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Report on the oceanographical, geological, geophysical activities during Cruise MNG0310 with R/V *Urania* : Adriatic Sea, 2010-03-02 - 2010-03-12. Projects EMMA (Dr. M. Ravaioli) and ADRICOSM (Prof. N. Pinardi).

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SUMMARY
We present the shipboard activities and results of Cruise MNG0310(2010-03-02- 2010-03-12)) with R/V *Urania* . The cruise was scheduled to acquire seasonal oceanographic data on the Adriatic Sea along the Gargano, Pescara, Senigallia, Rimini and Po Delta transects. In addition, bottom sampling, swath bathymetry and SBP activities were performed on the Montenegro and Northern Albania offshore.

Key words: Oceanography – Bathymetry – SBP – Adriatic Sea – Montenegro – Albania

1 INTRODUCTION AND SETTING

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.

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.

1.1 Geological and Oceanographical Setting

GEOLOGICAL SETTING

The Adriatic Sea (Fig.1) is an epicontinental sea showing two margin configurations, north and south of the Gargano Promontory (Ridente & Trincardi (2005) and references therein).

The northern Adriatic (NA) Sea is bounded by the Italian peninsula to the eest and by the Balkans to the east (Fig. 1) and is the northernmost part of the Mediterranean Sea. It is caharacterized by very shallow environment, with an average depth of ∼35 m, and regularly and gently slopes toward the south until the 120 m isobath, taken as its southern open boundary, approximately north of 43:20 (Artegiani et al. 1997a; Russo & Artegiani 1996; Poulain et al. 2001). Other authors consider Ancona or Rimini to be the southern limit of the NA.

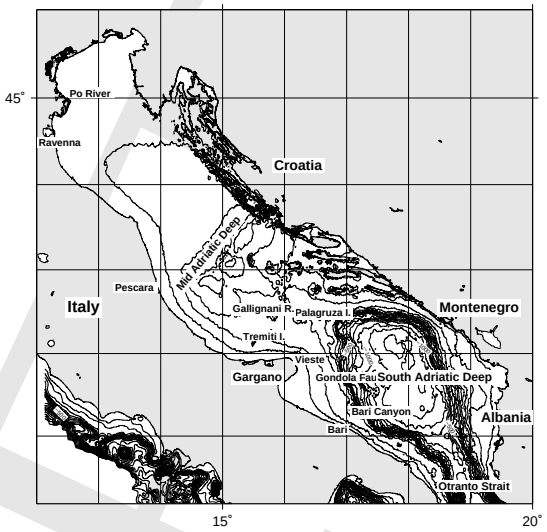

Figure 1. Adriatic Sea setting.

The Central area is characterized by the Mid Adriatic Deep (MAD), a remnant basin, 260 m deep, separated in 2 depocenters by the Central Adriatic deformation belt (Argnani & Frugoni 1997), and bordered by the Gallignani and Pelagosa (Palagruža) ridges to the south and by the structural high of the Tremiti Islands. The two depressions of the MAD are likely to be filled by the NadDW.

The southern area (Argnani et al. 2006) is characterized by a sub-circular depression, more than 1200 m deep (Southern Adriatic Deep, SAD), located between the coasts of Puglia, to the west, and Albania, Montenegro and Croatia to the east, considered the current foredeep of the Dinaride and Albanide fold-and-thrust belt (De Alteriis 1995; Argnani et al. 1996; Bertotti et al. 2001).

The Montenegrinian and Northern Albanian margins and coastal areas are part of the seismically active W-verging Dinaride/Albanide fold-and-thrust belt along the eastern Adriatic basin boundary (see Fig.1). The margins have relict shelf edge, with sediment stored on the albanian coastline, and evidence of large-scale mass wasting (Argnani et al. 2006; Roure et al. 2004). The continental shelf is very narrow from N in Croatia to C. Patamuni S of the Bay of Kotor, near Budva, where it develops offshore down to C. Rodonit. The seismic activity is present in the study area as moderate to strong intensity events. In partic-

