RAPPORTI ISMAR (2011) **2**, 1–52

Report on the oceanographical, bio-geochemical, geophysical and geological activities during Cruise ENVADRI2011with R/V *Urania* : Adriatic Sea, 2011-04-07- 2011-04-20. Projects ENVEUROPE (A.Pugnetti, M.Ravaioli, Project Coordinator and Manager) and LTER.

M. Bastianini[1],
F. Bernardy Aubry, F. Braga, E. Camatti, S. Finotto, G.Socal[1],
G. Bortoluzzi, F. Chiarini, E. Dal Passo, F. Del Bianco[2],
P. Focaccia, F. Giglio, E. Lipparini, F. Riminucci[2],
G. Caccamo, A. Campanelli, E. Frapiccini[3],
P. Del Negro, C. Fabbro[4],
A. Ianora, C. Lauritano, V. Roncalli[5],
A. Colluccelli, E. Carone, S. Santangeli, A. Miccoli[6],
L. Bertello, S. Saracino[7],
Z. Kljajic, A. Jovicic[8],
M.L. D'Amico, A. Girolimetto[9]

[1] *CNR, Istituto di Scienze Marine, Arsenale-Tesa 104, Castello 2737/F, 30122 Venezia, Italy*
[2] *CNR, Istituto di Scienze Marine, Bologna, Italy*
[3] *CNR, Istituto di Scienze Marine, Ancona, Italy*
[4] *INOGS, Trieste, Italy*
[5] *SZN, Napoli, Italy*
[6] *Universita' Politecnica Marche, Ancona, Italy*
[7] *Universita', Bologna, Italy*
[8] *IBMK, Kotor, Montenegro*
[9] *ARPAV, Veneto, Italia*

Received: May 2011 / Accepted: May 2011 - PDF FOR PRINT

SUMMARY
We present the shipboard activities and results of Cruise ENVADRI2011(2011-04-07- 2011-04-20)) with R/V *Urania* , performed in the framework of EU Life+ project EnvEurope. The cruise was scheduled to acquire seasonal oceanographic data on the Adriatic Sea along the Trieste and Venice gulfs, the Po Delta, Rimini, Senigallia, Pescara and transects. CTD casts, water, plankton and particulate sampling, optical properties measurements, bottom sampling and geophysical investigations (swath bathymetry, SBP, ADCP) were performed. The same activities, including also Single Channel Reflection Seismic, were performed in the Montenegro offshore.

Vengono presentate le attivita' ed i risultati preliminari della crociera ENVADRI2011(2011-04-07- 2011-04-20)con R/V *Urania* , all'interno del progetto EU Life+ project EnvEurope. Le attivita' principali previste erano la acquisizione di dati oceanografici stagionali lungo transetti nei golfi di Trieste e Venezia, Delta del Po, Rimini, Senigallia, Pescara. Si sono effettuate operazioni di calate CTD, campionamento di acqua, organismi plantonici e particolato, misure delle proprieta' ottiche, campionamento del fondo mare e indagini geofisiche (batimetria multifascio, SBP, ADCP). Le stesse attivita', con aggiunta di sismica a riflessione monocanale, si sono svolte in Montenegro.

Key words: Plankton - Nutrients - Ecophysiology – Optical properties – Oceanography – Bathymetry – CHIRP – Single Channel Seismic – Northern Adriatic Sea – Central Adriatic Sea – Montenegro

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYM	DESCRIPTION	URL-email
CNR	Consiglio Nazionale Delle Ricerche	www.cnr.it
ISMAR	Istituto di Scienze Marine	www.ismar.cnr.it
INOGS	Ist. Nazionale Oceanografia Geofisica Speriment.	www.ogs.trieste.it
SZN	Stazione Zoologica 'Anton Dohrn', Napoli	www.szn.it
ARPAV	Agenzia Reg. Prevenzione protezione Amb. del Veneto	www.arpa.veneto.it
UNIVPM	Universita' Politecnica delle Marche	www.univpm.it
IBMK	Inst.Marine Biology, Kotor	www.ibmk.org/indexe.htm
LIFE	EU's financial instrument supporting environmental and nature conservation projects throughout the EU	ec.europa.eu/environment/life
ENVEUROPE	Environmental quality and pressures assessment across Europe	www.enveurope.eu
EMMA	Environmental Management trough Monitoring and Modeling of Anoxia	emma.bo.ismar.cnr.it
LTER	European Long-Term Ecosystem Research Network	http://www.lter-europe.net
GMES	Global Monitoring for Environment and Security	ec.europa.eu/gmes
ADRICOSM	ADRIatic COastal areaS and river basin Management system pilot project	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
MFS	Mediterranean ocean Forecasting System	www.bo.ingv.it/mfs
MOON	Mediterranean Operational Oceanography	
POM	Princeton Oceanographical Model	www.aos.princeton.edu/WWWPUBLIC/htdocs.pom
ROMS	Regional Ocean Modeling System	www.myroms.org/
SIMC	Servizio Idro-Meteo Clima ARPA, Emilia Romagna	www.arpa.emr.it/sim
ARPA	Agenzie Regionali per la Protezione Ambientale	it.wikipedia.org/wiki/Agenzie_Regionali_per_la_Protezion
SIS	Sea-floor Information System	www.kongsberg.com
SBE	Sea Bird Electronics	www.seabird.com
BENTHOS	Teledyne Benthos	www.benthos.com
SWAN-PRO	Communication Technology	www.comm-tec.com
SB-Logger	Triton SBP Shallow Seismic data Logger	www.tritonimaginginc.com
GMT	Generic Mapping Tool	gmt.soest.hawaii.edu/gmt
MBES	Multibeam Echosounder System	
SCS	Single Channel Seismic	
SBP	Sub Bottom Profiling	
SVP	Sound Velocity Profile	
CTD	Conductivity/Temperature/Depth	
TSM	Total Suspended Matter	
POC	Particulate Organic Carbon	
PN	Particulate Nitrogen	
DIN	Dissolved Inorganic Nitrogen	
OAC	Optically Active Constituents	
CDOM	Colored Dissolved Organic matter	
IOP	Inherent Optical Properties	
SIOP	Specific Inherent Optical Properties	
Rrs	Remote Sensing Reflectance	
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
cal/val	Calibration/Validation	calvalportal.ceos.org

Table 1. Acronyms of Organizations, Manufacturers and Products

SHIP	R/V *Urania*
START	2011-04-07 PORT: Ancona
END	2011-04-20 PORT: Bari
SEA/OCEAN	Adriatic Sea
LIMITS	NORTH: 45:50 SOUTH: 41:00 WEST: 12:00 EAST: 19:45
OBJECTIVE	Biological Chemical Physical Oceanography Geology Geophysics
COORDINATING BODIES	ISMAR-CNR
CHIEF OF EXPEDITION	M.Bastianini
CONTACT	M.Bastianini at ismar.cnr.it
DISCIPLINES	Oceanography, water sampling, morphobathymetry, Chirp SBP, bottom sampling.
WORK DONE	136 CTD CASTS, 28 NANSEN NET-SAMPLER CASTS, 16 WP2 NET-SAMPLER CASTS, 23 FITO NET-SAMPLER CASTS, 23 HS OPTICAL MEASUREMENTS, ∼2250 KM SBP and MULTIBEAM, ∼1000 KM 300KHZ ADCP, ∼50 KM SPARKER 1KJ, 2 GRAVITY CORES, 5 GRABS, 9 BOX-CORERS, 5 SW104 CORES

Table 2. ENVADRI2011 CRUISE SUMMARY.

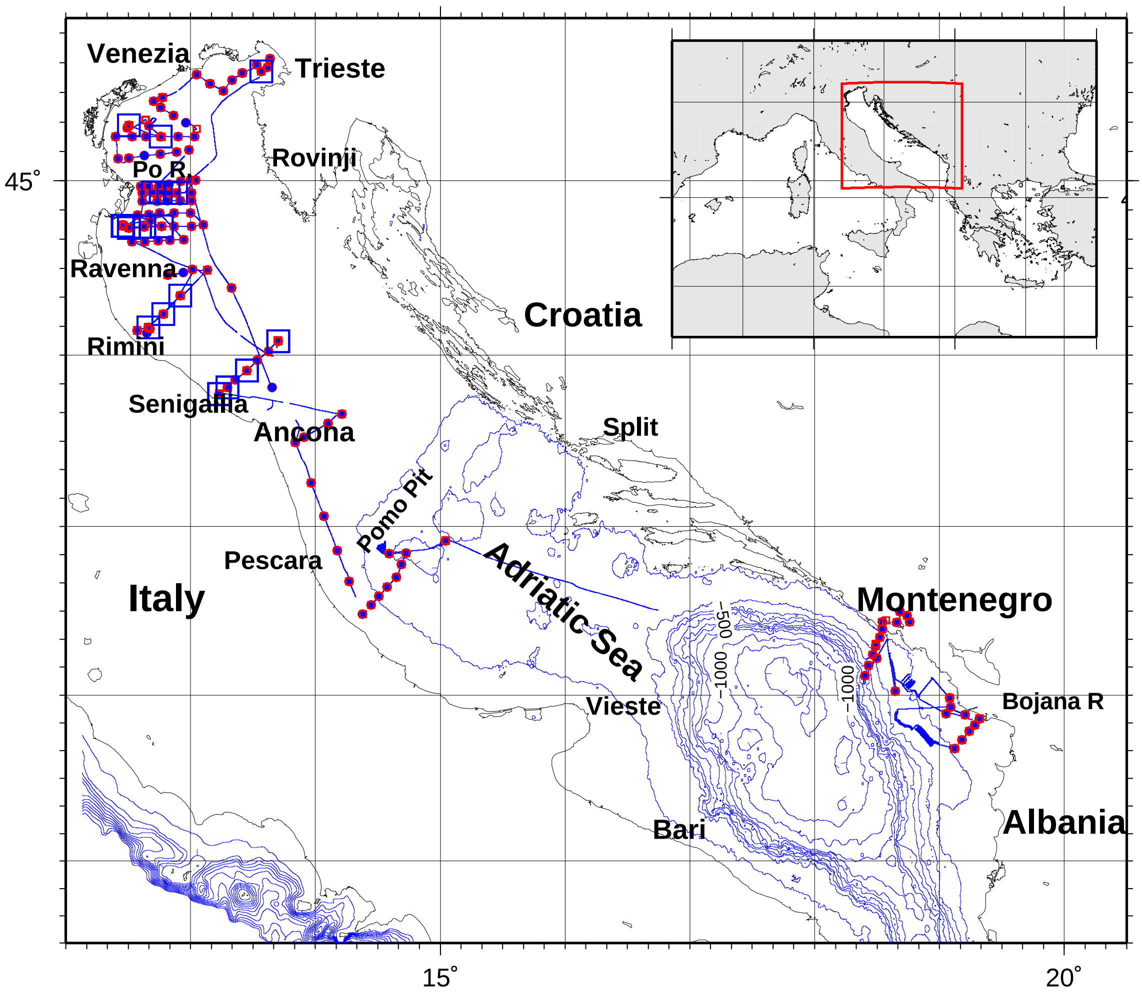

Figure 1. Whole ship track during Cruise ENVADRI2011. Blue circles are CTD stations. Blue line shows CHIRP lines.

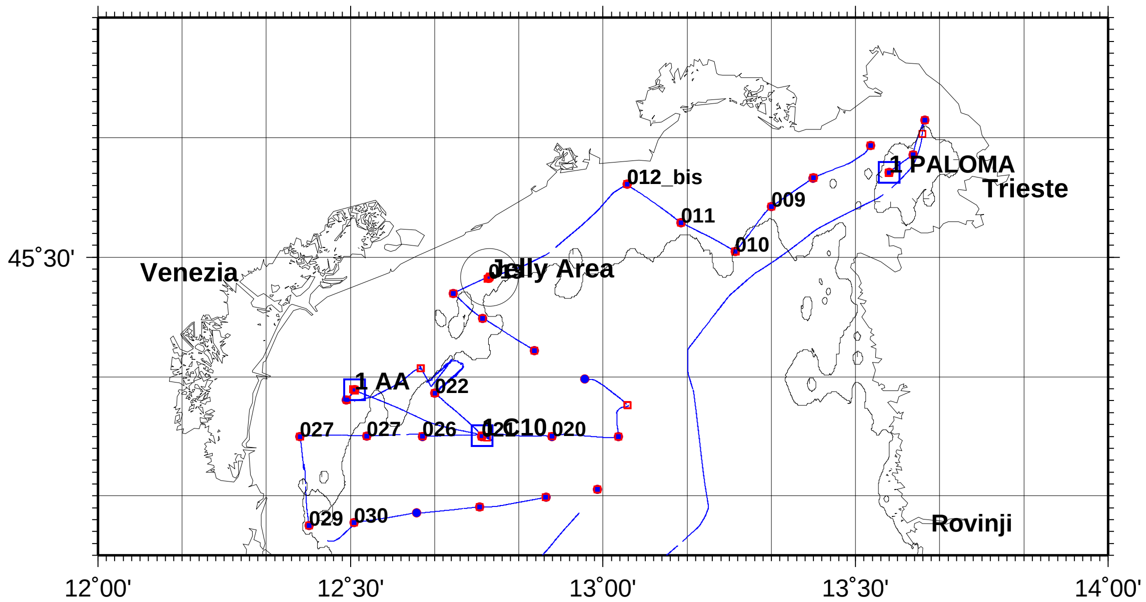

Figure 2. Whole ship track during Cruise ENVADRI2011. Blue circles are CTD stations. Blue line show CHIRP data.

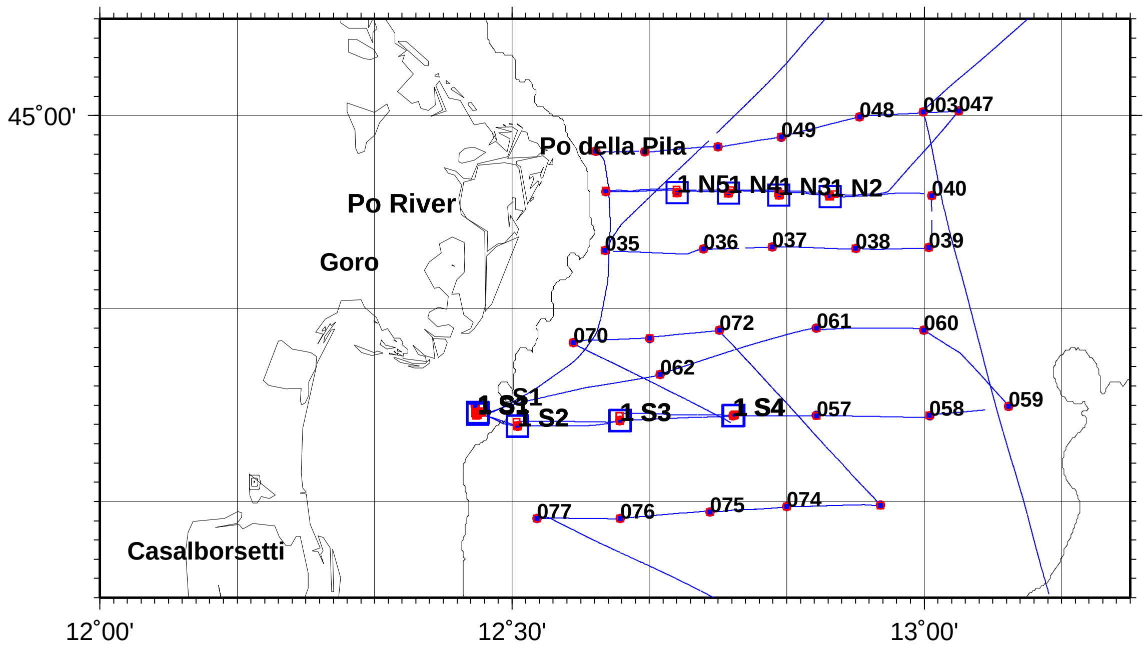

Figure 3. Whole ship track during Cruise ENVADRI2011. Blue circles are CTD stations. Blue line show CHIRP data.

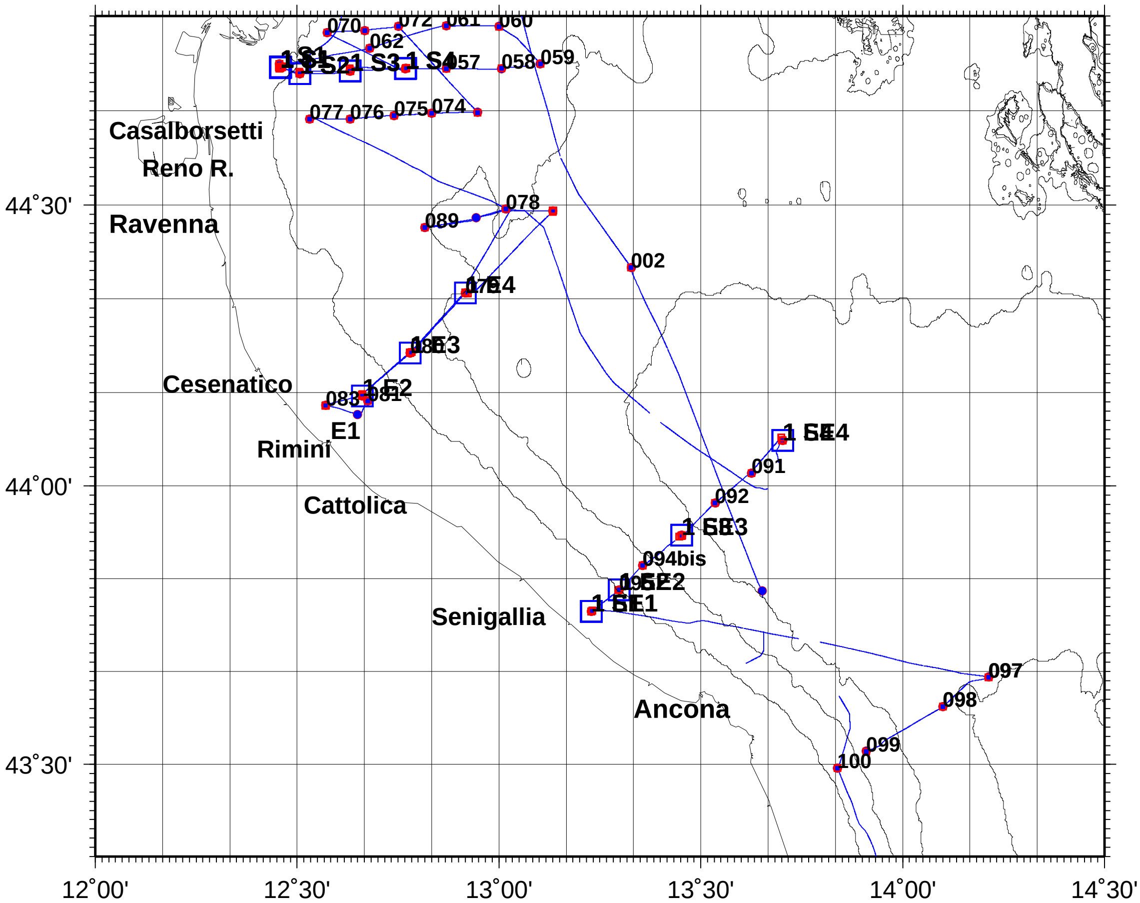

Figure 4. Whole ship track during Cruise ENVADRI2011. Blue circles are CTD stations. Blue line show CHIRP data.

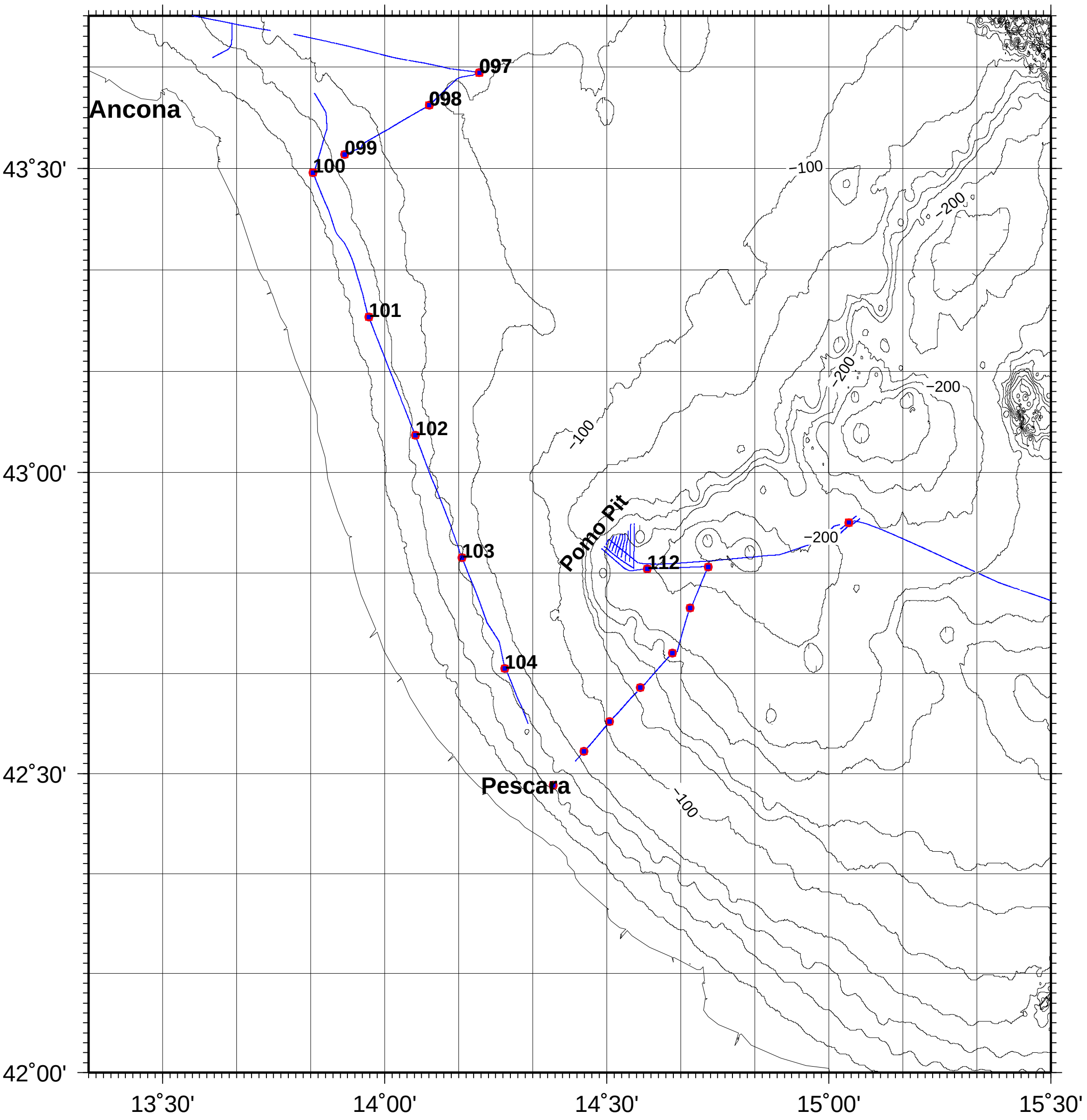

Figure 5. Whole ship track during Cruise ENVADRI2011. Blue circles are CTD stations. Blue line show CHIRP data.

