RAPPORTI ISMAR (2010) **2**, 2–**??**

Rapporto sulle attivita' oceanografiche, geologiche, geofisiche durante la crociera MNG0310 con R/V *Urania* : Mare ADriatico, 2010-03-02 - 2010-03-12. Progetti EMMA (Dr. M. Ravaioli) e ADRICOSM (Prof. N. Pinardi).

G. Bortoluzzi[1], F. D'Oriano[1], F. Del Bianco [1], V. Maselli[1] ,
C. Palmiotto[1], F. Falcieri[2], K. Marinaccio[2]
D. Radojevic[3], M. Milic[3], G. Castelli[4], E. Çomo[5], B. Murtaj[5]

[1] *CNR, Istituto di Scienze Marine, Italy*
[2] *Universita' Politecnica Marche, Ancona, Italy*
[3] *Geological Survey, Montenegro*
[4] *Environmental Protection Agency, Montenegro*
[5] *Institute Energy, Water, Environment, University, Tirana, Albania*

Ricevuto: March 2010 / Accettato: Maggio 2010 - VERSIONE PDF

SUMMARY
Vengono presentate le attivita' ed i risultati preliminari della crociera MNG0310(2010-03-02- 2010-03-12)con R/V *Urania* , le cui attivita' principali previste erano la acquisizione di dati oceanografici lungo i transetti Gargano, Pescara, Senigallia, Rimini e Delta del Po. In aggiunta, si sono svolte attivita' di campionamento fondo mare, batimetria multibeam e SBP in Montenegro e Albania.

Key words: Oceanografia – Batimetria – CHIRP SBP – Mare Adriatico – Montenegro – Albania

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

ACRONYM	DESCRIPTION	URL-email
CNR	Consiglio Nazionale Delle Ricerche	www.cnr.it
ISMAR	Istituto di Scienze Marine	www.ismar.cnr.it
ISMAR-BO	ISMAR, Bologna	www.bo.ismar.cnr.it
UNIVPM	Universita' Politecnica delle Marche	www.univpm.it
IBMK	Inst.Marine Biology, Kotor	
GSM	Geol.Survey Montenegro, Podgorica	www.geozavod.cg.yu
EPAM	Environmental Prot. Agency Montenegro	epa.org.me
UNITIRANA	University of Tirana	www.upt.al
IEWE	Inst.Energy Water Environment, UNITIRANA	
ADRICOSM	ADRIatic sea integrated COastal areaS	gnoo.bo.ingv.it/adricosm
ADRICOSM-STAR	ADRICOSM integrated river basin an coastal zone management system: Montenegro coastal area and Bojana river catchment	gnoo.bo.ingv.it/adricosm-star
ADRICOSM-EXT		gnoo.bo.ingv.it/adricosm-ext
MEDPOL	Program for the Assessment and Control of Pollution in the Mediterranean region	http://195.97.36.231/medpol
MFS	Mediterranean ocean Forecasting System	www.bo.ingv.it/mfs
MOON	Mediterranean Operational Oceanography	
SIAM	Sistema Informativo Ambiente Mediterraneo	moon.santateresa.enea.it
SIS	Sea-floor Information System	www.kongsberg.com
SBE	Sea Bird Electronics	www.seabird.com
SIPPICAN	Sippican Corp.	www.sippican.com
BENTHOS	Teledyne Benthos	www.benthos.com
SWAN-PRO	Communication Technology	www.comm-tec.com
GMT	Generic Mapping Tool	gmt.soest.hawaii.edu/gmt
MBES	Multibeam Echosounder System	
SBP	Sub Bottom Profiling	
SVP	Sound Velocity Profile	
CTD	Conductivity/Temperature/Depth	
MAW	Modified Atlantic Water	
LSW	Levantine Surface Water	
LIW	Levantine Intermediate Water	
CIW	Cretan Intermediate Water	
CDW	Cretan Deep Water (Involved recently in EMDW. Sometimes referred as CSOW).	
LDW	Levantine Deep Water (Formed in NW Levantine Basin).	
EMDW	Eastern Mediterranean Deep Water (Kept for historical reasons).	
EOW	Eastern Mediterranean Overflow Water (Sometimes called AIW or EMDW at the Sicily channel).	
GPS-DGPS-RTK	Global Positioning System	samadhi.jpl.nasa.gov
DTM	Digital Terrain Model	en.wikipedia.org

Table 1. Acronyms of Organizations, Manufacturers and Products

1 CRUISE SUMMARY

SHIP	R/V *Urania*
START	2010-03-02 PORT: Messina
END	2010-03-12 PORT: Bari
SEA/OCEAN	Adriatic Sea
LIMITS	NORTH: 45:30 SOUTH: 41:00 WEST: 12:00 EAST: 19:45
OBJECTIVE	Oceanography ...
COORDINATING BODIES	ISMAR-CNR Bologna
CHIEF OF EXPEDITION	Giovanni Bortoluzzi
CONTACT	G.Bortoluzzi at ismar.cnr.it
DISCIPLINES	Oceanography, morphobathymetry, Chirp SBP, magnetometry, bottom sampling.
WORK DONE	∼3500 KM SBP, ∼xxx KM MAGNETOMETRY, ∼xxx KM^2 MULTIBEAM, 66 CTD CASTS, 4 GRABS , 5 BOX-CORERS.

Table 2. Cruise Summary.

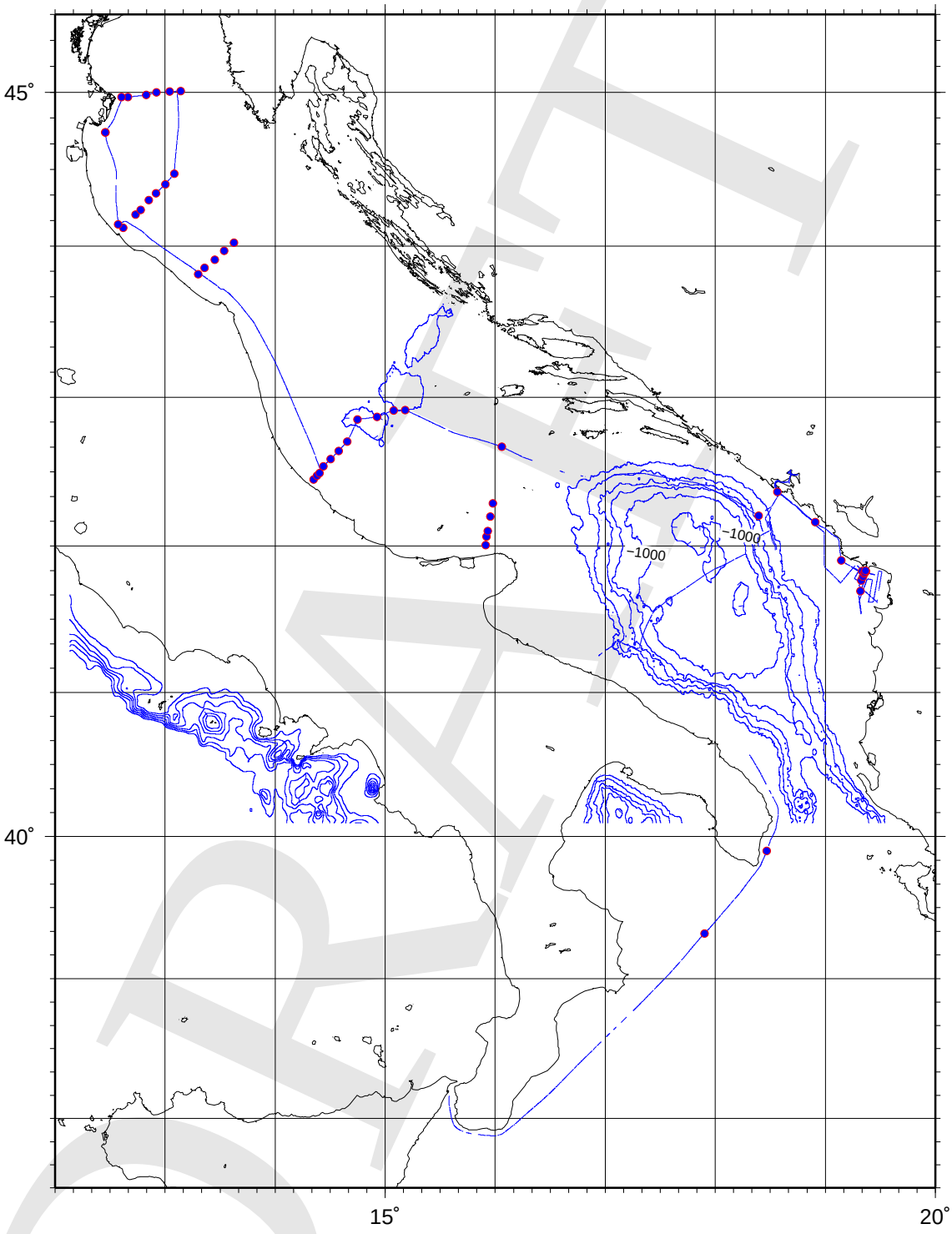

Figure 1. Whole ship track during Cruise MNG0310. Blue circles are CTD stations. Blue line shows CHIRP lines.

