

## **Cruise Report**

**Compiled by:** Dr. Joanna Waniek

**R.V. Poseidon Cruise No.:** 404

**Dates of Cruise:** from 02.09.2010 to 15.09.2010

**Areas of Research:** Physical Oceanography, Engineering

**Port Calls:** Ponta Delgad (Acores), Funchal (Madeira)

**Institute:** Institut für Ostseeforschung Warnemünde, Seestrasse 15, 18119 Rostock

**Chief Scientist:** Dr. Joanna Waniek

**Number of Scientists:** 10

**Project:** (DFG: WA2157/2-1, WA2157/3-1).

### **Cruise Report**

This cruise report consists of 27 pages including cover:

1. Scientific crew
2. Research programme
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4. Scientific report and first results
5. Moorings, scientific equipment and instruments
6. Additional remarks
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## 1. Scientific crew:

Name	Function	Institute	Leg
Dr. Waniek, Joanna	Chief scientist	IOW	404
Fründt, Birte	Student	IOW	404
Brust, Juliane	PhD Student	IOW	404
Xia, Zhen	Scientist	IOW/GMGS	404
Pleskach, Georgiy	Technician	Evologics	404
Huth, Hartmut	Technician	IOW	404
Thiede, Carl	Scientist	Enitech	404
Kebkal, Oleksiy	Technician	Evologics	404
Körner, Gerhard	Technician	Enitech	404
Rohleder, Marco	Technician	Sea&Sun	404
<b>Total : 10</b>			

IOW	Institut für Ostseeforschung Warnemünde
Evologics	EvoLogics GmbH, FuE Bionik, Berlin
Sea&Sun	Sea & Sun Technology GmbH, Trappenkamp
Enitech	Enitech GmbH, Rostock

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## **2. Research programme (J. Waniek, IOW)**

The objectives of the cruise P404 from Ponta Delgada to Funchal in September 2010 (02.09-15.09.2010) on board R/V Poseidon were:

- 1) To investigate the water column properties along a meridional transect (22°W from 31°N to 37°N) in order to localize the position of the Azores Front and to understand the changes in biogeochemical properties.
- 2) To perform deep sea trials (at depth greater than 5000 m) with the newly developed acoustic modems and DNS (Druck Neutrale Systeme) devices.

## **3. Narrative of the cruise with technical details (J. Waniek, IOW)**

The cruise P404 was carried out in collaboration between the Institut für Ostseeforschung Warnemünde (IOW), Enitech (Rostock, Germany) and Evologics (Berlin, Germany).

**01.09:** Ponta Delgada. The participants of the P404 embark on RV Poseidon in the morning. After lunch we start unloading and installing of our equipment and setting up of the laboratories. All work is completed in the early afternoon.

**02.09:** At 08:00 UTC RV Poseidon sails from Ponta Delgada towards our working area in the Madeira basin. We participate in the safety instruction training.

**03.09:** In the morning we start our work along the 22°W transect southwards with a CTD down to the bottom and first test of the acoustic modems. The aerosol sampler on the observational deck is installed and will sample over the entire cruise. Weather conditions are good (3-4Bft), so the work is going well.

**04.09:** Today after several CTDs we tested additionally the DNS- ROV ERNO. Unfortunately, due to problems with the thrusters we have to stop the test at shallow water depth.

**05.09-12.09:** The weather conditions are very good. The CTD, tests of acoustic modems and the ERNO are going well. In the meantime the front was detected at 34°N, several CTD cast were carried out in order to get good feeling for its width and the strength of the gradients.

**13.09:** Most of the work is accomplished; tonight we will have all together the crew and the scientists an BBQ. After that Poseidon will start the transit to Funchal.