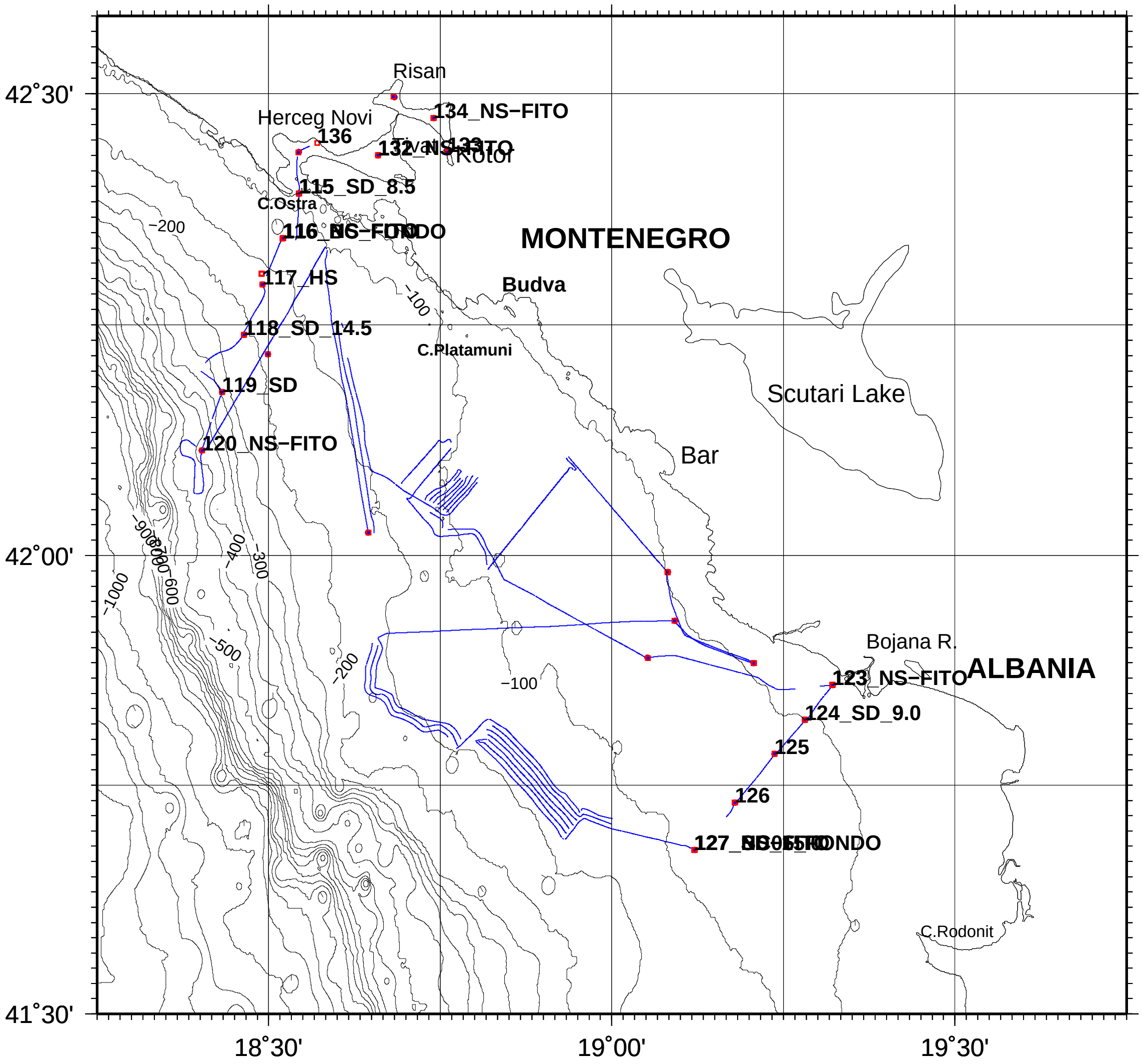

Figure 6. Whole ship track during Cruise ENVADRI2011. Blue circles are CTD stations. Blue line show CHIRP data.

PARTICIPANTS	ORGANIZATION	EXPERTISE	tel & email & www
Mauro Bastianini	ISMAR,Venezia	Chief-of-Expedition	M.Bastianini@ismar.cnr.it
Fabrizio Bernardi-Aubry	ISMAR,Venezia		F.Bernardi@ismar.cnr.it
Giorgio Socal	ISMAR,Venezia		G.Socal@ismar.cnr.it
Elisa Camatti	ISMAR,Venezia		E.Camatti@ismar.cnr.it
Stefania Finotto	ISMAR,Venezia		S.Finotto@ismar.cnr.it
Federica Braga	ISMAR,Venezia		F.Braga@ismar.cnr.it
Giovanni Bortoluzzi	ISMAR, Bologna		G.Bortoluzzi@ismar.cnr.it
Paola Focaccia	ISMAR, Bologna		P.Focaccia@ismar.cnr.it
Enrico Dal Passo	ISMAR, Bologna		E.Dalpasso@ismar.cnr.it
Enver Lipparini	ISMAR, Bologna		E.Lipparini@ismar.cnr.it
Francesca Chiarini	ISMAR, Bologna		F.Chiarini@ismar.cnr.it
Francesco Riminucci	ISMAR, Bologna		F.Riminucci@ismar.cnr.it
Adrianna Ianora	SZN, Napoli		ianora@szn.it
Vittoria Roncalli	SZN, Napoli		vittoria.roncalli@szn.it
Chiara Lauritano	SZN, Napoli		chiara.lauritano@szn.it
Paola Del Negro	INOGS, Trieste		pdelnegro@ogs.trieste.it
Cinzia Fabbro	INOGS, Trieste		cfabbro@ogs.trieste.it
Alessandra Girolimetto	ARPAV		
Maria Lavinia D'Amico	ARPAV		
Fabrizio Del Bianco	ISMAR, Bologna		F.Delbianco@ismar.cnr.it
Federico Giglio	ISMAR, Bologna		F.Giglio@ismar.cnr.it
Silvia Saracino	ISMAR, Bologna		
Lara Bertello	ISMAR, Bologna		
Alessandra Campanelli	ISMAR, Ancona		Alessandra.Campanelli@ismar.cnr.it
Emanuela Frapiccini	ISMAR, Ancona		
Giuseppe Caccamo	ISMAR, Ancona		Giuseppe.Caccamo@ismar.cnr.it
Alessandro Colluccelli	UNIVPM, Ancona		A.Coluccelli@univpm.it
Erica Carone	UNIVPM, Ancona		
Stefania Santangeli	UNIVPM, Ancona		
Andrea Miccoli	UNIVPM, Ancona		
Zoran Kliajic	IBMK, Kotor		biokotor@gmail.com
Alexandr Jovicic	IBMK, Kotor		aleksandar@jovicic.name

Table 3. Scientific and technical parties

1 INTRODUCTION AND SETTINGS

EnvEurope ("Environmental quality and pressures assessment across Europe: the LTER network as an integrated and shared system for ecosystem monitoring", www.enveurope.eu), is a Life+ project started in 2010, that gathers together 11 countries and 67 LTER sites from the LTER-Europe network (400 ca. sites). The project aims at contributing to the integration and coordination at the European level of long-term ecological research and monitoring initiatives, focused on understanding trends and changes of environmental quality, and on the elaboration of relevant detection systems and methods. The main target of the project EnvEurope is the analysis of the ecosystem status and the definition of appropriate environmental quality indicators with an integrated long-term, broad scale, cross-domain (terrestrial, freshwater, coastal and matrine ecosystems) approach, joining the efforts of 11 countries belonging to the LTER Europe network. Since parameters and methods harmonization is a major challenge for such a large network of sites, EnvEurope activity has started to provide *in situ* comparable measurements of selected ecological indicators suitable to evidence trends and changes on drivers, pressures, states and responses of European ecosystems. The ENVADRI2011oceanographic cruise is an objective of one of the action of the project (Action 5 'testing in the Field'). Action 5 concerns in fact the experimental phase of the project, based on the sampling in the field of new and pre-existing parameters and indicators at different level/scales of investigation. The implementation of a multi-level and multi-functional monitoring approach, allowing for the up- and down-scaling of results, is one of the keystones of the project. Thanks to the results of this action the project will contribute to a better assessment of European environmental quality, contributing to data collection for GMES (e.g. providing ground-truth data for remote sensing of ecosystem structure, productivity and status). Data will be collected having in the background the Shared Environmental Information System for Europe, in order to contribute to data sharing and publicity.

The objectives of ENVADRI2011 extend beyond those of EnvEurope and they aimed at:

- testing "in the field" of methodologies and common parameter measurements, analysis and calibration in the LTER stations
- measuring at the basin scale the optical properties of the water in order to determine the relations between water constituent concentration and the reflectance acquired above the water surface, essential for calibrating regional remote sensing algorithms
- understanding the dynamics of spring phytoplankton blooms and prokaryotic variability and their relations with environmental factors (Socal et al. 2008; Del Negro et al. 2008; Solidoro et al. 2009; Mozetič et al. 2009; Boldrin et al. 2009)
- estimating the effects of biotoxicity on trophic networks and on trophodynamics of zooplankton population by direct measurements of grazing, and eggs viability and vitality, egg production, egg hatching success, fecal pellet production (Miralto et al. 1999; Ianora et al. 2004, 2008)
- estimating the concentration of polyunsaturated aldheydes and other oxylipins in the particulate and dissolved phases and formulating hypotheses on their role
- estimating the rates of bacterial degradation activity and of secondary production during phytoplankton bloom
- evaluating the qualitative and quantitative modification of bacterial community during blooms
- monitoring cetaceans and jellies
- acquiring biogeochemical, oceanographical and geophysical data in the Montenegrin area in South Eastern Adriatic Sea

The operations at sea were coordinated in order to collect at every station (a) CTD data with water samples, (b) phyto and zoo-plankton organisms by net samplers, (c) optical properties measurements, and (d) bottom sampling by grabs, box-corers and gravity corers. The data set were complemented by ADCP, bathymetric and CHIRP investigation on station and on transits. A particular attention and sampling strategies were devoted to the LTER stations (Paloma, Acqua Alta, C10, S1) and to classical oceanographic transects, in particular those close to the Po River area, the Rimini, Senigallia and the Pomo (Marini et al. 2006). The on-field planning was helped by the download of the EMMA–ROMS model (Russo et al. 2009) forecast for the investigated subareas.

The studies in the Southern Adriatic Sea in Montenegrin and Albanian waters continued the work done during several cruises performed in the framework of the ADRICOSM Project. The geological and geophysical investigations have been reported by Bignami et al. (2008); Bortoluzzi et al. (2009a,b, 2010), whereas oceanographic data and modeling have been discussed by Campanelli et al. (2009); Marini et al. (2010); Bellafiore et al. (2011).

During the cruise a maintanance and QC work for the E1 and S1 buoys (Bortoluzzi et al. 2006) was performed.

We may cite the AREG and AdriaROMS (a POM modified model run by INGV, in the framework of the MFSTEP/MFS/MOON Projects, and an operational implementation of ROMS run by SIMC-ARPA-Emilia Romagna, respectively; (Pinardi & Coppini 2010; Chiggiato & Oddo 2008)) and another Adriatic operational implementation of ROMS with biogeochemical model (developed in the framework of the

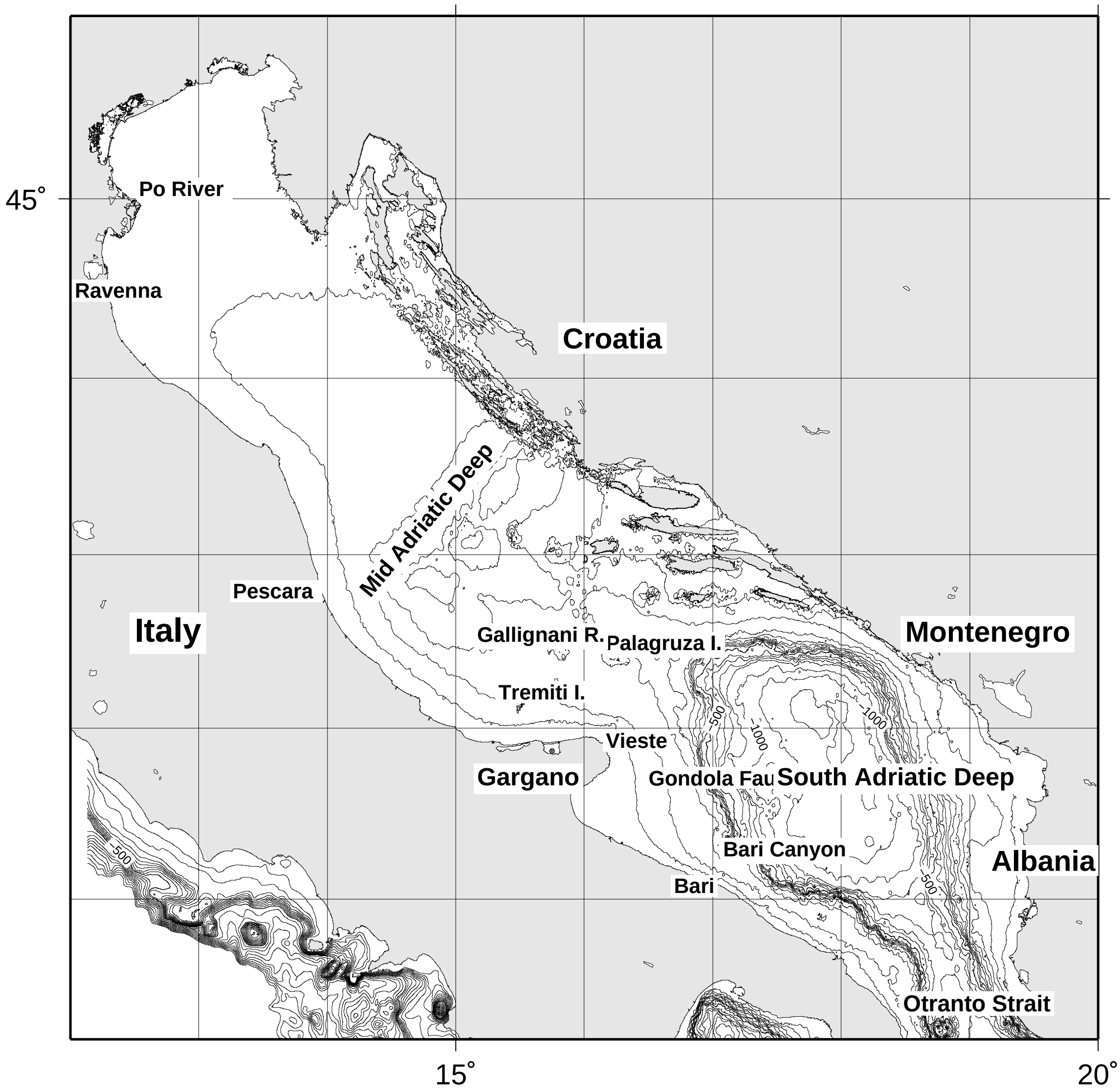

Figure 7. Adriatic Sea setting.

EUs EMMA LIFE Project and run by DIMSR-UNIVPM, Russo et al. (2009)).

1.1 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), with a pronounced seasonal variability, with peaks in spring and autumn (up to 8000 m^3/s and minima in summer (300-400 m^3/s). To the south-east the Buna-Bojana river shows an average discharge of 700 m^3/y. 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 et al. 2001; Poulain & Cushman-Roisin 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. Hypoxia is usually defined as occurring in regions where dissolved oxygen concentrations are less than 2 ml l^{-1} (equivalent to 2.8 mg l^{-1}). This concentration is the lower tolerance limit for many benthic species (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 Albania 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 determined by inflowing Ionian waters, by local winds, and by relatively large amounts of the Buna-Bojana river. The latter 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 indicate 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.

1.2 Biological Setting

One of the main aim of the cruise has been the study of the reponse of phytoplankton community. In coastal temperate ecosystems, the general pattern of the plankton dynamics shows a productive period with an important initial phytoplankton bloom during spring based on new production and characterized by large cells (.20 mm) on which the classical herbivorous food chain reposes. These spring blooms are a characteristic feature of the coastal and estuarine waters in temperate latitudes. However, over recent decades, the increasing quantities of nutrients produced by anthropogenic activities on the edges of coastal areas as well as the climatic variability have strongly modified the primary production calendar, its extent, and the nature of the phytoplankton communities. In a few coastal ecosystems, the phytoplankton dynamics pattern occasionally or recurrently shifts on the seasonal scale with early blooms starting by late winter.

Northern Adriatic is considered one of the most productive regions of the generally oligotrophic Mediterranean Sea (Russo et al. 2002; Bernardi Aubry et al. 2004, 2006a,b; Pugnetti et al. 2005, 2008; Socal et al. 2008; Solidoro et al. 2007; Ianora et al. 2008; Solidoro et al. 2009) although recent studies point to a decrease of the productivity during last decades (Mozetič et al. 2009). In particular, the largest phytoplankton blooms occur in surface layers on late winter and summer in the western part of the region close to the Po River delta.

The amount and the distribution of the diluted waters in the northern Adriatic basin are highly variable and they have a marked influence on phytoplankton communities, mainly through the supply of inorganic nutrients and seston, and through the control of the vertical stability of the water column. In particular, concurrent enrichment (mainly by river) and depletion (by phytoplankton uptake) of both DIN and P can cause rapid and marked variation of the N/P ratio (Degobbis et al. 2000). The meteo-ocenographic conditions, the patterns of currents, and the nutrient limitation (in particular by P) are considered to be the general environmental conditions that seem to favour mucilage formation in the Northern Adriatic basin (Giani et al. 2005). This phenomenon has been observed, at least at its early stage, almost every year since the 1990s and with a huge development in the years 1991, 1997, 2000, and 2002. Mucilage starts in late spring/early summer, when the stratification strengthens, and the exchange of water masses between the northern and the middle basin slows down (Grilli et al. 2005). However, there is no evidence of changes in the dominant species composition of microphytoplankton in the years when massive mucilage aggregates were observed (Totti et al. 2005). The Utermöhl fraction of the phytoplankton community (cells > 3 μm as a maximum linear dimension) has been extensively studied in the Northern Adriatic Sea in the past (Revelante & Gilmartin 1976; Socal & Bianchi 1989; Honsell et al. 1989; Fonda Umani et al. 1992; Socal et al. 1992; Mozetic et al. 1998, 2002; Bernardi Aubry et al. 2004) . The community is mainly made up by diatoms (*Skeletonema marinoi*, previously identied as *S. costatum*, *Chaetoceros spp.*, *Thalassiosira spp.*, and *Pseudo-nitzschia spp.*) and by small flagellates (nanoflagellates and cryptophyceans). The following seasonal pattern has been generally recognized: a late-winter/early-spring diatom bloom, related to the increase in day length and irradiance and to high nutrient inputs from the rivers; a late-spring/summer decline, when the community is mainly sustained by nutrient regeneration; a late autumn/winter minimum, mainly related to the decrease in light and temperature. Although these seasonal fluctuations are common to other coastal seas (Mozetic et al. 1998; Ribera D'Alcala' et al. 2004), the dynamic of phytoplankton in the Northern Adriatic Sea shows marked spatial and temporal heterogeneity and both seasonal and inter-annual fluctuations related to the freshwater inputs and to their distribution in the basin.

Zooplankton are critical for the functioning of aquatic food webs, being major grazers and, therefore, providing the principal pathway for energy transfer from primary producers to consumers at higher trophic levels. Copepods, the most prominent zooplankton taxon, are the most abundant multicellular animals on the planet (Schminke

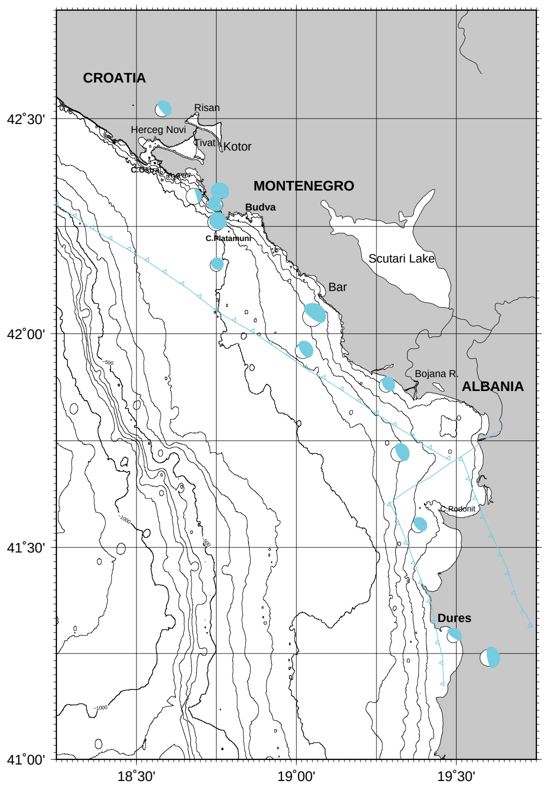

Figure 8. Structural setting of Montenegro.