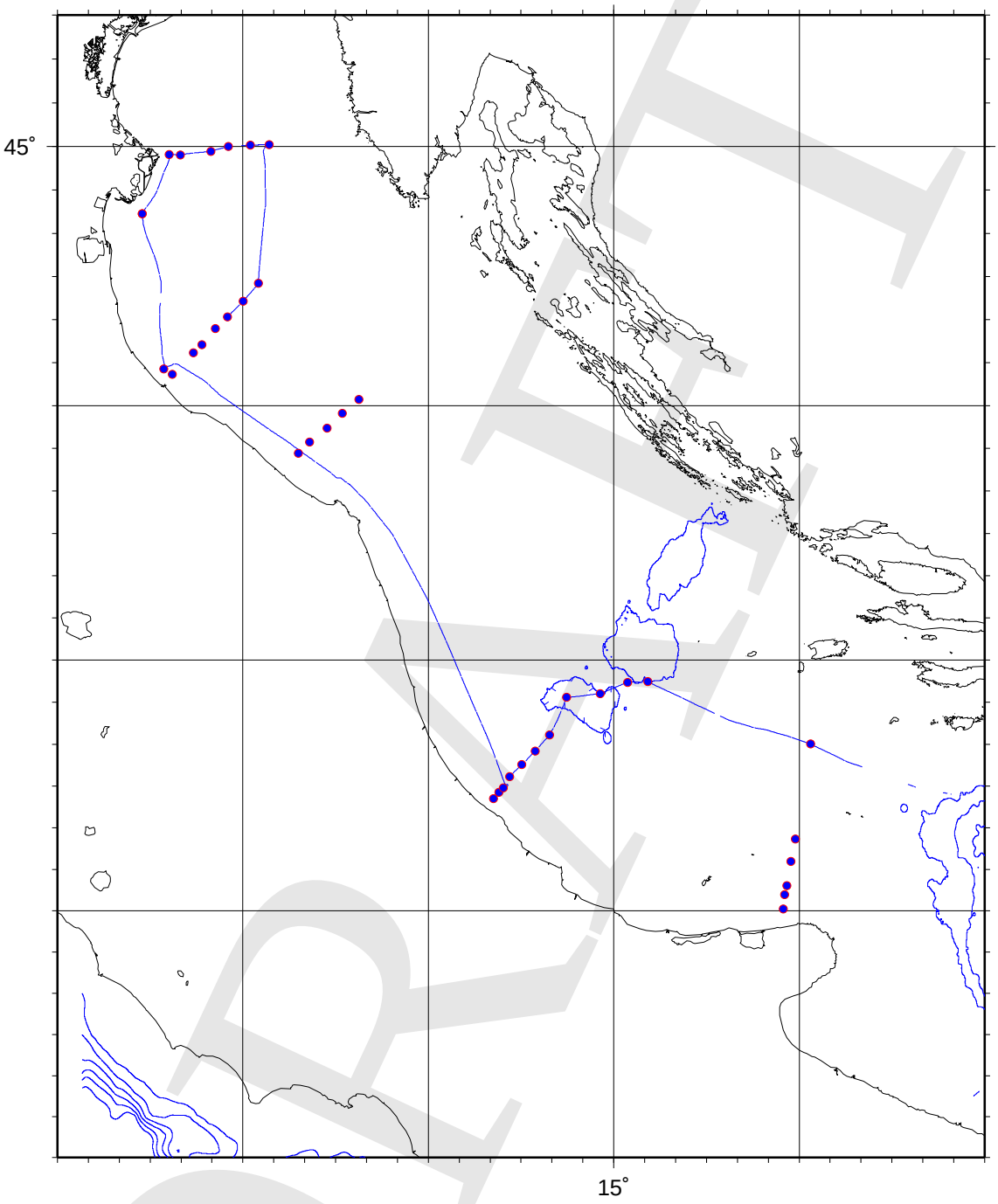

Figure 2. Whole ship track during Cruise MNG0310. Blue circles are CTD stations.

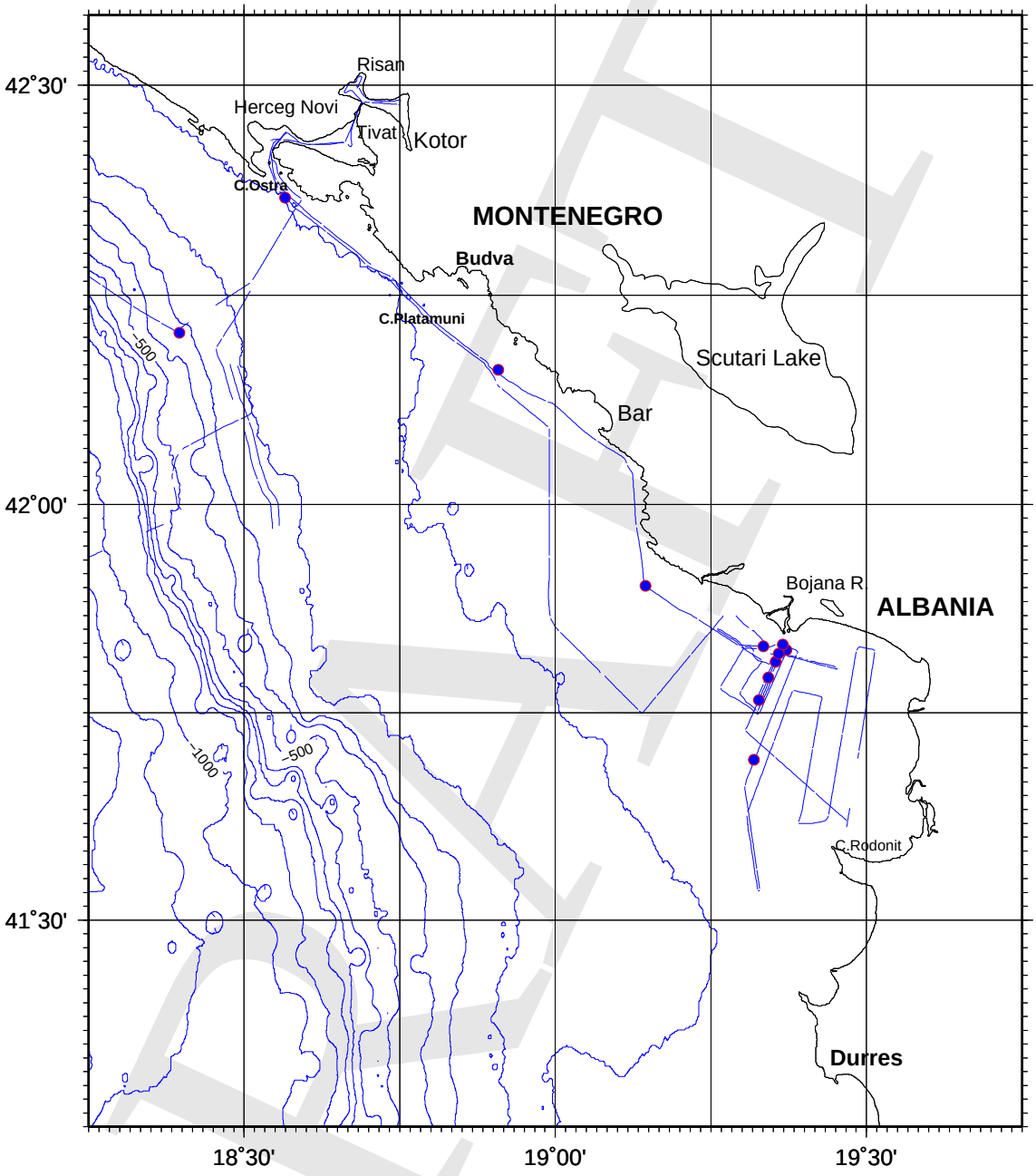

Figure 3. Whole ship track during Cruise MNG0310. Blue circles are CTD stations. Blue line show CHIRP data.

PARTICIPANTS	ORGANIZATION	EXPERTISE	tel & email & www
Giovanni Bortoluzzi	ISMAR,Bologna	Chief-of-Expedition	G.Bortoluzzi@ismar.cnr.it
Andrea Gallerani	ISMAR, Bologna		A.Gallerani@ismar.cnr.it
Fabrizio Del Bianco	ISMAR,Bologna		F.Delbianco@bo.ismar.cnr.it
Vittorio Maselli	ISMAR,Bologna		V.Maselli@bo.ismar.cnr.it
Camilla Palmiotto	ISMAR, Bologna		palmi8camy@hotmail.it
Francesco Falcieri	UNIVPM, Ancona		f.falcieri@univpm.it
Katia Marinaccio	UNIVPM, Ancona		katiamarinaccio@libero.it
Bledar Murtaj	IEWE, UNITIRANA		murtajbledar@yahoo.com
Elvin Çomo	IEWE, UNITIRANA		elvincomo@yahoo.com
Dragan Radojevic	GSM		radojevic.d@geozavod.co.me
Mileva Milic	GSM		mileva.milic@gmail.com
Giuliano Castelli	EPAM		giuliano.castelli@epa.org.me

Table 3. Scientific and technical parties

2 INTRODUZIONE E INQUADRAMENTO

Cruise MNG0310, coordinated by ISMAR-CNR of Bologna, has been dedicated to the EMMA-LIFE project , coordinated by Dr. Mariangela Ravaioli and to the ADRICOSM-STAR project (coordinating Institution CMCC, scientific Coordinator Prof. Nadia Pinardi)

The EMMA project aims at understanding and possibly forecast the anoxic and hypoxic conditions occuring in the Norther Adriatic Sea. This is done by operational physical and biogeochemical modeling, that require both seasonal oceanographical cruises in the Adriatic Basin and the use of Near real Time Meteoceanographical Buoys (among them the ISMAR's E1 and S1 buoys).

