Istituto Nazionale di **O**ceanografia e di **G**eofisica **S**perimentale
Sezione OCE

Multidisciplinary Approach to Research in Permanent Oceanographic Sites

Cruise Report

FIXO^3- RIT - 05

Vanessa Cardin

In collaboration with
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1 Cruise Details

Name	**FixO3 – RIT - 05**
Date	**28 October - 4 November 2015**
Study Area	**Southern Adriatic Sea**
Project Responsible	**Vanessa Cardin**
Head of the cruise	**Vanessa Cardin**
Participant Institutes	**OGS – Oceanography Department** **ISMAR - Bologna**
Research Vessel	**R/V OGS-Explora**
Harbour of Departure	**Bari - Italy**
Harbour of Arrival	**Bari - Italy**

The FixO^3 – RITMARE05 October 2015 survey includes:

1. **E2M3A Observatory Maintenance**
2. **CTD casts and Rosette water sampling**

2 Acknowledgement

We thank the Captain Carmine Teta and the crew of the R/V OGS EXPLORA for their hard work throughout the survey. We also thank OGS for the ship time given for this activity. The research leading to these activities has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° [312463], [FixO3]". This research was partially funded by OGS, the national project RITMARE.

3 Scientific and technical crew

POSITION	NAME	INSTITUTION
Project co-ordinator, Party Chief, CTD operator	Vanessa Cardin	OGS-OCE
Buoy Engineer	Fabio Brunetti	OGS-TECDEV
Mooring maintenance	Franco Arena	OGS-TECDEV
Mooring maintenance	Alessandro Bubbi	OGS-TECDEV
Mooring maintenance	Paolo Mansutti	OGS-TECDEV
CTD operator	Massimo Pacciaroni	OGS-OCE
Winch mechanic	Gianpaolo Visnovic	OGS-IRI
Chemical measurements	Martina Kralj	OGS-OCE
Chemical measurements, fellowship	Matteo Bazzaro	OGS-OCE
Sediment trap responsible, Phd student	Ilaria Conese	ISMAR-BO

Table 2-1 Scientific Crew

Scientific and Ship Crew participating to the FixO3-Ritmare05 Cruise

4 Scientific Background

The Southern Adriatic Sea is an area where vertical mixing (upwelling, wintertime convection) has a rather prominent role homogenizing physical and chemical seawater properties, and controlling the primary production (upwelling water is a source of nutrients in the euphotic zone which stimulates the growth of phytoplankton). The dynamics of the area is dominated by the presence of a quasi-permanent cyclonic gyre that intensifies in the winter season creating the conditions for the production of dense and oxygenated waters with the contribution of the saltier intermediate layer dominated by the Levantine Intermediate Water (LIW) and Cretan Intermediate Water (CIW). The Adriatic Dense Water (AdDW) formed prevalently by the open-ocean vertical convection, is then exported through the Strait of Otranto to the rest of the Eastern Mediterranean basin and becomes the main component of the Eastern Mediterranean Deep Water (EMDW).

The analyses of long-term thermohaline and biogeochemical properties collected in the Southern Adriatic help us to understand the complex mechanisms of the deep convection process. These data allow monitoring of changes that can be related to modifications in the general circulation of the Mediterranean Sea or, on a larger time scale, to climate variability of the area.

The high-frequency sampling is needed to resolve events and rapid processes and the long sustained measurements of multiple interrelated variables from the sea surface to the seafloor; data are provided by the observatory E2M3A located in the area of the Southern Adriatic Pit (Fig. 6.1). The E2-M3A system is characterized by a surface buoy (A) and a single mooring line (B) (Annex A1 and A2). The buoy hull of welded steel construction has a discus shape, which provides three main compartments, provision for installation of sensors, ballast compartments and provision for the attachment of the superstructure. The surface buoy in a separated???? mooring line communicates with the instrument mooring through hydro-acoustic modems that allows the real data transfer from the platform to the land station. The three types of measurements that are processed by the E2-M3A station are:

- Air-sea interface measurements which includes a meteorological station and solar radiation sensor;

- Biochemical and physical properties (pH and pCO2) of the subsurface layer, transmitted to the surface buoy through an inductive cable from probes mounted in a metal cage at 15 m depth;
- Biochemical and physical properties (temperature, conductivity, dissolved oxygen, horizontal and vertical currents, transmissometer) of the seawater in the layer 100m-bottom through probes attached on a deep mooring line (nettuno.ogs.trieste.it/e2-m3a/).

The observatory has been working continuously since 2006 providing precious information on the interannual variability of the water formation processes. In the framework of EuroSITES (EU-FP7-European Network of Observatories) (http://www.eurosites.info/) a completely redesigned surface buoy system was deployed in summer 2009. Currently, the system is part of the European contribution to OceanSITES global array (www.oceansites.org) within FixO3 (EU-FP7 Fixed Open Ocean Observatories Network, http://www.fixo3.eu), and of the Italian Project RITMARE, funded by the Ministry of Research and Education (MIUR). Plus, the site is part of the EMSO and ICOS Esfri Structures.

5 Bridge timetable of events

Date	Activity
27/10/2015	Arrival of Personnel in Bari
28/10/2015	Depart of Port of Bari – Transit to Mooring site
29/10/2015	Mooring E2M3A recover
29/10/- 03/11/2015	CTD, Rosette
1/11/2015	Mooring E2M3A re-deployment
2/11/2015	Surface Buoy recover
3/11/2015	Surface Buoy deployment
4/11/2015	Port of Bari

N.B.: *UTC times*
WD *= water depth*

27st October 2015 Tuesday

12.00 anchoring in Port of Bari (45° 55.99998'N – 013° 40.00002'E, 22 m WD)
19.00 arrival of scientific crew, accommodation on board

28st October 2015 Wednesday

10.00 Briefing with scientific crew, captain, chief officer, boatswain
13.30 Arrival of the truck and unloading material, setting up of laboratories and equipment testing
19.10 sailed from the port of Bari

29th October 2015 Thursday

05.00 Arrival to the buoy site for recover
05.50 Rubber dinghy into the water. Sea state 3; 1 m wave; 15 knots wind
06.15 Buoy radar detectable into the water
06.30 Prow of the rubber dinghy cut. Rescue boat on board. Stopped the buoy recover (Increasing of the sea state). Transit to the mooring site
07.32 Hydrophone into water. Reply of the acoustic modem #P1891 (1180 m). Attempt done with the old transducer. Release of the acoustic modem #P398 without reply
08.00 ADCP buoy at the surface
08.10 Buoy ORE on board
08.20 Sediment trap on board
08.40 ADCP buoy on board
08:43 SeaBird 16 #5273 on board
08:55 NKE #34099
09:00 CT SBE37 #4515 + NKE #34103

09:10 SBE37 ODO #13121 + buoys + CT SBE37 #4513
09:15 NKE #34102
09:30 CT SBE37 #4593
09:39 4 buoys
09:49 sediment trap on board
09:00 SBE37 ODO #10599
10:05 Aanderaa #1230
10:13 4 buoys + acoustic releasers on board
10:25 End of the recover
13:00 **Start CTD and Rosette at mooring site - 41° 31.811' N – 018° 30.790' E**
13:26 Rosette at the bottom: 41° 31.736' N – 018° 30.816' E
14:10 Rosette on deck 41° 31.636' N – 018° 30.816' E
16:00 End of the sampling
16:30 End of the work: safety measure due to strong rain and hours of work of the crew

30th October 2015 Friday

07.00 Start of work. Rosette preparation with instruments for test. Bottles 8-12
08.30 Start **Calibration CTD station (CAL1): 41° 34.276' N – 018° 30.940' E**
08.46 Rosette into the water, 41° 34.288' N – 018° 30.937' E. Instruments sampling time of 5' for 1.30 hour
10.06 Position 41° 34.279' N – 018° 30.948' E. End of the test. Transit to BADU09 station
12:54 Arrival in BADU09 station - 41° 44.612' N – 017° 41.486' E
12.58 Start **CTD and Rosette at the position BADU09 41° 44.612' N – 017° 41.486' E**
Bottom: CTD at 1182 m, alt at 10 m
13:26 Rosette at the bottom 41° 44.576' N - 017° 41.508' E
14:01 Rosette on deck 41° 44.58' N - 017° 41.519' E
14:08 Float DOVA into the water - 41° 44.583' N - 017° 41.660' E
14:10 Transit to BADU08
15:42 Start **CTD and Rosette at the station BADU08 - 41° 38.412' N – 017° 30.788' E**
Bottom: CTD at 1119 m, alt at 12 m
15:45 Rosette at the surface
17:02 End of the station 41° 38.466' N – 017° 30.811' E. End of the work. Transit to E2M3A

31th October 2015 Saturday

05.00 Sea state 6; wind state 7. Impossible to work! Standby until 12:00. Processing data and transit to BADU05 station
15:49 Arrival at BADU05 station
15.57 Start **CTD and Rosette at the position BADU05 41° 27.088' N - 017° 90.617' E**
16:11 41° 27.061' N - 017° 90.630' E,
Bottom: CTD at 489 m, alt at 6,7 m
16:31 End of the station 41° 27.114' N - 017° 90.664' E. Transit to BADU04
17:28 Arrival in BADU04 41° 23.639' N - 017° 40.663' E
17:37 Start **CTD and Rosette at the position BADU04 41° 23.653' N - 017° 40.675' E,**
Bottom: CTD at 164 m, alt at 9 m
17:51 End of the station 41° 23.639' N - 017° 40.674' E. Transit to BADU03
19:00 Arrival in BADU03 41° 22.536' N - 017° 20.516' E
19:05 Start **CTD and Rosette at the position BADU03 41° 22.536' N - 017° 20.516' E , pump doesn't work**
19:09 Rosette at the bottom 41° 22.540' N - 017° 20.556' E
Bottom: CTD at 143,3 m; alt at 9.3 m. No samples
19:15 End of the station 41° 22.561' N - 017° 20.549' E. Transit to BADU02
19:49 Arrival in BADU02