**14.09:** Transit to Funchal (Madeira).

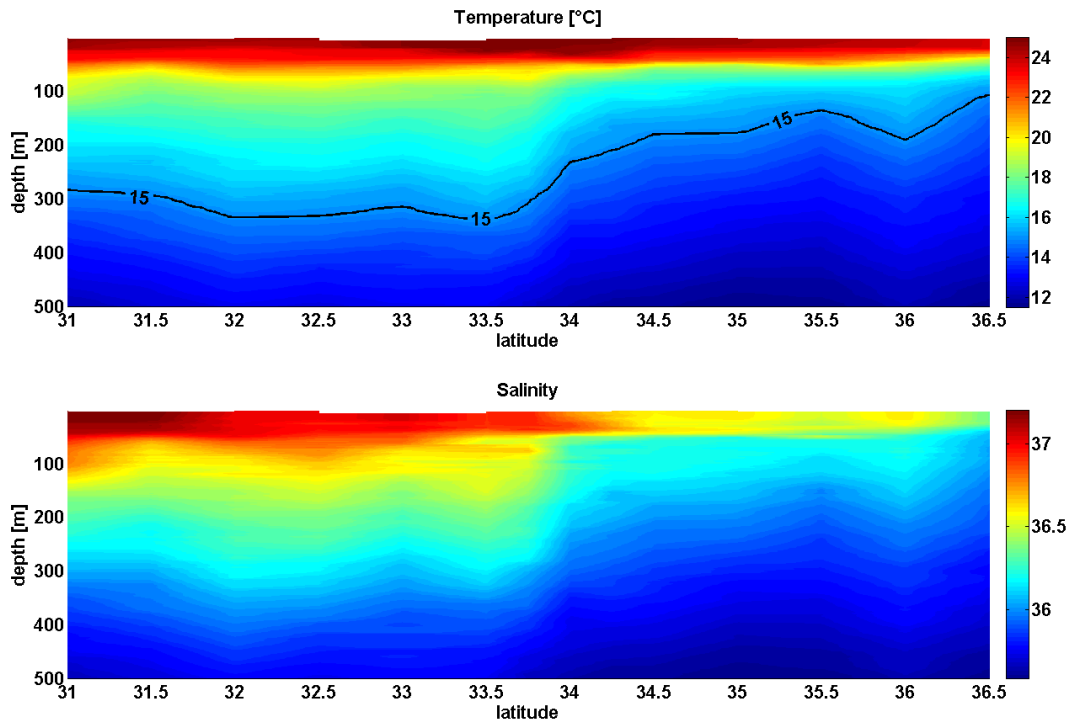
**15.09:** RV Poseidon reaches Funchal in the early morning of the 15th of September 2010 after completing a successful cruise. The day goes by with packing out instruments and cleaning labs.

**16.09:** In the morning all scientist transfer to a hotel in Funchal. We will departure from Funchal next day.

## 4. Scientific report and first results

### 4.1 Hydrographic sections (B. Fründt, H. Huth, J. Waniek, IOW)

CTD measurements were done on 22 stations along the 22°W transect from 36.5°N to 31°N. Most were performed down to the bottom of roughly 5000 m depth, some down to 2000 m depth. Additionally oxygen and fluorescence data were recorded on all stations. The equipment was a SBE 911plus CTD with a double sensor system. The temperature sensors have the serial numbers 5120 and 5213 and conductivity sensors 3722 and 3724. Oxygen was measured with SBE 43, serial numbers 1732 and 1733; the fluorometer was a Wetlab ECO-AFL/FL instrument, serial number FLRTD 1582. The results of the fluorometer have to be handled with care, because most of the recorded chlorophyll values are less than zero. Also an altimeter, type Benthos, was added. On all stations the altimeter did not work reliably. Parallel water sampling was done on all stations beside the stations down to 2000 m depth. On most CTD station samples from the rosette were obtained for chlorophyll a, nutrient concentrations, POC and suspended particulate matter. The samples were stored frozen until analysis at IOW.



**Figure 1:** Vertical temperature and salinity distribution (0 – 500 m depth) along the 22°W transect from 31°N to 36.5°N. The black line indicates the 15°C isotherm. The Azores Front was detected at 34°N where the 15°C isotherm moves upward from 300 m depth to 200 m depth.

Figure 1 shows the vertical temperature and salinity distribution in the top 500 m of the water column. To detect the Azores Front (AF) in-situ measurements are necessary, because the front

does not have any surface indication and so there is no possibility to localize the front using satellite observation. The position of the frontal system is defined where the 15°C isotherm moves upward from depth below 300 m to above 200 m depth. During this cruise (September 2010) AF was detected at 34°N (figure 1). In comparison to the former cruise P383 in April 2009 the Azores Front has moved 2.5° southwards.