The cruise planned to repeat classical and well known transects (Po-Rovinij, Rimini, Senigallia, Pescara, Gargano), as well as investigating structures near the Gargano Promontory and in the area of Bari Canyon, with particular regards to the North Adriatic Dense Water (NaDW) processes (Bignami et al. 1990a,b; Ridente et al. 2007; Trincardi et al. 2007; Canals et al. 2009).

ADRICOSM-STAR "... aims at the development and partial implementation of an integrated coastal area and river and urban waters management system that considers both observational and modelling components." The research area is the Montenegro and Albanian coastal and marginal zone, inclusive of Kotor Bay (Boka Kotorska). The project involves 19 public and private partners from Italy, Montenegro, Serbia and Albania and has a duration of 3 years starting from March 2007.

This is the fifth cruise in the area of Montenegro-Albania, following cruises ADR08 (R/V Dallaporta, July 2008), ADR02_08 (R/V Urania, October 2008 (Bignami & et al. 2008)), MNG01_09 (R/V Urania (Bortoluzzi et al. 2009a)) and MNG02_09 (R/V Maria Grazia, july 2009 (Bortoluzzi et al. 2009b)).

The cruise objectives were:

- To continue the systematic mapping of the study zone sea floor and sub-bottom with Multibeam and CHIRP technology
- To collect sediment samples in selected stations for sedimentological and chemical analysis
- To collect meteorological and continuous ongoing CTD data.

On the whole, Multibeam and CHIRP data will be used to assess the geological and surficial and subsurficial morphological setting, other than help to update bathymetric maps. Among the settings we may cite sediment transport pathways, such as accumulation and erosion areas, and risk and hazard studies.

This paper reports the shipboard activities during cruise MNG0310, including description of the ship, equipment and their usage, along with details of the general settings, performances and some scientific and technical results.

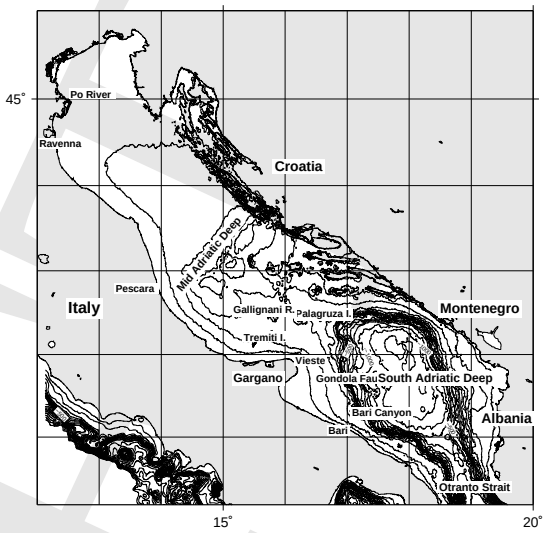

Figure 4. Adriatic Sea setting.

CHIRP SBP and Multibeam bathymetric data were acquired allover planned routes or during transits, from the SE to N, and the seafloor was sampled by box-corer and gravity corer in predetermined stations in front and to the south of the Bojana River. In particular, the planning of routes were dictated by the aim of obtaining full coverage multibeam images or to investigating geological features like one caused by submarine mass movements, depositional or erosional processes, or by fluid escapes.

Hydrological measurements included CTD vertical profiles (pressure, temperature, conductivity, dissolved oxygen, light transmission, fluorimetry). Among the many parameters, T, S, Pressure were used to provide to the MBES the necessary water column speed of sound profile. Data were extracted from the 0.5 or 1 m averaged profiles, and input on the MBES console. A procedure was set up in order to ease the handling of the procedure, in particular for the extension of data to the depth of 12000m, as required by the SIS Kongsberg's software.

2.1 Inquadramento Geologico e Oceanografico

INQUADRAMENTO GEOLOGICO

L' Adriatico (Fig.4) e' un mare epicontintale con due configurazioni dei propri margini (Ridente & Trincardi 2005) (con referenze). La zona Nord (NA) e' circondata dalla penisola italiana a Ovest e dai Balcani a Est, ed e' l'area piu' settentrionale del Mediterraneo. E' caratterizzato da batimetrie basse e bassissime (in media $\sim$ 35 m), che si approfondiscono regolarmente verso S fino alla batimetrica di -120 m, che viene consid-

erato il confine aperto a S, approssimativamente a N della latitudine 43:20 (Artegiani et al. 1997a; Russo & Artegiani 1996; Poulain et al. 2001). Altri autori considerano invece essere tale confine al traverso di Rimini o di Ancona.

L'area Centrale e' caratterizzata dalla fossa Meso-Adriatica (MAD), un bacino relitto, profondo $\sim$ 260 m, separato in due depocentri dalla cintura di deformazione Centro-Adriatica (Argnani & Frugoni 1997), e bordata dalle catene Gallignani e Pelagosa a SE e dall'alto strutturale delle Isole Tremiti a S. Le due depressioni della fossa possono essere riempite dalle acque dense (NadDW) prodotte nel bacino settentrionale.

L'area a Sud (Argnani et al. 2006) e' caratterizzata da una depressione subcircolare, profonda $>$ 1200 m (Fossa Sud Adriatica, SAD), localizzata fra le coste della Puglia, a Ovest, e di Albania, Montenegro, Croazia a Est, e considerata essere la avanfossa della cintura di pieghe e faglie delle catene Albanidi e Dinaridi (De Alteriis 1995; Argnani et al. 1996; Bertotti et al. 2001).

I margini e le aree costiere Montenegrine e Albanesi fanno parte della cintura di pieghe e faglie Ovest-vergente delle Dinaridi e Albanidi lungo la parte sud-orientale del bacino 4. I margini hanno un ciglio della piattaforma continentale relitto, con il sedimento stoccato lungo la costa albanese, e presenza di frane e movimenti di massa a larga scala (Argnani et al. 2006; Roure et al. 2004). La piattaforma continentale e' stretta da N in Coazia fino a C.Patamuni a S della Baia di Kotor, nei pressi di Budva, dove essa si sviluppa maggiormente fino a C.Rodonit in Albania. La attivita' sismica e' presente nell'area con eventi da moderati a molto intensi. In particolare, a parte i terremoti storici, il M6.9 del 1979-04-15 e forti scosse di assestamento nella regione di Bar e Kotor in Montenegro (Console & Favali 1981; Boore et al. 1981), con epicentro localizzato 5NM al largo, nella zona del fronte esterno. L'area a S del fiume Bojana a W e Sw di Capo Rodonit e' anche sismicamente attiva, ed e' interessata da un fronte compressivo allineato WNW e faglie trascorrenti e dirette orientate ENE. Secondo Tiberti et al. (2008) e citazioni, questi terremoti hanno un forte potenziale tsunamigenico. A casua dell'ambiente carsico nella vcatena DInarica, specialmente in N Montenegro, gli acquiferi costieri possono svilupparsi a mare con sifoni sottomarini, sorgenti e risorgive, all'interno di una ambiente geologico e idrogeologico fortemente correlato alla tettonica e alle fluttuazioni climatiche e del livello del mare passate e future (Fleury et al. 2007).

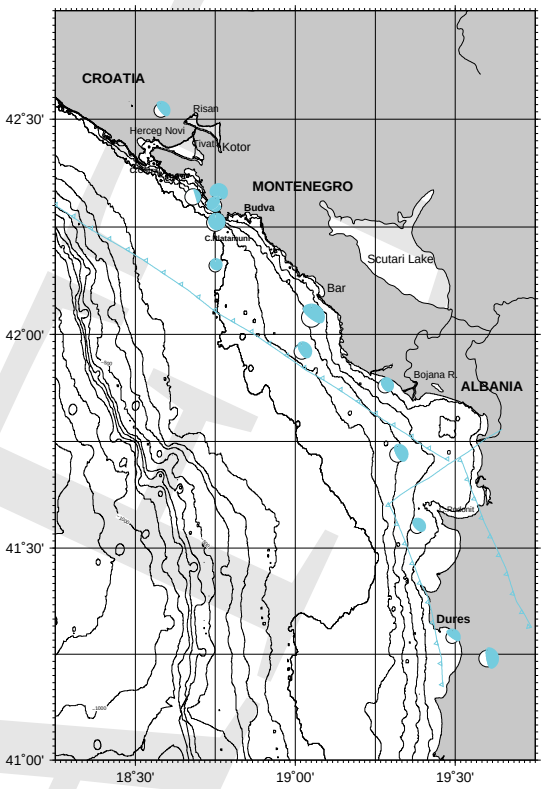

Figure 5. Structural setting of Montenegro.

Inquadramento oceanografico

Le note seguenti sono tratte da Russo et al. (2009).

Essendo un bacino epicontinentale, idrologia e dinamica del NA sono influenzate dal forzante meteorologico, variazioni termiche e dalle portate fluviali. Studi climatologici (Cushman-Roisin et al. (2001) e referenze) indicano che le situazioni meteorologiche principali in NA includono flussi dai quadranti NW, NE e SE (venti Etesiano, Bora, Scirocco). Bora e Scirocco sono i venti predominanti nell'area e possono causare forti eventi di tempesta. Nonostante il suo limitato volume, il NA riceve circa il 20% di acque dolci di tutto il Mediterraneo (Russo & Artegiani 1996), principalmente dal fiume Po (portata media $\sim$ 1500 m^3/a (Artegiani & Azzolini 1981; Raicich 1994), e portando ad un eccesso di acqua dolce.