2007) and in the northernmost part of the northern Adriatic Sea (Gulf of Trieste and northward of the river Po delta) mesozooplankton communities is dominated by strictly neritic species and prevalence of the cladoceran *Penilia avirostris* in summer, and by the copepods calanoids *Paracalanus parvus*, *Acartia clausi* and the *poecilostomatoids Oncaea spp.* during the rest of the year. Whereas coastal communities were more variable with time and location, a group of offshore stations with a similar species of taxa composition and annual dynamics was identified (Camatti et al. 2008). The analysis of the mesozooplankton series in the Gulf of Trieste for the periods 1970-2005 showed extensive changes in the copepod community around the end of the '80s probably due to a large scale and abrupt change in the Mediterranean circulation at the end of the '80s and the 1°Cwarming in Summer (Kamburska & Fonda-Umani 2006; Conversi et al. 2009).

1.3 Geological Setting

The Adriatic Sea (Fig.7) 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 west and by the Balkans to the east (Fig. 7) and is the northernmost part of the Mediterranean Sea. It is characterized 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.

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 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.7). 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 particular, 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 siphons, 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)

Figure 10. R/V *Urania* .

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 CTD, 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.

2.1 Navigation, Chirp SBP, Swath Bathymetry, Single Channel Reflection Seismic

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.

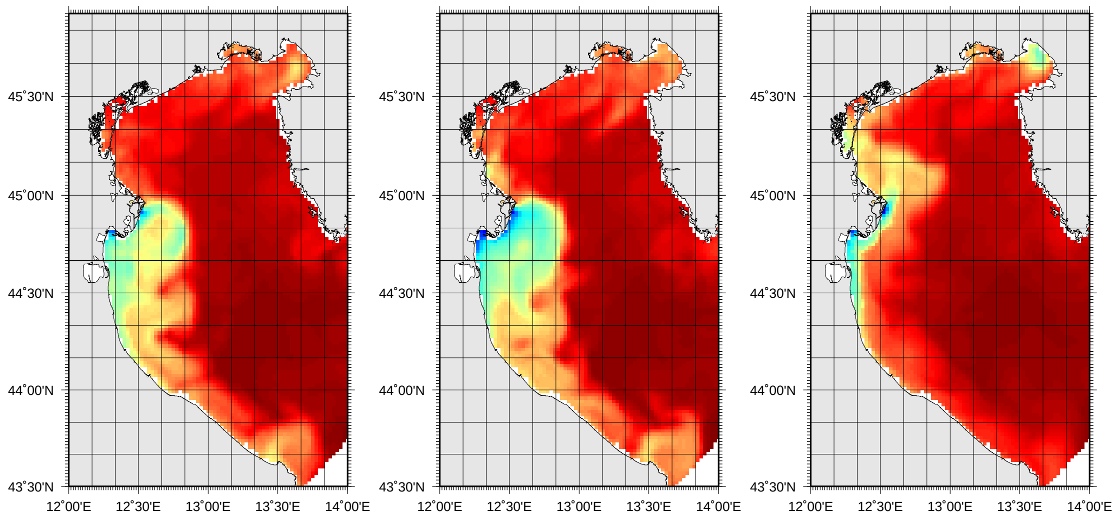

Figure 9. Cruise ENVADRI2011. EMMA–ROMS Model, UNIVPM, Salinity (14/38 PSU). Left to right: 2011-04-07,09,12

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

The SIS (EM-710) was able to build real-time DTM at the resolution of 2 and 1 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.

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 xtf-segy and segy-change (G.Stanghellini, personal communication) and processed by the ISMAR's SEISPRHO package Gasperini & Stanghellini (2009). The system setting was: length 5-10 ms, trigger rate varying from 0.125 to 0.5s,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.

A GEORESOURCE SP1000 Sparker was utilized. The source and hydrophone streamer were towed from the starboard and port sides at a distance of aproximately 15m from stern. The output power at source was set at 1KJ, while the shot time ranged between 1.05 to 1.10 s.

2.2 CTD, water sampling

CTD data were obtained by a Sea Bird SBE 911 probe, carrying C,T,Fluorescence, Oxygen, Beam attenuation and transmission sensors. Table A2 in the appendix shows the position of the stations. The binary data were converted to ascii and bin-averaged 0.25 dB by the Sea Bird SBE-Processing program. Data were then converted to the 'spreadsheet-format' by a Perl and Bash script and imported and processed by the ODV package (Schlitzer 2002).

Water sampling was obtained by firing the 24 bottles of the General Oceanic's Caroussel. The sampled water was filtered and stored for Nutrient and Chlorophyill analyses (Table A3 in the Appendix).

Biological samples for phyto and zoo plankton were taken by net samplers, among them the NANSEN and WP2 models.

Water transparency was measured by Secchi Disk.

2.3 Plankton Sampling and Analysis

Plankton was sampled from Rosette Bottles and by net sampler, including 200 μm Nansen and WP2 and other model nets, that were towed or deployed vertically. Etherotrophic (bacteria) and

Figure 11. CruiseENVADRI2011: The Paloma, Acqua Alta, E1 and S1 platforms.

Figure 12. Plankton sampling.

autothrophic picoplankton, nanoplankton, microphytoplankton and microzooplankton were sampled by Rosette Bottles. Microphyto and mesozoo plankton were also sampled by nets.

Samples (10 mL) taken to estimate picoplankton abundance (Pico) were fixed with a 2% final concentration borate-buffered formalin (prefiltered through a 0.2-μm Acrodisc filter) and stored at +4°C.

Picoplankton abundances will be determined using epifluorescence microscopy after staining the cells with 4,6-diamidino-2-phenylindole (DAPI) (Porter & Feig 1980) at 1 μg ml^{-1} final concentration.

For microzooplankton (Micro) analyses, 2 L of water were collected and preserved with 4% formaldehyde solution. Subsamples (50-100 mL) will be examined in a settling chamber using an inverted microscope (x200) according to the Uthermöl method (Uthermöhl 1931; Lund et al. 1958).

Hydrolytic enzyme activity was measured with fluorogenic analogs of natural substrates (Hoppe 1993): methyl umbelliferyl-β-D-glucoside, methyl umbelliferyl-α-D-glucoside, methyl umbelliferyl-β-D-galactoside, methyl umbelliferyl-β-D-galactoside (MUF, β-D-galactosidase). Hydrolysis rate was measured by incubation of 2.5 mL subsamples with 800, 400, 200, 100 and 50 μm substrates. Incubation was performed in the dark at *in situ* temperatures for 2-3 h. Fluorescence was measured at 380 nm excitation and 440 nm emission for ubstrates using a fluorometer (Shimadzu RF 1501). Standard solutions of MUF were used to calibrate the fluorometer.

Mesozooplankton samples were collected by vertical hauls, from the bottom to the surface, using a WP2 net (0.57 m diameter, 200 μm mesh). The samples were preserved in 4% borax-buffered formaldehyde until laboratory analysis, while a "fresh" aliquot was stocked in freezer at -20°C. Taxonomic and quantitative zooplankton determinations will be performed using a Zeiss stereomicroscope on a representative sub-samples or, for the rare species, on the total sample. Each sample will be poured into a beaker to allow a thorough mixing for random distribution of the organisms, and aliquots of the samples will be analysed until at least 1000 individuals will be counted. Not formaldehyde-fixed subsamples, deriving from origin samples, will be used for the determination of mesozooplankton biomass. The organic carbon content will be determined with a Perkin-Elmer 2400 CHN elemental analyser.

2.4 Copepod ecophysiology experiments

The SZN sampling and analysis strategy was as follows (samples were taken at N1,N2,N3,N4, S1,S2,S3,S4, E1,E2,E3,E4 and SE01,SE02,SE03 SE04 stations):

- For egg production and hatching success and RNA extraction for stress gene analyses, zooplankton was collected from the bottom to the surface with a Nansen net (200 μm mesh size); at each station, 10 *Calanus helgolandicus* females were sorted from samples and incubated in 50 ml bottles with natural sea water phytoplankton; after 24 h females were removed and eggs counted, after another 24 h the number of hatched eggs was determined; at each station, 30 females were incubated in filtered sea water for 24 h and then fixed with Trizol (Invitrogen) and stored in liquid nitrogen;
- Phytoplankton was sampled at each station with a 30 μm net (40 cm diameter)by towing at the surface for ten minutes; samples were cen-

trifuged at 3500 rpm for 3 minutes and pellets were stored in liquid nitrogen; each pellet will be analyzed for chemical costituents such as polyunsaturated aldehydes, epoxyalcohols, hydroxyacids and other oxylipins.

The 200 μm Nansen net sample was used to quantify the number of *Calanus helgolandicus* females, males and juveniles in order to estimate secondary production rates at the time for this important copepod species in the Adriatic Sea. Egg production and egg hatching success data will further allow the estimation of recruitment rates at each station in this period which generally coincides with the period of maximum population numbers for this species. To verify the possibility of using fluorescent markers to quantify live/dead eggs thereby avoiding cumbersome egg hatching success experiments that require 48h onboard ship incubations, 100 *Calanus* eggs were also collected at several stations and fixed in 4% formaldehyde for further Comet-assay analysis in the laboratory. This is a sensitive technique for the detection of DNA damage at the level of the individual cell and is a standard technique for evaluation of DNA damage/repair, biomonitoring and genotoxicity testing. The test has rarely been used for copepods before and SZN is currently developing this method in the laboratory, together with new methods for stress gene analyses in copepods, particularly in *C. helgolandicus*. Frozen samples (adult females and males) collected at different stations during the cruise will be evaluated for up- or down-regulation of the following genes: Cytochrome P450, Glutathione S-transferase, Glutathione Synthase, Aldehyde Dehydrogenases, Catalase, Superoxide Dismutase, Alpha and Beta Tubulins, Inhibitor of Apoptosis Protein (IAP), Cell Cycle and Apoptosis Regulatory Protein (CARP), Cellular Apoptosis Susceptibility Protein (CAS). These results will allow to determine whether copepods were more "stressed" at some stations rather than others, and to identify the possible causes leading to reduced fitness in *C. helgolandicus*. Previous studies in SZN laboratory have shown that diatoms produce a number of toxic oxylipins deriving from the oxidation of polyunsaturated fatty acids which reduce copepod egg hatching success and later larval recruitment (reviewed by Ianora & Miralto (2010)). Since the period of the cruise coincided with the end of a *Skeletonema marinoi* diatom bloom the objective of the studies was to evaluate oxylipin production at different stations and possible impacts on the *C. helgolandicus* population (e.g. reduced egg hatching success and population recruitment rates, down-regulation of specific stress genes).

Figure 13. ISMAR SW104 Water/sediment corers, long and short pipes.

2.5 Nutrient and Particulate Matter Analysis

The distribution of nutrients and pigments will be studied by analyzing water samples taken at suitable depths using the rosette of the CTD system. A number of 78 and 175 samples were collected for chlorophyll and nutrient analysis, respectively (Table A3 in the Appendix). Seawater samples for nutrients and pigments (4L) were filtered using GF/F Whatman filters (0.7 μm), and immediately stored at -20°C. Nutrients analysis will be made using a QuAAtro Autoanalyzer Strickland & Parsons (1968), while pigment data will be obtained by HPLC method Wright et al. (1991).

At selected stations, discrete water samples were also collected at surface, intermediate and at bottom depths for total suspended matter (TSM) concentration, particulate organic carbon (POC) and particulate nitrogen (PN) content. Total suspended matter samples were filtered onto precombusted, 25 mm diameter Whatman GF/F glass fibre filters. All filters were stored at -20°Cuntil analysis. In the laboratory, TSM filters were oven-dried at +60°C and then weighed. To estimate the organic/inorganic fraction, TSM filters were then combusted at +450°C for 3 h and reweighed. The POC and PN filters were exposed to HCl vapours for 24 h to remove the inorganic carbon (Hedges & Stern 1984), then analysed using a Perkin-Elmer 2400 CHN Elemental Analyzer (EA).

2.6 Optical properties measurements

The optical properties of coastal waters (IOCCG 2000; Mobley et al. 2004) can present wide spatial and seasonal variations related to the delivery of pigmented materials from surrounding watersheds and under the influence of the open sea water. Various dissolved and suspended substances (organic and inorganic) interacting with light along the water column influence in-water optical properties: these substances are defined as Optically Active Constituents (OAC), such as Tripton, Colored Dissolved Organic Matter (CDOM) and Chlorophyll (Chl). Their composition, concentration and size directly influence the Inherent Optical Properties (IOPs) of the water column, defined as the light absorption a(λ), scattering b(λ), backscattering bb(λ) and attenuation c(λ) coefficients. This set of properties constitutes the bio-optical model and allows us to determine the relations between the water constituents concentrations and the reflectance acquired above the water surface. Exploration of the relationship between the specific IOPs regional and temporal variability and biogeochemical quantities in coastal waters is essential for the modelling of underwater light field and represents distinct challenges for future regional remote sensing algorithms development. The Remote Sensing Reflectance (Rrs) spectrum is a result of the cumulative interactions of light with the water itself and the water quality parameters. To retrieve the water quality parameter concentrations, it is necessary to invert the reflectance spectrum. The water quality parameter concentrations and the reflectance spectrum are linked by the IOPs of the water. Any successful semi-analytic inversion approach needs to relate the water leaving reflectance to the IOPs, and then the IOPs to the water quality parameter concentrations. The IOPs and water quality parameter concentration relationship can be established by normalising the IOPs by the relevant water quality parameter concentration to calculate the specific inherent optical properties (SIOPs). The *in situ* measurements allow defining a different set of SIOPs for each sampling station. By means of the Hydrolight software, the Remote Sensing Reflectance (Rrs) is simulated considering all the parameters recorded at the time of the sampling (water constituents concentrations, illumination and acquisition geometry, wind speed, absorption and scattering coefficients). Comparing the simulated Rrs with the Rrs collected *in situ* it will be possible to verify the suitability of the adopted models and of the simulation procedures.

The radiometric *in situ* measurements were performed to achieve a comprehensive dataset of OACs concentrations and of SIOPs, leading to the parameterization of a three-component bio-optical model (Chl, CDOM, tripton). At all stations, discrete water samples for absorption and concentration measurements were collected from the surface. Filtration was performed immediately after sampling. Filters were kept in liquid nitrogen and then stored at -80°Cuntil analysis; all protocols described below are compliant with those recommended for SeaWIFS calibration/validation activities. Different illumination conditions were encountered during the fieldwork: clear, cloudy and covered skies. During partly cloudy conditions, the measurements were not carried out. The sea surface was quasi-plane and the wind speed lower than 5 m/s. The calibration and validation of satellite and/or airborne ocean remote sensing data requires field Rrs measurements concurrently with the collection of water samples. Water-leaving reflectance Rrs was calculated from above-water measurements using a Photo Research-Spectrascan PR-650 field portable hyperspectral radiometer operating between 380 and 780 nm with 4 nm resolution. The Rrs signal (in sr^{-1}) is calculated from:

$$R_{rs} = \frac{L_w}{E_d(O^+)} \quad (1)$$

where L_w (W m^{-2} sr^{-1} nm^{-1}) is the water-leaving radiance and $E_d(O^+)$ (W m^{-2} sr^{-1} nm^{-1}) is the downwelling irradiance incident on the water surface. The wavelength dependance of the parameters is omitted to simplify the notation. L_w also depends on the viewing direction, defined by the zenith and azimuth angles I_z and I_a. Ed(0+) can be measured above the water surface, directly using an irradiance sensor, or using a radiance sensor and a reference plaque of a known reflectance. L_w cannot be directly measured and it is determined from above-water or in-water measurements. In each station, the upwelling radiance L_u and the sky radiance L_{sky} were successively measured above the water surface (5 couples of measures) with an oblique viewing, respectively Θ=40°, ϕ=90°and Θ=130°, ϕ=90°. The upwelling radiance L_u can be expressed as

$$L_u = L_w + L_r \tag{2}$$

where L_r is the radiance signal resulting from reflection effects at the air/water interface, namely the sun and sky glint. L_r is due to a certain percentage (ρ) of the sky radiance L_{sky} reflected at the surface. The percentage ρ is the reflection coefficient for the wave-roughened air-water interface: it is a complex factor that depends on incident light and viewing directions, wavelength and wind speed. It also depends on the sensor field-of-view and sky radiance distribution.

2.7 Bottom Sampling

Bottom sampling was performed by 60cm diameter box corer, grab, Sediment/Water SW104 and 1.2 gravity corers. Table 5 shows the position of samples. On the undisturbed sample of box-corers a minimum of 2 subcores were taken. Surficial sediment and from particular levels of the sedimentary colums has been collected for further analyses. In the Montenegro survey subsamples for forams and grain size/metals distribution analyses were also obtained. The subsamples and cores were stored at +4°C. The remaining bulk sediment has been sieved at 1 cm and 3 mm in order to collect the biological content. Figure 14 presents a summary of sampling operations by Box corer and grab.

2.8 Models

During the cruise we took the NetCDF data of the EMMA–ROMS model 3-day forecast (2.0 km resolution) made available by UNIVPM 07:00 UTC on ISMAR's server in Bologna. By using an interactive routine we were able to extract T,S data for several subareas and at different depth levels. The model data (T,S) were regridded and displayed on the PDS2000 Navigation Software.

2.9 Miscellaneous and Mapping

A Pollux ROV by GEI of Barga was used on a bottom feature in front of the Kotor Bay (~ 100m depth).

The datum was set to WGS84 and the UTM, zone 33N projection was 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) packages.

The multibeam data were pre processed on

Figure 15. CruiseENVADRI2011: Bottom sampling by SW104 Water/Sediment Corer..

Figure 14. CruiseENVADRI2011: Bottom sampling by Oceanic Box-Corer and grab.

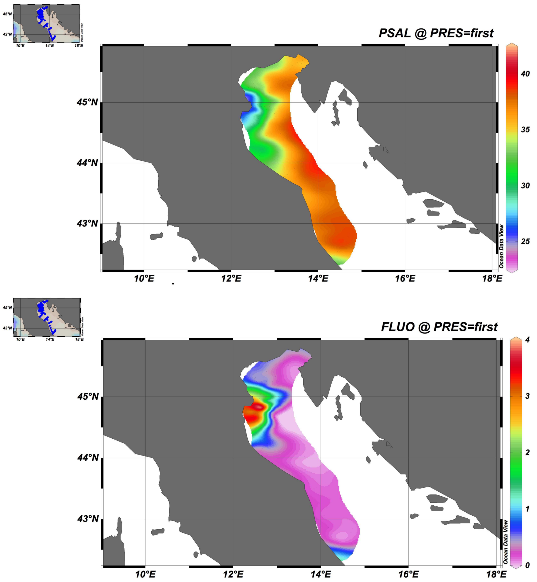

Figure 16. CruiseENVADRI2011: Northern and Central Adriatic: salinity and fluorescence.

board by the MB-SYSTEM (Caress & Chayes 2009) software and ISMAR's routines and scripts on raw .all file.

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

3 INITIAL RESULTS

3.1 Oceanography

During ENVADRI2011 cruise, the water column properties on the western side of the basin have been investigated along transects from Trieste Gulf to S. of Ancona, up to the Pomo transect. Figures 16 show the pattern of salinity and fluorescence data during Leg I of Cruise, while Figures 17 and 18 presents results from the Po River and Rimini Transects.

In addition, CTD casts were performed on the Eastern coast during the activities on Montenegro, including the Bay of Kotor.

In the Appendix Table A2 shows the metadata of the 136 CTD casts collected during the cruise, and figure A1 plots a summary of the data.

3.2 Bottom Sampling

A number of 14 box corers, 7 grabs, 6 SW104 and 2 gravity cores were performed. Grabs and boxc-corer bulk after subsampling were washed and sieved and the box-corer were subsampled with cores.

Table 5 shows sample description.

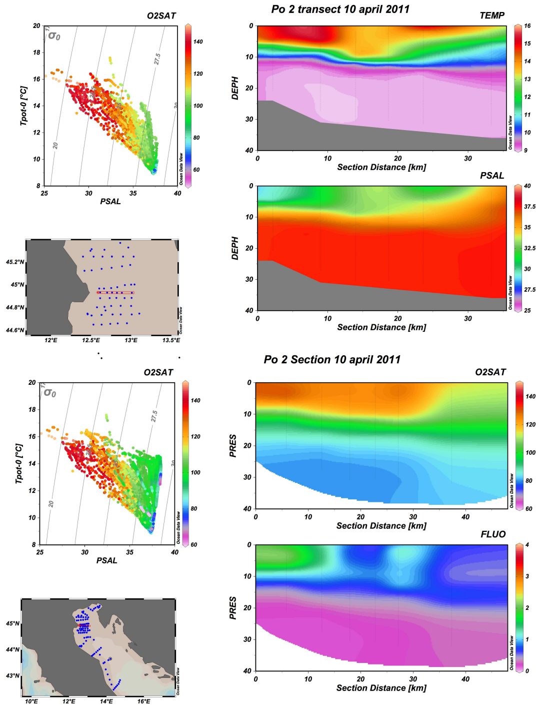

Figure 17. CruiseENVADRI2011: Po Delta transect: Salinity/temperature and O2/fluorescence.

