view because most microbes defy cultivation by standard methods. Numerous studies, based on culture-independent methodology, have been carried out to investigate microbes as key player in many environmental processes in the biosphere (Head et al., 1998; Moeseneder et al., 2005). At the moment, molecular phylogenetic studies applied to microbial ecology are based on the analysis of either DNA or RNA, whereas, simultaneous studies on both types of nucleic acids extracted from the same environment are still scarce (Nogales et al., 1999; 2001; Mills et al ., 2005; Moeseneder et al., 2005). To detect bacterial community composition without DNA amplification using 16S rRNA probes we have used CARD-FISH technique, a recently developed catalyzed reporter deposition FISH method that allows the use of oligonucleotide probes (Pernthaler et al., 2002). This approach permits the detection of small marine bacteria with low ribosome content. Eco BIOLOG GN plates were used to characterize the ability of the microbial communities to oxidize various carbon sources. Finally, some enrichments with Crude Oil, PCB and Mercuric Chloride were effected in 5 stations.

In many stations (see table list above) sea water samples at different depth have been collected, according to the physical and chemical survey by Niskin bottles.

Acknowledgements

The scientific/technical personnel embarked for the SICILY09 cruise wishes to thank the Consiglio Nazionale delle Ricerche (CNR) for the availability of the R/V URANIA and the Captain Lubrano Lavadera Vincenzo, the Officers and the Crew of the vessel for their help on board.

A large amount of graphs and data analysis in this report has been done by the freeware software ODV – Ocean Data View realised and updated by Dr R. Schlitzer (http:/www.awi-bremerhaven.de/GEO/ODV/2006).

The MedCO08 cruise is organised in the framework of international strategies:

⇒ **GOOS** (*Global Ocean Observing System)* facing three moments of the operational oceanography: measurements, monitoring and modelling. GOOS is sponsored by: IOC, WMO, UNEP and ICSU.

⇒ **MOON** (*Mediterranean Operational Observing Network*) part of the coordinating group of the EuroGOOS Mediterranean Task Team and is responsible of Mediterranean operational oceanography, sea foecast and observation.

⇒ **GNOO** (*Gruppo Nazionanle di Oceanografia Operativa*) created to consolidate and coordinate the activities in operational oceanography in Italy.

⇒ **MedGOOS** (*Mediterranean Global Ocean Observing System)* an association fundede under the auspices of UNESCO/IOC to give support the the Mediterranean GOOS.

⇒ **EuroGOOS** (*European Global Ocean Observing System)* part of the European GOOS. It is a programme between nations to exchanges of data and information at European level.

⇒ **MFS (***Mediterranean Forecasting System).* International project inside GOOS with the objective to give an operational product in the Mediterranean area. Several forecast numerical circulation models have been developed for the western Mediterranean. XBT probes have been furnished as part of the collaboration through the institutes participating at MFS in the frame work of the VOS component (Volunteer Observing Ships) of MFS.

The cruise is also part of the strategy of some CNR institutes in order to analyse hydrological and biogeochemical variabilities as part of the climatic changes. The cruise has been organised in the framework of the following projects:

⇒ **ECOOP - European COastal-shelf sea OPerational observing and forecasting system** (European IP);

⇒ **MyOcean, (**European IP);

⇒ **SESAME - Southern European Seas: Assessing and Modelling Ecosystem changes** (European IP);

⇒ **PRIMI - Progetto Pilota Inquinamento Marino da Idrocarburi**, financing ASI;

⇒ **VECTOR: VulnErabilità delle Coste e degli ecosistemi marini italiani ai cambiamenti climaTici e loro ruolO nei cicli del caRbonio mediterraneo** subproject DIVCOST;

⇒ **MaGIC: Marine geohazard along the Italian coast.**