19:58 Start **CTD and Rosette in station BADU02 41° 20.692' N - 017° 00.229' E**
20:03 Rosette at the bottom 41° 20.720' N - 017° 00.228' E
Bottom: CTD at 1227 m, alt at 9.2 m
20:15 End of the station 41° 20.717' N - 017° 00.218' E . Transit to BADU01bis
21:13 Arrival in BADU01bis 41° 15.732' N - 016° 53.678' E
21:17 Start **CTD and Rosette in station BADU01bis 41° 15.732' N - 016° 53.678' E**
21:23 Rosette at the bottom 41° 15.739' N - 016° 53.724' E,
Bottom: CTD at 102 m, alt at 9.3 m
21:37 End of the station 41° 15.788' N - 016° 53.696' E. End of the day work

1th November 2015 Sunday

06:00 Arrival in BADU06 41° 33.782' N – 017° 20.267' E
06.14 Start **CTD and Rosette in station BADU06 41° 33.774' N - 017° 20.279' E**
06:44 Rosette at the bottom 41° 33.763' N - 017° 20.352' E,
Bottom CTD 953 m, alt 8.69 m
08:18 End of the station 41° 33.782' N - 017° 20.468' E. Transit to BADU07
09:31 Arrival in BADU07 41° 35.053' N - 017°22.920' E
09:38 Start **CTD and Rosette in station BADU07 41° 35.053' N - 017°22.920' E**
09:03 Rosette at the bottom 41° 35.062' N - 017° 22.920' E,
Bottom: CTD at 1063 m, alt at 9.8 m.
During downcast at 800 m CTD's pump switch off. After 5 minutes, up to 790 m and the pump turned again on. Upcast ok.
09:36 End of the station 41° 35.059' N - 017° 22.948' E. Water for CTO, bottles 3-20. Transit to mooring position. Preparation for calibration test with new batteries. Sampling every 5 minutes.
11:38 Arrival at calibration station
11:44 Start station CAL2 41° 33.538' N - 017° 43.451' E
12:05 Calibration test at 1000 m for 40 minutes 41° 33.554' N - 017° 43.687' E
12:41 4 bottles closed
12:47 Start of upcast 41° 33.676' N - 017° 44.260' E
13:11 End of calibration test CAL2 41° 33.601' N - 017° 44.574' E. Transit to mooring deployment position
15:37 Arrival to point 3 miles away of the final mooring position and start of work
15:38 ORE buoy
15:39 Sediment trap in water
15:40 CTD #5057 in water + NKE #34101
15:54 ADCP flotation buoy + metal cage (SBE16 #6274) in water
16:00 NKE #34099 in water
16:07 CT #4515 + NKE #34103 in water
16:16 Buoys + metal cage (SBE37 ODO #13121) in water
16.24 CT #4513 + NKE #34102
16:30 CT #4514
16:55 Vitrovex Buoys
16:57 Sediment trap + SBE37 ODO #10599
17:00 Aanderaa #1230
17:04 Buoys
17:34 Releasers in water – Mooring deployment complete. During this last phase the motors were put to zero that led the ship carrying it drift a little off course.
17.38 Ballast out of board
17.39 Ballast released. End of deployment
41° 31.520' N - 018° 04.582' E, 1188 m WD
19:00 Abortive attempt to communicate with releasers

2th November 2015 Monday

07.00 Start of work
07.42 underwarter positioning operation
08:11 P1TRI VAM1 41.53051° 018.05912°
08:29 P2TRI VAM1 41.53155° 018.06474°
08:54 P3TRI VAM1 41.52824° 018.06338°
09:42 Arrival in **VAM1 position 41° 31.520' N - 018° 40.582' E**
09:46 Start of CTD and Rosette in VAM1.
During downcast at 330 m CTD's pump switched off. After 5 minutes the pump turned again on.
10:14 Rosette at the bottom 41° 31.516' N - 018° 40.115' E,
CTD at 1175 m, alt at 8.7 m
11:00 End of station 41° 31.834' N - 018° 30.904' E.
Preparation of buoy recovery
12:03 Buoy radar detectable into the water
12:15 Rubber dinghy into the water
12:20 Buoy attached to the zodiac
12:27 Buoy attached to the ship
13:00 Buoy on board
13:45 cage on board
14:00 Buoy and intrumente cleaning, maintenance and data download

3th November 2015 Tuesday

12.40 Start buoy redeployment at the E2M3A site
13.04 Rubber dinghy into the water
13.10 Buoy radar detectable attached by the rubber dinghy
13:20 Buoy onboard
13:50 hooking wire mooring to the cage
13:52 Cage into the water
14:05 Start buoy deployment
14:20 Buoy deployed

4th November 2015 Wednesday

07.00 Arrival at Bari Port
10:00 DEMOB Start
14:00 Cruise end

6 Cruise Rationale

The cruise and maintenance of the observatory was done with the use of the R/V "Explora" property of OGS. Altogether 13 standard hydrographic stations were carried out during the cruise, employing a SeaBird SBE911 plus CTD-O2 probe, attached to a SeaBird carousel 24 bottle water sampler. The CTD was equipped with 2 temperature and conductivity sensors, an oxygen sensor, and a fluorometer.

Figure 6.1 ***Map of the Adriatic Sea with the position of the E2M3A Observation Site***

All sensible sensors are calibrated at the factory or at the OGS Calibration Centre once a year on average. The serial numbers and calibration dates are listed in table 8.2.1. At almost all stations oxygen water samples were taken along the water column from the surface to the bottom at desired depths. From three depth levels, depending on the vertical profile of the stations, samples were taken for salinity analysis. CTD calibration cast were performed after and before mooring recovering and deployment with most of the instrument forming the secondary mooring line tight up to the rosette. In the area of the site water samples were taken for calibration before the mooring was redeployed.

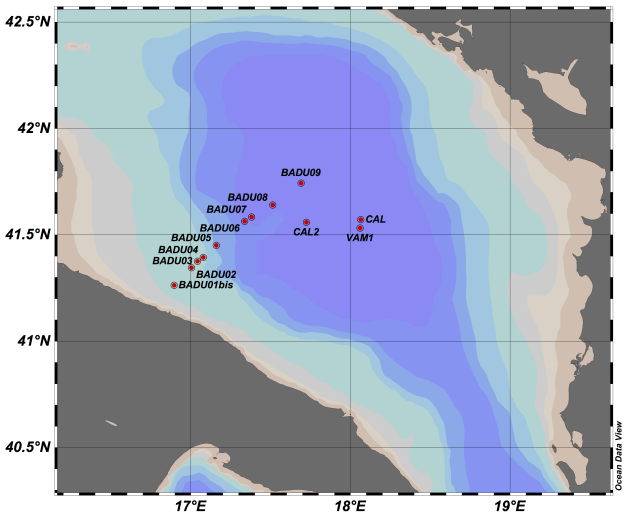


Figure 6.2 *Cruise track and CTD station marked with the position of the E2M3A Observatory. For station position see cruise map in Annex A.*

6.1 PRELIMINARY SCIENTIFIC ANALYSIS

The half section across the Southern Adriatic Pit i.e. Bari-Dubrovnik transect (Fig. 6.2) shows oceanographic characteristics accordingly of the time of the year (Fig. 6.1.1) with the surface layer well-stratified in the first 150-200 m, but with a mixed layer reaching almost 40 m A layer with high salinity waters with values between 38.78 and 38.82 (attributed to the presence of LIW) lays between 400 and 700m, values much higher and deeper than those observed during the maintenance cruise the year before. Above this layer, waters are characterized by the OML (Oxygen Minimum Layer) with values around 4.65 ml/l (202 µmol/kg). Similar values were measured near the bottom, and this may indicate that no ventilation had occurred during the last winter and the resident water mass of north Adriatic origin (T=13.26 C, S=38.72, σ=29.26 kg/m3) fills the pit. More oxygenated waters fill the underlying layer reaching values > 5 ml/l (> 221 µmol/kg), specially towards the centre of the pit. The clorophyll maximum was found between BADU05 and BADU09 at a depth between 40m and 80m with the highest value found in BADU07 at 68m depth.

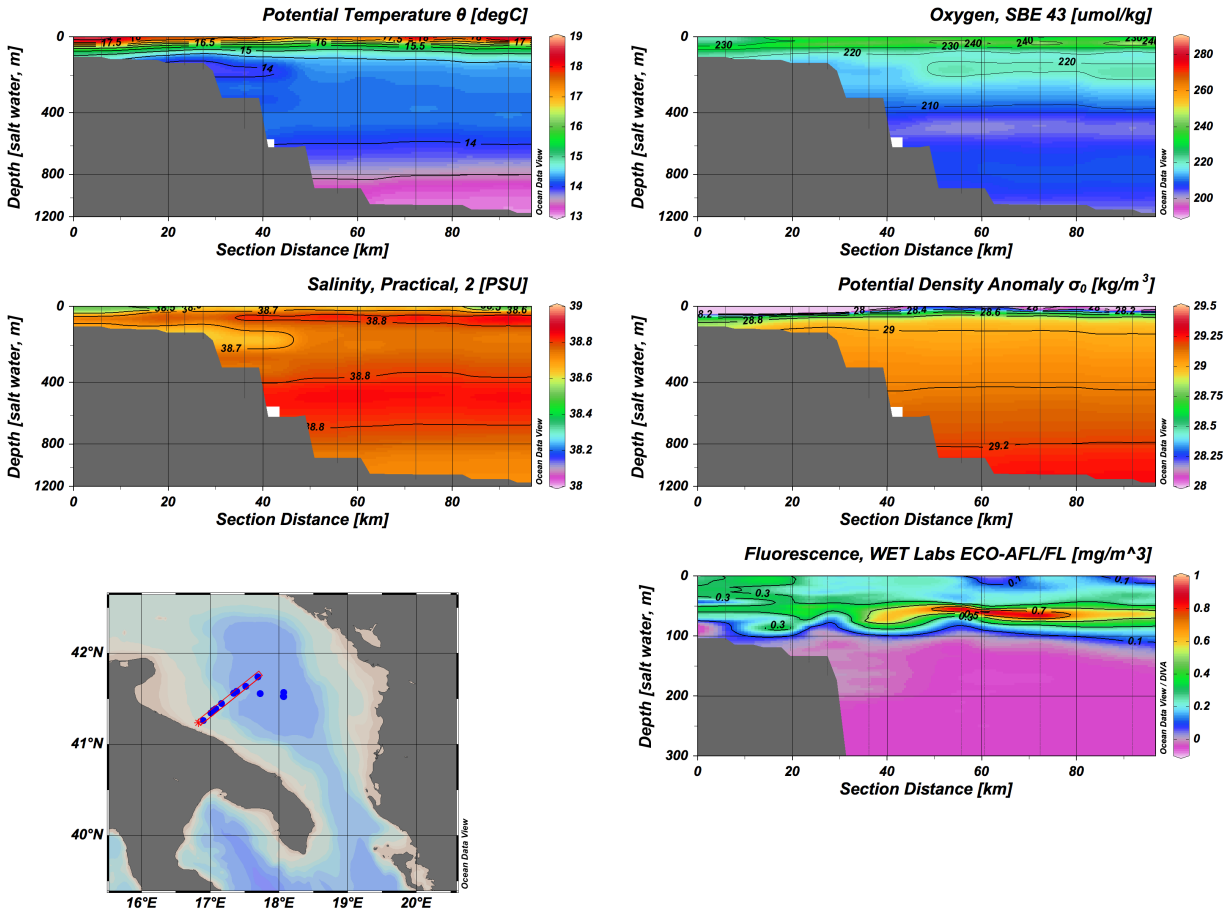


Figure 6.1.1: *Temperature, salinity,density, oxygen and fluorescence sections along the Bari-Dubrovnik transect*