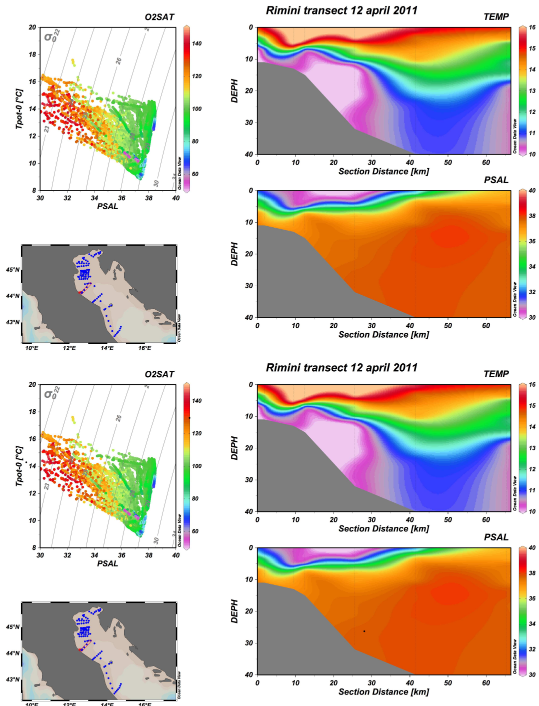

Figure 18. CruiseENVADRI2011: Rimini transect: salinity/temperature and O2/Fluorescence.

STA	CTD	LON LAT ddmm.xxx	DEPTH m	REC cm	DATE dd/mm/2011	DESCRIPTION
G01-PA	007	1333.969 4537.066			08/04 07:38	Paloma, Silt and clay
SW01-PA	007	1333.958 4537.060		117	08/04 07:50	
G02		1238.341 4520.706			09/04 04:54	CAVA-B, sieved for benthos
G03		1238.388 4520.729			09/04 05:07	CAVA-B
G04	023	1229.528 4518.049			09/04 06:15	CAVA-A
G05-AA	024	1230.284 4518.973			09/04 08:13	Acqua Alta, fine, medium sand, sieved for benthos
BC01-AA	024	1230.290 4518.973		12	09/04 08:41	Acqua Alta, Two sub cores
G06-C10	025	1245.576 4515.051			09/04 12:30	sieved for benthos
SW02-C10	025	1245.585 4515.046			09/04 12:51	Empty
BC02-C10	025	1245.591 4515.038			09/04 13:10	C10, medium and coarse sand. presence of shell fragments and worms
SW03-S1		1227.312 4444.589		121	10/04 20:23	
G07-S1	063	1227.380 4444.462			11/04 06:17	S1, mud, silty clay, plastic top, gray/brown with black bands, tubes and worms 2-10 cm, sieved for benthos
SW04-S1		1227.448 4444.507		35	11/04 06:35	Core for incubator
SW05-S1		1227.519 4444.479		35	11/04 07:09	Core for incubator
SW06-S1		1227.395 4444.498		35	11/04 07:34	Core for incubator
BC03-E1	083	1234.255 4408.585			12/04 06:35	E1, Box-Corer sieved for benthos
BC04-E1		1234.226 4408.617		18	12/04 06:55	E1, sub-sampled into two smaller cores, dark-grey Compact Clay (silty) . Top 2 cm less compact color brown. 10-15 cm darker sediment. Presence of shell fragments and anoxis levels
MNG-BC01	116	1831.225 4220.623	128	25	16/04 11.29	Top, hydrated silty sand, olive green in color. From 5 cm to bottom coarse sediment, dark gray sand. Many fresh and reworked shell fragments Strongly bioturbated. .
MNG-BC02	118	1827.844 4214.366	205	24	16/04 13.31	Top-3 cm, silty/silty clay hydrated, olive green/gray in color, hydrate and oxidated. Silty clay plastic sediment fro 3 cm to bottom. Lighlty bioturbated. Few shell fragment
MNG-BC03	123	1919.323 4151.540	14	15	17/04 10.30	Silty clay sediment column, hydrate and lighlty oxidated in the first 3/4 cm, olive green at the top, gray-green fro 4 to bottom. Close to the bottom decrease the coarse sediment. Lighlty bioturbated. Few shell fragment.
MNG-BC04	124	1916.891 4149.588	51	27	17/04 11.16	Top- 3 cm hydrated yallow-green silty clay, lightly oxidated. 4 cm bottom fine clay sediment, gray-green. Lightly bioturbated. Black organic matter accumulation along the sediment column
MNG-BC05	125	1914.232 4147.040	76	33	17/04 12.03	Clay green-gray uniform sediment. Bioturbated along all the sediment column, worm still the bottom. Top 3 cm is more hydrated. Reworked shell fragment close to the bottom
MNG-BC06	126	1910.759 4143.845	86	30	17/04 12.58	On the top hydrated olive green clay sediment. From 4 to 19 cm green-gray clay Bioturbated sediment. From 19 to bottom more hydrated and lightly plastic and fine sediment
MNG-BC07	127	1907.246 4140.755	99	39	17/04 14.00	Top-3 cm, olive green hydrated silty clay. 3cm -Bottom clay bioturbated. Some fresh shell probably still alive.
MNG-C08	129	1912.413 4152.968	42	163	18/04 06.46	top-4 cm very hydrated yellow brown silty clay; from 4cm to bottom plastic gray/brown silty clay. Bioturbated. Close to the bottom fragments of reworked shells.
MNG-BC09	129	1912.386 4152.964	43	25	18/04 07.04	Top 3 cm is more hydrated. Clay, color green gray. Lightly bioturbated.
MNG-C10	130	1904.860 4158.936	53	174	18/04 08.21	Top Hydrated silty clay; section cut gray silty clay.
MNG-BC11	130	1904.890 4158.930	54	27	18/04 08.27	All the sequence is composed by fine green gray clay sediments. Top 3 cm is more hydrated and bioturbated.

Table 5. Samples on cruise ENVADRI2011. BC=box-corer, G=grab., C=Core

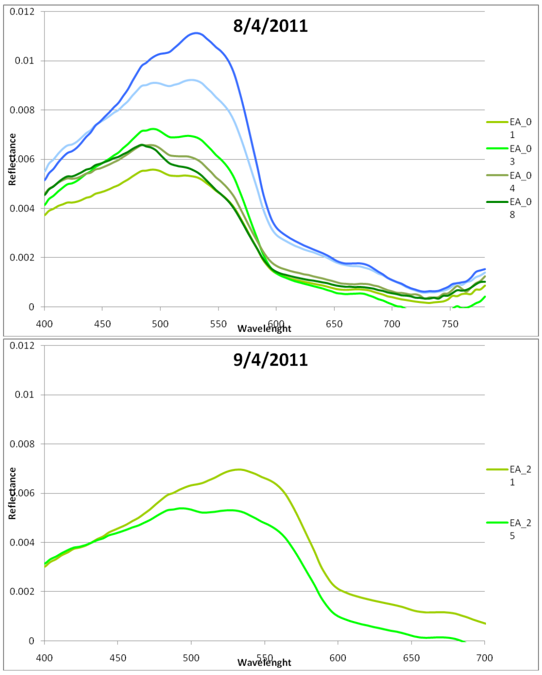

Figure 19. CruiseENVADRI2011: Optical properties measurements.

Figure 20. CruiseENVADRI2011: Jelly survey.

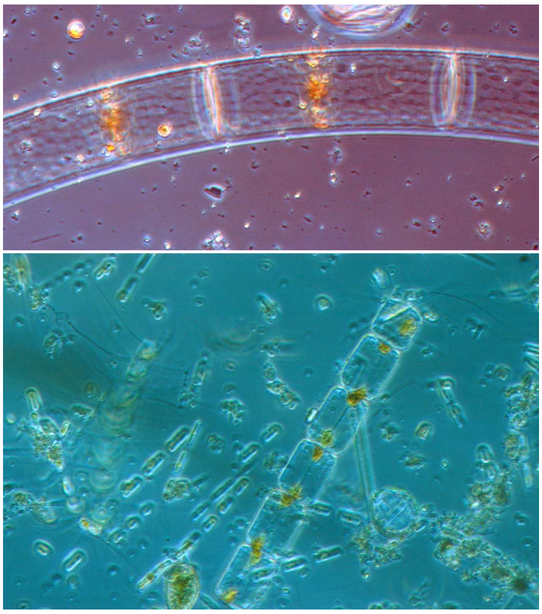

Figure 21. CruiseENVADRI2011: Phytoplankton at the Microscope.

3.3 Buoy Maintanance

Buoy S1 was visited 2011-04-11 for sensor change and installation (T,H and compass). Buoy E1 was visited 2011-01-12. A number of 3 CTD casts within minutes from measurement time of Buoy data logging were performed close to S1 and E1. Furthemore, some multibeam runs were obtained for accurate mapping (see Fig. 22, while table 6 reports the coordinates).

3.4 Bathymetry, Chirp, Sparker

During ENVADRI2011 cruise, high-resolution morpho-bathymetric and CHIRP SBP surveys were made. Three Sparker lines were run in the Bar region in Montenegro. Fig. 23 shows examples of data acquired by the CHIRP SBP and 1KJ Sparker.

4 CONCLUSIONS

During the cruise ENVADRI2011 several aspects have been investigated with a multi-disciplinary effort. One of the major focus has been on the biodiversity levels in different hetero and autotrophic

	DATE UTC	LON-LAT ddmmss.xx	DEPTH m
S1	04-11 09:30	444432.37 122724.72	21
E1	04-12 06:27	440834.45 123409.10	11

Table 6. Buoys (anchor) coordinates.

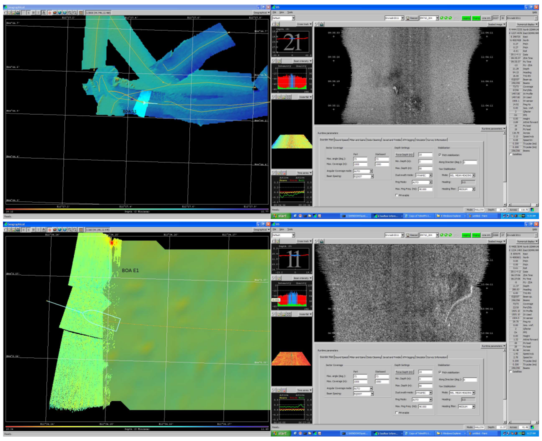

Figure 22. CruiseENVADRI2011: S1 (up) and E1(down) Buoys.

compartments starting from picoplanktonic forms to mesozooplankton and jellyfish organisms.

A dedicated survey has been organized during the cruise regarding the latter organisms and their growing role in the trophic web. A massive swarm of *Aurelia aurita* has been spotted during the first days of the campaign (Fig.20). Some experiments and analysis were organized on board to reveal the causes of the phenomena. The planktonic organisms have been observed directly on board (Fig.21) in order to keep the best observation quality achievable with the observation of fresh material and the evaluation of their physiological response to environmental conditions trough incubation experiments.

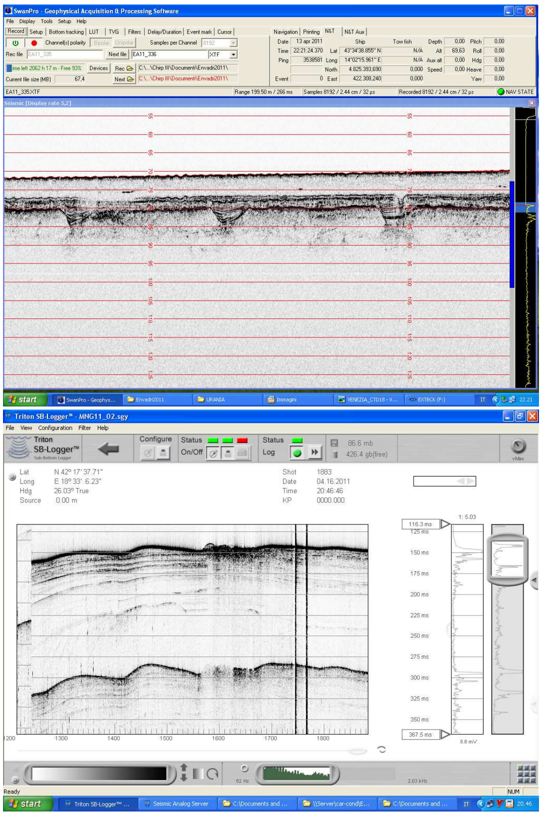

Figure 23. CruiseENVADRI2011: Up: example of acquisition of CHIRP-III data (SWAN Pro); down: example of Sparker 1KJ data acquisition (Triton SB Logger Seismic data logger).

A comprehensive set of environmental variables have been measured and samples stored for successive analysis collected regarding the main forcing factors conditioning biodiversity in the basin such as pigments, nutrients, organic carbon and particulate matter. A data-set of radiometric measurements and inherent optical properties was collected for testing a trans-domain (coastal/inland waters) cal/val activity of remotely sensing images. A preliminary analysis of radiometric data has highlighted the wide spatial variability of the water optical behaviour related to Po river plume and phytoplankton bloom (Fig. 19).

At the same time a huge effort has been posed on the study of bathymetric and geophysical asset of the basin that has a direct influence on water proprieties and circulation with the aid of state of the art equipment such as multibeam, chirp and sparker. Some benthological sampling have been performed to investigate benthos communities and stratigraphic sets.

The chance to have direct access to state of the art hydrological models allowed the team on board to spot some of the areas where sampling could have been more interesting or fruitful (fronts, plume spatial distribution) so optimizing sampling effort. Moreover the comparison between the collected data and the forecast made in near real time provides useful information about a future improvement of the model itself and helps to put /data assimilation/ tecniques into perspective.

The interaction among different teams on board have been really successful giving the chance to continue the comparisons among different compartments and to start new speculations. Technical and logistic support onboard of R/V Urania has been of the usual very high level going beyond a simple support and allowing scientists to focus on their job in a friendly and relaxed atmosphere.

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. We thank Alessio Cesari and Luigi Di Salvo of SO.PRO.MAR. for their dedication and support.

REFERENCES

Aliaj, S., 2008. The Albanian Orogen: convergence Zone between Eurasia and the Adria microplate, in *The Adria Microplate: GPS Geodesy, Tectonics and Hazards*, vol. 61 of **NATO Science Series, IY, Earth and Environmental Sc.**, eds Pinter, N., Gyula, G., Stein, S., & Medak, D., Springer.

Aliaj, S., Adams, J., Halchuk, S., Sulstarova, E., Peci, V., & Muco, B., 2004. Probabilistic seismic hazard maps for Albania, in *13th World Conference on Earthquake Engineering*, Vancouver, B.C., Canada, Paper No. 2469.

Argnani, A., 2006. Some Issues Regarding the Central Mediterranean Neotectonics, *Boll. Geofisica Teorica Applicata*, **47**, 13–37.

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.

Bellafiore, D., Guarnieri, A., Grilli, F., Penna, P., Bortoluzzi, G., Giglio, F., & Pinardi, N., 2011. Study of the hydrodynamical processes in the boka kotorska bay with a finite element model, *Dynamics of Atmospheres and Oceans*, **In Press, Accepted Manuscript**, –.

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

Bernardi Aubry, F., Berton, M., Bastianini, M., Socal, G., & Acri, F., 2004. Phytoplankton succession in a coastal area of the NW Adriatic over 10 years of sampling (1990–1999), *Cont. Shelf Res.*, **24**, 97–115, doi:10.1016/j.csr.2003.09.007.

Bernardi Aubry, F., Acri, F., Bastianini, M., Bianchi, F., Cassin, D., Pugnetti, A., & Socal, G., 2006a. Seasonal and interannual variations of phytoplankton in the Gulf of Venice (Northern Adriatic Sea), *Chemistry and Ecology*, **22(Suppl. 1)**, S71–S91, doi:10.1080/02757540600687962.

Bernardi Aubry, F., Acri, F., Bastianini, M., Pugnetti, A., & Socal, G., 2006b. Picophytoplankton Contribution to Phytoplankton Community Structure in the Gulf of Venice (Nw Adriatic Sea), *Int. Rev. Hydrobiology*, **9**, 51–7.

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., 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.

Bignami, F., B.Buongiorno Nardelli, G.Bortoluzzi, Giglio, F., Miserocchi, S., Betti, M., Caccamo, G., Marcelli, M., Piermattei, V., Madonia, A., Cardin, V., Arena, F., Mansutti, P., Kljajic, Z., Zujovic, R., Jovicic, A., & C.Pizzi, 2008. Report on the Oceanographic, Morphobathymetric, Geological And Geophysical Activities during Cruise ADR0208 (17-28 October 2008, R/V Urania, ADRICOSM-Star Project) .

Boldrin, A., Carniel, S., Giani, M., Marini, M., Bernardi Aubry, F., Campanelli, A., Grilli, F., & Russo, A., 2009. The effects of Bora wind on Physical and Bio-Chemical properties of stratified waters in the northern Adriatic, *J. Geophys. Res.*, **114**, C08S92, doi:10.1029/2008JC004837.

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., Frascari, F., Giordano, P., Ravaioli, M., Stanghellini, G., Coluccelli, A., Biasini, G., & Giordano, A., 2006. The S1 Buoy station, Po River Delta: data handling and presentation, *Acta Adriatica*, **47**(Suppl), 113–131.

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, www.ismar.cnr.it.

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, www.ismar.cnr.it.

Bortoluzzi, G., D'Oriano, F., Bianco, F. D., Maselli, V., Palmiotto, C., Falcieri, F., & Marinaccio, K., 2010. 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), Tech. rep., ISMAR-CNR, http://www.ismar.cnr.it/prodotti/reports-campagne.

Buljan, M. & Zore-Armanda, M., 1976. Oceanographical properties of the Adriatic Sea, *Oceanogr. Mar.*

Biol. Ann. Rev., **14**, 11–98.

Camatti, E., Comaschi, A., de Olazabal, A., & Fonda Umani, S., 2008. Annual dynamics of the mesozooplankton communities in a highly variable ecosystem (North Adriatic Sea, Italy), *Marine Ecology*, **29**, 387–398, DOI: 10.1111/j.1439-0485.2008.00256.x.

Campanelli, A., Bulatovic, A., Cabrini, M., Grilli, F., Kljajic, Z., Mosetti, R., Paschini, E., & Marini, M., 2009. Spatial distribution of physical, chemical and biological oceanographic properties, phytoplankton, nutrients and coloured dissolved organic matter (CDOM) in the Boka Kotorska Bay (Adriatic Sea), *Geofizika*, **26**(2), 215–228.

Caress, D. & Chayes, D., 2009. MB-System, Mapping the Seafloor, Software for the Processing and Display of Swath Sonar Data,V5.2, www.ldeo.columbia.edu/res/pi/MB-System/.

Chiggiato, J. & Oddo, P., 2008. Operational ocean models in the Adriatic Sea: a skill assessment, *Ocean Sci*, **4**, 61–71.

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

Conversi, A., Peluso, T., & Fonda-Umani, S., 2009. Gulf of Trieste: A changing ecosystem, *J. Geophys. Res.*, **114**, C03S90, doi:10.1029/2008JC004763.

Cushman-Roisin, B., Gačiċ, 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.

Del Negro, P., Celussi, M., Crevatin, E., Paoli, A., Bernardi Aubry, F., & Pugnetti, A., 2008. Spatial and temporal prokaryotic variability in the northern Adriatic Sea, *Mar. Ecology*, **29**(3), 375–386, DOI: 10.1111/j.1439-0485.2008.00249.x.

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

Fonda Umani, S., Franco, P., Ghirardelli, E., & Malej, A., 1992. Outline of oceanography and the plankton of the Adriatic Sea, in *Marine Eutrophication and Population Dynamics*, pp. 347–365, eds Colombo, G., Ferrari I., Ceccherelli, V., & Rossi, R., Olsen & Olsen, Fredesborg.

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.

Giani, M., Rinaldi, A., & Degobbis, D., 2005. Mucilages in the Adriatic and Tyrrhenian sea: an introduction, *Sci. Total Environ.*, **353**, 3–9.

Grilli, F., Paschini, E., Precali, R., Russo, A., & Supic, N., 2005. Circulation and horizontal fluxes in the Northern Adriatic Sea in the period June 1999–July 2002. Part I: Geostrophic circulation and current measurement, *Sci. Total Environ.*, **353**, 57–67.

Hedges, J. & Stern, J., 1984. Carbon and nitrogen determination of carbonate-containing solids, *Limnol. Oceanogr.*, **19**, 984–989.

Honsell, G., Lausi, D., & Cabrini, M., 1989. Individuazione di comunita' fitoplanctoniche nel mare Adriatico e loro correlazione con parametri biotici ed ambientali mediante analisi multivariata, *Boll. Oceanol. Teor. Applic.*, pp. 111–126, Numero speciale.

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.

Hoppe, H., 1993. Use of fluorogenic model substrates for extracellular enzyme activity (EEA) measurement of bacteria, Handbook of methods in aquatic microbial ecology, pp. 423–431, eds Kemp, P. F., Sherr, B. F., Sherr, E. B., & Cole, J. J., Lewis Publishers, Boca Raton, Fla.

Ianora, A. & Miralto, A., 2010. Toxigenic effects of diatoms on grazers, phytoplankton and other microbes: a review, *Ecotoxicology*, **19**, 493–511.

Ianora, A., Miralto, A., Poulet, S., Carotenuto, Y., Buttino, I., Romano, G., Casotti, R., Pohnert, G., Wichard, T., Colucci-D'Amato, L., Terrazzano, G., & Smetacek, V., 2004. Aldehyde suppression of copepod recruitment in blooms of a ubiquitous planktonic diatom, *Nature*, **429**, 403–407.

Ianora, A., Casotti, R., Bastianini, M., Brunet, C., D'Ippolito, G., Acri, F., Fontana, A., Cutignano, A., Jefferson, T., Turner, T., & Miralto, A., 2008. Low reproductive success for copepods during a bloom of the non-aldehyde-producing diatom Cerataulina pelagica in the North Adriatic Sea, *Marine Ecology*, **29**(3), 399–410.

IOCCG, 2000. Remote sensing of ocean colour in coastal, and other optically-complex, waters, in *Reports of the International Ocean-Colour Coordinating Group*, vol. 3, Dartmouth, Canada: IOCCG.

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.