Nel tardo autunno, gli intensi processi di raffreddamento e evaporazione, tipicamente associati con eventi di Bora sul NA, creano condizioni per la generazione di acqua densa durante l'inverno (Vibilič & Supič 2005).

A causa dell'aumento delle portate fluviali e del riscaldamento in tarda primavera e estate, correnti di gradiente sono generate in un sistema di circolazione ciclonico (Zore-Armanda 1956; Buljan & Zore-Armanda 1976; Franco et al. 1982; Orlić et al. 1992; Artegiani et al. 1997a,b; Russo & Artegiani 1996; Hopkins et al. 1999; Poulain & Cushman-Roisin 2001), consistenti in una corrente che entra a S e fluisce verso NO lungo la costa orientale (corrente Adriatica Orientale, EAC), e una corrente che fluisce a SE lungo la costa italiana e esce a Otranto (Corrente Adriatica Occidentale, WAC). La EAC introduce nel bacino

a Sud acque piu' calde e salate, mentre la WAC immette acque piu' dolci verso le regioni a S.

La circolazione generale nel NA e' inoltre estremamente affetta dai venti. Eposodi di Bora possono generare una circolazione transiente a doppia rotazione, consistente in un ciclone a N del delta del Po e un anticiclone a S, in grado di trasportare molto al largo filamenti del pennacchio fluviale (Jeffries & Lee 2007); una circolazione anticiclonica si sviluppa inoltre lungo la costa Istriana a Sud (Poulain & Cushman-Roisin 1992, 2001), mentre la Bora forza flussi nella WAC (Book et al. 2007; Ursella et al. 2006).

Il NA e' una delle zone maggiormente produttive dell'intero Mediterraneo. Il tasso di consumo di O_2 dovuto ai processi biogeochimici e' il piu' alto dell'intero Bacino Adriatico, con un massimo che generalmente si concentra attorno al delta del Po (Artegiani et al. 1997b). Questa regione puo' quindi essere considerata zona favorevole alla insorgenza di ipossie. La formazione di strati anossici di fondo in ampie aree del bacino (Degobbis et al. 1993, 2000) puo' causare grossi problemi ecologici come mortalita' massive di animali, defaunazione della popolazione bentonica e riduzione della produttivita' dell'industria della pesca.

La ipossia e' definita comunemente tale quando la concentrazione dell'ossigeno disciolto e' inferiore a 2 ml l^{-1} (equivalenti a 2.8 mg l^{-1}). Tale concentrazione e' il limite di tolleranza per molte specie bentiche (Simunovic et al. 1999; Rabalais et al. 2000; Wu 2002).

The dynamics of the SAD is dominated by the presence of a quasi-permanent cyclonic gyre that in the winter season creates the conditions for the open-ocean convection and the production of dense and oxygenated waters. Studies show that two types of dense water formation processes occur during winter within the Adriatic Sea: the major portion of the Adriatic Deep Water (ADW) is formed through open ocean convection inside the Southern Adriatic Deep (SAD) within the cyclonic gyre, while the remaining dense water is formed on the continental shelf of the Northern and Middle Adriatic that moves southward and ultimately sinks to the bottom of the SAD (Ovchinnikov et al. 1985; Bignami et al. 1990a,b; Malanotte-Rizzoli 1991). The eastern margin is characterized by the influence of the incoming waters of Ionian origin which flow northward being restricted mainly to the continental slope. This area is interested by the Levantine Intermediate water (LIW) that occupies the layer between 150 and 600m.

The coastal zone of Albanian and Montenegro in the eastern margin consists of a narrow shelf area North of the Strait of Otranto, with smooth bathymetry and with circulation features presumably determinate by inflowing Ionian waters, by local winds, and by relatively large amounts of the Buna-Bojana river. The latest provide a strong

Figure 6. R/V *Urania* .

contribution to the Adriatic freshwater budget, in a way that their influence in feeding the freshwater coastal zone is sometimes felt far downstream along the Croatian coast.

The current state of knowledge of oceanographic characteristics of the Albanian shelf is limited. Numerical simulations and satellite infrared images indicates that the circulation on the Albanian shelf responds strongly to the local wind forcing (Bergamasco & Gačič 1996). More specifically, the northeasterly wind generates very intense coastal upwelling along the Albanian shoreline due to the sudden change of the coastline orientation in that area. Bora wind induces an undercurrent at intermediate depths near the Albanian shelf break, which is directed in the opposite direction of the Levantine Intermediate Water (LIW) inflow from the Ionian. Therefore, in addition to coastal upwelling, Bora in the Strait of Otranto weakens and occasionally blocks completely the LIW inflow.

3 MATERIALI E METODI

The research cruise was carried out with the 61 meter R/V *Urania* owned and operated by SO.PRO.MAR. and on long-term lease to CNR. Ship is normally used for geological, geophysical and oceanographical work in the Mediterranean Sea and adjoining waters, including but not limited to, the Atlantic Ocean, the Red Sea, and the Black Sea.

R/V *Urania* is equipped with DGPS positioning system (satellite link by FUGRO), single-beam and multibeam bathymetry and integrated geophysical and oceanographical data acquisition systems, including ADCP, CHIRP SBP and other Sonar Equipment, other than water and sediment sampling. Additional equipment can be accommodated on the keel or towed, e.g. Side Scan Sonars.

3.1 NAVIGAZIONE, CHIRP, MATIMETRIA MULTIFASCIO

The vessel was set-up for data acquisition and navigation with PDS-2000 software by RESON, in-

POSITION	ACROSS	ALONG	HEIGHT
REF.POINT	0.00	0.00	0.00
DGPS	1.64	14.30	14.18
MBEAM	0.00	14.36	-4.96
MAHRS	0.00	0.0	-3.40
DESO	5.50	-1.85	-3.80
CHIRP	-1.0	11.80	-4.00
A-FRAME	6.5	-6.70	0.0
STERN	0.00	-30.60	0.00
MAGNETOM.	-5.50	-210	0.0
DGPSGRAV	0.0	-4.0	10.0
GRAV	-1.0	-1.0	0.0

Table 4. Instrumental Offsets of PDS2000 on Ship Urania (PDS2000). The GPS antenna (primary positioning system) is located on point DGPS.

terfacing by a multiserial and Ethernet link several instruments, among them the DGPS (Fugro), the Atlas-Krupp Deso-25 single-beam echosunder, the MAHRS MRU and the meteorological station. The position and depth data were also distributed to the CTD data acquisition console. A Kongsberg processor running the SIS software, collected the multibeam data, including a SEAPATH MRU, compass, and DGPS. The MBES was the 70kHz, 400 1x2° beams, 150° aperture EM-710 (2000 m range) model by Kongsberg. The sonar head is positioned on the ship's keel using a V-shaped steel frame. A Sound Velocity probe at the keel 1m above the Sonar Head is interfaced directly to the MBES processor, thus providing the necessary real-time data for the beam-forming. CTD casts were normally used for input of the sound velocity profile to the system. An Anderaa Meteorological Station was also made available, at a rate of one measurement every 5 minutes.

BATIMETRIA

The SIS (EM-710) was able to build real-time DTM at the resolution of 20 and 5 m during the acquisition of the entire surveyed areas. The data from these production DTMs were exported and used for planning and update of the SIS projects.

POSITION	ACROSS	ALONG	HEIGHT
REF. POINT	0.00	0.00	0.00
SEAPATH_GPS	-4.039	0.163	-18.211
MRU	-0.341	-1.342	-1.596
MBEAM_TX	0.0936	10.2964	5.0623
MBEAM_RX	-0.0031	11.0144	5.0600
SEALEVEL	0	0	-0.0875

Table 5. Instrumental Offsets on Ship Urania (EM710). The DGPS antenna (primary positioning system) is located on point SEAPATH_GPS.

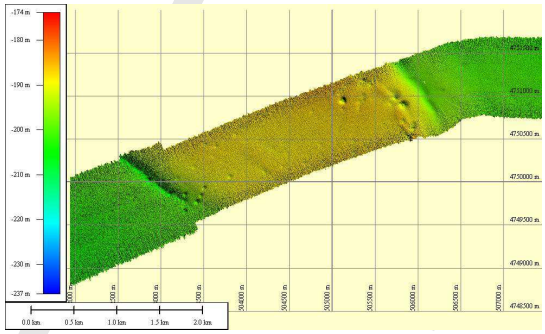

Figure 7. CruiseMNG0310: pokmark filed on faults and tectonic lineaments on top of Gallignani Ridge, Pomo.

The raw data were instead saved in the Kongsberg's .all format, for postprocessing with packages like NEPTUNE or MB-SYSTEM or other. The processed data will therefore be used for an up-to-date regional and local bathymetric compilation.