#### **4.2. Sampling of suspended particles in the water column (SPM, Chl-a, POC) and aerosol sampling (J. Brust, IOW, B. Fründt, IOW, J. Waniek, IOW, Z. Xia GMGS/IOW)**

During the POS 404 cruise, water and filter samples of surface and deep water were taken along the 22° W transect from 31° to 36.5°N at each station. The main aim of sampling is to determine the nutrient concentration of ocean water in different depths intervals and the amount and composition of suspended particulate matter (SPM). Suspended particulate matter consists of a variety of particles dispersed in the water column as lithogenic particles (silicates), biogenic minerals (e.g. opal, calcite), chlorophyll and other particulate organic compounds (POC). The knowledge about composition and distribution of dispersed particles in the water column along the transect supports a biogeochemical characterization of water masses across the Azores Front, which is detected by the CTD measurements. Sampling was performed with Niskin bottles during CTD rosette runs in defined water depth intervals (0m, 5m, 50m, 85m, 100m, 200m, 500m, 1000m, 2000m, 3000m, 4000m, bottom). For SPM, Chl-a and POC one litre of sea water was filtrated through GF/F filters (0.7 µm pore size; for SPM: weighted Ø 47mm filters, Chl-a and POC: Ø 25mm filters, glowcd filters for POC analysis) and frozen at -20°C for further sample processing at the home laboratory. During SPM filtration 150ml of filtrated sea water was collected for the purpose of nutrient measurements.

For the determination of mineral phases which are dispersed in the water column 1.5 – 2 litres of sea water was filtered through Nucleopore polycarbonate filters (0.4 µm pore size). The filters were dried at room temperature. All water filter samples meant for the different analytical and scientific purposes were desalinized by rinsing with “Milli-Q” clean fresh water before storage. The determination of mineral phases will be done by means of SEM-EDX analysis (scanning electron microscopy - energy dispersive X-ray microanalysis) at the IOW (SEM, FEI Quanta 400). The automated particle analysis by means of SEM-EDX provides data about the chemical properties (major element composition, Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, Mn, Fe) and species

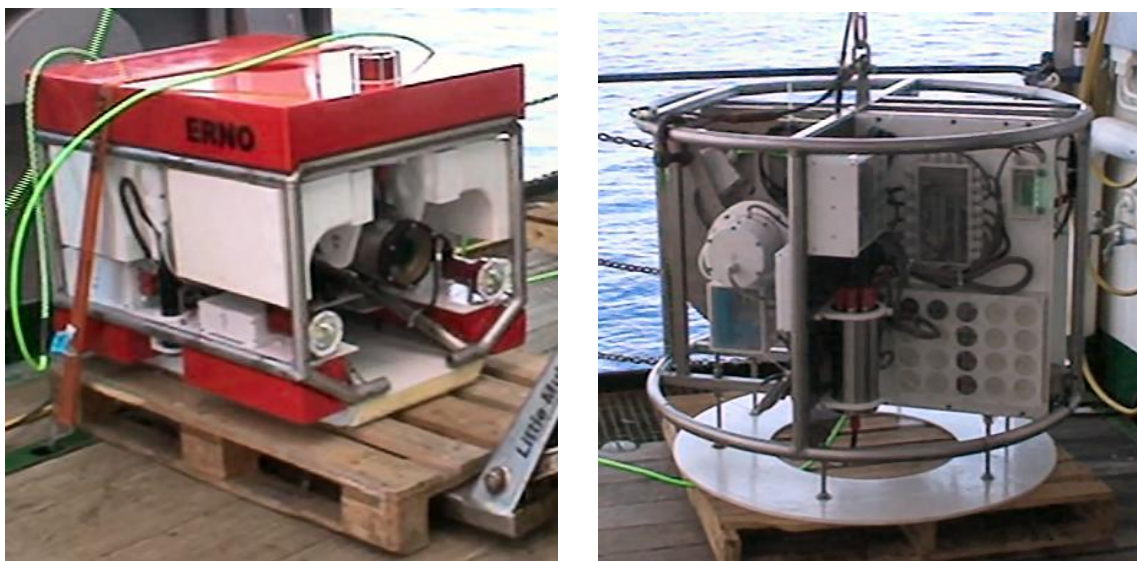
of biogenic and lithogenic particles on each filter sample and their morphological features (size, area, shape).