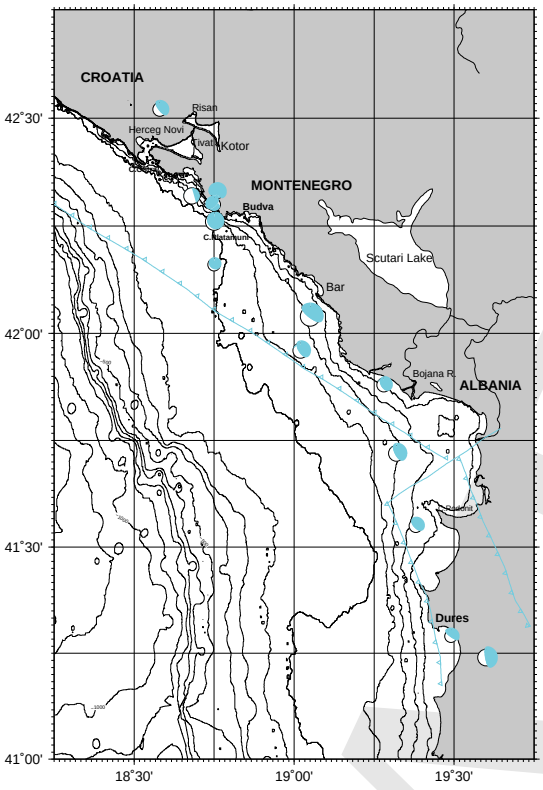

Figure 2. Structural setting of Montenegro.

ular, it must be cited the M6.9 destructive event of 1979-04-15 and aftershocks in the Bar region (Console & Favali 1981; Boore et al. 1981), whose epicenter was located offshore 5-10 NM, at the most external thrust. The area south of the mouth of Bojana River to W and SW of Cape Rodonit is also seismically active, being interested by a WNE pure-compression thrust and by ENE trending strikeslip faults (Aliaj et al. 2004; Aliaj 2008). According to Tiberti et al. (2008) and therein cited authors, the events have large potential for generating tsunamis.

Because of karst environment in the Dinaric range, especially in N Montenegro, coastal aquifers may also develop at sea with submarine syphons, springs and resurgences, within a geological and hydrogeological setting strongly related to tectonics and to past (and future) climate and sea level fluctuations (Fleury et al. 2007)

Oceanographical setting

The following notes are from Russo et al. (2009). Being an epicontinental basin, the hydrology and dynamics of the NA are primarily influenced by meteorological forcing, thermal variations and river runoff. Climatological studies (see Cushman-Roisin et al. (2001) and citations therein) indicate that prominent weather situations in the NA include unperturbed weather or airflow from the northwestern, northeastern and south-eastern quadrants (respectively Etesian, Bora and Sirocco winds; these two last are the most frequent winds in the area and often trigger severe wind-storms). The NA receives approximately 20 % of the total Mediterranean river runoff (Russo & Artegiani 1996), mainly from the Po River, average flow rate approximately 1500 m^3/y (Artegiani & Azzolini 1981; Raicich 1994). This leads to a net gain of fresh water. In autumn, intense cooling and evaporation processes, usually associated with Bora wind events over the NA, create conditions for dense water formation during the winter (Vibilič & Supič 2005).

Due to runoff and heating in the late spring and summer and to autumn-winter cooling, gradient currents are established within a cyclonic circulation system (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) consisting of an entering NW-ward current (the Eastern Adriatic Current, EAC), and an exiting SE-ward current (the Western Adriatic Current, WAC), that introduce warmer and saltier water into the subbasin, while pushing fresher water towards the southern regions. The general circulation pattern in the NA is also largely affected by wind. Bora episodes can generate a transient double gyre circulation consisting of a cyclone north of Po delta and an anticyclone to the south, driving the upwind extension river plume filaments (Jeffries & Lee 2007); an anticyclonic circulation also develops along the southern Istrian coast (Poulain & Cushman-Roisin 1992, 2001), while Bora enforce flow in the WAC (Book et al. 2007; Ursella et al. 2006).

The NA Sea is one of the most biologically productive regions of the whole Mediterranean. The rate of oxygen consumption due to biogeochemical processes is the largest of the entire Adriatic basin, with a maximum occurring around the Po River delta area (Artegiani et al. 1997b). This region can thus be regarded as a favourable environment for the development of hypoxic conditions. The formation of a hypoxic bottom layer in wide areas of the basin (Degobbis et al. 1993, 2000) can cause major ecological problems such as the mass mortality of marine animals, defaunation of benthic populations and a decline in fisheries production.

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 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.

2 MATERIALS AND METHODS

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.

Figure 3. R/V *Urania* .

2.1 NAVIGATION, CHIRP SBP, SWATH BATHYMETRY

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

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

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

MULTIBEAM BATHYMETRY

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. 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.1. 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.