CHIRP SBP

A Teledyne Benthos CHIRP-III SBP system (16 hull-mounted transducers) was used. The data were acquired by the SWANPRO software by Communication Technology, with direct interfacing to the DGPS, therefore actual positioning data have to be converted according to the offsets of Tab.4. The data were recorded in the XTF format and converted also into the SEG-Y format for processing with ISMAR's SEISPRHO package Gasperini & Stanghellini (2009). The system setting was: length 5-10 ms, trigger rate variyng from 0.25 to 1.5 s,gain 9dbm preamp gain ranging from 1.5 to 3 db. Power to the transducers and gains were set in order to obtain non-clipped returns.

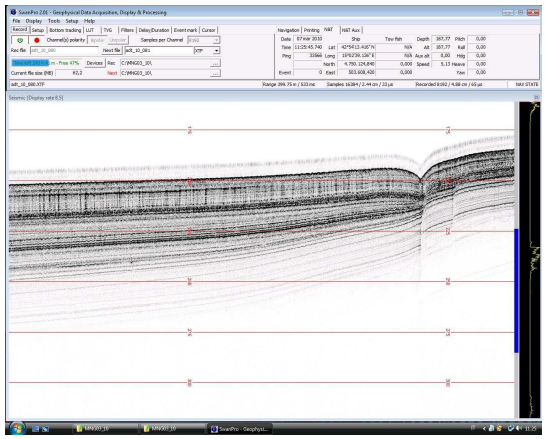

Figure 8. CruiseMNG0310: fault on top of Gallignani Ridge(WSE), Pomo (see Fig. 7).

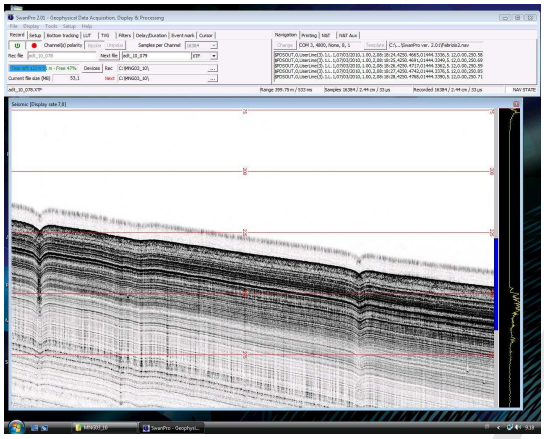

Figure 9. CruiseMNG0310: pokmark filed on top of Gallignani Ridge, Pomo.

CAMPIONAMENTYO FONDO

Bottom sampling was performed by 60cm diameter box corer and grab. Table 6 shows the position of samples. On the undisturbed sample a minimum of 2 subcores were taken and stored. Subsampling at particular levels was also performed. Some subasamples were washed and seived.

CTD

CTD data were obtained by a Sea Bird SBE 911 probe. Table A1 in the appendix shows the position of the stations.

MAGNETOMETRIA

A Seaspy by Marine Magnetics magnetometer was used. Sensor was towed at 180 m from stern, on the port side. Data acquisition was by Marine Magnetic's Sealink software.

CARTOGRAFIA E MISCELLANEA

An ROV by GEI of Barga was used on a karstic hole in the Kotor Bay.

The datum was set to WGS84 and the Direct Mercator 38N, UTM, zone 33N and 34N were chosen for navigation, display, and data acquisition. The time zone was set to the UTC for the instrumental data acquisition.

The positioning maps and bathymetric images were produced with GMT Wessel & Smith (1998).

The multibeam data were pre processed on board by the CARIS and GMT software and ISMAR's routines and scripts, using the SIS production DTMS or raw .all file.

Photographs and video were taken by digital cameras and video-camera.

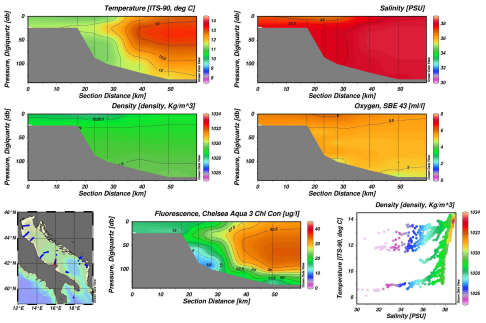

Figure 10. CruiseMNG0310: Gargano transect.

4 RISULTATI INIZIALI

OCEANOGRAFIA

During MNG0310cruise, the water column properties on the western side of the basin have been investigated along transects from Gargano to the Po Delta (Figures 10, 11, 12, 13 and 14). In addition, some CTD casts were performed on the Eastern coast during the activities on Montenegro and Albania.

In the Appendix Table A1 shows the CTD data collected during cruise MNG0310, and figure A1 plots a summary of the data.

BATIMETRIA, CHIRP

During MNG0310cruise, high-resolution morphobathymetric and CHIRP SBP surveys were made. We present hereafter a set of figures showing the capabilities of the Multibeam and CHIRP systems. See hereafter some of the images obtained by the multibeam.

CAMPIONAMENTO FONDO

A number of 5 box corers and 4 grabs were performed. Table 7 shows sample description. Some pictures hereafter show some of the samples.

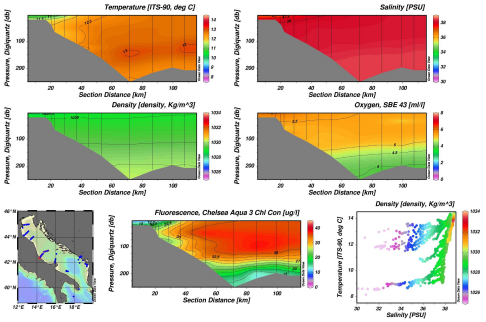

Figure 11. CruiseMNG0310: Pescara transect.

LON-LAT (ddmm.xxx)	UTM34	DEPTH	SAMPLE	DATE
1921.142 4149.869	363184 4632342		BC1	2010-03-09
1920.910 4149.706	362858 4632046		BC2	2010-03-09
1920.716 4149.509	362582 4631687		BC3	2010-03-09
1917.880 4149.743	358665 4632196		BC4	2010-03-09
1844.785 4228.379	314748 4704753		G1	2010-03-10
1840.878 4229.979	309476 4707859		G2	2010-03-10
1839.704 4225.942	307662 4700431		G3	2010-03-10
1832.515 4226.064	297812 4700937		G4	2010-03-10

Table 6. Samples on cruise MNG0310. BC=box-corer, G=grab.

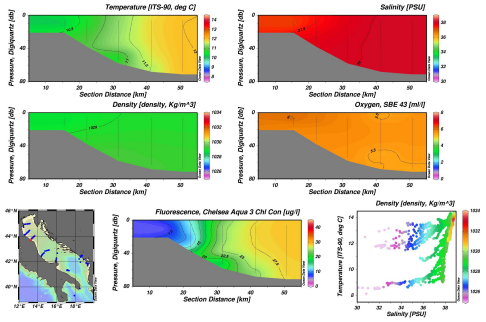

Figure 12. CruiseMNG0310: Senigallia transect.

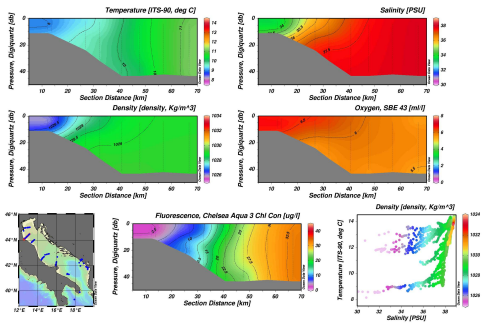

Figure 13. CruiseMNG0310: Rimini transect.

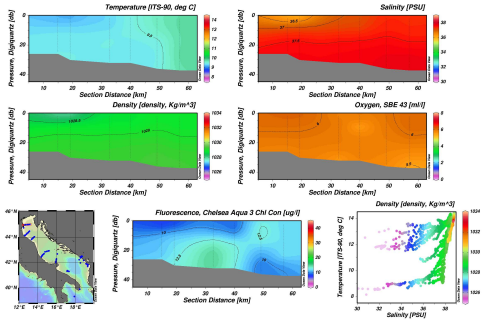

Figure 14. CruiseMNG0310: Po Delta transect.

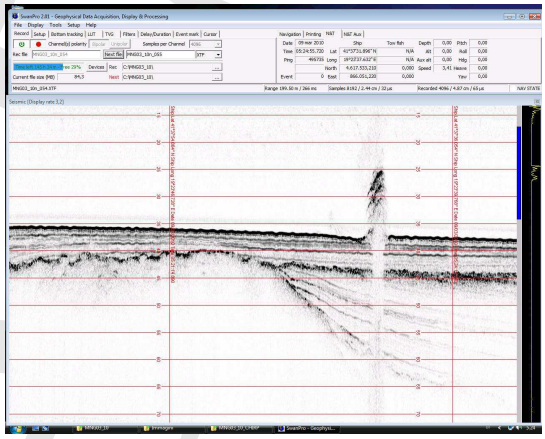

Figure 15. CruiseMNG0310: Ship wreck, Montenegro, CHIRP.

5 CONCLUSIONI

During the 11 days of cruise MNG0310, including transits and port calls, we obtained:

- CTD casting and water sampling along Adriatic transects;
- high-resolution SBP and multibeam coverage on the Montenegrin and Albanese offshore;
- bottow sampling on the Buna-Bojana offshore and in the Bokakotorska;
- ROV investigations

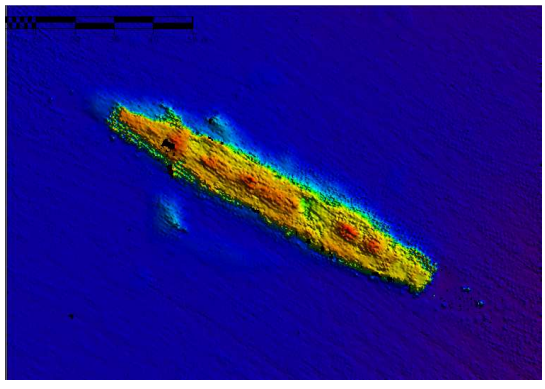

Figure 16. CruiseMNG0310: Ship wreck, Montenegro.