To compare the mineralogy of water samples with the eolian mineral input to the Atlantic Ocean at the study site, aerosol samples were taken additionally. Two sampling procedures (bulk samples via air filtration and particulate size-fractionated air filtration via PIXE cascade impactor) were applied with the aim to collect aerosols. The aerosol sampling instruments were installed on the compass platform.

Aerosols were collected on Nucleopore filters (0.4  $\mu\text{m}$  pore size) inset in sample holders (air filtration:  $\varnothing$  47 mm, impactor:  $\varnothing$  25 mm). The impactor consists of several stages, which collect particle of particular sizes. During the POS 404 cruise, the stages 7 to 3 were used, collecting particle size of aerodynamic cut-off diameter ranges of >16, 16-8, 8-4, 4-2, 2-1, 1.0-0.5  $\mu\text{m}$ . The sampling interval was defined to last 48 h. Five samplings were carried out (5th-13th September 2010) in double array instruments for comparison measurements. Sample filters will be investigated in the IOW by means of SEM-EDX analysis.

#### **4.3. Deep-sea trial of an pressure tolerant test and emergency recovery system (ERNO) for a deep-sea AUV (C. Thiede, G. Körner, Enitech).**

The ERNO-system consists of a tether management system (TMS) and a ROV (see Figure 2). The special feature of the system is that it can be run on a conventional single conductor as it is commonly used for CTD deployment. This allows the use of ERNO system on any research vessel which has a winch with a single conductor for CTD deployment.



**Figure 2:** Tested ERNO-system with ROV left and the TMS right.

The especially rugged construction of the ROV allows loads from 1 t to the ROV to couple and bring them to the surface. Both, the ROV, the tether and the TMS are specifically designed for these loads. The operating depth of the ERNO-system is tested in laboratory to 6.000 m. The working range of ROV, based on the TMS is about 75 m. Apart from the camera telemetry modules are all components built up in the pressure tolerant technology.

The ROV is equipped with two cameras: a HD-camera with recorder function and a b/w-camera. The lighting is realized through two 50 W LED headlights. The TMS also has a camera to monitor the relevant functions. A mounted in the ROV scanning sonar allows the acoustic orientation on sea bottom. A pressure-tolerant battery in each of the ROV and the TMS provide the energy for the ERNO system. Using the single conductor, it is possible to reload the batteries during use so that the operating time can be extended to several hours.

The main task of the deep sea trial was the testing of the various pressure tolerant concepts, components, assemblies and equipment as follows.

- Deep-sea testing of various pressure tolerant component potting concepts
- Deep-sea testing pressure tolerant circuit structures
- Review of appropriate components
- Deep-sea testing of the various pressure tolerant actuators
- Deep-sea testing of the DSL - communication via the single conductor
- Deep-sea testing of the various camera systems and lighting equipment
- Deep-sea testing of the pressure tolerant energy supply systems
- General testing of the handling of the ERNO - system in the deep sea

**Implementation of the testing** The weather conditions in the test area were extremely favorable, so that all testing tasks could be carried out under well conditions. The ERNO - system could be operated successfully with the devices on the research vessel Poseidon for CTD deployment. Handling, and the requisite commands and communications with the ship's officers made in accordance with the procedure of CTD handling.

**Testing results** By the deep sea trials, valuable results, findings and experiences are collected. The in the ERNO - system used components and subsystems in various potting technologies showed in the real deep-sea testing in contrast to the pressure chamber testing on land suitability significantly different results. Similarly, Component failures were identified which were not

detected in long time pressure chamber tests. During the trial, two dives to sea bottom in 5.000 m could be realized, the extensive footage supplied with high quality. Through these dives important knowledge gained on the sea bed in the testing area. Continue to stand by these trials, the first positive experiences and important knowledge about the different system components and assemblies of the ERNO - system and its handling system available. The behavior of the ERNO system - at the vessel's single conductor could be tested with positive results associated with the CTD winch system.