Kamburska, L. & Fonda-Umani, S., 2006. Long-term copepod dynamic in the Gulf of Trieste (Northern Adriatic Sea). Recent changes and trends, *Clim. Res.*, **31**, 195–203, doi:10.3354/cr031195.

Lund, J., Kipling, C., & Cren, E. D., 1958. The inverted microscope method of estimating algal numbers and the statistical basis of estimations by counting, *Hydrobiologia*, **11**(2), 143–170, DOI: 10.1007/BF00007865.

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.

Marini, M., Russo, A., Paschini, E., Grilli, F., & Campanelli, A., 2006. Short-term physical and chemical variations in the bottom water of middle Adriatic depressions, *Climate Research*, **31**, 227–237.

Marini, M., Grilli, F., Guarnieri, A., Jones, B. H., Kljajic, Z., Pinardi, N., & Sanxhaku, M., 2010. Is the southeastern Adriatic Sea coastal strip an eutrophic area?, *Est. Coast. Shelf Sc.*, **88**(3), 395–406.

Miralto, A., Barone, G., Romano, G., Poulet, S., Ianora, A., Russo, G., Buttino, I., Mazzarella, G., Laabir, M., Cabrini, M., & Giacobbe, M., 1999. The insidious effect of diatoms on copepod reproduction, *Nature*, **402**, 173–176.

Mobley, C., Stramski, D., Bissett, W., & Boss, E., 2004. Optical modeling of ocean waters: Is the Case I-Case 2 classification still useful? , *Oceanography*, **17**(2), 60—67.

Mozetic, P., Fonda Umani, S., Cataletto, B., & Malej, A., 1998. Seasonal and inter-annual planktonic variability in the Gulf of Trieste (northern Adriatic), *ICES J. Mar. Sci.*, **55**, 711–722.

Mozetic, P., Fonda Umani, S., & Kamburska, L., 2002. Plankton variability in the Gulf of Trieste (Northern Adriatic), *Arch. Oceanogr. Limnol.*, **23**, 7–19.

Mozetič, P., Solidoro, C., Cossarini, G., Socal, G., Precali, R., Francé, J., Bianchi, F., Vittor, C. D., Smodlaka, N., & Umani, S. F., 2009. Recent Trends Towards Oligotrophication of the Northern Adriatic: Evidence from Chlorophyll a Time Series, *Estuaries and Coasts*, **33**(2), 362–375, DOI: 10.1007/s12237-009-9191-7.

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.

Pinardi, N. & Coppini, G., 2010. Operational oceanography in the Mediterranean Sea: the second stage of development, *Ocean Science*, **6**, 263–267.

Porter, K. G. & Feig, Y. S., 1980. The Use of DAPI for Identifying and Counting Aquatic Microflora, *Limnology and Oceanography*, **25**(5), 943–948.

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.

Pugnetti, A., Armeni, M., Camatti, E., Crevatin, E., Dell'Anno, A., Del Negro, P., Milandri, A., Socal, G., Fonda Umani, S., & Danovaro, R., 2005. Imbalance between phytoplankton production and bacterial carbon demand in relation to mucilage formation in the Northern Adriatic Sea, *Sc.Tot.Environ.*, **353**, 162–177, doi:10.1016/j.scitotenv.2005.09.014.

Pugnetti, A., Bazzoni, A. M., Beran, A., Bernardi Aubry, F., Camatti, E., Celussi, M., Coppola, J., Crevatin, E., Negro, P. D., & Paoli, A., 2008. Changes in biomass structure and trophic status of the plankton communities in a highly dynamic ecosystem (Gulf of Venice, Northern Adriatic Sea), *Marine Ecology*, **29**, 367–374, doi:10.1111/j.1439-0485.2008.00237.x.

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, pp. 1–167, 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.

Revelante, N. & Gilmartin, M., 1976. The effect of Po River discharge on phytoplankton dynamics in the Northern Adriatic Sea, *Mar. Biol.*, **34**, 259–271.

Ribera D'Alcala', M., Conversano, F., Corato, F., Licandro, P., Mangoni, O., Marino, D., Mazzocchi, M., Modigh, M., Montresor, M., Nardella, M., Saggiomo, V., Sarno, D., & Zingone, A., 2004. Seasonal pattern in plankton communities in a pluriannual time series at a coastal Mediterranean site (Gulf of Naples): an attempt to discern recurrences and trends, *Scient. Mar.*, **68**, 63–83.

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.

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., Rabitti, S., & Bastianini, M., 2002. Decadal climatic anomalies in the Northern Adriatic Sea inferred from a new oceanographic data set, *Marine Ecology*, **23(Suppl. 1)**, 340–351, doi:10.1111/j.1439-0485.2002.tb00032.x.

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.

Schlitzer, R., 2002. Ocean Data View, *http://odv.awi.de*.

Schminke, H., 2007. Entomology for the copepodologist, *J. Plankton Res.*, **29**, 149–162.

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.

Socal, G. & Bianchi, F., 1989. Adriatico settentrionale in condizioni di stratificazione. 3. Distribuzione della biomassa e dei popolamenti fittoplanctonici (1983–84), *Boll. Oceanol. Teor. Applic.*, pp. 93–109, Numero speciale.

Socal, G., Monti, M., Mozetic, P., & Bianchi, F., 1992. Phytoplankton seasonal trends in the coastal waters of the Northern Adriatic Sea (ALPE ADRIA project March–July 1990, *Commiss. Int. Esplor. Scient. Mer Mediterr. (CIESM)*, **33**, 373.

Socal, G., Acri, F., Bastianini, M., Bernardi Aubry, F., Bianchi, F., Cassin, D., Coppola, J., Lazzari, A. D., Bandelj, V., Cossarini, G., & Solidoro, C., 2008. Hydrological and biogeochemical features of the Northern Adriatic Sea in the period 2003–2006, *Marine Ecology*, **29**(4), 449–468, doi:10/1111/j1439-0485.2008.00266.x.

Solidoro, C., Bandelj, V., Barbieri, P., Cossarini, G., & Fonda Umani, S., 2007. Understanding dynamic of biogeochemical properties in the northern Adriatic Sea by using self-organizing maps and k-means clustering, *J. Geophys. Res.*, **112**, C07S90.1–C07S90.13, doi:10.1029/2006JC003553.

Solidoro, C., Bastianini, M., Bandelj, V., Codermatz, R., Cossarini, G., Melaku Canu, D., Ravagnan, E., Salon, S., & Trevisani, S., 2009. Current state, scales of variability and decadal trends of biogeochemical properties in the Northern Adriatic Sea, *J. Geophys. Res.*, p. C07S91, doi:10.1029/2008JC004838.

Strickland, J. & Parsons, T., 1968. A practical handbook of seawater analysis, *Bull. Fish. Res. Canada*, **167**, 167–310.

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).

Totti, C., Cangini, M., Ferrari, C., Kraus, R., M. Pompei, A. P., Romagnoli, T., Vanucci, S., & Socal, G., 2005. Phytoplankton-size distribution and community structure in relation to mucilage occurrence in Northern Adriatic Sea, *Sci. Total Environ.*, **353**, 204–217.

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.

Uthermöhl, H., 1931. Uber das umgekchrte Mikroskop., *Arch.Hydrobiol.Plankt.*, **22**(3).

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.

Wright, S., Jeffrey, S., Mantoura, R., Llewellyn, C., Bjornland, T., Repeta, D., & Welschmeyer, N., 1991. Improved HPLC method for the analysis of chlorophylls and carotenoids from marine phytoplankton, *Mar. Ecol. Prog. Ser.*, **77**, 183–196.

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.

Table A1: Cruise ENVADRI2011 with R/V *Urania* . Operations at sea.

LON LAT	DATE TIME	OPERATION
ddmm.xxx	UTC	
1821.518 3947.669	0-00-00 00:00:00	Santa
1339.124 4348.698	2011-04-07 15:41:35	CTD-001-AMARE
1339.120 4348.701	2011-04-07 15:45:21	CTD-001-ABORDO
1319.644 4423.320	2011-04-07 19:41:06	CTD-002-AMARE
1259.927 4500.192	2011-04-08 00:13:10	CTD-003
1337.925 4540.296	2011-04-08 05:51:33	RHZ
1338.227 4541.463	2011-04-08 06:03:57	CTD04-AMARE
1336.856 4538.564	2011-04-08 06:37:21	CTD05-AMARE
1333.966 4537.089	2011-04-08 07:09:32	PALOMA-CTD06-AMARE
1333.957 4537.072	2011-04-08 07:21:48	EA11-PALOMA-NS-FITO-AMARE
1333.962 4537.069	2011-04-08 07:25:49	EA11-PALOMA-NS-FITO-ABORDO
1333.963 4537.069	2011-04-08 07:27:54	EA11-PALOMA-NS-WP2-AMARE
1333.969 4537.070	2011-04-08 07:31:11	EA11-PALOMA-NS-WP2-ABORDO
1333.969 4537.066	2011-04-08 07:38:38	G01-PA-BOTTOM
1333.958 4537.060	2011-04-08 07:50:18	SW01-PA-BOTTOM
1331.777 4539.338	2011-04-08 08:45:25	CTD07-AMARE
1331.775 4539.343	2011-04-08 08:48:48	EA11-03-HS
1325.001 4536.658	2011-04-08 09:33:54	CTD08-AMARE
1324.998 4536.648	2011-04-08 09:38:51	EA11-04-HS
1324.982 4536.643	2011-04-08 09:53:50	EA11-04-NS-WP2-AMARE
1319.990 4534.242	2011-04-08 10:53:16	CTD-009-AMARE
1315.726 4530.502	2011-04-08 11:42:20	CTD-010
1315.718 4530.491	2011-04-08 11:44:14	EA11-05-HS-ABORDO
1315.749 4530.500	2011-04-08 11:47:49	EA11-08-NS-FITO
1315.744 4530.486	2011-04-08 11:53:09	EA11-08-NS-FITO-02
1315.723 4530.477	2011-04-08 11:56:21	EA11-08-NS-WP2
1309.270 4532.895	2011-04-08 12:43:38	CTD-011
1309.270 4532.895	2011-04-08 12:44:38	EA11-06-HS-01
1302.859 4536.116	2011-04-08 13:36:49	EA11-07-HS
1302.857 4536.114	2011-04-08 13:38:47	CTD-012
1302.859 4536.113	2011-04-08 13:42:31	CTD-012-bis
1246.270 4528.216	2011-04-08 16:16:33	Avvistamento
1246.374 4528.246	2011-04-08 16:26:05	CTD-013
1246.513 4528.305	2011-04-08 16:44:59	Inizio
1246.566 4528.415	2011-04-08 16:59:35	Prelievo
1242.210 4526.993	2011-04-08 18:15:40	CTD14-AMARE
1245.692 4524.885	2011-04-08 18:47:31	CTD15-AMARE
1251.818 4522.197	2011-04-08 19:36:42	CTD16-AMARE
1302.907 4517.600	2011-04-08 21:00:44	CTD18-AMARE
1302.879 4517.658	2011-04-08 21:19:28	EA11-16-NS-FITO-AMARE
1301.846 4514.975	2011-04-08 21:53:00	CTD019-AMARE
1253.934 4515.003	2011-04-08 22:42:42	CTD-020
1245.582 4514.984	2011-04-08 23:36:01	CTD-021
1240.040 4518.641	2011-04-08 23:40:19	CTD-22-WPT
1240.017 4518.630	2011-04-09 00:23:11	CTD-022
1238.347 4520.709	2011-04-09 04:54:34	G02-CAVA-B-BOTTOM
1238.341 4520.706	2011-04-09 04:54:59	gra02-TRUE
1238.388 4520.729	2011-04-09 05:07:53	G03-CAVA-B-BOTTOM
1229.528 4518.049	2011-04-09 06:15:43	G04-CAVA-A-BOTTOM
1229.531 4518.077	2011-04-09 06:26:05	CTD23-AMARE
1230.540 4518.835	2011-04-09 06:50:50	p-aa-trav
1230.472 4518.914	2011-04-09 07:15:43	AA-HS
1230.469 4518.919	2011-04-09 07:16:19	AA-CTD-024
1230.483 4518.916	2011-04-09 07:20:13	AA-NS-FITO
1230.449 4518.931	2011-04-09 07:27:45	AA-NS-WP2
1230.448 4518.934	2011-04-09 07:29:00	AA-SD
1230.284 4518.973	2011-04-09 08:13:54	G05-AA-BOTTOM

1230.295 4518.955	2011-04-09 08:41:19	AA-BC01-fondo
1230.290 4518.973	2011-04-09 08:41:39	BC01-AA-BOTTOMT
1245.573 4515.042	2011-04-09 12:00:03	C10-HS
1245.618 4515.047	2011-04-09 12:07:41	C10-CTD-025
1245.596 4515.055	2011-04-09 12:18:36	C10-NS-WP2
1245.576 4515.051	2011-04-09 12:30:04	G06-C10-BOTTOM
1245.591 4515.049	2011-04-09 12:51:25	SW02-C10-BOTTOM
1245.585 4515.046	2011-04-09 12:51:56	SW02-C10-BOTTOMT
1245.591 4515.038	2011-04-09 13:10:54	BC02-C10-BOTTOM
1246.233 4514.901	2011-04-09 13:29:52	MEDA-ARPA
1238.562 4515.006	2011-04-09 14:55:15	CTD-026
1231.956 4515.014	2011-04-09 15:41:37	CTD-027
1224.005 4515.000	2011-04-09 16:28:27	CTD-027
1224.032 4515.000	2011-04-09 16:33:39	EA11-022-SD
1225.089 4507.492	2011-04-09 17:44:58	CTD-029-AMARE
1230.432 4507.752	2011-04-09 18:32:59	CTD-030
1245.370 4509.081	2011-04-09 20:03:26	CTD32-AMARE
1253.205 4509.880	2011-04-09 20:54:02	CTD33-AMARE
1259.326 4510.549	2011-04-09 21:31:34	CTD34-AMARE
1236.773 4453.027	2011-04-10 00:15:59	CTD-035
1243.942 4453.105	2011-04-10 01:02:31	CTD-036
1248.932 4453.205	2011-04-10 01:38:06	CTD-037
1255.022 4453.131	2011-04-10 02:21:48	CTD-038
1300.346 4453.187	2011-04-10 03:00:54	CTD-039
1300.551 4455.871	2011-04-10 03:33:35	CTD-040
1300.564 4455.876	2011-04-10 03:40:06	EA11-054BIS-NS-FITO
1253.100 4455.870	2011-04-10 04:28:00	CTD41-AMARE
1236.826 4456.082	2011-04-10 05:54:14	CTD42-AMARE
1236.835 4456.112	2011-04-10 06:00:17	EA11-058-NS-FITO-AMARE
1242.014 4456.022	2011-04-10 06:42:08	N5-CTD43-AMARE
1242.045 4456.026	2011-04-10 06:55:27	N5-NS-NANSEN-01-AMARE
1242.053 4456.037	2011-04-10 06:58:33	N5-NS-NANSEN-01-ABORDO
1241.986 4455.987	2011-04-10 07:05:21	N5-NS-NANSEN-02-AMARE
1241.990 4455.998	2011-04-10 07:08:43	N5-NS-NANSEN-02-abordo
1242.002 4455.985	2011-04-10 07:20:30	N5-WP2-AMARE
1242.025 4455.999	2011-04-10 07:23:29	N5-WP2-ABORDO
1242.009 4455.994	2011-04-10 07:28:49	N5-NS-FITO-AMARE
1241.975 4456.182	2011-04-10 07:41:19	N5-NS-FITO-abordo
1245.748 4455.989	2011-04-10 08:21:55	N4-CTD44-AMARE
1245.759 4455.994	2011-04-10 08:32:52	N4-NS-WP2-AMARE
1245.781 4456.006	2011-04-10 08:35:30	N4-NS-WP2-ABORDO
1245.752 4455.977	2011-04-10 08:41:14	N4-NS-NANSEN-01-AMARE
1245.760 4455.985	2011-04-10 08:45:07	N4-RET-NAPOLI-01-ABORDO
1245.734 4455.970	2011-04-10 08:49:28	N4-NS-NANSEN-02-AMARE
1245.742 4455.990	2011-04-10 08:53:02	N4-NS-NANSEN-02-ABORDO
1245.727 4455.985	2011-04-10 08:55:16	N4-SD-AMARE
1245.739 4455.983	2011-04-10 08:59:54	N4-NS-FITOO-AMARE
1245.883 4456.154	2011-04-10 09:13:02	N4-RET-FITO-ABORDO
1249.431 4455.886	2011-04-10 10:57:31	N3-CTD45-AMARE
1249.438 4455.889	2011-04-10 11:07:33	N3-HS
1249.446 4455.885	2011-04-10 11:08:49	N3-NS-NANSEN-01
1249.480 4455.903	2011-04-10 11:12:29	N3-NS-NANSEN-01-ABORDO
1249.461 4455.878	2011-04-10 11:19:43	N3-NS-NANSEN-02-AMARE
1249.495 4455.877	2011-04-10 11:23:01	N3-NS-NANSEN-02-ABORDO
1249.442 4455.882	2011-04-10 11:29:39	N3-RETINO-VP2
1249.457 4455.882	2011-04-10 11:32:18	N3-RETINO-WP-ABORDO
1249.426 4455.869	2011-04-10 11:37:33	N3-FITO-AMARE
1249.389 4456.057	2011-04-10 11:50:46	N3-FITO-ABORDO
1249.392 4456.060	2011-04-10 11:51:18	N3-SD
1253.129 4455.825	2011-04-10 12:47:50	N2-HS
1253.147 4455.816	2011-04-10 12:51:11	N2-CTD-046

1253.101 4455.821	2011-04-10 12:59:25	N2-NS-NANSEN-01-AMARE
1253.119 4455.835	2011-04-10 13:04:28	N2-NS-NANSEN-01-ABORDO
1253.112 4455.823	2011-04-10 13:07:03	N2-NS-NANSEN-02-AMARE
1253.129 4455.830	2011-04-10 13:11:40	N2-NS-NANSEN-02-ABORDO
1253.114 4455.816	2011-04-10 13:19:57	N2-WP2-AMARE
1253.109 4455.813	2011-04-10 13:23:02	N2-WP2-ABORDO
1253.110 4455.826	2011-04-10 13:28:24	N2-NS-FITO-AMARE
1253.473 4455.949	2011-04-10 13:43:54	N2-NS-FITO-ABORDO
1302.527 4500.248	2011-04-10 15:09:07	CTD-047
1255.310 4459.933	2011-04-10 15:55:27	CTD-048
1249.607 4458.892	2011-04-10 16:36:16	CTD-049
1245.008 4458.379	2011-04-10 17:08:39	CTD50-AMARE
1239.670 4458.126	2011-04-10 17:49:20	CTD51-AMARE
1236.113 4458.149	2011-04-10 18:20:32	CTD52-AMARE
1227.315 4444.594	2011-04-10 20:23:56	S1-SW
1227.312 4444.589	2011-04-10 20:24:13	SW03-S1-BOTTOM
1227.510 4444.621	2011-04-10 21:03:39	S1-CTD53-AMARE
1230.399 4443.921	2011-04-10 21:34:46	S2-CTD54-AMARE
1237.851 4444.199	2011-04-10 22:23:58	S3-CTD55-AMARE
1246.086 4444.464	2011-04-10 23:14:43	S4-CTD56-AMARE
1252.175 4444.464	2011-04-10 23:55:18	CTD-057
1300.397 4444.465	2011-04-11 00:47:16	CTD-058-AMARE
1306.152 4444.944	2011-04-11 01:27:34	CTD-059
1259.984 4448.902	2011-04-11 02:25:55	CTD-060
1252.166 4448.990	2011-04-11 03:19:22	CTD-061
1240.778 4446.601	2011-04-11 04:28:23	CTD-062
1227.494 4444.531	2011-04-11 06:02:58	S1-CTD63-AMARE
1227.380 4444.462	2011-04-11 06:17:40	G07-S1-BOTTOM
1227.448 4444.507	2011-04-11 06:35:21	SW04-S1-BOTTOM
1227.519 4444.479	2011-04-11 07:09:41	SW05-S1-BOTTOM
1227.395 4444.498	2011-04-11 07:34:23	SW06-S1-BOTTOM
1227.349 4444.963	2011-04-11 07:57:35	S1-PLUME-CTD-064-AMARE
1227.334 4444.958	2011-04-11 08:01:59	S1-PLUME-HS
1227.341 4444.956	2011-04-11 08:05:53	S1-PLUME-SD
1227.341 4444.956	2011-04-11 08:06:16	S1-plume-NS-FITO
1227.541 4444.596	2011-04-11 08:18:49	S1-CTD65-AMARE
1227.598 4444.658	2011-04-11 08:32:03	S1-NS-NANSEN-AMARE
1227.683 4444.665	2011-04-11 08:38:02	S1-NS-NANSEN-01-ABORDO
1227.710 4444.667	2011-04-11 08:39:37	S1-NS-NANSEN-02-AMARE
1227.730 4444.679	2011-04-11 08:42:41	S1-HS-MISURA
1227.724 4444.691	2011-04-11 08:47:01	S1-NS-NANSEN-02-ABORDO
1227.703 4444.688	2011-04-11 08:50:08	S1-NS-NANSEN-03-AMARE
1227.727 4444.695	2011-04-11 08:52:31	S1-NS-NANSEN-03-ABORDO
1227.711 4444.612	2011-04-11 09:01:26	S1-NS-WP2-AMARE
1227.724 4444.623	2011-04-11 09:03:57	S1-NS-WP2-ABORDO
1227.766 4444.635	2011-04-11 09:08:02	S1-SD-AMARE
1227.758 4444.636	2011-04-11 09:11:05	S1-NS-FITO-AMARE
1227.827 4444.614	2011-04-11 09:22:02	S1-NS-FITO-ABORDO
1230.399 4443.931	2011-04-11 09:57:54	S2-CTD-066
1230.407 4443.913	2011-04-11 11:00:56	S2-CTD67-AMARE
1230.390 4443.921	2011-04-11 11:10:20	S2-HS
1230.392 4443.920	2011-04-11 11:12:04	S2-NS-NANSEN-01
1230.389 4443.932	2011-04-11 11:24:47	S2-NS-NANSEN-02
1230.387 4443.930	2011-04-11 11:30:11	S2-NS-NANSEN-03
1230.381 4443.934	2011-04-11 11:33:39	S2-NS-NANSEN-03-ABORDO
1230.370 4443.947	2011-04-11 11:41:17	S2-WP2
1230.362 4443.962	2011-04-11 11:44:03	S2-WP2-ABORDO
1230.376 4443.945	2011-04-11 11:50:24	S2-NS-FITO-AMARE
1230.327 4444.133	2011-04-11 12:02:41	S2-NS-FITO-ABORDO
1237.865 4444.215	2011-04-11 12:51:35	S3-CTD-068
1237.864 4444.210	2011-04-11 12:54:52	S3-HS