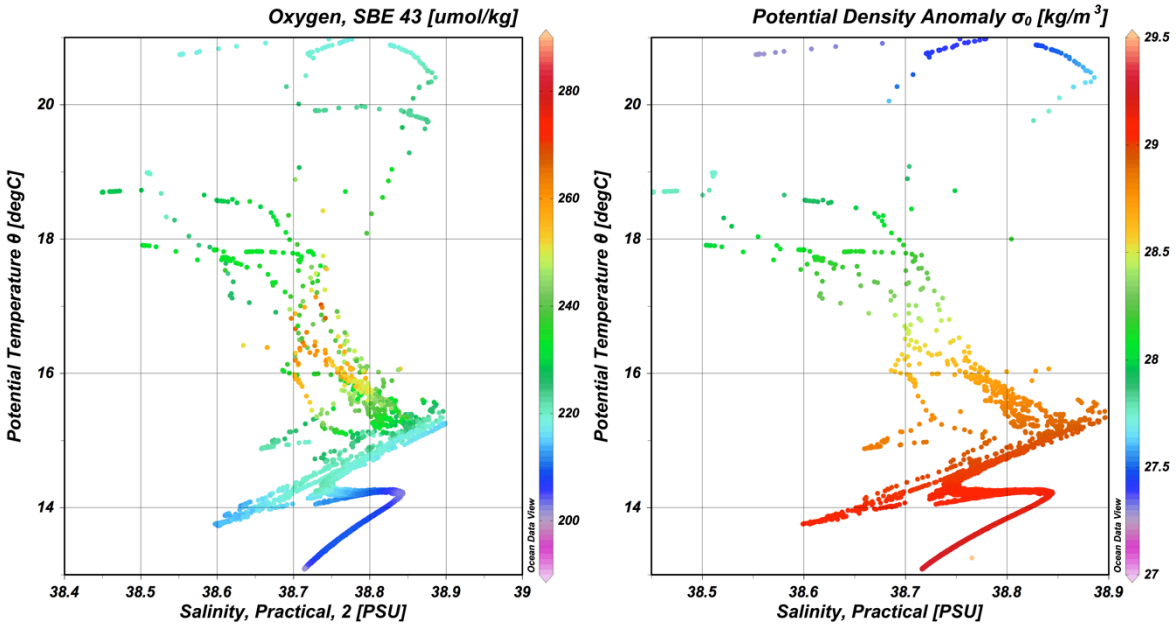


Figure 6. 1.2: *TS diagrams considering dissolved oxygen and potential density anomaly as the third parameter. For station coordinates see table in Annex A.*

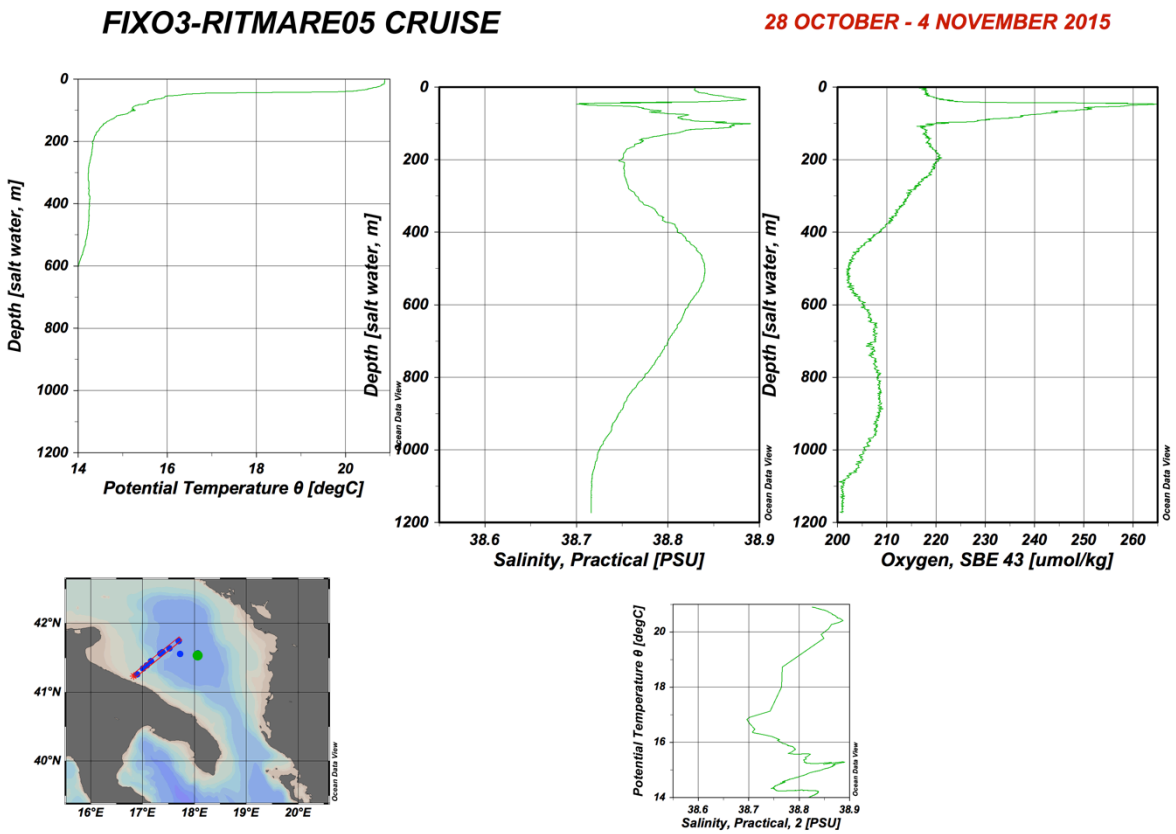


Figure 6.1.3: *Oceanographic properties measured at the E2M3A site. For station coordinates see table in Annex A.*

7 Deck operations

Deck operation methods were discussed with the Chief Mate and a scheme was developed for using the winches and the stern A-frame. The recovery of the mooring was succesfully done on the first day of the cruise, October 29th 2015 and redeployed on November 1st. The surface buoy and its cage were recovered on November 2nd and redeployed the day after.

Mooring deployment positions and timings are given in the Bridge Timetable. All mooring diagrams can be found in the ANNEX B.

7.1 RECOVERY OF SECONDARY MOORING

The E2M3A subsurface mooring was recovered on Thursdat 29th October. Acoustic locationing was made on arrival at the site, but despite the echo sounder and the swath system had been turned off a reliable communication with both the releasers was not easy to be established. Releaser s/n 1891 answered but did not release, while the other released without answering. The mooring was released using the IXSEA TT-801 deck unit on-board the ship's tender.

Figure 7.1.1 *Recovering of ADCP with flotation buoy and cage*

Shortly after the mooring release the ADCP flotation buoy was sighted at the surface. The recovery manouvres proceeded without any hitch in two and an half hour.

On a first inspection anodes were in good condition with less than 10 % erosion. The instrumentation in general presented much biofouling if compared to the previous campaigns. Again, rust was found especially on the instruments inside the metal cage that was located at about 300 db. Surprisely, the shackle used for the Aanderaa Seaguard in blending galvanized steel (original from factory) was highly corrosed and rusted.

Figure 7.1.2 *Instrument conditions after recovering*

7.2 RE-DEPLOYMENT OF THE SECONDARY MOORING

All the wire sections of the mooring had been pre-wound to the dedicated winch ready for deployment. On completion of all the wire winding the remaining mooring hardware was assembled and ready for deployment. Zinc anodes had been changed. As this mooring is comparatively high risk satellite mooring location beacons (Argos and Iridium satellite platforms) are incorporated into the design.

The deployment commenced with no problems at 15:37 of November 2nd. The top 40-inch buoy and wire section were deployed using ship's crane, as the sphere is too heavy for hand deployment. The initial distance from the waypoint was fixed at 3.0 nm. The following changes

were performed: a SBE CTD 37 s/n5057 was positioned below the sediment trap at 120m, SBE16 Plus s/n 6273 was replaced by SBE16 Plus s/n 6274 recently calibrated in factory, SBE37 ODO s/n 4593 replaced by SBE37 s/n 4514 at -1000m, acoustic releaser Ixsea Oceano 2500S s/n 1891 was replaced with s/n 433.

The operations continued till the deployment of the Vitrovex buoy (1170m) at 17:04 when it was arranged the ship's course and navigated 0.5 nm until the point of release. At 17:38 the dead weight hanging from the crane's hook was released. The new mooring drawing is reported in the ANNEX-A.

Figure 7.2.1 *Some stages of the deployment of the subsurface secondary mooring*

7.3 SURFACE BUOY OPERATIONS

Bouy recover operations and related activities started 11:00 on Monday 2 November. During the recover of the buoy due to rolling of the ship the weather slams on the cables of the crane, the airplane of the anemometer broke down. It was replaced with a spare, and after testing the instrument the buoy was again deployed in the water.