In the deep sea trials were important practices for handling the ERNO - determined system and tested as follows:

- The positioning and parking near the bottom of the TMS with the aid of the Sonar
- The coupling of the ROV
- Visibility, lighting and camera recordings near the bottom
- handling und driving the ROV near the bottom

On the basis of test results is the design and development and future trials of ERNO - system allows the testing platform deep-sea fish as well as the communications and navigation network with much higher technical security.

#### **4.4. Underwater acoustic sensor network and USBL positioning (O. Kebkal, G. Pleskach, Evologics)**

The acoustic trials were aimed for testing the performance of newly developed acoustic transducers (omnidirectional and directional) for S2C (Sweep-Spread Carrier) modem units. The trials comprised proving the ability of S2C modems, equipped with new transducers, to communicate over 5 km distances, testing the new omnidirectional transducers in a USBL (Ultra-Short BaseLine) positioning antenna, and testing the data routing in a 3-node underwater acoustic sensor network of S2C modems with new omnidirectional transducers.

At the first stage, two S2C modems were used during directional transducer testing, one of them mounted on the ship bottom approx. 5 m deep, the other mounted on a CTD rosette. Directional transducers performed well and enabled a stable communication link between modems over a distance exceeding 5 km. The communication demonstrated a raw bit rate of 5-6 Kbps, the net bit-rate reaching around 1.7-2 Kbps.

Next, a similar scheme was used to test S2C modems with omnidirectional transducers. Communication messages were sent from a top-side modem, located at the ship bottom, to a down-side modem, lowered on a TMS (Tether Management System) unit and a CTD rosette.



Compared to the directional versions, the omnidirectional transducers' sensitivity to ambient noise was higher, reducing the operating range and impairing the performance of the modems. The ambient noise level difference between omnidirectional and directional transducers comprised 21 dB for top-side modems. The communication demonstrated a raw bit rate of 1-3 Kbps, a net bit rate around 500 bps over a distance up to 2 km.

Communicating over a 5 km range was proven possible under lower noise conditions. Here, the ambient noise depth-profile was investigated. The measurements were taken, as the TMS-mounted omnidirectional modem was slowly lowered from 5 down to 200 m. The acquired data demonstrated that noise levels are acceptable for depths over 100 m and lowering the modems below 100 m may thus be one of the ways to decrease the noise level and increase the operational range of omnidirectional transducers.

At the third stage of the trials, an USBL positioning antenna, based on the omnidirectional version, also demonstrated a relatively low performance, primarily caused by the high level of the ship noise.

The last stage of the acoustic trials involved proving the modems' ability to exchange data in a 3-node sensor network.

Two S2C modems were mounted under the ship approx. 5 m deep; the 3rd modem was mounted on a CTD rosette and submerged to the depth of 1 km. The test comprised routing all data exchange between top-side modems via the down-side modem. Two different data exchange mechanisms were to be tested. One of them, the point to point delivery algorithm, is targeted for most efficient use of the acoustic channel, maintaining the highest possible bit rate under current channel conditions. The other one was the instant messages delivery algorithm that minimizes delivery time for short messages and enables broadcasting and overhearing of the data exchange between neighbouring network nodes.

The modems demonstrated stable data exchange in the test network scenario. Both point to point and instant messages delivery mechanisms were successful.

#### **4.5. Video and data transmission system (M. Rohleder, Sea & Sun)**

The purpose of this cruise was to commission our video and data transmission system with a deep sea ROV device of our customer. This deep sea telemetry system was especially designed to match the customers' requirements.

The challenge was to design a video and data transmission system with the capability to transmit two high quality videos of 24Fps and 8 serial (RS-232) channels bi-directional in real-time via 5600 m coaxial cable, parallel to the power needed for the ROV. It is anticipated to transmit all controls of the ROV via the telemetry system.

One of the tasks during the development was to estimate the disturbances caused by the electromagnetic environment on the vessel.