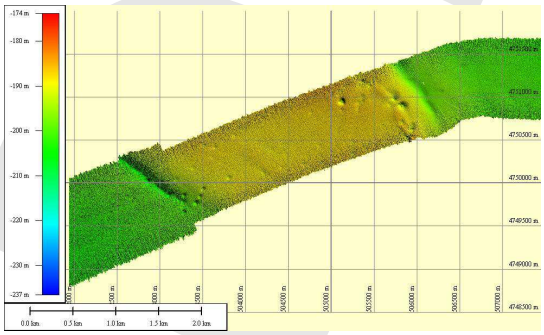

Figure 4. CruiseMNG0310: pokmark filed on faults and tectonic lineaments on top of Gallignani Ridge, Pomo.

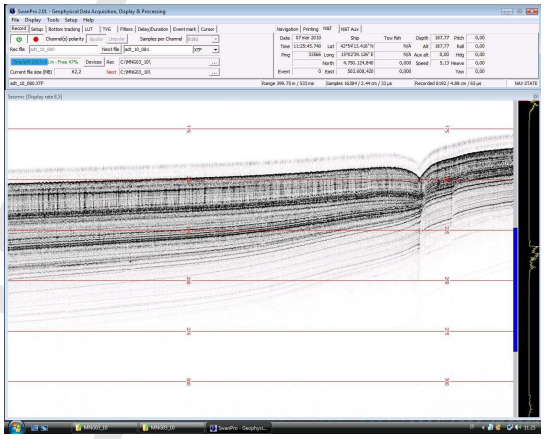

Figure 5. CruiseMNG0310: fault on top of Gallignani Ridge(WSE), Pomo (see Fig. 4).

BOTTOM SAMPLING

Bottom sampling was performed by 60cm diameter box corer and grab. Table 3 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 A4 in the appendix shows the position of the stations.

MAGNETOMETRY

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.

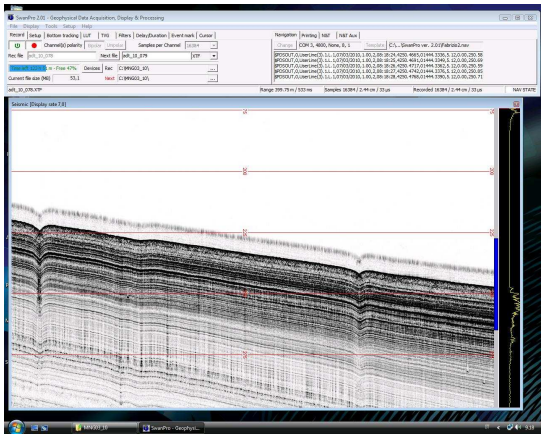

Figure 6. CruiseMNG0310: pokmark filed on top of Gallignani Ridge, Pomo.

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

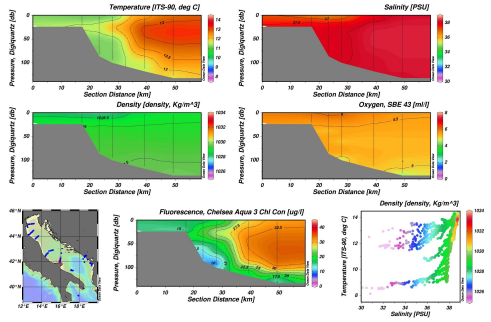

Figure 7. CruiseMNG0310: Gargano transect.

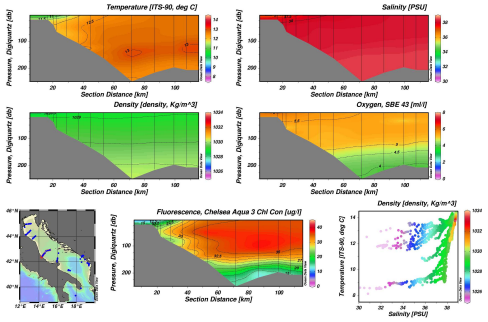

Figure 8. CruiseMNG0310: Pescara transect.

MAPPING AND MISCELLANEOUS

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.

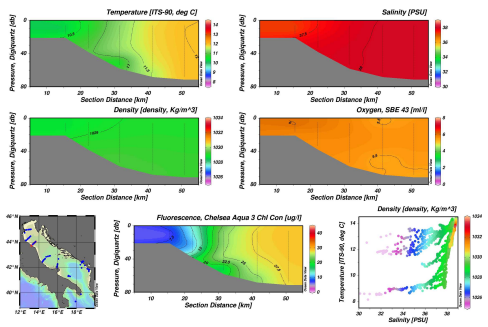

Figure 9. CruiseMNG0310: Senigallia transect.