1237.851 4444.206	2011-04-11 13:04:27	S3-NS-NANSEN-01
1237.857 4444.205	2011-04-11 13:11:48	S3-NS-NANSEN-02
1237.858 4444.204	2011-04-11 13:16:03	S3-NS-NANSEN-02-ABORDO
1237.861 4444.207	2011-04-11 13:21:13	S3-WP2-AMARE
1237.846 4444.221	2011-04-11 13:28:16	S3-NS-FITO-MEDIO-AMARE
1237.802 4444.465	2011-04-11 13:43:44	S3-NS-FITO-MEDIO-ABORDO
1237.828 4444.464	2011-04-11 13:45:17	S3-SD-AMARE
1246.146 4444.470	2011-04-11 14:39:36	S4-CTD-069-AMARE
1246.159 4444.475	2011-04-11 14:47:04	S4-HS
1246.163 4444.482	2011-04-11 14:52:41	S4-NS-NANSEN-01-AMARE
1246.204 4444.493	2011-04-11 15:07:33	S4-SD-AMARE
1246.207 4444.494	2011-04-11 15:08:35	S4-NS-NANSEN-02-AMARE
1246.224 4444.499	2011-04-11 15:15:27	S4-WP2-AMARE
1246.241 4444.530	2011-04-11 15:26:15	S4-NS-FITO-MEDIO-AMARE
1234.461 4448.245	2011-04-11 16:53:36	CTD-070-AMARE
1240.037 4448.473	2011-04-11 17:30:09	CTD071-AMARE
1245.089 4448.910	2011-04-11 18:10:45	CTD-072-AMARE
1256.840 4439.800	2011-04-11 19:51:23	CTD073-AMARE
1250.000 4439.731	2011-04-11 20:35:26	CTD-074-AMARE
1244.408 4439.468	2011-04-11 21:16:35	CTD-075-AMARE
1237.894 4439.114	2011-04-11 22:01:48	CTD-076-AMARE
1231.832 4439.112	2011-04-11 22:42:35	CTD-077-AMARE
1301.054 4429.547	2011-04-12 01:15:18	CTD-078-AMARE
1254.988 4420.637	2011-04-12 03:02:05	CTD-079-AMARE
1246.791 4414.224	2011-04-12 04:11:26	CTD-080-AMARE
1240.511 4409.084	2011-04-12 05:15:16	CTD-081-AMARE
1234.208 4408.565	2011-04-12 06:26:26	E1
1234.279 4408.590	2011-04-12 06:35:18	E1-BC-GRAB
1234.255 4408.585	2011-04-12 06:35:42	BC03-E1-BOTTOMT
1234.277 4408.612	2011-04-12 06:47:28	CTD-083-AMARE
1234.247 4408.625	2011-04-12 06:55:35	E1-BC-02
1234.226 4408.617	2011-04-12 06:56:06	BC04-E1-BOTTOMT
1239.674 4409.632	2011-04-12 07:38:09	E2-CTD-084-AMARE
1239.649 4409.626	2011-04-12 07:42:54	E2-HS
1239.639 4409.625	2011-04-12 07:48:25	E2-NS-NANSEN-01-AMARE
1239.621 4409.621	2011-04-12 07:54:39	E2-NS-NANSEN-01-ABORDOt
1239.605 4409.623	2011-04-12 07:58:18	E2-NS-NANSEN-02-AMARE
1239.600 4409.624	2011-04-12 07:59:16	E2-NS-NANSEN-02-ABORDO
1239.598 4409.698	2011-04-12 08:09:25	E2-NS-WP2-AMARE
1239.617 4409.704	2011-04-12 08:11:55	E2-NS-WP2-ABORDO
1239.631 4409.718	2011-04-12 08:16:19	E2-NS-FITO-AMARE
1239.669 4409.783	2011-04-12 08:27:35	E2-NS-FITO-ABORDO
1239.714 4409.836	2011-04-12 08:30:55	E2-SD-AMARE
1246.796 4414.228	2011-04-12 09:23:19	E3-CTD-085-AMARE
1246.813 4414.248	2011-04-12 09:32:58	E3-NS-Nansen
1246.821 4414.256	2011-04-12 09:35:32	E3-NS-Nansen-01-abordo
1246.809 4414.270	2011-04-12 09:40:12	E3-HS
1246.772 4414.243	2011-04-12 09:42:59	E3-NS-Nansen-02-AMARE
1246.768 4414.246	2011-04-12 09:45:40	E3-NS-Nansen-02-abordo
1246.813 4414.268	2011-04-12 09:52:16	E3-NS-WP2-AMARE
1246.808 4414.270	2011-04-12 09:55:38	E3-NS-WP2-ABORDO
1246.790 4414.265	2011-04-12 09:58:14	E3-NS-FITO-AMARE
1247.039 4414.287	2011-04-12 10:11:04	E3-NS-FITO-ABORDO
1247.059 4414.300	2011-04-12 10:14:24	E3-SD-AMARE
1255.022 4420.635	2011-04-12 11:28:13	E4-CTD-086-AMARE
1255.026 4420.635	2011-04-12 11:28:48	E4-HS
1255.026 4420.648	2011-04-12 11:37:38	E4-NS-NANSEN-01
1255.038 4420.665	2011-04-12 11:43:41	E4-NS-NANSEN-01-ABORDO
1255.064 4420.633	2011-04-12 11:50:05	E4-NS-NANSEN-02-AMARE
1255.077 4420.626	2011-04-12 11:52:05	E4-NS-NANSEN-02-ABORDO
1255.035 4420.647	2011-04-12 11:57:50	E4-NS-WP2-AMARE

1255.035 4420.673	2011-04-12 12:02:55	E4-NS-WP2-ABORDO
1255.045 4420.670	2011-04-12 12:05:06	E4-NS-WP2-AMARE
1255.380 4420.586	2011-04-12 12:21:00	E4-SD
1255.386 4420.587	2011-04-12 12:22:04	E4-NS-FITO-ABORDO
1308.020 4429.383	2011-04-12 13:55:48	E5-HS
1308.022 4429.384	2011-04-12 13:56:08	E5-CTD-087-AMARE
1308.029 4429.429	2011-04-12 14:12:20	E5-NS-NANSEN-01-AMARE
1308.065 4429.426	2011-04-12 14:18:43	E5-NS-NANSEN-01-ABORDO
1308.077 4429.418	2011-04-12 14:22:14	E5-NS-NANSEN-02-AMARE
1308.076 4429.412	2011-04-12 14:26:23	E5-NS-NANSEN-02-ABORDO
1308.078 4429.413	2011-04-12 14:32:22	E5-NS-WP2-AMARE
1308.092 4429.418	2011-04-12 14:37:07	E5-NS-WP2-ABORDO
1308.093 4429.416	2011-04-12 14:41:15	E5-NS-FITO-AMARE
1307.988 4429.246	2011-04-12 14:55:50	E5-NS-FITO-ABORDO
1307.978 4429.265	2011-04-12 14:57:45	E5-SD-AMARE
1248.977 4427.596	2011-04-12 17:20:27	CTD-089-AMARE
1342.150 4404.855	2011-04-13 07:13:39	SE4-CTD-090-AMARE
1342.094 4404.850	2011-04-13 07:26:30	SE4-NS-NANSEN-AMARE
1342.066 4404.862	2011-04-13 07:30:00	SE4-NS-NANSES-ABORDO
1342.097 4404.866	2011-04-13 07:34:38	SE4-NS-NANSEN-02-AMARE
1342.093 4404.916	2011-04-13 07:40:05	SE4-NS-NANSEN-02-ABORDO
1342.132 4404.834	2011-04-13 07:47:32	SE4-NS-WP2-AMARE
1342.132 4404.838	2011-04-13 07:52:31	SE4-NS-WP2-ABORDO
1342.145 4404.865	2011-04-13 07:58:06	SE4-NS-FITO-AMARE
1341.972 4405.186	2011-04-13 08:11:14	SE4-NS-FITO-ABORDO
1341.971 4405.163	2011-04-13 08:15:14	SE4-SD-AMARE
1337.541 4401.330	2011-04-13 09:03:36	CTD-091-AMARE
1332.128 4358.156	2011-04-13 10:06:10	CTD-092-ABORDO
1327.182 4354.700	2011-04-13 11:07:41	SE3-CTD-093-ABORDO
1327.198 4354.680	2011-04-13 11:11:31	SE3-NS-NANSEN-01-AMARE
1327.205 4354.649	2011-04-13 11:25:24	SE3-NS-NANSEN-01-ABORDO
1327.178 4354.641	2011-04-13 11:27:17	SE3-NS-NANSEN-02-AMARE
1327.149 4354.603	2011-04-13 11:33:07	SE3-NS-NANSEN-02-ABORDO
1327.143 4354.640	2011-04-13 11:38:04	SE3-NS-WP2-AMARE
1327.085 4354.620	2011-04-13 11:43:12	SE3-NS-WP2-ABORDO
1327.086 4354.582	2011-04-13 11:45:57	SE3-NS-FITO-AMARE
1326.819 4354.534	2011-04-13 12:02:11	SE3-NS-FITO-ABORDO
1326.788 4354.538	2011-04-13 12:04:49	SE3-SD-AMARE
1321.349 4351.438	2011-04-13 13:02:15	CTD-094bis-AMARE
1321.325 4351.438	2011-04-13 13:06:16	CTD-094bis-ABORDO
1321.321 4351.441	2011-04-13 13:09:10	EA11-158-SD
1317.839 4348.803	2011-04-13 13:45:47	CTD-095-AMARE
1317.842 4348.785	2011-04-13 13:49:26	SE2-CTD-095-ABORDO
1317.835 4348.783	2011-04-13 13:51:21	SE2-SD-AMARE
1317.815 4348.789	2011-04-13 13:57:39	SE2-NS-NANSEN-01-AMARE
1317.791 4348.795	2011-04-13 14:00:58	SE2-NS-NANSEN-01-ABORDO
1317.785 4348.807	2011-04-13 14:03:30	SE2-NS-NANSEN-02-AMARE
1317.782 4348.812	2011-04-13 14:06:48	SE2-NS-NANSEN-02-ABORDO
1317.755 4348.812	2011-04-13 14:09:55	SE2-NS-NANSEN-03-AMARE
1317.737 4348.806	2011-04-13 14:12:51	SE2-NS-NANSEN-03-ABORDO
1317.728 4348.798	2011-04-13 14:16:59	SE2-NS-FITOxSZN-AMARE
1317.892 4348.798	2011-04-13 14:29:09	SE2-NS-FITOxSZN-ABORDO
1313.744 4346.505	2011-04-13 15:09:37	SE1-CTD-096-AMARE
1313.744 4346.508	2011-04-13 15:12:08	SE1-CTD-096-ABORDO
1313.738 4346.511	2011-04-13 15:18:31	SE1-NS-NANSEN-01-AMARE
1313.736 4346.512	2011-04-13 15:21:21	SE1-NS-NANSEN-01-ABORDO
1313.741 4346.512	2011-04-13 15:24:00	SE1-NS-NANSEN-02-AMARE
1313.737 4346.510	2011-04-13 15:25:32	SE1-NS-NANSEN-02-ABORDO
1313.738 4346.507	2011-04-13 15:28:55	SE1-NS-NANSEN-03-AMARE
1313.736 4346.508	2011-04-13 15:31:43	SE1-NS-NANSEN-03-ABORDO
1313.733 4346.509	2011-04-13 15:34:59	SE1-NS-WP2-AMARE

1313.728 4346.510	2011-04-13 15:37:30	SE1-NS-WP2-ABORDO
1313.724 4346.511	2011-04-13 15:39:54	SE1-NS-FITO-AMARE
1313.850 4346.576	2011-04-13 15:52:33	SE1-NS-FITO-ABORDO
1313.847 4346.573	2011-04-13 15:52:48	SE1-DS-ABORDO
1412.802 4339.413	2011-04-13 20:55:12	CTD-097-AMARE
1412.745 4339.406	2011-04-13 21:03:58	CTD-097-ABORDO
1406.018 4336.234	2011-04-13 21:53:21	CTD-098-AMARE
1405.994 4336.210	2011-04-13 22:01:01	CTD-098-ABORDO
1354.570 4331.397	2011-04-13 23:07:03	CTD-099-AMARE
1350.339 4329.581	2011-04-14 13:19:40	CTD-100-AMARE
1350.343 4329.581	2011-04-14 13:20:01	HS-MISURA
1357.850 4315.375	2011-04-14 15:07:55	CTD-101-AMARE
1357.851 4315.375	2011-04-14 15:08:08	EA-101-HS
1404.130 4303.674	2011-04-14 16:45:33	CTD-102-AMARE
1410.424 4251.542	2011-04-14 18:29:37	CTD-103-AMARE
1416.238 4240.500	2011-04-14 20:02:56	CTD-104-AMARE
1422.745 4228.821	2011-04-14 21:36:33	PO1-AMARE
1426.927 4232.221	2011-04-14 22:23:05	CTD106-atsEA
1430.398 4235.204	2011-04-14 23:14:08	CTD107-atsEA
1434.525 4238.608	2011-04-15 00:07:31	CTD108-atsEA
1438.843 4242.054	2011-04-15 00:57:38	CTD109-atsEA
1441.270 4246.524	2011-04-15 01:57:43	CTD110-atsEA
1443.690 4250.596	2011-04-15 02:40:41	POMO-04-CTD-111-AMARE
1435.470 4250.415	2011-04-15 03:49:37	CTD-112-AMARE
1502.688 4255.007	2011-04-15 11:54:22	PO05-CTD-113-AMARE
1502.688 4255.007	2011-04-15 11:54:37	PO05-HS-MISURA
1502.685 4255.029	2011-04-15 12:11:41	PO5-NS-FITO-AMARE-100M
1502.681 4255.032	2011-04-15 12:20:22	PO5-NS-FITO-ABORDO
1832.607 4226.199	2011-04-16 09:17:00	CTD114-atsEA
1832.643 4223.528	2011-04-16 09:59:37	CTD-115-AMARE
1832.633 4223.515	2011-04-16 10:03:11	EA11-CDT-115-HS
1832.677 4223.526	2011-04-16 10:11:47	CTD-115-SD-8.5
1831.220 4220.624	2011-04-16 10:52:04	CTD116-SD-14.0
1831.230 4220.624	2011-04-16 10:56:16	CTD-116-AMARE
1831.256 4220.615	2011-04-16 11:12:04	CTD-116-NS-FITO-AMARE
1831.306 4220.620	2011-04-16 11:20:18	CTD-116-NS-FITO-ABORDO
1831.217 4220.610	2011-04-16 11:29:55	CTD-116-BC01-BOTTOM
1829.453 4217.616	2011-04-16 12:14:12	CTD-117-HS
1829.460 4217.611	2011-04-16 12:25:52	CTD117-SD-18.5
1827.841 4214.365	2011-04-16 13:06:08	CTD-118-AMARE
1827.836 4214.368	2011-04-16 13:25:12	CTD-118-SD-14.5
1827.846 4214.373	2011-04-16 13:31:16	CTD118-BC02-BOTTOM
1825.932 4210.652	2011-04-16 14:23:56	CTD119-atsEA
1825.936 4210.643	2011-04-16 14:47:34	CTD-119-SD-AMARE
1824.175 4206.850	2011-04-16 15:58:11	CTD-120-NS-FITO-ABORDO
1838.710 4201.488	2011-04-16 23:56:12	CTD121-AMARE
1903.137 4153.310	2011-04-17 08:33:59	CTD122-AMARE
1919.328 4151.544	2011-04-17 10:15:38	CTD-123-AMARE
1919.277 4151.560	2011-04-17 10:22:08	CTD-123-NS-FITO-AMARE
1919.261 4151.566	2011-04-17 10:30:16	CTD123-BC03-BOTTOM
1919.282 4151.554	2011-04-17 10:33:57	CTD123-SD-6.5
1916.882 4149.263	2011-04-17 11:05:11	CTD124-AMARE
1916.881 4149.276	2011-04-17 11:14:13	CTD-124-SD-9.0
1916.876 4149.285	2011-04-17 11:16:55	CTD124-BC04-BOTTOM
1914.236 4147.040	2011-04-17 11:48:30	CTD-125-AMARE
1914.227 4147.049	2011-04-17 11:58:21	CTD125-SD-13.0
1914.224 4147.051	2011-04-17 12:03:54	CTD125-BC05-BOTTOM
1910.761 4143.845	2011-04-17 12:43:37	CTD-126-AMARE
1910.739 4143.865	2011-04-17 12:54:09	CD-126-SD-13.0
1910.752 4143.862	2011-04-17 12:58:49	CTD126-BC06-BOTTOM
1907.247 4140.751	2011-04-17 13:36:14	CTD-127-AMARE

1907.257 4140.758	2011-04-17 13:47:38	ST-127-NS-FITO-AMARE
1907.219 4140.769	2011-04-17 13:54:52	CTD-127-NS-FITO-ABORDO
1907.215 4140.766	2011-04-17 13:57:34	CTD-127-SD-15.0
1907.225 4140.756	2011-04-17 14:00:57	CTD-127-BC07-BOTTOM
1905.484 4155.755	2011-04-18 05:17:42	CTD128-AMARE
1912.380 4152.986	2011-04-18 06:13:36	CTD129-AMARE
1912.413 4152.968	2011-04-18 06:46:01	MNG-GC08-BOTTOM
1912.386 4152.964	2011-04-18 07:04:48	CTD129-BC09-BOTTOM
1904.860 4158.936	2011-04-18 08:21:43	MNG-GC10-BOTTOM
1904.874 4158.939	2011-04-18 08:27:44	CTD130-BC11-BOTTOM
1904.902 4158.891	2011-04-18 08:45:37	CTD130-AMARE
1829.352 4218.333	2011-04-18 19:19:10	ROV-AMARE
1829.370 4218.315	2011-04-18 19:42:29	ROV-BOTTOM
1829.401 4218.328	2011-04-18 19:57:09	ROV-ROCCIA
1829.937 4213.088	2011-04-18 21:51:00	CTD131-atsEA
1839.541 4225.981	2011-04-19 05:03:45	CTD-132-AMARE
1839.562 4226.011	2011-04-19 05:12:35	CTD-132-NS-FITO-AMARE
1845.625 4226.201	2011-04-19 06:21:25	CTD-133-AMARE
1845.649 4226.192	2011-04-19 06:26:32	CTD133-NS-AMARE
1844.448 4228.420	2011-04-19 06:49:41	CTD134-AMARE
1844.408 4228.407	2011-04-19 06:56:02	CTD-134-NS-FITO-AMARE
1840.912 4229.806	2011-04-19 07:27:00	CTD135
1834.232 4226.786	2011-04-19 08:38:16	CTD-136-AMARE

Table A2: Stazioni CTD ENVADRI2011 con R/V *Urania* .