The conditions on the vessel were different than expected. The single conductor cable was exchanged with a cable 6200 m long with a diameter of 10.2 mm. The result was an increased attenuation of nearly 10%. Also, the inner pin of the winch coaxial connector was damaged.

At first the telemetry system was connected directly to the cable without the customers system. A connection was established with a bit rate of 4.8Mbit/s to operate in a 'save area' against disturbances. The signal to noise ratio was chosen very high. By selecting a lower signal to noise ratio, the bit rate would increase to >8Mbit/s.

In next step, the telemetry system was connected to the customers' system. The complete system was started and everything checked. The customers' system was powered with a constant current of 2 Ampere. The telemetry system attained again 4.8Mbit/s. There were no connection loses during the complete system check. The video system worked with high video quality and without any disturbances. After this, the system was ready for the first test in the deep sea.

After several dives, no connection failure or any problems with the video or data transmission occurred during the entire time. The bandwidth of the telemetry was more than enough to transmit 2 high quality video streams and 8 serial channels with 115200 Baud at the same time. For more video streams or data, the bit rate could be increased by choosing a lower signal to noise ratio.

The Sea & Sun Technology telemetry has successfully passed all tests and proven its reliability.

## **5. Scientific equipment, moorings and instruments**

### **5.1. CTD/ Water Sampling**

The CTD was a SBE 911plus with a double sensor system and 5 L Niskin bottles. The temperature sensors have the serial numbers 5120 and 5213 and conductivity sensors 3722 and

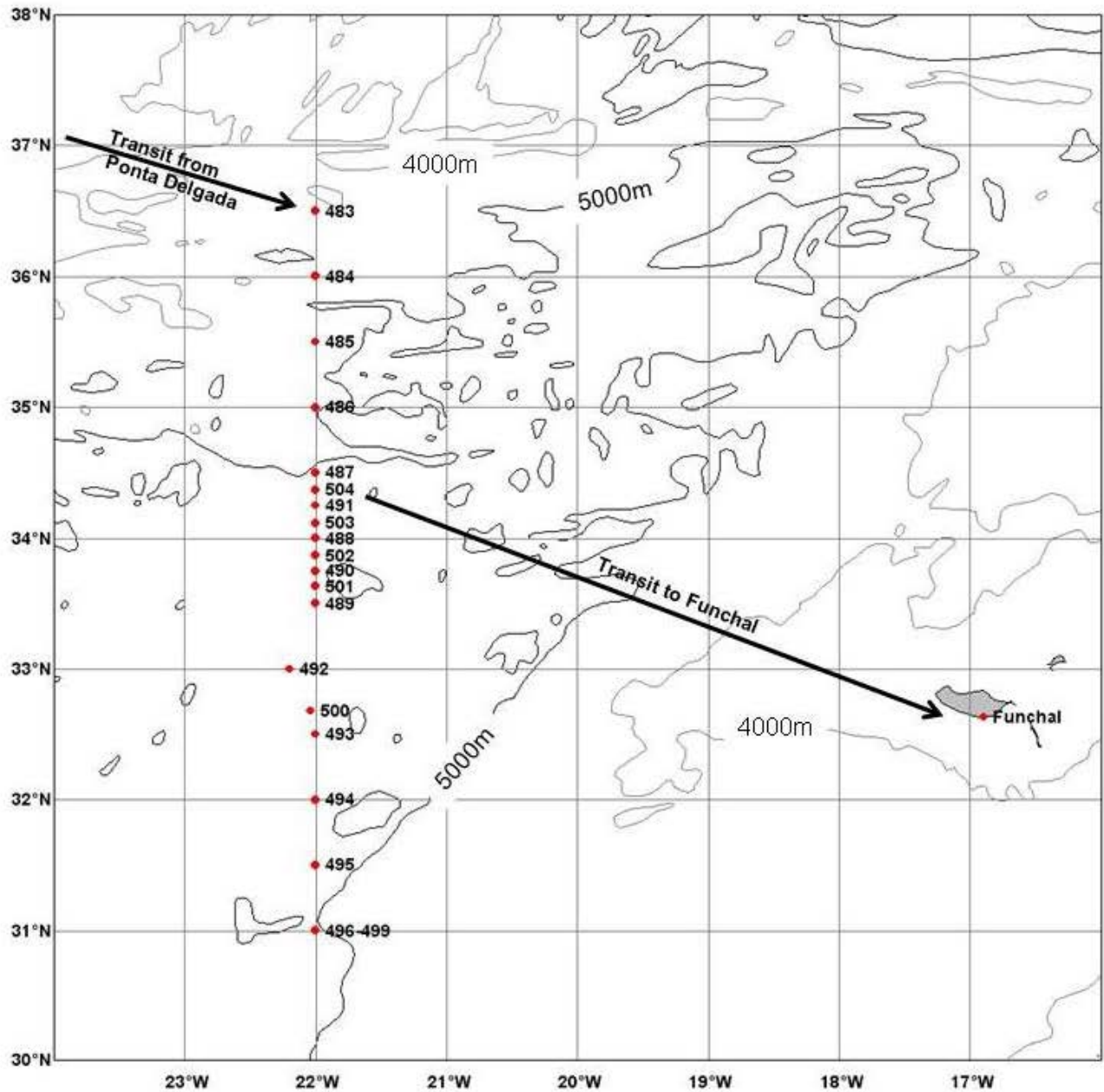
3724. Oxygen was measured with SBE 43, serial numbers 1732 and 1733; the fluorometer was a Wetlab ECO-AFL/FL instrument, serial number FLRTD 1582.