STATION	DATE	DESCRIPTION
BC01	2010-03-09	0-2cm oacre, silty mud, oxidized, liquid on top, presence of *turritella comunis*; 2cm to bottom, olive-gray mud, more plastic
BC02	2010-03-09	0-2cm oacre, silty mud, oxidized, liquid on top, presence of *turritella comunis*, less than BC01; 2cm to bottom, olive-gray mud, more plastic
BC03	2010-03-09	0-2cm oacre, silty mud, oxidized, liquid on top, very scarce presence of *turritella*; 2cm to bottom, olive-gray mud, more plastic
BC04	2010-03-09	25 cm; TOP (0 - 1 cm): silty mud, sub-mm bioclasts, light brown, olive (5Y4/1), oxidyzed 1-5 cm: low plastic clay, low fluid content, non organic, odorless, rare sub-mm bioclatic fragments, darker olive (5Y4/1). BOTTOM (5 cm): very plastic clay, non organic, odorless, no bioclasts. color 5Y4/1. WASHED: 1 valve of bivalve (2-3 mm), 2 young *turritella comunis*, piece of sea-urchin, sub-cm foraminifer; round, reworked black coal clast(?).
BC05	2010-03-09	23 cm; same as BC04 (?)
G01	2010-03-10	Kotor Bay. (?)
G02	2010-03-10	Risan Bay. (?)
G03	2010-03-10	Tivat Bay. Mud with stones. (?)
G04	2010-03-10	Herzeg-novi bay. Mud with shells. (?)

Table 7. Bottom samples description. G=grab, BC=Box-corer

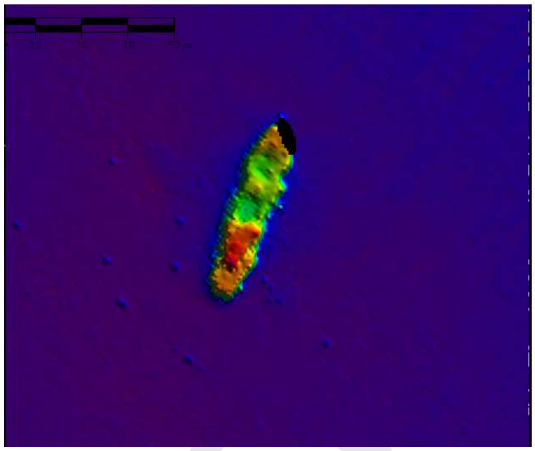

Figure 17. CruiseMNG0310: Ship wreck, Montenegro.

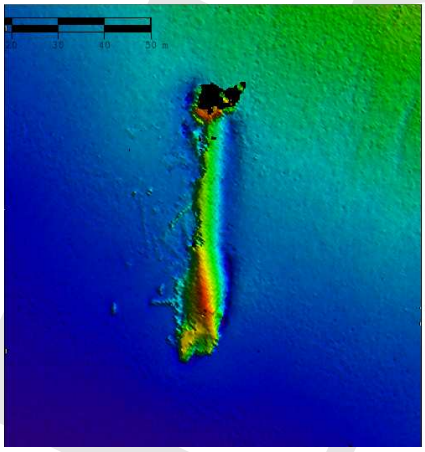

Figure 18. CruiseMNG0310: Ship wreck, Montenegro.

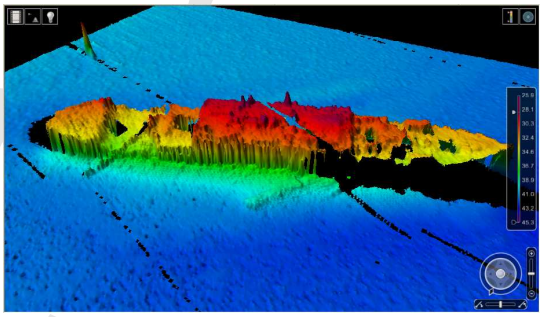

Figure 19. CruiseMNG0310: Ship wreck, Albania.

Analysis of the data collected during the expedition is under process, and will continue during the forthcoming several months.

No problems were encountered regarding neither the people nor the environment during the cruise.

Figure 20. CruiseMNG0310: Box corer 01.

Figure 21. CruiseMNG0310: Box corer 01, washed.

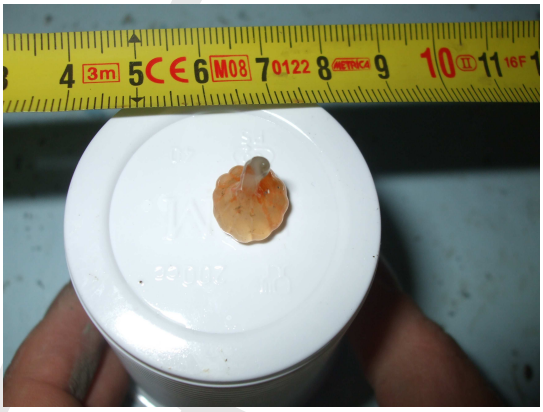

Figure 23. CruiseMNG0310: Box corer BC04, foraminifer.

ACKNOWLEDGMENTS

We are indebted to the officers and crew members of R/V *Urania* for their professionalism and efforts in assuring the success of the cruise.

Figure 22. CruiseMNG0310: Box corer BC04.

REFERENCES

Argnani, A. & Frugoni, F., 1997. Foreland deformation in the central adriatic and its bearing on the evolution of the northern apennines, *Ann. Geophys.*, **40**(3), 77–780.

Argnani, A., Bonazzi, C., Evangelisti, D., Favali, P., Frugoni, F., Gasperini, M., Ligi, M., Marani, M., G., & Mele, G., 1996. Tettonica dell'Adriatico meridionale, *Mem. Soc. Geol. It.*, **51**, 227–237.

Argnani, A., Rovere, M., & Bonazzi, C., 2006. Tectonics and large-scale mass wasting along the slope of the southern adriatic basin, *Geophysical Research Abstracts*, **8**, 07261.

Artegiani, A. & Azzolini, R., 1981. Influence of the Po floods on the western Adriatic coastal water up to Ancona and beyond, *Rapp. Comm. int. Mer Medit.*, **27**(6), 115–119.

Artegiani, A., Bregant, D., Paschini, E., Pinardi, N., Raicich, F., & Russo, A., 1997a. The Adriatic Sea general circulation. Part I: Air-sea interactions and water mass structure, *J. Phys. Oceanogr.*, **27**(8), 1492–1514.

Artegiani, A., Bregant, D., Paschini, E., Pinardi, N., Raicich, F., & Russo, A., 1997b. The Adriatic Sea general circulation. Part II: Baroclinic circulation structure, *J. Phys. Oceanogr.*, **27**(8), 1515–1532.

Bergamasco, A. & Gačìc, M., 1996. Baroclinic response of the adriatic sea to an episode of bora wind, *J. Phys. Oceanogr.*, **26**, 1354–1369.

Bertotti, G., Picotti, V., Chilovi, C., Fantoni, R., Merlini, S., & Mosconi, A., 2001. Neogene to Quaternary sedimentary basins in the south Adriatic (Central Mediterranean):Foredeeps and lithospheric buckling, *Tectonics*, pp. 771–787.

Bignami, F. & et al., 2008. Cruise report adr02_08 urania.

Bignami, F., Mattietti, G., Rotundi, A., & Salusti, E., 1990a. On a Suigimoto-Whitehead effect in the Mediterranean Sea: Sinking and mixing of a bottom current in the Bari Canyon, southern Adriatic Sea, *Deep-Sea Research*, **37**(4), 65–665.

Bignami, F., Salusti, E., & Schiarini, S., 1990b. Observations on a bottom wein of dense water in the southern Adriatic and Ionian Seas, *J. Geophys. Res.*, **95**, 7249–7259.

Book, J. M., Signell, R. P., & Perkins, H., 2007. Measurements of storm and nonstorm circulation in the northern Adriatic: October 2002 Through April 2003, *J. Geophys. Res.*, **112**, C11–S92.

Boore, D. M., Sims, J. D., Kanamori, H., & Harding, S., 1981. The Montenegro, Yugoslavia, earthquake of April 15, 1979: source orientation and strength, *Phys. Earth Planet. Int.*, **27**, 133–142.

Bortoluzzi, G., Bianco, F. D., D'Oriano, F., Giglio, F., Taticchi Mandolini Borgia, T., Santi, D., Bulatovic, A., Devic, N., Radojevic, D., Matovic, M., Sretenovic, A., Diaconov, A., & Tola, M., 2009a. Report on the morphobathymetric, oceanographic, geological and geophysical investigations during cruise MNG01_09 (19-27 April 2009, R/V Urania), Tech. rep., ISMAR-CNR, projects.bo.ismar.cnr.it/CRUISE_REPORTS/2009/MNG0109_REP.