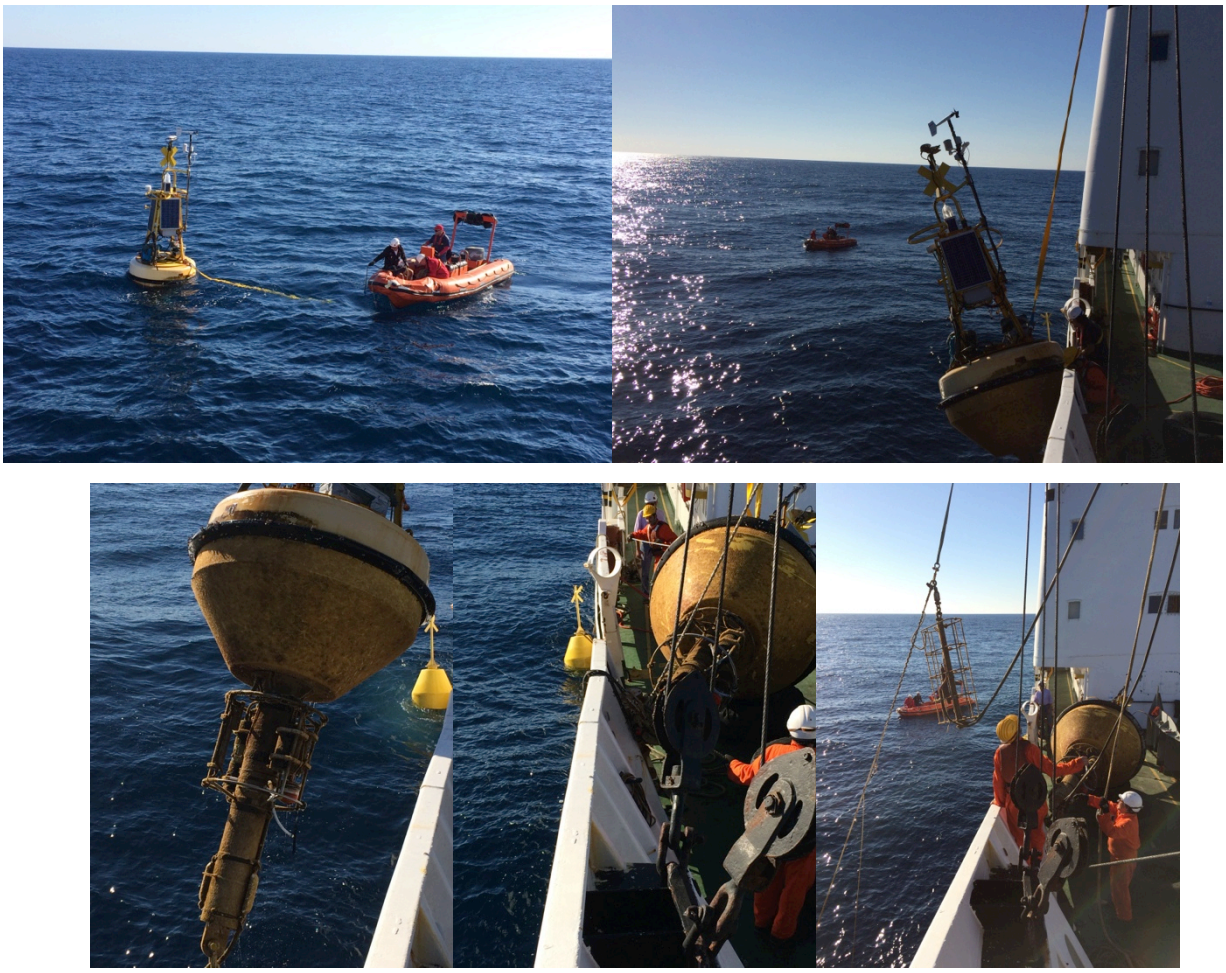


Figure 7.3.1 *Recovering of the E2M3A buoy*

Operations:

- Disassembled instruments from the cage and put in a tub with water,
- Replaced propeller meteo station,
- Battery fuse burned, replaced,
- Controlled solar panels, output voltage = 13.5 V,
- Checked the batteries, output voltage = 12.7 V,

- Checked the safety battery pack= 16.9 V,
- Opened lockers batteries, batteries in good condition,
- Replaced GPS and backup contoller battery,
- Repalced batteries and reagent on SAMI-pH, connected controller to the instruments, programmed and restarts normal operation,
- Replaced batteries and reagents on ProOCEANUS pCO2, connected controller to the instruments, programmed and restarts normal operation.

Figure 7.3.2 *a) Instruments check after recovering, notice the high biofouling on the**m***

Figure 7.3.2 *b) Cleaned instruments ready to be re-deployed*

On November 3rd at 13:00 buoy re-deployment manovres started and they were held without incident. The whole operation lasted until 14:20 when the E2M3A buoy was released. To prevent the airplane weather station falls apart again, 3 fenders ship were tied to the upper circles of the buoy with great results.

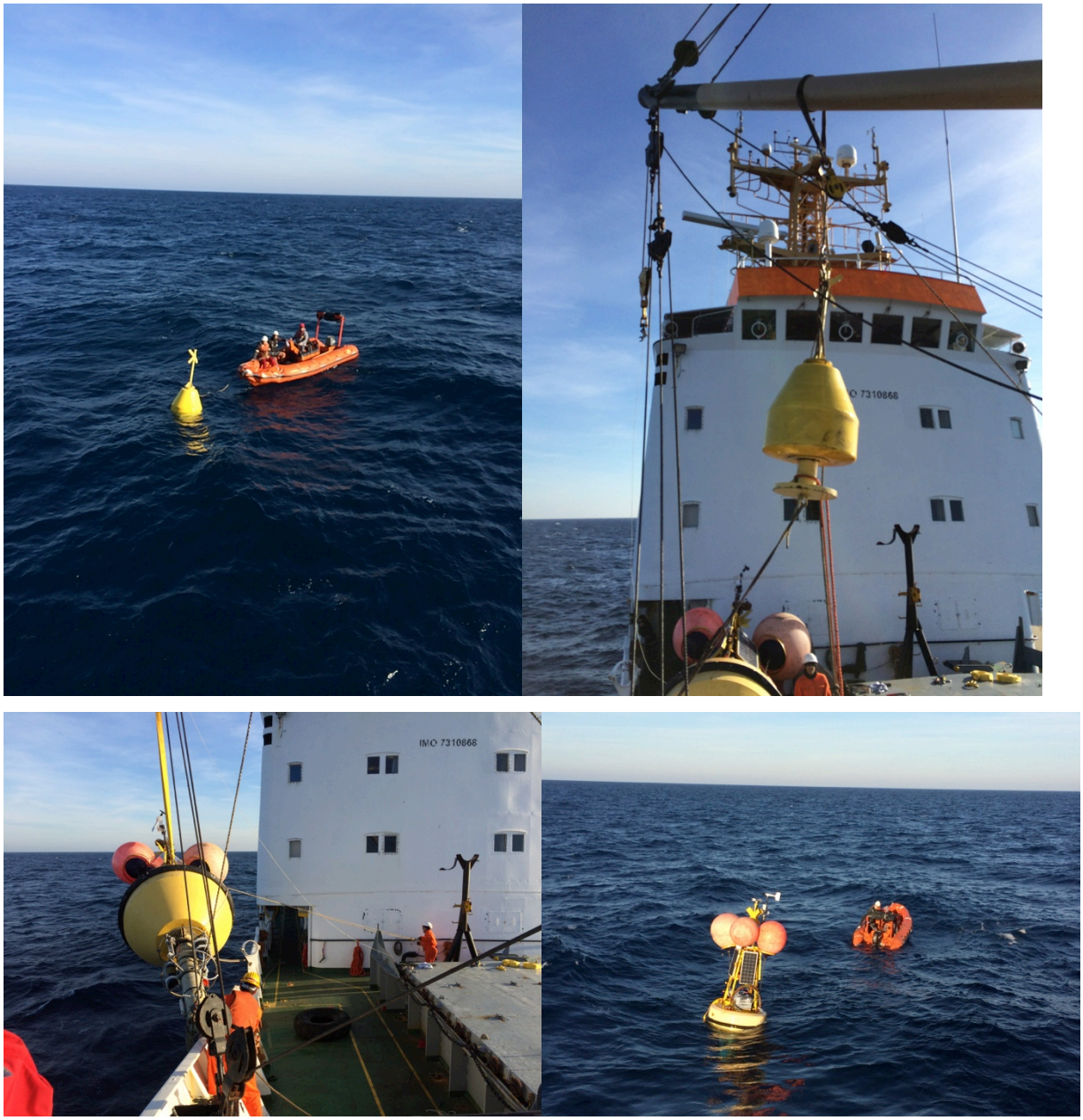


Figure 7.3.3 Recover of the small radar buoy and re-deployment

7.4 SEDIMENT TRAPS SERVICING

7.5 DATA AND METHODS

A mooring line with 2 sediment traps (top at 160 m ca. depth and bottom at 1150 m ca. depth) in addition to recording instruments to acquire time-series of oceanographic data, was deployed on 1 December 2013, at 1186 m depth, in southern Adriatic pit. Previously, the mooring line has been serviced on 8 March and 9 September 2014, and on 27 March 2015 (Table 7.3.1). During this cruise the mooring line has been serviced on 29 October 2015.