## **6. Acknowledgements**

We thank Captain K. Ricke and the crew of RV Poseidon for their cooperation and help during this cruise.

## 7. Appendices

### Appendix A: Map P404



Cruise track with the location of occupied stations.

## Appendix B: Station list P404 September 2010

St.	month	day	hour	min.	device	action	LAT	LON	wire length
483-1	09	03	07	17	CTD-RO 12	modem to water	36.50027	-22.00022	
483-1	09	03	07	18	CTD-RO 12	CTD to water	36.50032	-22.00022	
483-1	09	03	08	55	CTD-RO 12	at depth	36.50027	-21.99993	3950
484-1	09	03	14	18	CTD-RO 12	modem to water	35.99930	-21.99962	
484-1	09	03	14	19	CTD-RO 12	CTD to water	35.99918	-21.99950	
484-1	09	03	15	35	CTD-RO 12	at depth	36.00013	-21.99998	4127
485-1	09	03	20	42	CTD-RO 12	to water	35.49973	-22.00032	
485-1	09	03	22	10	CTD-RO 12	at depth	35.50000	-21.99997	4838
486-1	09	04	07	26	CTD-RO 12/ ROV	CTD & Modem 1 & 2 to water	35.00028	-21.99967	
486-1	09	04	08	57	CTD-RO 12/ ROV	at depth	34.99993	-21.99992	4939
486-2	09	04	12	24	CTD-RO 12/ ROV	ROV to water	34.99922	-21.99972	
486-2	09	04	12	33	CTD-RO 12/ ROV	at depth	34.99888	-21.99970	75
487-1	09	04	16	32	CTD-RO 12/ ROV	CTD & Modem 1 & 2 to water	34.49982	-21.99982	
487-1	09	04	18	11	CTD-RO 12/ ROV	at depth	34.49998	-22.00003	5034
488-1	09	04	23	44	CTD-RO 12/ ROV	CTD to water	33.99990	-21.99968	
488-1	09	05	01	10	CTD-RO 12/ ROV	at depth	34.00057	-22.00052	5223
489-1	09	05	06	32	CTD-RO 12/ ROV	to water	33.49962	-22.00012	
489-1	09	05	08	02	CTD-RO 12/ ROV	at depth	33.50000	-21.99993	5133
489-2	09	05	09	49	CTD-RO 12/ ROV	Modem to water	33.50007	-21.99993	
489-2	09	05	10	54	CTD-RO 12/ ROV	to water	33.49813	-21.99950	2
489-2	09	05	10	56	CTD-RO 12/ ROV	at depth	33.49802	-21.99912	75
489-2	09	05	11	05	CTD-RO 12/ ROV	ROV discontinued from garage	33.49750	-21.99917	
489-2	09	05	11	10	CTD-RO 12/ ROV	ROV connected to garage	33.49733	-21.99953	
489-2	09	05	11	12	CTD-RO 12/ ROV	heave stopped	33.49713	-21.99958	65 m
489-2	09	05	11	13	CTD-RO 12/ ROV	heave stopped	33.49697	-21.99962	55 m
489-2	09	05	11	14	CTD-RO 12/ ROV	heave stopped	33.49678	-21.99965	45 m
489-2	09	05	11	15	CTD-RO 12/ ROV	heave stopped	33.49663	-21.99972	35 m
489-2	09	05	11	16	CTD-RO 12/ ROV	heave stopped	33.49650	-21.99980	25 m
489-2	09	05	11	17	CTD-RO 12/ ROV	heave stopped	33.49638	-21.99988	20 m
489-2	09	05	11	18	CTD-RO 12/ ROV	heave stopped	33.49630	-21.99997	15 m
489-2	09	05	11	19	CTD-RO 12/ ROV	heave stopped	33.49622	-22.00002	10 m
489-3	09	05	12	12	CTD-RO 12/ ROV	CTD to water	33.49923	-22.00080	
490-1	09	05	16	19	CTD-RO 12/ ROV	at depth	33.74948	-21.99963	1979
491-1	09	05	20	44	CTD-RO 12/ ROV	CTD to water	34.24997	-21.99987	
491-1	09	05	21	20	CTD-RO 12/ ROV	heave started	34.24907	-22.00005	1179 m
492-1	09	06	06	50	CTD-RO 12/ ROV	to water	32.99983	-22.19813	
492-1	09	06	08	17	CTD-RO 12/ ROV	at depth	32.99992	-22.19872	5132 m
493-1	09	06	13	58	ROV	to water	32.50010	-22.00022	
493-1	09	06	15	42	ROV	at depth	32.49988	-22.00028	5124
493-2	09	06	18	08	CTD-RO 12 /	to water	32.50015	-22.00020	
493-2	09	06	19	36	CTD-RO 12	at depth	32.50000	-21.99982	4959
494-1	09	07	06	38	CTD-RO 12	to water	32.00028	-22.00008	10
494-1	09	07	08	03	CTD-RO 12	at depth	32.00005	-21.99992	4986 m