LON LAT	STAZ.	DATA-NMEA	DATA-UPLOAD	FILE
ddmm.xxx		UTC		FILE
1339.120 4348.700	CTD-001	2011-00-07T15:40:29	2011-00-07T15:40:52	CTD-001.hex
1319.650 4423.320	CTD-002	2011-00-07T19:40:08	2011-00-07T19:39:44	CTD-002.hex
1259.930 4500.190	CTD-003	2011-00-08T00:12:44	2011-00-08T00:12:20	CTD-003.hex
1338.230 4541.460	CTD-004	2011-00-08T06:03:40	2011-00-08T06:03:13	CTD-004.hex
1336.860 4538.560	CTD-005	2011-00-08T06:37:26	2011-00-08T06:38:00	CTD-005.hex
1333.970 4537.090	CTD-006	2011-00-08T07:08:47	2011-00-08T07:09:30	CTD-006.hex
1331.780 4539.340	CTD-007	2011-00-08T08:42:54	2011-00-08T08:43:42	CTD-007.hex
1325.000 4536.660	CTD-008	2011-00-08T09:34:12	2011-00-08T09:34:29	CTD-008.hex
1324.920 4536.620	CTD-008-bis	2011-00-08T10:08:44	2011-00-08T10:08:43	CTD-008-bis.hex
1319.980 4534.240	CTD-009	2011-00-08T10:51:18	2011-00-08T10:52:31	CTD-009.hex
1315.710 4530.500	CTD-010	2011-00-08T11:39:53	2011-00-08T11:40:32	CTD-010.hex
1309.260 4532.900	CTD-011	2011-00-08T12:44:28	2011-00-08T12:44:46	CTD-011.hex
1309.250 4532.900	CTD-011-bis	2011-00-08T12:48:23	2011-00-08T12:47:59	CTD-011-bis.hex
1302.850 4536.110	CTD-012	2011-00-08T13:38:34	2011-00-08T13:38:26	CTD-012.hex
1302.860 4536.110	CTD-012-bis	2011-00-08T13:43:07	2011-00-08T13:42:52	CTD-012-bis.hex
1246.390 4528.250	CTD-013	2011-00-08T16:24:45	2011-00-08T16:25:22	CTD-013.hex
1242.210 4526.990	CTD-014	2011-00-08T18:15:35	2011-00-08T18:16:11	CTD-014.hex
1245.690 4524.890	CTD-015	2011-00-08T18:47:07	2011-00-08T18:47:37	CTD-015.hex
1251.820 4522.200	CTD-016	2011-00-08T19:35:03	2011-00-08T19:35:23	CTD-016.hex
1257.840 4519.800	CTD-017	2011-00-08T20:17:08	2011-00-08T20:17:23	CTD-017.hex
1301.850 4514.970	CTD-019	2011-00-08T21:52:53	2011-00-08T21:53:25	CTD-019.hex
1253.940 4515.000	CTD-020	2011-00-08T22:41:20	2011-00-08T22:42:00	CTD-020.hex
1245.590 4514.990	CTD-021	2011-00-08T23:34:30	2011-00-08T23:35:15	CTD-021.hex
1240.020 4518.630	CTD-022	2011-00-09T00:22:00	2011-00-09T00:22:27	CTD-022.hex
1229.520 4518.070	CTD-023	2011-00-09T06:25:11	2011-00-09T06:25:36	CTD-023.hex
1230.470 4518.910	CTD-024	2011-00-09T07:13:57	2011-00-09T07:14:32	CTD-024.hex
1245.610 4515.040	CTD-025	2011-00-09T12:03:37	2011-00-09T12:04:12	CTD-025.hex
1238.560 4515.000	CTD-026	2011-00-09T14:53:47	2011-00-09T14:54:24	CTD-026.hex
1231.950 4515.010	CTD-027	2011-00-09T15:40:09	2011-00-09T15:40:41	CTD-027.hex
1224.000 4515.000	CTD-028	2011-00-09T16:27:34	2011-00-09T16:28:19	CTD-028.hex
1225.080 4507.490	CTD-029	2011-00-09T17:43:02	2011-00-09T17:43:38	CTD-029.hex
1230.440 4507.740	CTD-030	2011-00-09T18:30:58	2011-00-09T18:31:09	CTD-030.hex
1237.870 4508.560	CTD-031	2011-00-09T19:16:48	2011-00-09T19:17:35	CTD-031.hex
1245.370 4509.080	CTD-032	2011-00-09T20:04:04	2011-00-09T20:04:16	CTD-032.hex
1253.220 4509.880	CTD-033	2011-00-09T20:51:43	2011-00-09T20:52:10	CTD-033.hex
1259.320 4510.550	CTD-034	2011-00-09T21:29:50	2011-00-09T21:30:28	CTD-034.hex
1236.790 4453.030	CTD-035	2011-00-10T00:14:33	2011-00-10T00:15:06	CTD-035.hex
1243.940 4453.100	CTD-036	2011-00-10T01:01:10	2011-00-10T01:01:44	CTD-036.hex
1248.940 4453.200	CTD-037	2011-00-10T01:37:00	2011-00-10T01:37:15	CTD-037.hex
1255.030 4453.130	CTD-038	2011-00-10T02:19:52	2011-00-10T02:20:17	CTD-038.hex
1300.350 4453.180	CTD-039	2011-00-10T02:59:40	2011-00-10T03:00:07	CTD-039.hex
1300.560 4455.860	CTD-040	2011-00-10T03:31:59	2011-00-10T03:32:40	CTD-040.hex
1253.100 4455.870	CTD-041	2011-00-10T04:28:10	2011-00-10T04:28:36	CTD-041.hex
1236.830 4456.080	CTD-042	2011-00-10T05:53:18	2011-00-10T05:53:12	CTD-042.hex
1242.020 4456.020	CTD-043	2011-00-10T06:42:20	2011-00-10T06:42:36	CTD-043.hex
1245.750 4455.990	CTD-044	2011-00-10T08:22:01	2011-00-10T08:22:23	CTD-044.hex
1249.430 4455.890	CTD-045	2011-00-10T10:58:00	2011-00-10T10:58:16	CTD-045.hex
1302.530 4500.250	CTD-047	2011-00-10T15:07:32	2011-00-10T15:08:17	CTD-047.hex
1255.310 4459.930	CTD-048	2011-00-10T15:55:07	2011-00-10T15:54:45	CTD-048.hex
1249.620 4458.890	CTD-049	2011-00-10T16:34:47	2011-00-10T16:35:30	CTD-049.hex
1245.010 4458.380	CTD-050	2011-00-10T17:08:23	2011-00-10T17:09:11	CTD-050.hex
1239.670 4458.130	CTD-051	2011-00-10T17:49:06	2011-00-10T17:48:37	CTD-051.hex
1236.110 4458.150	CTD-052	2011-00-10T18:20:54	2011-00-10T18:21:05	CTD-052.hex
1227.500 4444.630	CTD-053	2011-00-10T21:04:34	2011-00-10T21:05:03	CTD-053.hex
1230.400 4443.920	CTD-054	2011-00-10T21:33:49	2011-00-10T21:34:41	CTD-054.hex
1237.850 4444.200	CTD-055	2011-00-10T22:23:00	2011-00-10T22:23:45	CTD-055.hex
1246.070 4444.460	CTD-056	2011-00-10T23:12:41	2011-00-10T23:13:18	CTD-056.hex

1252.160 4444.480	CTD-057	2011-00-10T23:51:45	2011-00-10T23:54:19	CTD-057.hex
1300.400 4444.460	CTD-058	2011-00-11T00:46:19	2011-00-11T00:46:27	CTD-058.hex
1306.140 4444.940	CTD-059	2011-00-11T01:26:23	2011-00-11T01:26:40	CTD-059.hex
1259.990 4448.910	CTD-060	2011-00-11T02:24:44	2011-00-11T02:25:01	CTD-060.hex
1252.160 4448.990	CTD-061	2011-00-11T03:18:04	2011-00-11T03:18:22	CTD-061.hex
1240.770 4446.600	CTD-062	2011-00-11T04:27:28	2011-00-11T04:28:01	CTD-062.hex
1227.490 4444.530	CTD-063	2011-00-11T06:01:54	2011-00-11T06:02:20	CTD-063.hex
1227.340 4444.960	CTD-064	2011-00-11T07:56:40	2011-00-11T07:57:01	CTD-064.hex
1227.550 4444.600	CTD-065	2011-00-11T08:19:14	2011-00-11T08:19:46	CTD-065.hex
1230.410 4443.930	CTD-066	2011-00-11T09:56:18	2011-00-11T09:56:51	CTD-066.hex
1230.390 4443.920	CTD-067	2011-00-11T11:03:17	2011-00-11T11:03:22	CTD-067.hex
1237.870 4444.220	CTD-068	2011-00-11T12:49:26	2011-00-11T12:50:13	CTD-068.hex
1246.150 4444.470	CTD-069	2011-00-11T14:37:58	2011-00-11T14:38:29	CTD-069.hex
1234.460 4448.240	CTD-070	2011-00-11T16:53:10	2011-00-11T16:53:35	CTD-070.hex
1240.030 4448.470	CTD-071	2011-00-11T17:29:40	2011-00-11T17:30:18	CTD-071.hex
1245.090 4448.910	CTD-072	2011-00-11T18:11:06	2011-00-11T18:11:58	CTD-072.hex
1256.830 4439.810	CTD-073	2011-00-11T19:49:47	2011-00-11T19:50:23	CTD-073.hex
1250.000 4439.730	CTD-074	2011-00-11T20:35:16	2011-00-11T20:35:36	CTD-074.hex
1244.410 4439.470	CTD-075	2011-00-11T21:15:41	2011-00-11T21:16:10	CTD-075.hex
1237.890 4439.110	CTD-076	2011-00-11T22:00:59	2011-00-11T22:01:35	CTD-076.hex
1231.830 4439.110	CTD-077	2011-00-11T22:42:05	2011-00-11T22:42:30	CTD-077.hex
1301.060 4429.550	CTD-078	2011-00-12T01:15:15	2011-00-12T01:15:36	CTD-078.hex
1254.990 4420.640	CTD-079	2011-00-12T03:00:38	2011-00-12T03:01:19	CTD-079.hex
1246.790 4414.220	CTD-080	2011-00-12T04:11:38	2011-00-12T04:12:01	CTD-080.hex
1240.510 4409.090	CTD-081	2011-00-12T05:14:06	2011-00-12T05:14:40	CTD-081.hex
1239.000 4407.620	CTD-082	2011-00-12T05:50:39	2011-00-12T05:51:04	CTD-082.hex
1234.280 4408.610	CTD-083	2011-00-12T06:47:31	2011-00-12T06:48:20	CTD-083.hex
1239.670 4409.630	CTD-084	2011-00-12T07:38:10	2011-00-12T07:39:01	CTD-084.hex
1246.800 4414.230	CTD-085	2011-00-12T09:23:20	2011-00-12T09:23:52	CTD-085.hex
1255.030 4420.640	CTD-086	2011-00-12T11:28:23	2011-00-12T11:28:41	CTD-086.hex
1308.020 4429.380	CTD-087	2011-00-12T13:55:51	2011-00-12T13:56:14	CTD-087.hex
1256.600 4428.630	CTD-088	2011-00-12T16:23:41	2011-00-12T16:23:54	CTD-088.hex
1248.980 4427.590	CTD-089	2011-00-12T17:19:01	2011-00-12T17:19:32	CTD-089.hex
1342.150 4404.860	CTD-090	2011-00-13T07:12:26	2011-00-13T07:12:53	CTD-090.hex
1337.540 4401.330	CTD-091	2011-00-13T09:04:02	2011-00-13T09:04:33	CTD-091.hex
1332.130 4358.160	CTD-092	2011-00-13T10:05:46	2011-00-13T10:06:08	CTD-092.hex
1327.190 4354.690	CTD-093	2011-00-13T11:01:36	2011-00-13T11:01:49	CTD-093.hex
1321.350 4351.440	CTD-94bis	2011-00-13T13:01:54	2011-00-13T13:01:42	CTD-094-bis.hex
1317.840 4348.800	CTD-95	2011-00-13T13:45:44	2011-00-13T13:46:07	CTD-095.hex
1313.750 4346.500	CTD-96	2011-00-13T15:08:14	2011-00-13T15:08:54	CTD-096.hex
1412.800 4339.420	CTD-97	2011-00-13T20:54:54	2011-00-13T20:55:30	CTD-097.hex
1406.020 4336.240	CTD-98	2011-00-13T21:52:32	2011-00-13T21:53:23	CTD-098.hex
1354.580 4331.400	CTD-99	2011-00-13T23:07:07	2011-00-13T23:07:25	CTD-099.hex
1350.340 4329.580	CTD-100	2011-00-14T13:19:36	2011-00-14T13:20:33	CTD-100.hex
1357.850 4315.370	CTD-101	2011-00-14T15:07:50	2011-00-14T15:08:14	CTD-101.hex
1404.130 4303.670	CTD-102	2011-00-14T16:45:33	2011-00-14T16:48:42	CTD-102.hex
1410.420 4251.540	CTD-103	2011-00-14T18:28:53	2011-00-14T18:29:21	CTD-103.hex
1416.240 4240.500	CTD-104	2011-00-14T20:03:12	2011-00-14T20:03:33	CTD-104.hex
1422.740 4228.820	CTD-105	2011-00-14T21:34:57	2011-00-14T21:35:20	CTD-105.hex
1426.920 4232.230	CTD-106	2011-00-14T22:21:39	2011-00-14T22:22:03	CTD-106.hex
1430.390 4235.210	CTD-107	2011-00-14T23:12:28	2011-00-14T23:12:40	CTD-107.hex
1434.530 4238.610	CTD-108	2011-00-15T00:05:48	2011-00-15T00:06:13	CTD-108.hex
1438.840 4242.040	CTD-109	2011-00-15T00:55:34	2011-00-15T00:55:50	CTD-109.hex
1441.270 4246.520	CTD-110	2011-00-15T01:53:27	2011-00-15T01:53:40	CTD-110.hex
1443.690 4250.600	CTD-111	2011-00-15T02:40:42	2011-00-15T02:40:46	CTD-111.hex
1435.470 4250.420	CTD-112	2011-00-15T03:49:25	2011-00-15T03:49:53	CTD-112.hex
1502.690 4255.010	CTD-113	2011-00-15T11:54:39	2011-00-15T11:54:59	CTD-113.hex
1832.620 4226.200	CTD-114	2011-00-16T09:14:32	2011-00-16T09:14:50	CTD-114.hex
1832.640 4223.520	CTD-115	2011-00-16T10:00:22	2011-00-16T10:00:43	CTD-115.hex
1831.230 4220.620	CTD-116	2011-00-16T10:56:00	2011-00-16T10:56:07	CTD-116.hex
1829.450 4217.620	CTD-117	2011-00-16T12:08:18	2011-00-16T12:08:33	CTD-117.hex

1827.840 4214.370	CTD-118	2011-00-16T13:04:30	2011-00-16T13:04:41	CTD-118.hex
1825.930 4210.650	CTD-119	2011-00-16T14:22:18	2011-00-16T14:22:41	CTD-119.hex
1824.150 4206.850	CTD-120	2011-00-16T15:24:31	2011-00-16T15:24:36	CTD-120.hex
1838.700 4201.490	CTD-121	2011-00-16T23:56:09	2011-00-16T23:56:43	CTD-121.hex
1903.130 4153.320	CTD-122	2011-00-17T08:34:11	2011-00-17T08:34:54	CTD-122.hex
1919.320 4151.540	CTD-123	2011-00-17T10:16:34	2011-00-17T10:15:50	CTD-123.hex
1916.890 4149.260	CTD-124	2011-00-17T11:04:59	2011-00-17T11:04:15	CTD-124.hex
1914.240 4147.040	CTD-125	2011-00-17T11:49:08	2011-00-17T11:49:23	CTD-125.hex
1910.760 4143.850	CTD-126	2011-00-17T12:43:29	2011-00-17T12:43:44	CTD-126.hex
1907.250 4140.750	CTD-127	2011-00-17T13:35:02	2011-00-17T13:35:28	CTD-127.hex
1905.490 4155.750	CTD-128	2011-00-18T05:17:21	2011-00-18T05:17:51	CTD-128.hex
1912.380 4152.990	CTD-129	2011-00-18T06:13:32	2011-00-18T06:14:00	CTD-129.hex
1904.890 4158.930	CTD-130	2011-00-18T08:46:01	2011-00-18T08:46:31	CTD-130.hex
1829.920 4213.090	CTD-131	2011-00-18T21:48:49	2011-00-18T21:48:59	CTD-131.hex
1839.540 4225.980	CTD-132	2011-00-19T05:02:25	2011-00-19T05:02:40	CTD-132.hex
1845.630 4226.200	CTD-133	2011-00-19T06:21:23	2011-00-19T06:21:36	CTD-133.hex
1844.440 4228.420	CTD-134	2011-00-19T06:49:33	2011-00-19T06:50:02	CTD-134.hex
1840.980 4229.770	CTD-135	2011-00-19T07:24:45	2011-00-19T07:24:51	CTD-135.hex
1834.230 4226.790	CTD-136	2011-00-19T08:38:25	2011-00-19T08:38:41	CTD-136.hex

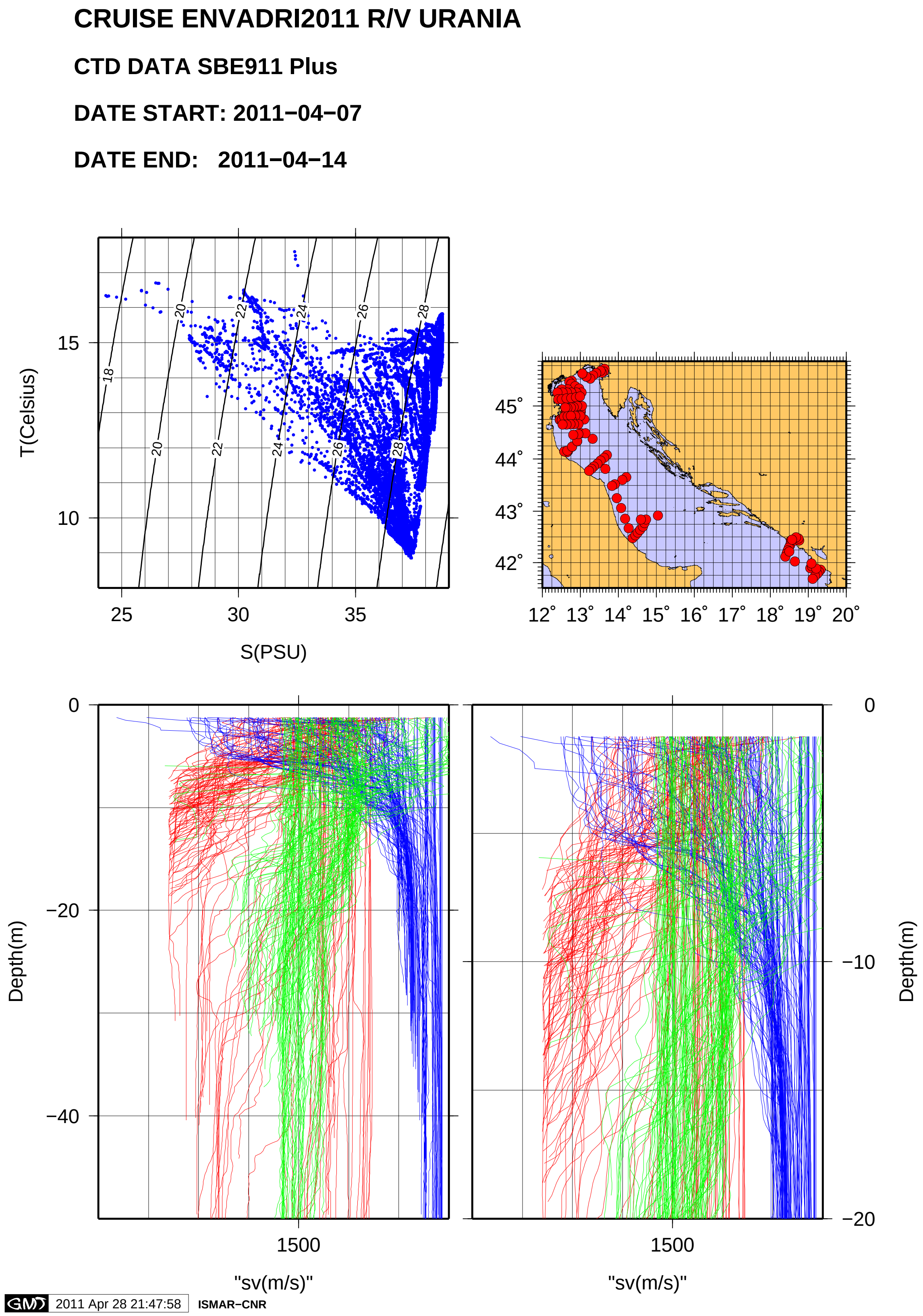

Figure A1. CTD data of ENVADRI2011.

Table A3: Cruise ENVADRI2011 with R/V *Urania* . Water samples (nutrient/chl).