Time series	Sample	Days	Date
1 December 2013 to 8 March 2015	1	15	01-Dec-13
1 December 2013 to 8 March 2015	2	16	16-Dec-13
1 December 2013 to 8 March 2015	3	15	01-Jan-14
1 December 2013 to 8 March 2015	4	16	16-Jan-14
1 December 2013 to 8 March 2015	5	14	01-feb-14
1 December 2013 to 8 March 2015	6	14	15-feb-14
1 December 2013 to 8 March 2015	7	10	1 Mach 2014
14 March 2015 to 9 October 2015	1	18	14-mar-14
14 March 2015 to 9 October 2015	2	30	01-apr-14
14 March 2015 to 9 October 2015	3	31	01-May-14
14 March 2015 to 9 October 2015	4	30	01-Jun-14
14 March 2015 to 9 October 2015	5	62	01-Jul-14
14 March 2015 to 9 October 2015	6	61	01-Sep-14
14 September 2014 to 27 March 2015	1	48	14-Sep-14
14 September 2014 to 27 March 2015	2	45	01-nov-14
14 September 2014 to 27 March 2015	3	47	16-Dec-14
14 September 2014 to 27 March 2015	4	14	01-feb-15
14 September 2014 to 27 March 2015	5	14	15-feb-15
14 September 2014 to 27 March 2015	6	8	01-mar-15
14 September 2014 to 27 March 2015	7	7	09-mar-15
14 September 2014 to 27 March 2015	8	8	16-mar-15
14 September 2014 to 27 March 2015	9	8	24-mar-15
1 April 2015 to 29 October 2015	1	15	01-apr-15
1 April 2015 to 29 October 2015	2	15	16-apr-15
1 April 2015 to 29 October 2015	3	31	01-May-15
1 April 2015 to 29 October 2015	4	30	01-Jun-15
1 April 2015 to 29 October 2015	5	62	01-Jul-15
1 April 2015 to 29 October 2015	6	61	01-Sep-15

Table 7.4.1. Data time series, from 1 December 2013 to 29 October 2015 (28 samples).

Mooring was successfully recovered on October 29th, 2015. Sediment traps provided 6 samples both, as expected. The trap at about 160 m depth was covered by bio-fouling but on the top it was relatively clean. The traps were accurately cleaned and visually inspected for corrosion.

The 12 bottles of samples were changed with new bottles filled with a buffered solution of formaldeide at 5% and filtered sea-water. Each motor unit programming was downloaded and then re-programmed for the following deployment (Table 7.4.2.).

Fig.7.4.2.1 *Field activity and sediment traps servicing*

The new motor unit programming for each sediment trap is:

Sample	From	To	Days
1	03-Nov-15	01-Dec-15	28
2	01-Dec-15	01-Jan-16	31
3	01-Jan-16	01-Feb-16	31
4	01-Feb-16	01-Mar-16	29
5	01-Mar-16	16-Mar-16	15
6	16-Mar-16	01-Apr-16	16
7	01-Apr-16	16-Apr-16	15
8	16-Apr-16	01-May-16	15
9	01-May-16	01-Jun-16	31
10	01-Jun-16	01-Jul-16	30
11	01-Jul-16	01-Aug-16	31
12	01-Aug-16	01-Sep-16	31

Table 7.4.2. New motor unit programm for sediment traps

7.6 BIOGEOCHEMICAL WATER SAMPLING

The aim of the water sampling during the cruise was to characterize the physical and biogeochemical characteristics of the water column and define different water masses properties in order to verify the presence of dense waters formed in the North Adriatic.

A 24 Niskin bottles (10L) rosette was used for water samples collection. Specifically, water samples were collected along a 9 stations transect throughout the whole water column. From three to twelve sampling depths were chosen depending on water column stratification and bottom depth. Dissolved oxygen concentration measurements were done directly on-board by means of a Potentiometric Titrator Mettler Toledo G20 (Winkler method) in order to check the stability of the CTD cast Oxygen sensor. Whereas pH, Total Alkalinity, Inorganic Nutrients, Dissolved Organic Nitrogen and Phosphate analysis will be performed at the OGS laboratory.

Samples collected for pH (spectrophotometric) and Total Alkalinity analysis were fixed with HgCl2 and conserved in a cool place. Samples for Total Alkalinity were also filtered with 47 mm diameter GF/F glass fiber filters (0.7µm nominal pore size, Whatman International Ltd). Inorganic Nutrients and Dissolved Organic Nitrogen and Phosphate samples were filtered on 25 mm GF/F glass fiber filters and frozen immediately.

Additionally, water samples for dissolved oxygen analysis and carbonate system determination were collected along the water column in proximity of the Deep Ocean Observatory E2-M3A Sailor. Data obtained by laboratory analysis will be compared with those provided in continuum by the sensors of the fixed stations.

DATE	STATION	DEPTH (m)	DISSOLVED OXYGEN (mL/L)	INORGANIC NUTRIENTS	ORGANIC NUTRIENTS	pH	TOTAL ALKALINITY
29/10/15	VAM 1	BOTTOM	4.729	x	x	x	x
29/10/15	VAM 1	1000	4.826	x	x	x	x
29/10/15	VAM 1	900	4.944	x	x	x	x
29/10/15	VAM 1	736	4.960	x	x	x	x
29/10/15	VAM 1	540	4.733	x	x	x	x
29/10/15	VAM 1	320	5.008	x	x	x	x
29/10/15	VAM 1	200	5.790	x	x	x	x
29/10/15	VAM 1	120	5.656	x	x	x	x
29/10/15	VAM 1	100	5.169	x	x	x	x
29/10/15	VAM 1	50	5.947	x	x	x	x
29/10/15	VAM 1	20	5.148	x	x	x	x
30/10/15	CAL 1	500	4.849	-	-	-	-
30/10/15	CAL 1	500	4.830	-	-	-	-
30/10/15	CAL 1	500	4.801	-	-	-	-
30/10/15	CAL 1	500	4.827	-	-	-	-
30/10/15	CAL 1	500	4.077	-	-	-	-
30/10/15	CAL 1	500	4.819	-	-	-	-
30/10/15	BADU 09	BOTTOM	4.784	-	-	-	-
30/10/15	BADU 09	900	4.883	-	-	-	-
30/10/15	BADU 09	500	4.766	-	-	-	-
30/10/15	BADU 09	200	5.561	-	-	-	-
30/10/15	BADU 09	30	6.111	-	-	-	-
30/10/15	BADU 08	BOTTOM	4.777	x	x	x	x
30/10/15	BADU 08	900	4.845	x	x	x	x
30/10/15	BADU 08	700	4.854	x	x	x	x
30/10/15	BADU 08	470	4.740	x	x	x	x
30/10/15	BADU 08	350	4.919	x	x	x	x
30/10/15	BADU 08	250	5.025	x	x	x	x
30/10/15	BADU 08	150	5.213	x	x	x	x
30/10/15	BADU 08	61	5.217	x	x	x	x
30/10/15	BADU 08	33	5.306	x	x	x	x
30/10/15	BADU 08	SURFACE	5.783	x	x	x	x
31/10/15	BADU 05	BOTTOM	4.723	-	-	-	-
31/10/15	BADU 05	89	5.069	-	-	-	-
31/10/15	BADU 05	30	5.751	-	-	-	-
31/10/15	BADU 05	15	5.383	-	-	-	-
31/10/15	BADU 04	BOTTOM	4.940	x	x	x	x
31/10/15	BADU 04	130	4.911	x	x	x	x
31/10/15	BADU 04	101	4.957	x	x	x	x
31/10/15	BADU 04	50	5.138	x	x	x	x
31/10/15	BADU 04	39	5.805	x	x	x	x
31/10/15	BADU 04	15	5.384	x	x	x	x
31/10/15	BADU 02	BOTTOM	4.911	x	x	x	x
31/10/15	BADU 02	85	5.084	x	x	x	x
31/10/15	BADU 02	55	5.699	x	x	x	x
31/10/15	BADU 02	25	5.476	x	x	x	x
31/10/15	BADU 02	11	5.222	x	x	x	x
31/10/15	BADU 01	BOTTOM	5.355	-	-	-	-
31/10/15	BADU 01	45	5.544	-	-	-	-
31/10/15	BADU 01	21.3	5.082	-	-	-	-

DATE	STATION	DEPTH (m)	DISSOLVED OXYGEN (mL/L)	INORGANIC NUTRIENTS	ORGANIC NUTRIENTS	pH	TOTAL ALKALINITY
01/11/15	BADU 06	BOTTOM	4.783	x	x	x	x
01/11/15	BADU 06	700	4.837	x	x	x	x
01/11/15	BADU 06	490	4.719	x	x	x	x
01/11/15	BADU 06	299	4.187	x	x	x	x
01/11/15	BADU 06	190	5.143	x	x	x	x
01/11/15	BADU 06	50	5.174	x	x	x	x
01/11/15	BADU 06	29	5.726	x	x	x	x
01/11/15	BADU 06	15	5.408	x	x	x	x
01/11/15	BADU 07	BOTTOM	5.319	-	-	-	-
01/11/15	BADU 07	500	5.185	-	-	-	-
01/11/15	BADU 07	180	5.114	-	-	-	-
01/11/15	CAL 2	1000	4.933	-	-	-	-
01/11/15	CAL 2	1000	4.904	-	-	-	-
01/11/15	CAL 2	1000	4.911	-	-	-	-
01/11/15	CAL 2	1000	4.924	-	-	-	-
01/11/15	CAL 2	1000	5.304	-	-	-	-
01/11/15	CAL 2	1000	4.869	-	-	-	-
02/11/15	VAM 1bis	BOTTOM	4.811	x	x	x	x
02/11/15	VAM 1bis	1000	4.834	x	x	x	x
02/11/15	VAM 1bis	900	4.971	x	x	x	x
02/11/15	VAM 1bis	736	4.818	x	x	x	x
02/11/15	VAM 1bis	540	4.811	x	x	x	x
02/11/15	VAM 1bis	320	4.974	x	x	x	x
02/11/15	VAM 1bis	200	5.085	x	x	x	x
02/11/15	VAM 1bis	120	5.070	x	x	x	x
02/11/15	VAM 1bis	100	4.251	x	x	x	x
02/11/15	VAM 1bis	50	5.957	x	x	x	x
02/11/15	VAM 1bis	20	5.863	x	x	x	x
02/11/15	VAM 1bis	SURFACE	5.630	x	x	x	x

Table 7.6.1 *Station Sampling scheme*

Figure 7.5.1 *Water sampling and dry laboratory*

8 MOORING INSTRUMENT CALIBRATION

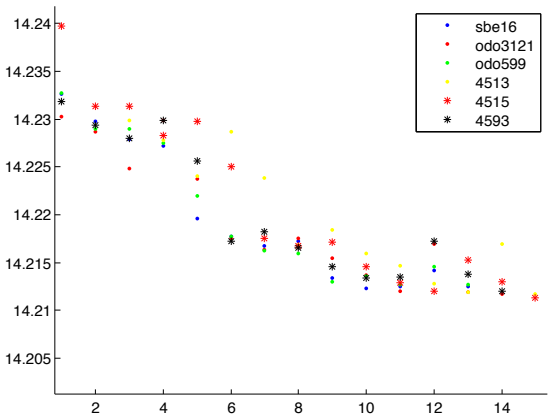
8.1 INSTRUMENT TEST

During the EXPLORA cruise, on the 30 October 2015 at 08:30, a specific instrument test was performed in order to verify the quality of the data recorded by SBE911plus, SBE37-ODOs, SBE37-SM, RCM Seaguard (Aanderaa).