Bortoluzzi, G., Bianco, F. D., Giglio, F., D'Oriano, F., Chedy, V., Bulatovic, A., Kljajic, Z., & Muccini, F., 2009b. Report on the morphobathymetric, oceanographic, geological and geophysical investigations during cruise MNG02_09 (11-24 july 2009, R/V Mariagrazia, Montenegro.), Tech. rep., ISMAR-CNR, projects.bo.ismar.cnr.it/CRUISE_REPORTS/2009/MNG0209_REP.

Buljan, M. & Zore-Armanda, M., 1976. Oceanographical properties of the Adriatic Sea, *Oceanogr. Mar. Biol. Ann. Rev.*, **14**, 11–98.

Canals, M., Danovaro, R., Heussner, S., Lykousis, V., Puig, P., Trincardi, F., Calafat, A., de Madron, X., Palanques, A., & Sanchez-Vidal, A., 2009. Cascades in Mediterranean submarine grand canyons, *Journ. Oceanography*, **22**(1), 26–43.

Console, R. & Favali, P., 1981. Study of the Montenegro earthquake sequence (March-July 1979), *Bull. Seismol. Soc. Am.*, **71**, 1233–1248.

Cushman-Roisin, B., Gačìc, Poulain, P. M., & Artegiani, A., 2001. *Physical Oceanography of the Adriatic Sea: Past, Present and Future*, Kluwer Acad., Norwell.

De Alteriis, G., 1995. Different foreland basins in italy: examples from the central and southern adriatic sea, *Tectonophysics*, **252**, 349–373.

Degobbis, D., Travizi, A., & Jaklin, A., 1993. Meccanismi di formazione di strati di fondo ipossici e anossici nel bacino dell'Alto Adriatico settentrionale e reazioni delle comunita' bentoniche, in *Ipossie e anossie di fondali marini. L'Alto Adriatico e il Golfo di Trieste*, eds Orel, G., Umani, S. F., & Aleffi, F., Regione Autonoma Friuli-venezia Giulia.

Degobbis, D., Precali, R., Ivancic, I. I., Smodlaka, N., Fuks, D., & Kveder, S., 2000. Long-term changes in the northern Adriatic ecosystem related to anthropogenic eutrophication, *Int. J. Environment and Pollution*, **13**(1-6), 495–533.

Fleury, P., Bakalowicz, M., & de Marsily, G., 2007. Submarine springs and coastal karst aquifers: a review, *J. of Hydrology*, **339**, 79–92.

Franco, P., Jeftić, L., Malanotte Rizzoli, P., Michelato, A., & Orlić, M., 1982. Descriptive model of the northern Adriatic, *Oceanol. Acta*, **5**(3), 379–389.

Gasperini, L. & Stanghellini, G., 2009. SEISPRHO: an interactive computer program for processing and interpretation of high-resolution seismic reflection profiles, *Comp. Geosci.*, **37**(7), 1497–1507.

Hopkins, T. S., Kinder, C., Artegiani, A., & Pariante, R., 1999. A discussion of the northern Adriatic circulation and flushing as determined from the ELNA hydrography, in The Adriatic Sea, in *Ecosystem Report*, vol. 32, pp. 85–106, ed. et al., T. S. H., European Commission, Brussels, Belgium, EUR 18834.

Jeffries, M. A. & Lee, C. M., 2007. A climatology of the northern Adriatic Sea's response to bora and river forcing, *J. Geophys. Res.*, **112**, C03–S02.

Malanotte-Rizzoli, P., 1991. The Northern Adriatic Sea as a prototype of convection and water mass formation on the continental shelf, in *Deep Convections and Deep Water Formation in the Oceans*, vol. 57 of **Elsevier Oceanography Series**, pp. 229–239, eds Chu, P. & Gascard, J., Elsevier.

Orlić, M., Gačić, M., & Violette, P. L., 1992. The currents and circulation of the Adriatic Sea, *Oceanol. Acta*, **15**(2), 109–124.

Ovchinnikov, I. M., Zats, V. I., Krivosheya, V. G., & Idodov, A. I., 1985. The formation of deep Eastern Mediterranean Waters in the Adriatic Sea, *Okeanologija*, **25**, 911–917, English translation:

Oceanology, 25, 704-707.

Poulain, P. M. & Cushman-Roisin, B., 1992. Circulation, in *Physical oceanography of the Adriatic Sea*, pp. 67–109, ed. et al., B. C.-R., Kluwer Academic Publishers, Dordrecht, Netherlands.

Poulain, P. M. & Cushman-Roisin, B., 2001. Circulation, in *Physical oceanography of the Adriatic Sea*, pp. 67–109, eds Cushman-Roisin, B., Gacic, M., Poulain, P. M., & Artegiani, A., Kluwer Academic Publishers, Dordrecht, Netherlands.

Poulain, P. M., Kourafalou, V. H., & Cushman-Roisin, B., 2001. Northern Adriatic Sea, in *Physical oceanography of the Adriatic Sea*, pp. 143–165, eds Cushman-Roisin, B., Gacic, M., Poulain, P. M., & Artegiani, A., Kluwer Academic Publishers, Dordrecht, Netherlands.

Rabalais, N. N., Turner, R. E., Justic, D., Dortch, Q., & Wiseman, W. J., 2000. *Integrated Assessment of Hypoxia in the Northern Gulf of Mexico*, vol. 15 of **Coastal Ocean Program Decision Analysis Series**, chap. Topic 1: Report for the Integrated Assessment of Hypoxia in the Gulf of Mexico, p. 167 pp, NOAA, Coastal Ocean Program, Silver Spring, MD.

Raicich, F., 1994. Note on the flow rates of the Adriatic rivers, Tech.report, CNR. Ist. Sper. Talassografico, Trieste, Italy.

Ridente, D. & Trincardi, F., 2005. Pleistocene 'muddy' forced-regression deposits on the Adriatic shelf: A comparison with prodelta deposits of the late Holocene highstand mud wedge, *Mar. Geol.*, **222-223**, 213–233.

Ridente, D., Minisini, D., Trincardi, F., & Verdicchio, G., 2007. The onset of the Bari Canyon System on the South-Western Adriatic Margin, Central Mediterranean, *Mar. Geol.*, **246**, 193–207.

Roure, F., Nazaj, S., Mushka, K., Fili, I., Cadet, J., & Bonneau, M., 2004. Kinematic evolution and petroleoum systems - an appraisal of the Outer Albanides, in *Thrust tectonics and hydrocarbon systems*, vol. 82 of **AAPG Memoires**, pp. 474–493, ed. McClay, K. R., AAPG.

Russo, A. & Artegiani, A., 1996. Adriatic Sea hydrography, *Sci. Mar.*, **60**(Suppl. 2), 33–43.

Russo, A., Coluccelli, A., Iermano, I., Falcieri, F., Ravaioli, M., Bortoluzzi, G., Focaccia, P., Stanghellini, G., Ferrari, C. R., Chiggiato, J., & Deserti, M., 2009. An operational system for forecasting hypoxic events in the northern Adriatic Sea, *Geofizika*, **26**(2), 191–212.

Simunovic, A., Piccinetti, C., & Zore-Armanda, M., 1999. Kill of benthic organisms as a response to anoxic state in the northern adriatic (a critical review), *Acta Adriat.*, **40**(1), 37–47.

Tiberti, M. M., Lorito, S., Basili, R., Kastelic, V., Piatanesi, A., & Valensise, G., 2008. Scenarios of earthquake-generated tsunamis in the Adriatic Sea, *Pure Appl. Geophys.*, **65**(11-12).

Trincardi, F., Verdicchio, G., & Miserocchi, S., 2007. Seafloor evidence for the interaction between cascading and along-slope bottom water masses, *J. Geophys. Res.*, **112**, F03011.

Ursella, L., Poulain, P. L., & Signell, R. P., 2006. Surface drifter derived circulation in the northern and middle adriatic sea: Response to wind regime and season, *J. Geophys. Res.*, **111**, C03–S04.

Vibilič, I. & Supič, N., 2005. Dense water generation on a shelf: the case of the Adriatic Sea, *Ocean. Dynam.*, **55**, 403–415.

Wessel, P. & Smith, W. H. F., 1998. New, improved version of generic mapping tools released, *EOS Trans. Amer. Geophys. U.*, **79**(47), 579.

Wu, R. S. S., 2002. Hypoxia: from molecular responses to ecosystem responses, *Marine Pollution Bulletin*, **45**, 35–45.

Zore-Armanda, M., 1956. On gradient currents in the Adriatic Sea, *Acta Adriat.*, **8**(6), 1–38.