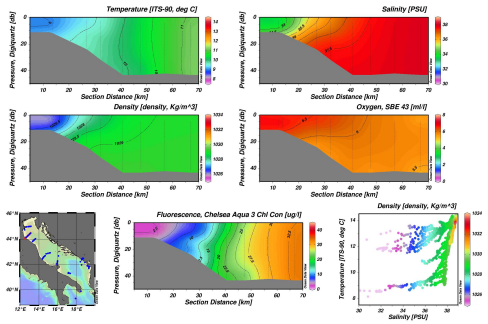

Figure 10. CruiseMNG0310: Rimini transect.

3 INITIAL RESULTS

OCEANOGRAPHY

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 7, 8, 9, 10 and 11). In addition, some CTD casts were performed on the Eastern coast during the activities on Montenegro and Albania.

In the Appendix Table A4 shows the CTD data collected during cruise MNG0310, and figure A4 plots a summary of the data.

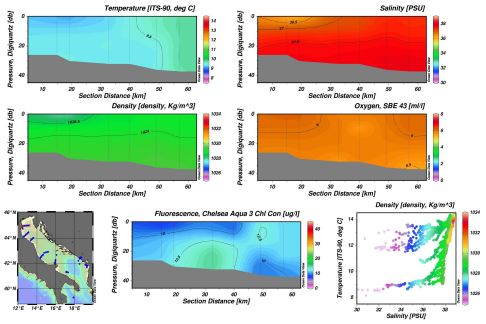

Figure 11. CruiseMNG0310: Po Delta transect.

BATHYMETRY, CHIRP

During MNG0310cruise, high-resolution morpho-bathymetric 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.

BOTTOM SAMPLING

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

4 CONCLUSIONS

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;

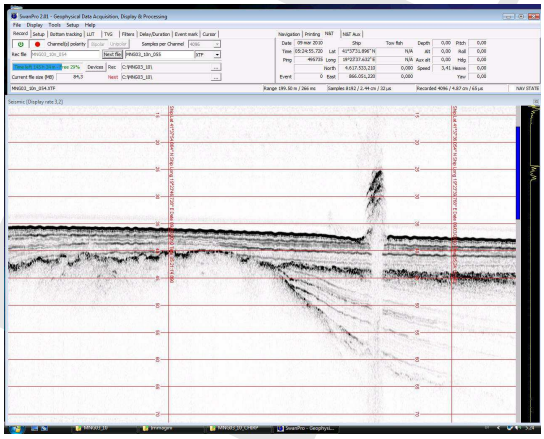

Figure 12. CruiseMNG0310: Ship wreck, Montenegro, CHIRP.

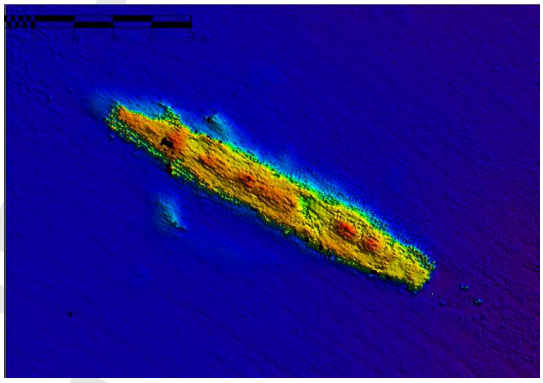

Figure 13. CruiseMNG0310: Ship wreck, Montenegro.

- bottow sampling on the Buna-Bojana offshore and in the Bokakotorska;
- ROV investigations

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.

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.

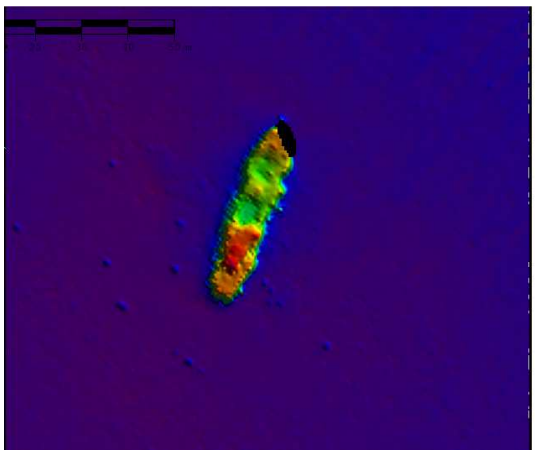

Figure 14. CruiseMNG0310: Ship wreck, Montenegro.