Six instruments were attached to the rosette system (equipped with a SBE911plus, Fig 8.1.1) used for CTD casts and deployed at a fixed depth (≈500m) for ≈70 minutes. The depth and duration of the experiment were decided accordingly to the suggestions provided by the engineering of the Sea-Bird Electronics. Double Water samples for oxygen and salinity comparison were also taken from two niskin bottles.

Figure 8.1.1 *Instrument attached to the Rosette system*

Two calibration experiments were conducted during the cruise: the first immediately after the recovery of the mooring, instruments without batteries change and the second before the redeployment with new batteries and cleaned instruments. In both cases the sampling time was set to 5'. For both tests the mooring self-recording instruments were mounted on the SBE32 Carousel sampling device together with the CTD 9/11 probe and lowered at 300 m for 1 hour in the first case and at 1000m for 45minutes.



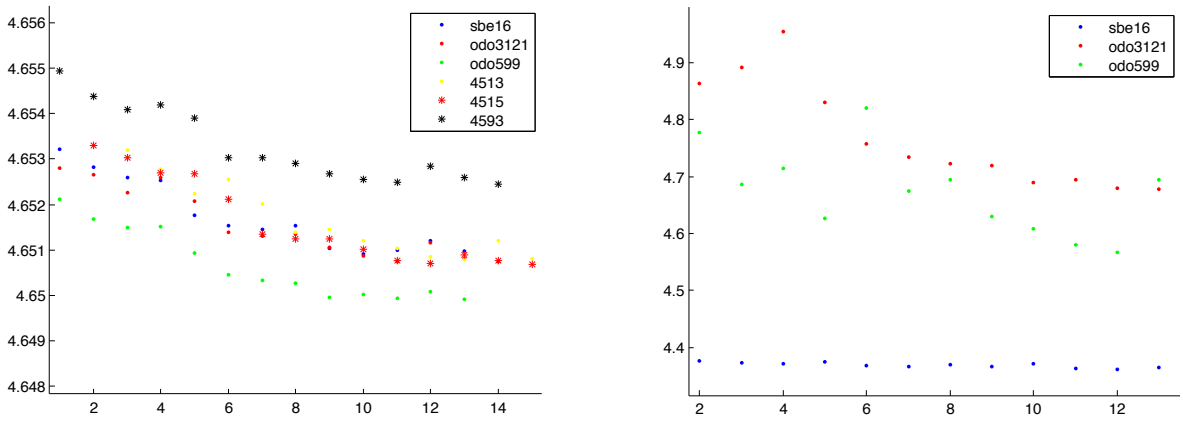


Figure 8.1.2 – *Temperature, conductivity and dissolved oxygen, recorded by several instruments attached to the rosette system equipped with a SBE911plus used for CTD casts during the EXPLORA cruise in October 2015..*

8.2 CTD casts

CTD casts were performed during the cruise using a SeaBird SBE911plus CTD-O_2 probe equipped with dual sensors of temperature, conductivity and dissolved oxygen attached to a SBE32 Carousel Water Sampler with 24 bottles (10 lt) together with an altimeter. Additionally, a fluorometer sensor was installed on the CTD during the cruise.

Sensor type	Serial number	Calibration
SBE 3 Temperature	1717	***OGS Technical Report, REL. 2014/48 Sez. OCE 15 TECDEV-CTO,*** 21 July 2014
SBE 4 Conductivity	3442	***OGS Technical Report, REL. 2015/06 Sez. OCE 3 TECDEV-CTO,*** 28 January 2015
SBE 3 Temperature	1709	***OGS Technical Report, REL. 2014/48 Sez. OCE 15 TECDEV-CTO,*** 21 July 2014
SBE 4 Conductivity	1487	***OGS Technical Report, REL. 2015/06 Sez. OCE 3 TECDEV-CTO,*** 28 January 2015
SBE 43 Oxygen	2513	SBE Oxygen Calibration Sheet, 20 December 2012

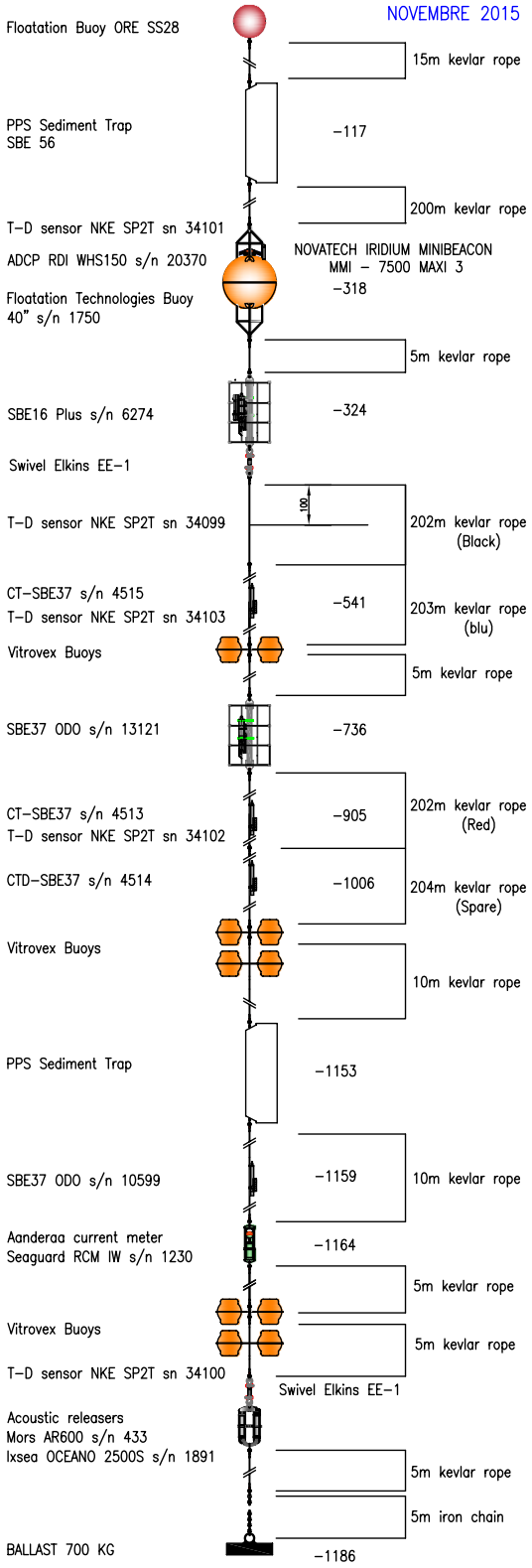
Table 8.2.1 *Sensors installed on the CTD - SBE 911 plus and calibration references*

At almost all stations, water samples for dissolved oxygen were taken at different depths throughout the whole water column. The oxygen samples were analysed on board using a Winkler potentiometric method. From three depth levels, depending on the vertical profile of the stations, water samples were taken, also for calibration purposes of the salinity values and they were analysed at OGS headquarter using a Guildline Autosal Salinometer. Data were processed applying the Seabird Data Processing software and a Matlab post-processing package. Spikes were removed from all data by applying the instrumental and climatological range criteria backed up by visual checks. Profiles were then averaged every 1 dbar. The overall accuracies are within 0.002°C for temperature and 0.003 for salinity.

Cast	Cruise	Station	Depth [dbar]	Latitude [° N]	Longitude [°E]	Date
1	FIXO3_RIT05	BADU1bis	111	41°15.732’	16°53.678’	2015-10-31T21:17
2	FIXO3_RIT05	BADU2	132	41°20.692’	17°0.229’	2015-10-31T19:58
3	FIXO3_RIT05	BADU3	153	41°22.536’	17°2.516’	2015-10-31T19:00
4	FIXO3_RIT05	BADU4	173	41°23.639’	17°4.663’	2015-10-31T17:28
5	FIXO3_RIT05	BADU5	497	41°27.088’	17°9.617’	2015-10-31T15:49
6	FIXO3_RIT05	BADU6	962	41°33.763’	17°20.352’	2015-11-01T06:44
7	FIXO3_RIT05	BADU7	1073	41°35.052’	17°22.920’	2015-11-01T08:36
8	FIXO3_RIT05	BADU8	1131	41°38.412’	17°30.788’	2015-10-30T15:42
9	FIXO3_RIT05	BADU9	1192	41°44.612’	17°41.486’	2015-10-30T12:54
10	FIXO3_RIT05	VAM1	1184	41°31.811’	18°3.790’	2015-10-29T13:00
11	FIXO3_RIT05	CAL		41°34.288’	18°3.940’	2015-10-30T08:46
12	FIXO3_RIT05	CAL-2		41°31.811’	18°3.790’	2015-11-01T11:44