LON-LAt (ddmm.xxx)	UTM34	CTD	
1554.850 4200.400	78789 4663044	CTD-003	Mar 04 2010 12:22:45
1555.240 4203.870	79710 4669436	CTD-004	Mar 04 2010 13:00:07
1556.010 4206.020	81009 4673353	CTD-005	Mar 04 2010 13:32:27
1557.290 4211.910	83419 4684152	CTD-006	Mar 04 2010 14:34:05
1558.780 4217.250	86054 4693917	CTD-007	Mar 04 2010 15:33:42
1337.500 4401.380	-91110 4900940	CTD-008	Mar 05 2010 09:52:27
1332.140 4358.140	-98818 4895589	CTD-009	Mar 05 2010 10:42:28
1327.160 4354.670	-106068 4889773	CTD-010	Mar 05 2010 11:37:05
1321.530 4351.410	-114166 4884434	CTD-011	Mar 05 2010 12:37:51
1317.950 4348.800	-119416 4880048	CTD-012	Mar 05 2010 13:21:12
1237.220 4407.240	-170539 4919536	CTD-013	Mar 05 2010 17:43:00
1243.930 4412.340	-160633 4928068	CTD-015	Mar 05 2010 18:59:12
1246.780 4414.220	-156486 4931166	CTD-016	Mar 05 2010 19:27:11
1251.050 4417.970	-150107 4937539	CTD-017	Mar 05 2010 20:08:29
1254.960 4420.680	-144410 4942039	CTD-018	Mar 05 2010 20:44:28
1300.160 4424.250	-136851 4947967	CTD-019	Mar 05 2010 21:30:15
1304.980 4428.410	-129703 4955043	CTD-020	Mar 05 2010 22:20:33
1308.560 4500.440	-119196 5013886	CTD-021	Mar 06 2010 02:01:14
1302.470 4500.250	-127230 5014320	CTD-022	Mar 06 2010 02:47:43
1255.350 4459.970	-136633 5014733	CTD-023	Mar 06 2010 03:37:16
1249.680 4458.900	-144282 5013504	CTD-024	Mar 06 2010 04:18:18
1239.810 4458.080	-157408 5013315	CTD-025	Mar 06 2010 05:21:55
1236.180 4458.100	-162175 5013848	CTD-026	Mar 06 2010 05:54:09
1227.430 4444.490	-176345 4989861	CTD-027bis	ctd bis Mar 06
1227.410 4444.510	-176368 4989900	CTD-027	ctd Mar 06 2010
1234.430 4408.550	-174011 4922345	CTD-028	Mar 06 2010 12:53:17
1421.040 4226.950	-46902 4721118	CTD-029	Mar 07 2010 03:42:24
1422.780 4228.480	-44293 4723764	CTD-030	Mar 07 2010 04:08:54
1424.220 4229.560	-42163 4725609	CTD-031	Mar 07 2010 04:32:16
1426.360 4232.260	-38842 4730380	CTD-032	Mar 07 2010 05:04:49
1430.290 4235.190	-33043 4735390	CTD-033	Mar 07 2010 05:46:30
1434.590 4238.400	-26706 4740882	CTD-034	Mar 07 2010 06:28:47
1439.200 4242.160	-19879 4747367	CTD-035	Mar 07 2010 07:14:42
1444.770 4251.150	-11033 4763443	CTD-036	Mar 07 2010 08:26:55
1455.610 4252.080	3858 4764080	CTD-037	Mar 07 2010 09:38:47
1504.540 4254.730	16367 4768117	CTD-038	Mar 07 2010 10:38:49
1510.980 4254.910	25154 4767837	CTD-039	Mar 07 2010 11:25:54
1603.720 4240.070	95309 4735764	CTD-040	Mar 07 2010 15:56:05
1823.750 4212.300	285015 4675821	CTD-041	Mar 08 2010 04:27:47
1833.940 4221.980	299549 4693322	CTD-042	Mar 08 2010 09:04:02
1854.490 4209.640	327192 4669733	CTD-043	Mar 08 2010 11:50:10
1908.680 4154.130	346108 4640578	CTD-044	Mar 08 2010 14:40:08
1920.050 4149.760	361669 4632169	CTD-045	Mar 08 2010 15:58:08
1922.260 4149.510	364719 4631648	CTD-046	Mar 08 2010 17:43:06
1919.140 4141.600	360115 4617093	CTD-047	Mar 08 2010 22:31:49
1919.600 4145.900	360908 4625038	CTD-048	Mar 09 2010 10:18:04
1920.520 4147.530	362240 4628030	CTD-049	Mar 09 2010 10:48:37
1921.230 4148.680	363264 4630139	CTD-050	Mar 09 2010 11:13:16
1921.530 4149.270	363700 4631223	CTD-051	Mar 09 2010 11:33:21
1921.930 4149.890	364276 4632359	CTD-052	Mar 09 2010 11:55:30
1754.070 3919.160	232851 4356794	CTD-1ionio	Mar 03 2010 11:05:52
1828.000 3953.840	283419 4419435	CTD-2-leuca	Mar 03 2010 16:27:50

Table A1. CTD on cruise MNG0310.

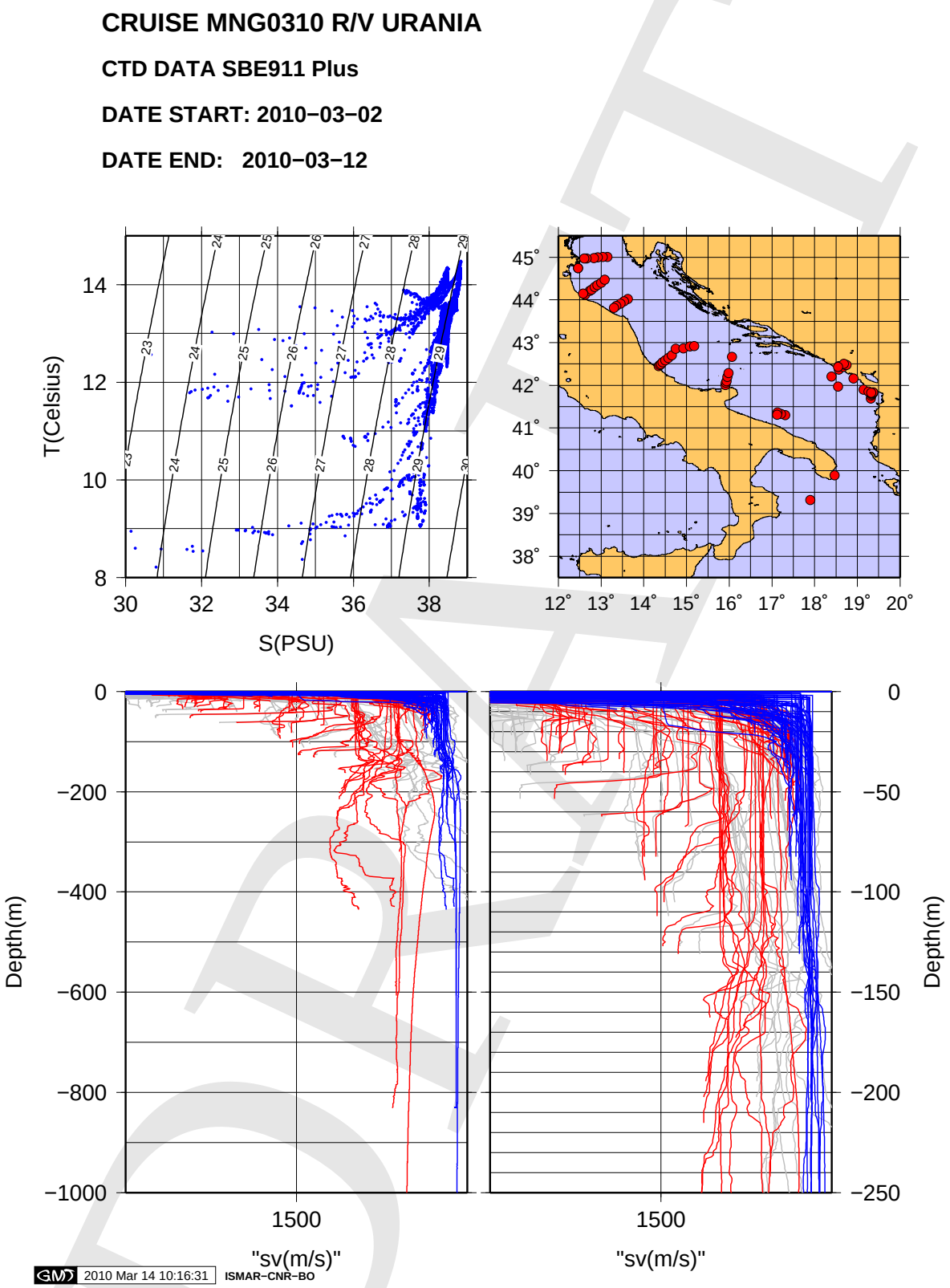

Figure A1. CTD data of MNG0310.

DATE	OPERATIONS
2010-03-02 mob Messina. Departure 18:30 local, head to S.Maria di Leuca, CTD, CHIRP, MULTIBEAM	
2010-03-03 transit, CTD, CHIRP, MULTIBEAM	
2010-03-04 CTD Gargano, CTD, CHIRP, MULTIBEAM	
2010-03-05 transit CTD Senigallia, CTD, CHIRP, MULTIBEAM	
2010-03-06 transit CTD Po-Rovinij, Rimini, CTD, CHIRP, MULTIBEAM	
2010-03-07 transit CTD Pescara, CTD, CHIRP, MULTIBEAM	
2010-03-08 Zelenika 08:00 embark Montenegrin Albanese, CTD, CHIRP, MULTIBEAM	
2010-03-09 Chirp, Multibeam Bojana,CTD, CHIRP, MULTIBEAM, Box corer	
2010-03-10 Chirp, Multibeam, Bokakotorska ROV, GRABS,CTD, CHIRP, MULTIBEAM	
2010-03-11 08:00 Disembark Montenegrin, Albanese people, head to Bari CTD, CHIRP, MULTIBEAM	
2010-03-12 12:00 de-mob Bari	

Table A2. Diary of Operations.