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

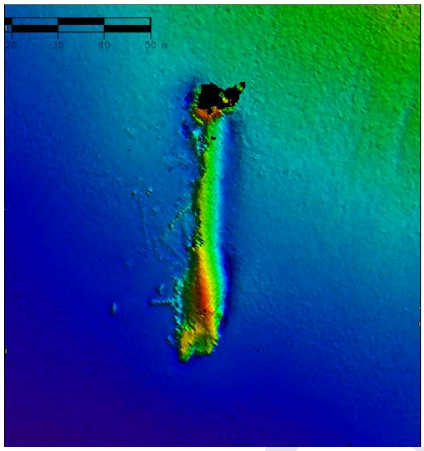

Figure 15. CruiseMNG0310: Ship wreck, Montenegro.

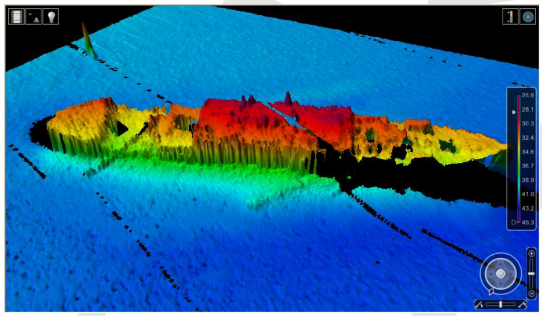

Figure 16. CruiseMNG0310: Ship wreck, Albania.

Figure 17. CruiseMNG0310: Box corer 01.

Figure 18. CruiseMNG0310: Box corer 01, washed.

Figure 19. CruiseMNG0310: Box corer BC04.

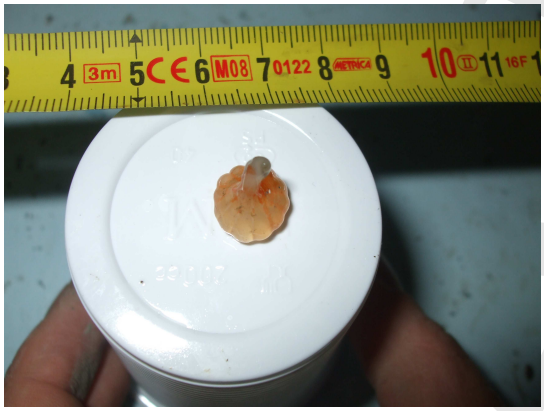

Figure 20. CruiseMNG0310: Box corer BC04, foraminifer.

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APPENDIX A: 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 A1. Cruise Summary.

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 A2. Scientific and technical parties

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 A3. Diary of Operations.