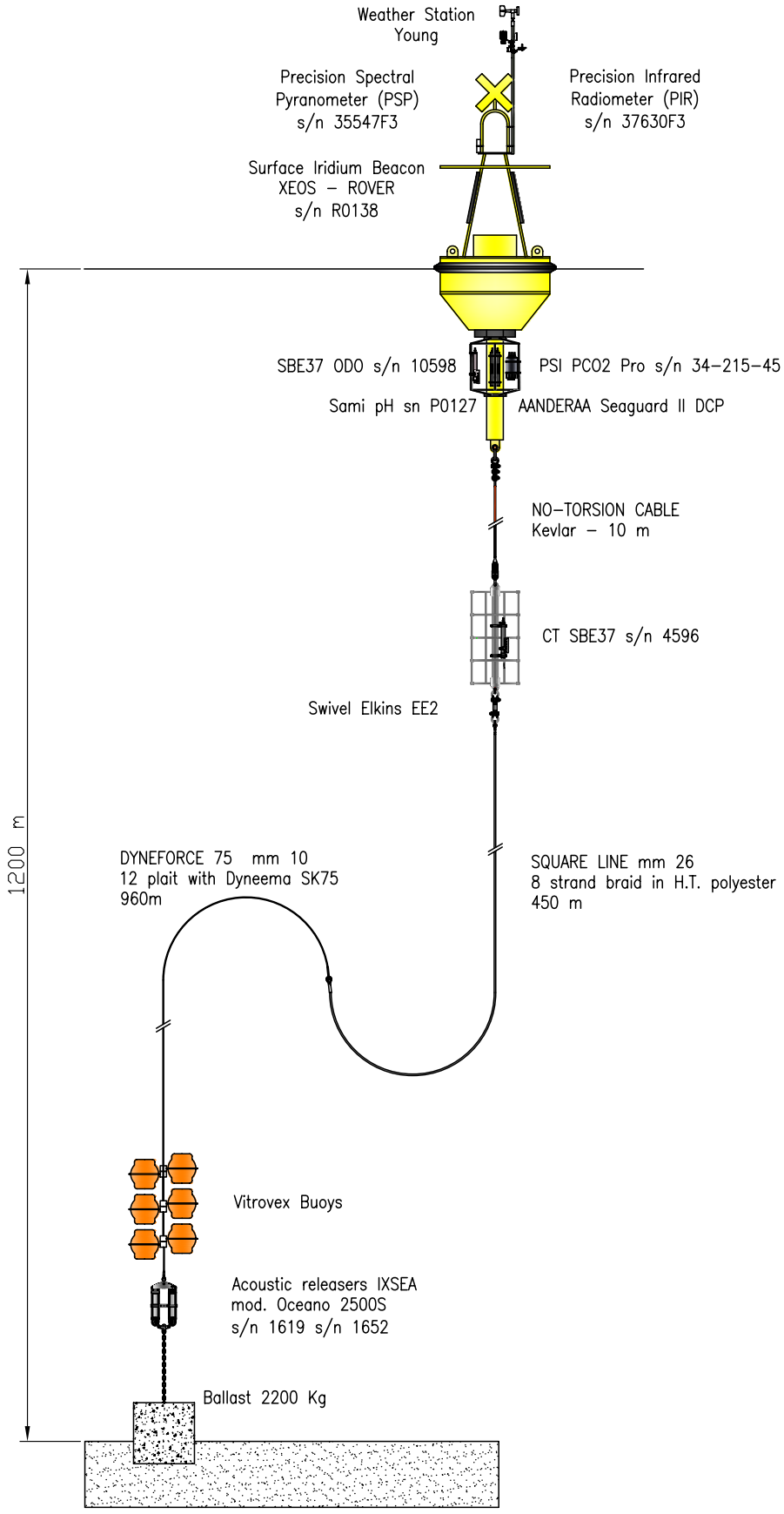
Table 8.2.2 *CTD cast information*

ANNEX A: Mooring drawings



***Annex A.**1 Drawing of the subsurface secondary mooring deployed on November 1st , 2015 at*

41° 31.520' N - 018° 04.582' E, 1188 m WD



Annex A.2 *Drawing of the Surface Buoy primary mooring with the payload deployed at* ***41°31.2006'N – 18°04.8102'E, 1185 m WD*** *on November 3rd , 2015*

ANNEX B: Vessel's characteristics

B.1. General Characteristics

The Vessel	
Built by	Elsflether Werft A.G., Germany, 1973
Owner	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS
Flag	Italy
Classification	Scientific or technological research RINA 100-A-1.1 IAQ-1; Ice Class B
LOA	65.42 m
Beam / Draft	11.8 m / 6.55 m
Gross tonnage	1408 T
Workboat	Zodiac Ribo 600 (6m, 70 Hp)
Endurance	50 days
Propulsion	2 x 1294.5 Kw (1780 Hp)
Cruising speed	13 Knots
Accomodation	12 technician 17 crew 1 doctor

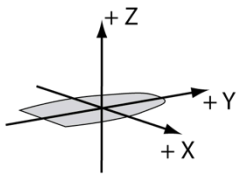
Maritime Navigation & Communication	
VHF	2 VHF SKANTI 1000 DSC (GMDSS A4)
Immarsat	Inmarsat C SKANTI Scansat (GMDSS A4) Immarsat B-M NERA SATURN Immarsat Fleet77 Thrane
Radars+ARPA	FR2117 FURUNO + AIS TM 340AM SPERRY X band Bridgemaster DECCA
Gyro Compass	3 Gyro Star II Anshutz
Autopilot	1 Naviplot AP50 FURUNO
Echo sounder	1 EA600 Simrad
Log	1 Dopplerlog EML500 Yokogawa
GPS	1 GPS Acquarius 1 GPS GB500 TOPCON 1 LANDASTAR Veripos 1 RS500 SHIPMATE (maritime only)
Magnetic Comp.	Navipol II Plath
Network	Ethernet
Network speed	100 Mb / sec

Safety	
MOB	Rescue boat PESBO BSC (40 m)
Lifeboat	Rescue boat PESBO BSC (42 people)
Life Rafts	5 x 25, 1 x 20, 1 x 6 (156 people)
Survival suits	48
Fire Fighting	Hydrants, hoses and nozzles (3 fire pumps + 1 emergency fire pump) 58 portable fire extinguishers (6 kg – 9 lt – 5 kg) 5 fire estiguisher 50 kg
Engine Room	CO_2
Compressor Room	Estinguisher + fixed fire CO_2

B.2. Vessel offsets

	OFFSET	X (m)	Y (m)	Z (m)
1	CRP	0.00	0.00	0.00
2	GPS TOPCON	2.69	8.60	20.36
3	GPS AQUARIUS	2.24	8.20	20.00
4	GPS VERIPOS	-2.13	8.63	20.28
5	PHINS	-0.28	-0.76	0.25
6	MBES 8111	-0.29	17.89	-4.82
7	MBES 8150	0.00	16.49	-4.50
8	SBP	-0.63	6.93	-4.32
9	SBES	-0.63	27.23	-4.46
10	ADCP	-0.73	3.75	-4.92
11	THERM. INTAKE	0.87	30.08	-3.75
12	THERM. SENSOR	0.83	16.32	-4.49

SIGN CONVENTION



(Offset referred to Central Reference Point - CRP)