DATE	STATION NAME	DEPTH SAMPLING	NUTRIENTS	CHLOROPHYLL
			subsample	subsample
2011-04-08	EA16	SURF	A	
2011-04-11	EA39	SURF	B	
2011-04-11	EAS1	SURF	22	
2011-04-11	EAS1	INT	23	
2011-04-11	EAS1	BOTTOM	24	
2011-04-11	EAS?	SURF	C	
2011-04-11	EAS4	SURF	25	
2011-04-11	EAS4	INT	26	
2010-03-11	EAS4	BOTTOM	27	
2011-04-12	EAE2	SURF	28	
2011-04-12	EAE2	INT	29	
2011-04-12	EAE2	BOTTOM	30	
2011-04-12	EAE3	SURF	D	
2011-04-12	EAE4	SURF	E	
2011-04-12	EAE5	SURF	31	
2011-04-12	EAE5	INT	32	
2011-04-12	EAE5	BOTTOM	33	
2011-04-13 09:00+0200	EA154(SE04)	SURF	34	34
2011-04-13	EA154(SE04	10	35	35
2011-04-13	EA154(SE04	20	36	36
2011-04-13	EA154(SE04	40	37	37
2011-04-13	EA154(SE04	68	38	38
2011-04-13 10:55+0200	EA155	SURF	39	
2011-04-13	EA155	10	40	40
2011-04-13	EA155	20	41	41
2011-04-13	EA155	40	42	42
2011-04-13	EA155	68	43	43
2011-04-13 12:05+0200	EA156	SURF	44	44
2011-04-13	EA156	10	45	45
2011-04-13	EA156	20	46	46
2011-04-13	EA156	40	47	47
2011-04-13	EA156	57	48	48
2011-04-13 13:02+0200	EA157(SE53?	SURF	49	49
2011-04-13	EA157(SE503?	10	50	50
2011-04-13	EA157(SE503?	20	51	51
2011-04-13	EA157(SE503?	40	52	52
2011-04-13	EA157(SE503?	57	53	53
2011-04-13 12:45+0200	EA158	SURF	54	54
2011-04-13	EA158	10	55	55
2011-04-13	EA158	20	56	56
2011-04-13	EA158	33	57	57
2011-04-13 13:40+0200	EA159	SURF	58	58
2011-04-13	EA159	10	59	59
2011-04-13	EA159	20	60	60
2011-04-13	EA???	SURF	61	61
2011-04-13	EA???	5	62	62
2011-04-13	EA???	12	63	62
2011-04-14	P1(105)	SURF	7-9	
2011-04-14	P1(105)	20	4-6	
2011-04-14	P1(105)	BOTTOM	1-3	
2011-04-15	P2(107)	SURF	18-21	
2011-04-15	P2(107)	50	16-18	
2011-04-15	P2(107)	75	13-15	
2011-04-15	P2(107)	BOTTOM	10-12	
2011-04-15	P3(109)	SURF	34-36	
2011-04-15	P3(109)	50	31-33	

2011-04-15	P3(109)	100	28-30	
2011-04-15	P3(109)	150	25-27	
2011-04-15	P3(109)	BOTTOM	22-24	
2011-04-15	P4(111)	SURF	58-60	
2011-04-15	P4(111)	50	55-57	
2011-04-15	P4(111)	100	52-54	
2011-04-15	P4(111)	150	49-51	
2011-04-15	P4(111)	170	46-48	
2011-04-15	P4(111)	210	43-45	
2011-04-15	P4(111)	230	40-42	
2011-04-15	P4(111)	BOTTOM	37-39	
2011-04-15	Pextra(112)	SURF	79-81	
2011-04-15	Pextra(112)	50	76-78	
2011-04-15	Pextra(112)	100	73-75	
2011-04-15	Pextra(112)	150	70-72	
2011-04-15	Pextra(112)	170	67-69	
2011-04-15	Pextra(112)	210	64-66	
2011-04-15	Pextra(112)	BOTTOM	61-63	
2011-04-15	P5(113)	SURF	94-96	
2011-04-15	P5(113)	50	91-93	
2011-04-15	P5(113)	100	88-90	
2011-04-15	P5(113)	150	85-87	
2011-04-15	P5(113)	170	82-84	
2011-04-15	P5(113)	BOTTOM	-	
2011-04-16	CTD114	SURF	103-105	3
2011-04-16	CTD114	13	100-103	2
2011-04-16	CTD114	BOTTOM	97-99	1(2L)
2011-04-16	CTD115	SURF	112-114	6
2011-04-16	CTD115	28	109-111	5
2011-04-16	CTD115	BOTTOM	106-108	4(4L)
2011-04-16	CTD116	SURF	127-129	9
2011-04-16	CTD116	20	124-126	8
2011-04-16	CTD116	50	121-123	7
2011-04-16	CTD116	75	118-120	
2011-04-16	CTD116	BOTTOM	115-117	
2011-04-16	CTD117	SURF	127-129	12
2011-04-16	CTD117	30	124-126	11
2011-04-16	CTD117	60	139-141	10
2011-04-16	CTD117	100	136-138	
2011-04-16	CTD117	130	133-135	
2011-04-16	CTD117	BOTTOM	130-132	
2011-04-16	CTD118	SURF	166-168 15	
2011-04-16	CTD118	20	163-165 14	
2011-04-16	CTD118	60	160-162 13	
2011-04-16	CTD118	100	157-159	
2011-04-16	CTD118	145	154-156	
2011-04-16	CTD118	175	152-153	
2011-04-16	CTD118	BOTTOM	148-150	
2011-04-16	CTD119	SURF	187-189 18	
2011-04-16	CTD119	30	184-186 17	
2011-04-16	CTD119	90	181-183 17	
2011-04-16	CTD119	130	178-180	
2011-04-16	CTD119	175	175-177	
2011-04-16	CTD119	220	171-174	
2011-04-16	CTD119	BOTTOM	169-171	
2011-04-16	CTD120	SURF	214-216 21	
2011-04-16	CTD120	30	211-213 20	
2011-04-16	CTD120	75	208-210 19	
2011-04-16	CTD120	105	305-207	
2011-04-16	CTD120	150	202-204	
2011-04-16	CTD120	200	199-201	

2011-04-16	CTD120	250	196-198	
2011-04-16	CTD120	300	193-195	
2011-04-16	CTD120	BOTTOM	190-192	
2011-04-17	CTD123	SURF	220-222	23
2011-04-17	CTD123	BOTTOM	217-219	22
2011-04-17	CTD124	SURF	232-234	26
2011-04-17	CTD124	10	229-231	25
2011-04-17	CTD124	30	226-228	24
2011-04-17	CTD124	BOTTOM	223-225	
2011-04-17	CTD125	SURF	247-249	29
2011-04-17	CTD125	10	244-246	28
2011-04-17	CTD125	30	241-243	
2011-04-17	CTD125	50	238-240	27
2011-04-17	CTD125	BOTTOM	235-237	
2011-04-17	CTD126	SURF	262-264	32
2011-04-17	CTD126	10	259-261	31
2011-04-17	CTD126	30	256-258	
2011-04-17	CTD126	50	253-255	30
2011-04-17	CTD127	BOTTOM	250-152	
2011-04-17	CTD127	SURF	277-279	35
2011-04-17	CTD127	10	274-275	34
2011-04-17	CTD127	30	271-273	
2011-04-17	CTD127	50	268-270	33
2011-04-17	CTD127	BOTTOM	265-267	
2011-04-17	CTD127	BOTTOM	250-152	
2011-04-19	CTD132(TIVAT)	SURF	286-288	38
2011-04-19	CTD132	20	283-285	37
2011-04-19	CTD132	BOTTOM	280-282	36
2011-04-19	CTD133(IBMK)	SURF	292-294	40
2011-04-19	CTD133	BOTTOM	289-291	39
2011-04-19	CTD134(KOTOR)	SURF	301-303	43
2011-04-19	CTD134	24	298-300	42
2011-04-19	CTD134	BOTTOM	295-297	41
2011-04-19	CTD135(RISAN)	SURF	310-312	46
2011-04-19	CTD135	20	307-309	45
2011-04-19	CTD135	BOTTOM	304-306	44
2011-04-19	CTD136(HERZEG-NOVI)	SURF	316-319	48
2011-04-19	CTD136	BOTTOM	313-315	47

DATE	OPERATIONS
2011-04-07	Mobilization in Ancona. Departure 15:45 local, heading to Trieste, CTD, CHIRP, MULTIBEAM
2011-04-08	Gulf of Trieste Venice, Stations Paloma Acqua Alta, Water Sampling, CTD, CHIRP, MULTIBEAM
2011-04-09	Station C10, Po River, transect N1, water sampling, CTD, CHIRP, MULTIBEAM
2011-04-10	Po River, transect S1, water sampling, CTD, CHIRP, MULTIBEAM
2011-04-11	Station S1, 08:15 local Maintanance S1 Buoy (change of Temperature and Humidity sensors, installation of compass for true wind direction), Po River, transect , water sampling, CTD, CHIRP, MULTIBEAM
2010-03-12	Stations E1, CTD control E1 Buoy, transect E1 Rimini, CTD, CHIRP, MULTIBEAM
2011-04-13	transect Senigallia, CTD, CHIRP, MULTIBEAM
2011-04-14	Crew change, Ancona.
2011-04-15	transit CTD Pescara, Pomo CTD, CHIRP, MULTIBEAM
2011-04-16	Zelenika 08:00 embark Montenegrin People, CTD, CHIRP, MULTIBEAM
2011-04-17	Chirp, Multibeam Bojana,CTD, CHIRP, MULTIBEAM, Box corer
2011-04-18	Ulcinji, Bar area, Coring, Chirp, Multibeam, Sparker, Bokakotorska ROV, CTD, CHIRP, MULTIBEAM
2011-04-19	06:30 Pilot on board Zelenika, work in Tivat, Kotor Bay, CTD, CHIRP, MULTIBEAM
2011-04-19	10:30 Disembark Montenegrin, head to Bari
2011-04-20	12:00 demobilization Bari

Table A4. DIARY OF OPERATIONS.

Listing 1 cnv2odv

```
#!/usr/bin/perl
#
# converts SBE .cnv data into spreadsheet ODV
#
use Getopt::Long;

$cdi = 1;
$ISMAR_ID = 145;
%MONTH_BY_NAME = ('JAN','1','FEB','2','MAR','3','APR','4','MAY','5','JUN','6',
                  'JUL','7','AUG','8','SEP','9','OCT','10','NOV','11','DEC','12',
);
@optl = ("vars:s","header:s", "every:s","ref:s","format:s","cruise:s",
        "ship:s","ship_code:s",
        "start_date:s","end_date:s","region:s","institute:s","country:s",
        "project:s","name:s","nsta:s","qc_dllb:s","conf:s",
        "limits:s","avail:s","dc_history:s","dm_history:s", "v|verbose");
GetOptions @optl;
#$opt_ref =~ /PRES|DEPH/ or die "Usage: $0 --ref=PRES|DEPH ...";
$opt_ref = "PRES" unless $opt_ref;
$opt_qc_dllb = "0000" unless $opt_qc_dllb;  # header qc data/time lat lon bottom_depth
#printf "%d", find_nrows_in_cnv($opt_every) and exit if $opt_find_lines;
if ($opt_format =~ /plain/i) {
    if ( not ( $opt_vars and not $opt_header) and
    not ( $opt_header =~ /station/i ) ) {
        print "Usage:␣$0␣--format=plain␣--var1=TEMP|SAL|...␣--var2=DEPTH|TEMP...␣cnv_file\
        print "Usage:␣$0␣--format=plain␣--header=station␣cnv_file\n";
        exit;
   }
}
@VARNAMES = qw (Pressure Depth Temperature Salinity Oxygen OxygenPS
        Fluorescence Transmission Sound Density Altimeter Beam_Transmission Beam_Attenuati
@VARNAMES_TO_EXPORT = split (/\,/,$opt_vars);
$NP = $#VARNAMES_TO_EXPORT + 1;
$NL = $opt_nlines;
%SBE_VARNAMES = (
        PRES => "Pressure,%7.2f␣,-999.99,␣dbar",
        TEMP => "Temperature,%6.3f␣,99.999,␣Deg␣C",
        PSAL => "Salinity,%6.3f␣,99.999,␣psu",
        DOX1 => "Oxygen,%6.3f␣,99.999,␣ml/l",
        DEPH => "Depth,%7.2f␣,-999.99,␣m",
        SVEL => "Sound,%7.1f␣,99.999,␣m/s",
        DENS => "Density,%6.3f␣,99.999,␣kg/m3",
        BTRM => "Beam_Transmission,%6.3f␣,-99.999,␣%",
        BATT => "Beam_Attenuation,%6.3f␣,-99.999,␣1/m",
        FLUO => "Fluorescence,%6.3f␣,-99.999,␣ug/l",
        ALTM => "Altimeter,%6.3f␣,-99.999,␣m",
        OSAT => "OxygenPS,␣%6.3f,␣99.999,␣%␣sat",
);
# Cruise header
$NOW=`date`; chop $NOW;
# cnv file processing ...
@TEMP=@DEPH=@PSAL=@DOX1=@PRES=@ALTM=undef;
@SVEL=@DENS=@BRTM=@BATT=@FLUO=@OSAT=undef;
$nl = 0;
while (<>) {
        s/\r\n/\n/g;  # filters DOS EOR ..
#       header variable parsing ...
        s/Oxygen/OxygenPS/ if /sbeox0PS\:/;
        s/Beam /Beam\_/ if /xmiss\:/ or /bat\:/;
        if (/System UpLoad Time/) {
```

```
                @A = split (/\=|\s+/);
                $month = $MONTH_BY_NAME{uc $A[6]};
                $day = $A[7]; $year = $A[8];
                $DATE2 = sprintf "%002d%002d%00004d", $day,$month,$year;
# medatlas
                $DATE = sprintf "%00004d%002d%002d", $year,$month,$day;
# whop e altri
                ($hh,$mm,$ss) = split (/\:/,$A[9]);
                $TIME = sprintf "%002d%002d",$hh,$mm;
                $DATE_TIME = sprintf "%d-%002d-%002dT%002d:%002d:%002d",
                        $year,$month,$day, $hh,$mm, $ss;
# ODV iso-8601
        }
        if (/NMEA Latitude/) {
                @A = split (/\=|\s+/);
                $latd = $A[5]; $latm=$A[6]; $lats = $A[7];
                $lat = sprintf "%.6f", dmhd60 (sprintf "%s%s", $latd,$latm);
        }
        if (/NMEA Longitude/) {
                @A = split (/\=|\s+/);
                $lond = $A[5]; $lonm = $A[6]; $lons=$A[7];
                $lon = sprintf "%.6f", dmhd60 (sprintf "%s%s", $lond,$lonm);
        }
        if (/NMEA UTC/) {
                ($a,$b,$c,$d,$utc) = split (/\=|\s+/);
        }
        if (/Station/) {
                ($a,$b,$sta) = split (/\=|\s+/);
        }
        if (/\*\* Depth/) {
                ($a,$b,$depth) = split (/\=|\s+/);
        }
        if (/^\# name/) {
#       finds variable name and index on data records
                @A = split(/\=|\:|name|\[/);
                print STDERR "@A\n" if $opt_v;
                foreach $n (@VARNAMES) {
#                       $A[1]=~s/ /\_/;
                        if (/$n/) {
                        $INDEX_POSITION{$n}=$A[1];
                        $MU{$n} = "[" . $A[$#A];
                        print STDERR ".. $MU{$n} ..\n" if $opt_v;
                        }
                }
        }
#       Data processing
        if (/^\s+\d+\./) {
          (@D)=split;
#         print "@D\n";
          foreach $s ( keys %SBE_VARNAMES) {
# assigns value to variables according to index in CNV file ..
                ($sbe_string,$format,$default) = split (/\,/,$SBE_VARNAMES{$s});
                ${$s}[$nl] = sprintf ($format,$D[$INDEX_POSITION{$sbe_string}]);
# examples $PRES = sprintf "%.2f", $D[$INDEX_POSITION{Pressure}];
#          $DEPH = sprintf "%.2f", $D[$INDEX_POSITION{Depth}]; DEPtH below sea surface
          }
          $nl++;
        } else { chop; $OH.=("$_ ; "); }
}

$NL=$nl-1;
```

```
# calculates number of lines if data reduction required
$NL_RED = 0;
if ($opt_every) {
  for ($i=0;$i<$NL;$i++) {
# selects data
        $NL_RED++ if test_every ($PRES[$i],$opt_every) ;
  }
}
check_quality ($NL);
#print_cruise_header ($opt_format);
#print_station_header($opt_format,$opt_every?$NL_RED:$NL);
print_data ($opt_format,$NL) ;

exit;

sub test_every {
        my ($REF,$EVERY)=@_;
        my ($mul,$retval);
# (times 10 when ==1, 100 < 1 to make modulus working with 1 or fractional values !!)
        $mul =   1 if ($EVERY > 1 );
        $mul =  10 if ($EVERY ==1 );
        $mul = 100 if ($EVERY < 1 );
        return 1 if ($REF*$mul % ($EVERY*$mul) == 0) ;
        return 0;
}
#####################    SUBROUTINES
sub check_quality {
  my ($nl) = @_;
  my ($i,$v,$l,$vv,$min,$max);
#       Quality flags  ODV 0 = correct, 1 = no quality control,
4=probably bad, 8 = bad
  my @L = split (/\;/,$opt_limits);
  foreach $l (@L) {
        ($vv,$min,$max) = split (/\,/,$l);
        $LIMITS{$vv} = "$min $max";
#       print "$l - $LIMITS{$l} - $min - $max \n";
  }

  foreach $v (@VARNAMES_TO_EXPORT) {
        ($min,$max) = split (/\s+/,$LIMITS{$v});
        $vflag = 0;
        for ($i=0;$i<=$nl;$i++) {
          $QC{$v}[$i] = 1;
          $QC{$v}[$i] = 2 if (${$v}[$i]<=$min or ${$v}[$i]>=$max);
#         print "$v -> ${$v}[$i] - $min - $max - $LIMITS{$v} \n";
          if ($v eq "PRES") {
                $QC{PRES}[$i] = 4 if ($PRES[$i-1]>=$PRES[$i] and ($i>=1));
          } elsif ($v eq "DENS") {
                $PRES[$i] <= 10 ? $EPS = 0.05 : $EPS = 0.03;  # 0.05 0.03
                $QC{DENS}[$i] = 4 if (($DENS[$i-1]-$EPS) > $DENS[$i] and ($i>=1));
          }
          $vflag += 1 if $QC{$v}[$i] > 1;
#         print ".. $QC{$v}[$i] ..\n";
        }
        $QC_PROFILE{$v} = $vflag > $nl * 0.1 ? "4" : "1";
  }
}
sub print_data { my ($FORMAT,$nl) = @_;
# prints data
  my ($v,$i,$sbe_string,$format,$default);
  print "Cruise\tStation\tType\tyyyy-mm-ddThh:mm:ss\tLon [degrees_east]\tLat [degrees_nort
```

```
        foreach $v (@VARNAMES_TO_EXPORT) { print "\t${v}_$MU{$v}\tQF";} print "\n";
    for ($i=0;$i<$nl;$i++) {
        print "$opt_cruise\t$sta\tC\t$DATE_TIME\t$lon\t$lat\t$depth\t";

        foreach $v (@VARNAMES_TO_EXPORT) {
            $QC{$v}[$i] = 1;
            ($sbe_string,$format,$default) = split (/\,/,$SBE_VARNAMES{$v});
            printf $format, ${$v}[$i];
            printf "\t%d\t", $QC{$v}[$i];
        }
#       foreach $v (@VARNAMES_TO_EXPORT) { printf "%d", $QC{$v}[$i];}
        print "\n";
    }
}

sub dmhd60 { local ($alfa)=@_;
# from ddmm.xxx to dd.xxxx lat, lon
        local ($segno)=$alfa<0?(-1):1;
        local ($temp)=$segno<0?$alfa*(-1):$alfa;
        local ($xd)=int($temp/100); $yd=$temp-($xd*100);
        return $segno*($xd+$yd/60);
}

sub dbar2m { my ($P0,$LAT) = @_;
# WHOI package depth conversion dbar -> m
        local $X,$P,$GR,$DEPTH;
#               REAL FUNCTION DEPTH(P0,LAT)
# ********************************
# DEPTH IN METERS FROM PRESSURE IN BARS USING
# SAUNDERS AND FOFONOFF'S METHOD.
# DEEP-SEA RES., 1976,23,109-111.
# FORMULA REFITTED FOR 1980 EQUATION OF STATE
# UNITS:
#         PRESSURE          P0         DECIBARS
#         DEPTH             DEPTH      METERS
# CHECKVALUE: DEPTH = 9712.654 M FOR P=10000 DECIBARS, LATITUDE=30 DEG
#       ABOVE FOR STANDARD OCEAN: T=0 DEG. CELSUIS ; S=35 PSU
#
      $X = sin($LAT/57.29578);
#   SCALE PRESSURE TO BARS
      $P=$P0/10.0;
      $X = $X*$X;
# GR= GRAVITY VARIATION WITH LATITUDE: ANON (1970) BULLETIN GEODESIQUE
      $GR = 9.780318*(1.0+(5.2788E-3+2.36E-5*$X)*$X) + 1.092E-5*$P;
      $DEPTH = (((-1.82E-11*$P+2.279E-7)*$P-2.2512E-3)*$P+97.2659)*$P;
      return $DEPTH/$GR;
}
sub m2dbar { my ($M0,$LAT)=@_;
# WHOI package depth conversion m-> dbar
        local ($X,$GR,$P);
        $X=sin($LAT/57.29578);
        $X=$X*$X;
        $P=$M0/10;
        $GR = 9.780318*(1.0+(5.2788E-3+2.36E-5*$X)*$X)+1.092E-5*$P;
        return ($M0)*10/$GR;
}

__DATA__

=head1 NAME
 cnv2odv.pl  A routine to convert SEA BIRD cnv data to ODV spreadsheet
```

```
=head1 SYNOPSIS
 cnv2odv.pl CNV_FILE --vars="$VARS_TO_EXPORT" --format=$FORMAT --qc=$QC_DLLB \
        --header=station --project=$PROJECT --cruise=$CRUISE  \
        --ref=$REF --every=$EVERY --limits=$LIMITS \
        --dc_history=$DC_HISTORY --dm_history=$DM_HISTORY \
        --ship=$SHIP --ship_code=$SHIP_CODE --country=$COUNTRY \
        --institute=$INSTITUTE_ADDRESS >> $MEDATLAS_FILE

 where options are

        format          medatlas|whpo|plain ...
        vars            List of variables to export   --vars="PRES_PSAL_TEMP_..."
        header          cruise|station
        project         Project name
        cruise          Cruise Name
        ref             Reference Variable PRES|DEPH
        every           value for decimation
        limits          Variable limits VAR1,min,max;VAR2,min,max;...
        qc_dllb         Medatlas quality flag Date/Time, Lat., Lon., Bottom Depth
        dc_history      Medatlas Data description (instrumentation etc)
        dm_history      Medatlas Data Manipulation

=head1 REQUIREMENTS
        Perl interpreter (Linux, Windows, Mac)
        Programmable interactive shell
=head1 TODO
        Conversion to NETCDF
        Import all codes for quality check and data description
=head1 KNOWN PROBLEMS
        Checks and automatizazion of quality flags needs better control
=head1  AUTHORS
 Giovanni Bortoluzzi <g.bortoluzzi@ismar.cnr.it>
=cut
```

Listing 2 CNV2ODV

```
#!/bin/bash


#BASE_DIR=/home/ismar/WORKS/CRUISES/ENVADRI2011
SRC=/home/ismar/WORKS/CRUISES/SRC/CNV_ODV_SPREADSHEET
SRC=.
BASE_DIR=../OCEAN/CTD/BINAVG
CRUISE=ENVADRI2011
ODV_FILE=ENVADRI2011_ALLDATA

#BINAVG=`ls $BASE_DIR/OCEAN/CTD/BINAVG/*_0.25DB.cnv | sed s/\.cnv//`
BINAVG=`ls $BASE_DIR/*13[1-5]*.cnv | sed s/\.cnv//`
BINAVG=`ls $BASE_DIR/*.cnv | sed s/\.cnv//`
#adr02_001
rm $CRUISE.txt odv_tmp.txt
for b in $BINAVG; do
  $SRC/cnv2odv.pl -proj=ENVEUROPE --cruise=$CRUISE ${b}.cnv \
  --vars="PRES,DEPH,ALTM,TEMP,PSAL,DOX1,OSAT,FLUO,BATT,BTRM,SVEL"
>> odv_tmp.txt
  echo "Done with $b ..";
done
perl -ne 'next if /Cruise/ and $.>1; print' odv_tmp.txt > ${ODV_FILE}.txt
# --limits="PRES,0,100;DEPTH,0,100;TEMP,5,15;PSAL,27,39;DOX1,2,8" | ncgen -o
```