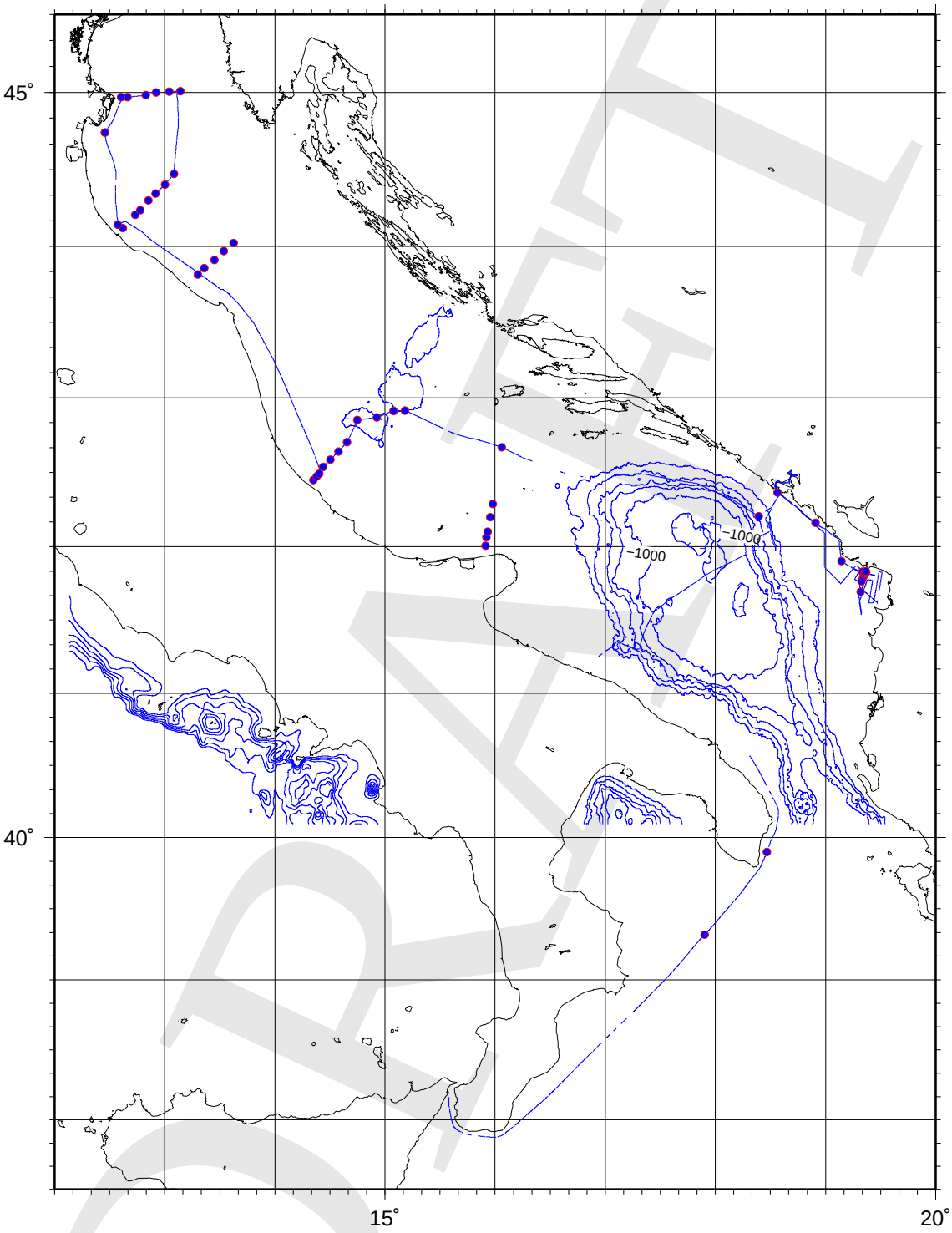

Figure A1. Whole ship track during Cruise MNG0310. Blue circles are CTD stations. Blue line shows CHIRP lines.