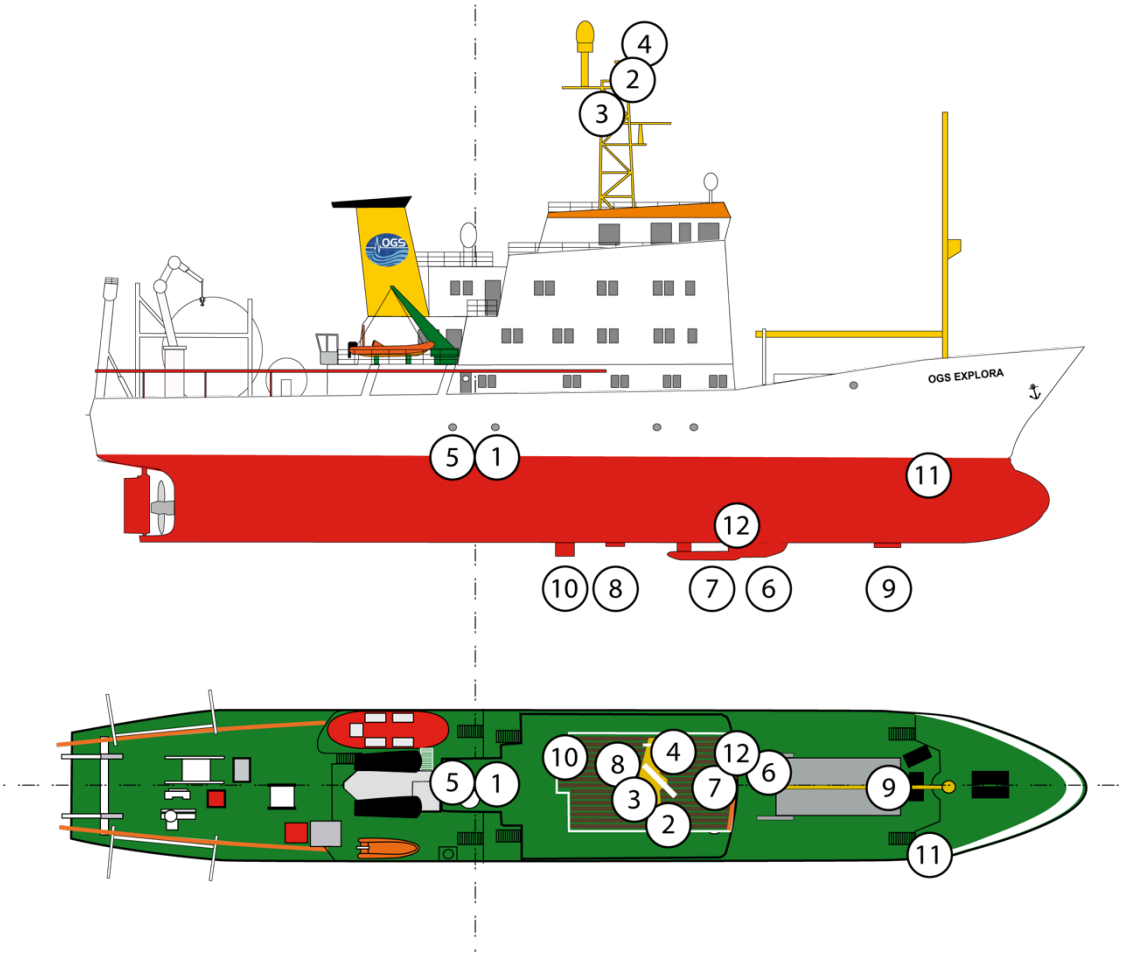


Figure B-2-1 *Drawing of the vessel offsets*

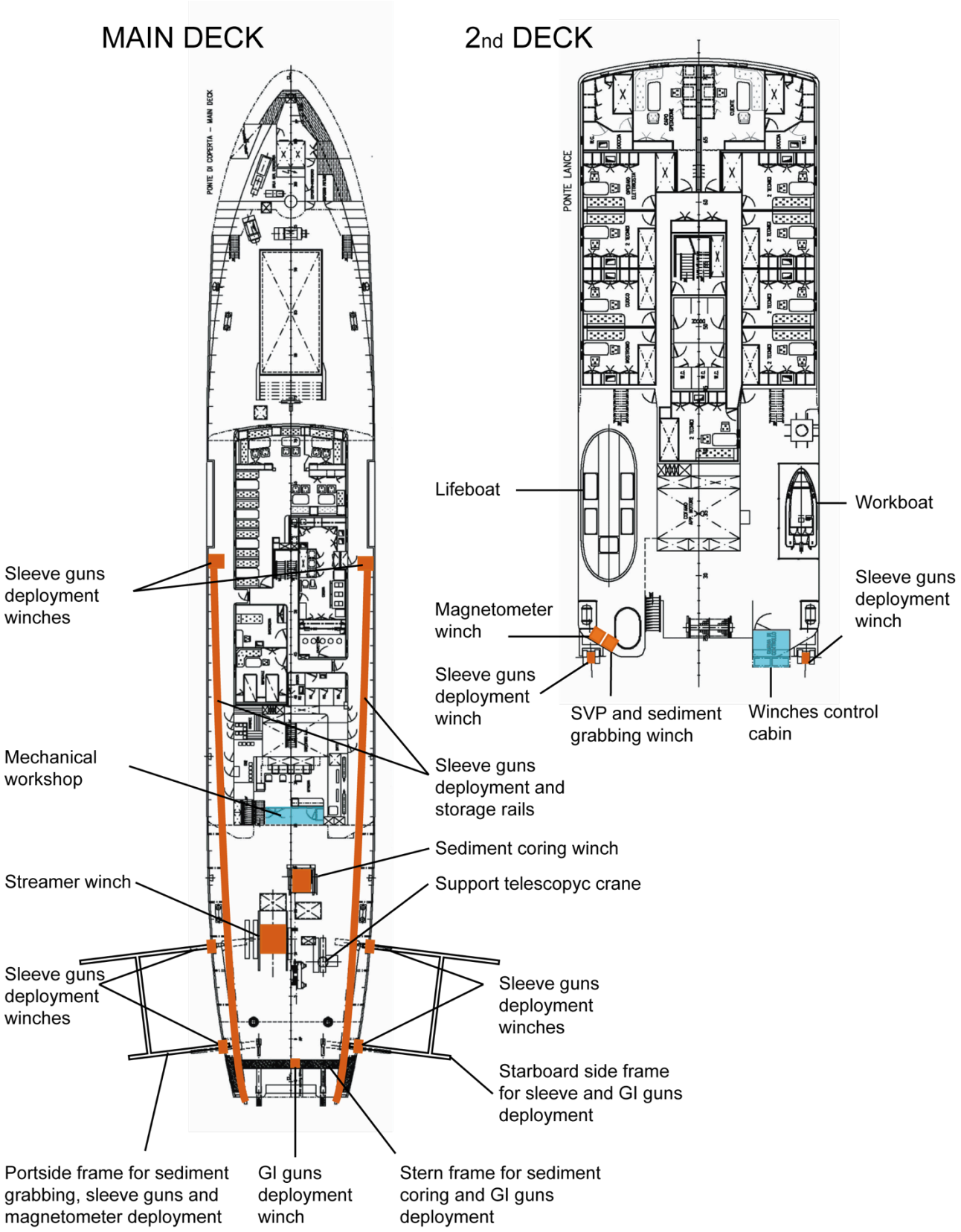


Figure B-2-2 *Schematics of ship's hardware*

ANNEX C: Scientific Equipment

The general equipment configuration is shown in the block diagram of Figure D-1. A detailed description of each component is provided over the following paragraphs.

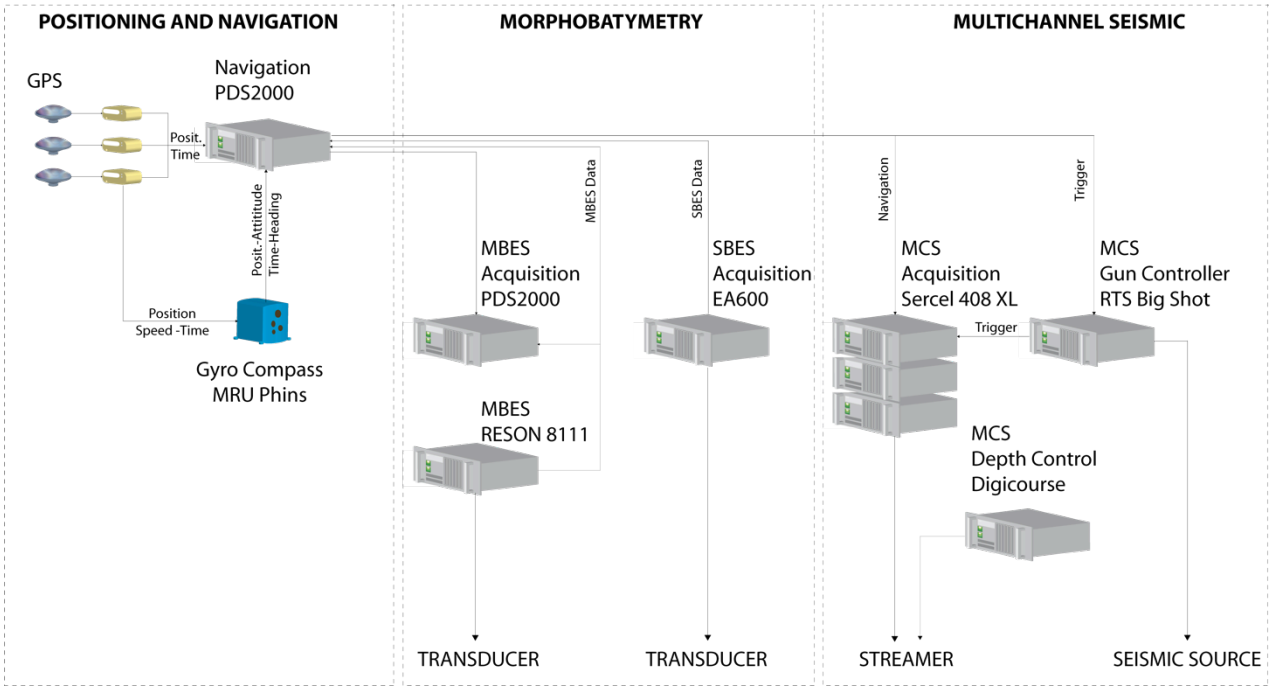


Figure C-1: *General block diagram*

C.1. Positioning and navigation

C1.1. GPS e Gyros

The vessel is equipped with three GPS systems: an Ashtec Aquarius works as primary GPS, a Topcon GB-500 as secondary GPS (GPS + GLONASS); also available is a Landstar MK Veripos that can work as DGPS.

All of them are interfaced to the IXSEA Phins Inertial Navigation Sytem (INS), which delivers heading and attitude information, as well as position and speed, to the navigation system and to the MBES. The heart of the system that is also used as a gyrocompass, is the inertial measurement unit, consisting of three high class (0.01 deg/h) fibre optic gyroscopes (FOG) and three high precision pendulum-type accelerometers.

Apart from its Inertial Motion Unit, PHINS contains a complete navigation algorithm based on Kalman Filtering. This structure enables PHINS to work either as a black box or to be connected

to external sensor systems (GPS, Doppler velocity log, Depth sensor, acoustic positioning systems…).

The GPSs, the Phins MRU-Inertial Navigation System and the PDS2000 Navigation System are all interfaced according to the attached sketch. The data are real time displayed both in the navigation room and on the bridge. All the data from the sensors are stored by the navigation system in the PDS2000 format and can be retrieved either in CVS, XLS and ASCII format.

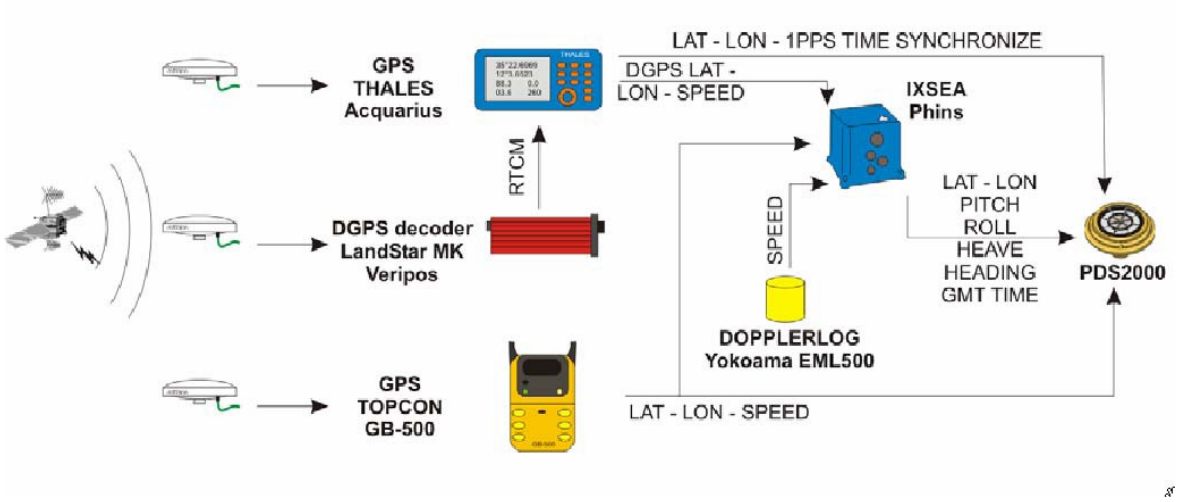


Figure C-1-1: *Positioning and navigation*

C.1.2. Navigation system

The software PDS2000 that is also used to manage MBES data acquisition provides navigation. Other capabilities offered by the navigation software are: data acquisition from sensors, computations, presentation, quality control, vessel guidance, output messages, data storage and event generation (shot command to the gun controller and fix position to the sub bottom profiler acquisition software in particular).