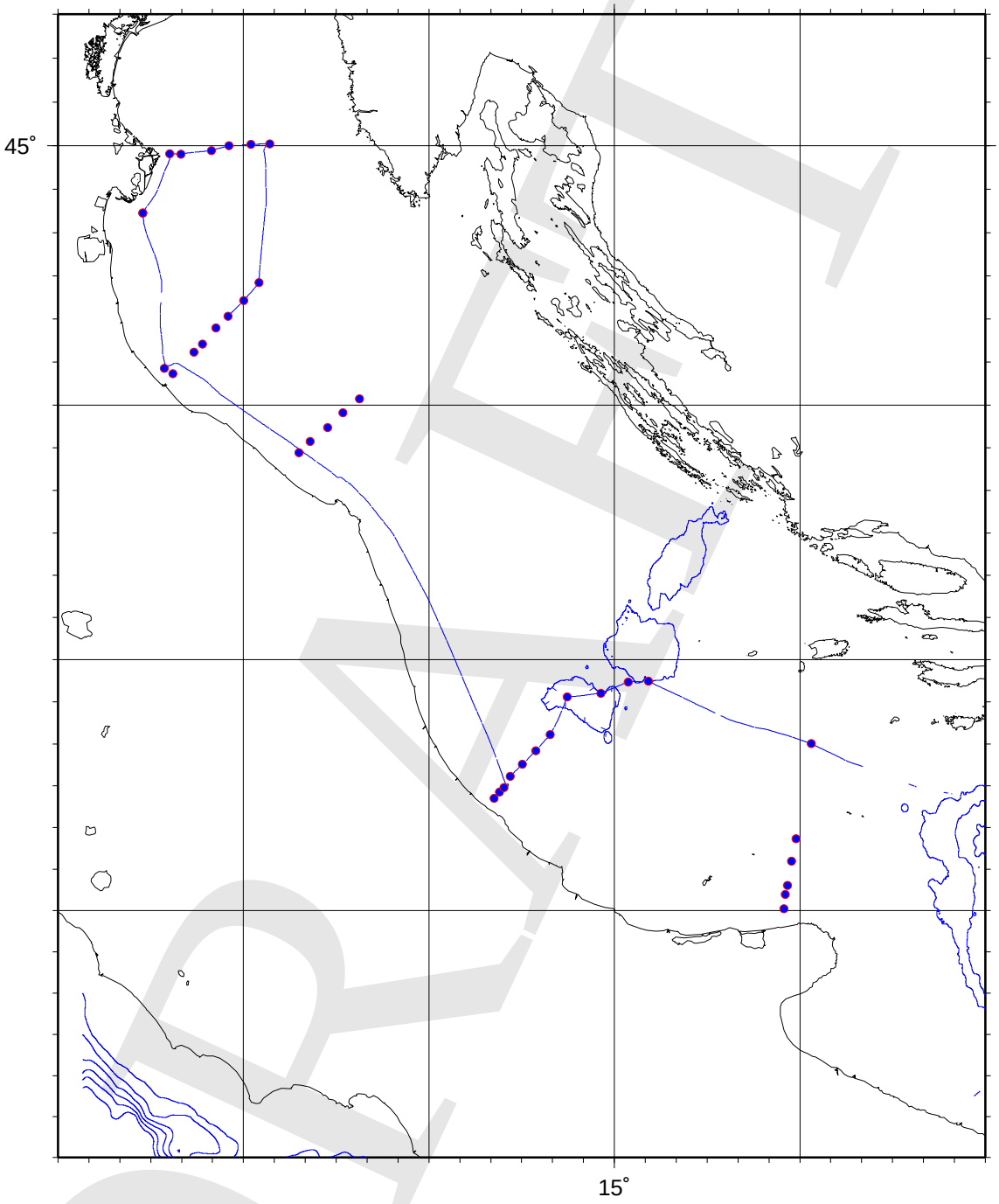

Figure A2. Whole ship track during Cruise MNG0310. Blue circles are CTD stations.

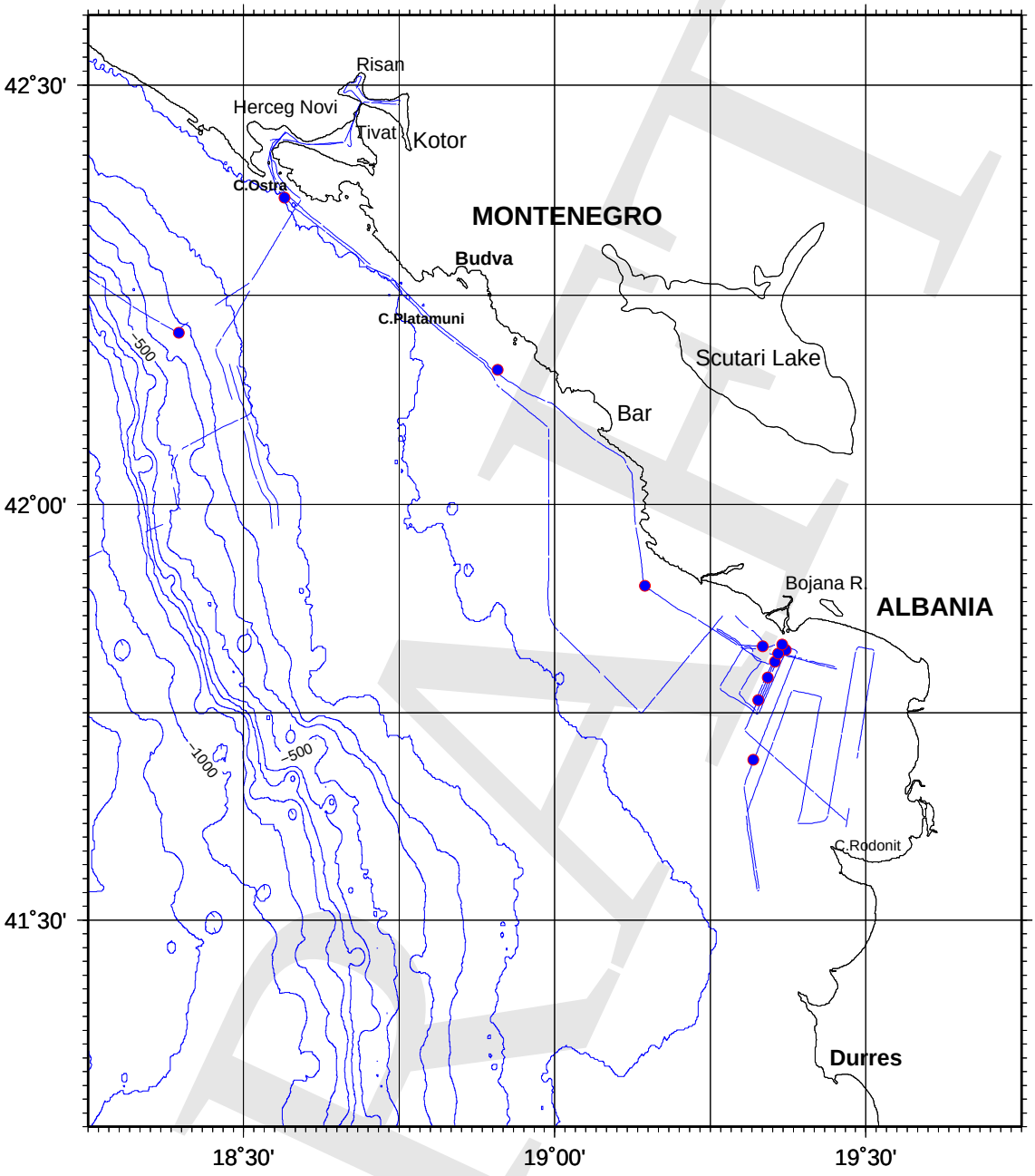

Figure A3. Whole ship track during Cruise MNG0310. Blue circles are CTD stations. Blue line show CHIRP data.

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 A4. CTD on cruise MNG0310.

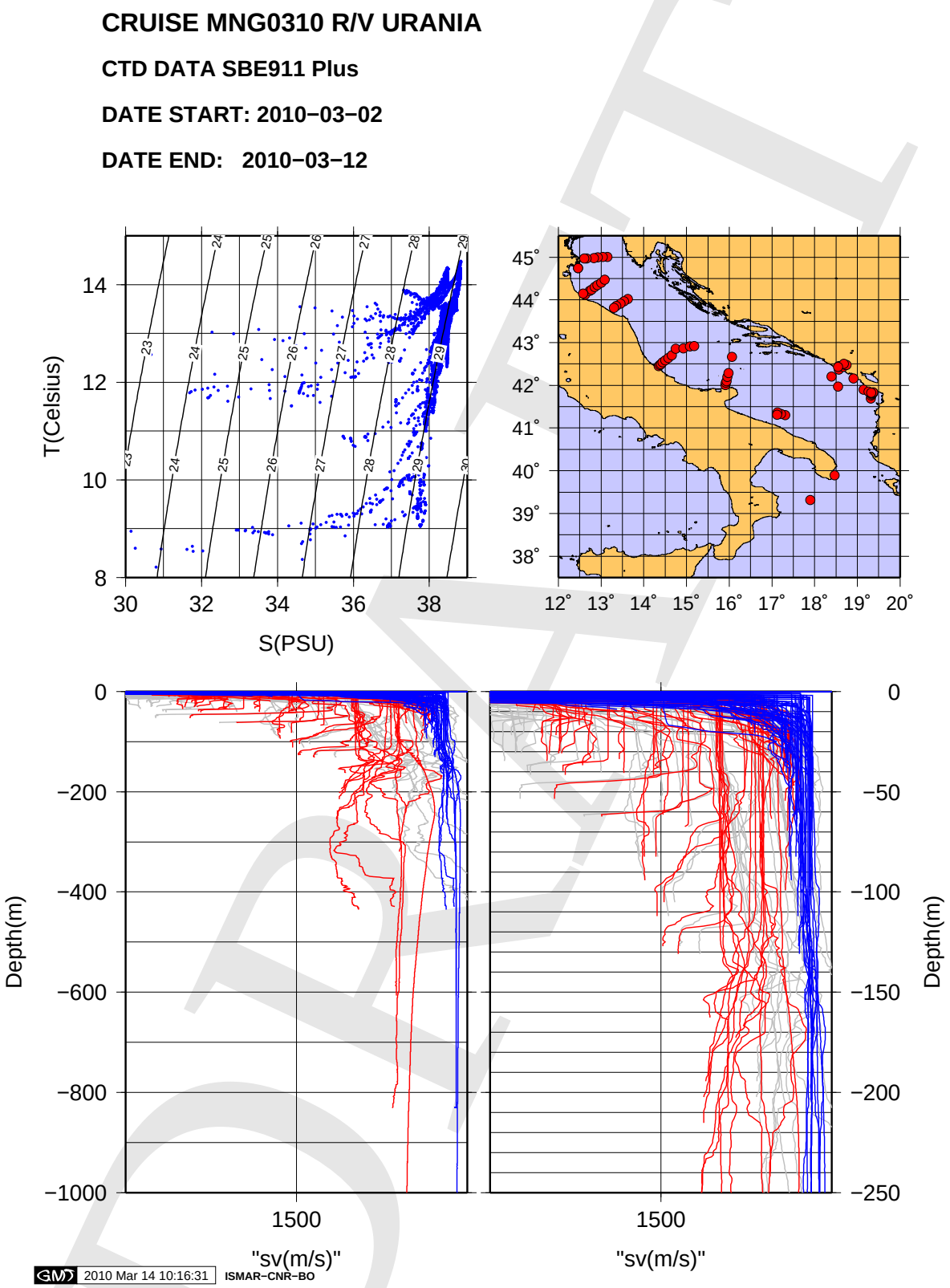

Figure A4. CTD data of MNG0310.

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 A5. Acronyms of Organizations, Manufacturers and Products