495-1	09	07	13	54	CTD-RO 12	to water	31.50007	-22.00023	
495-1	09	07	15	37	CTD-RO 12	at depth	31.50017	-21.99973	4967
496-1	09	08	06	29	CTD-RO 12	Modem to water	30.99970	-22.00003	
496-1	09	08	06	30	CTD-RO 12	to water	30.99972	-21.99993	
496-1	09	08	07	54	CTD-RO 12	at depth	30.99998	-22.00003	4937
496-2	09	08	10	20	ROV	to water	31.00007	-22.00002	
496-2	09	08	11	47	ROV	at depth	31.00007	-22.00010	4962 m
496-3	09	08	14	40	CTD	to water	30.99993	-22.00022	
496-3	09	08	16	06	CTD	at depth	31.00045	-21.99992	4894
497-1	09	09	08	06	CTD	to water	30.99983	-22.00012	10 m
497-1	09	09	08	14	CTD	heave started	30.99988	-22.00005	
497-1	09	09	08	23	CTD	to water	30.99997	-21.99993	10 m
497-1	09	09	09	44	CTD	at depth	31.00012	-22.00025	4921 m
497-2	09	09	12	32	ROV	to water	30.99930	-22.00172	
497-2	09	09	13	59	ROV	at depth, start testing acoustic modem	30.99770	-22.01432	4992
497-2	09	09	15	14	ROV	ROV disengaged from recovery system	30.99423	-22.02017	4986
497-2	09	09	15	55	ROV	ROV reengaged to recovery system	30.99175	-22.02340	4986
498-1	09	10	08	09	CTD - RO 12	to water	30.99982	-22.00052	10 m
498-1	09	10	08	22	CTD - RO 12	acoustic test	30.99985	-22.00012	499 m
498-1	09	10	08	45	CTD - RO 12	acoustic test	30.99987	-22.00003	989 m
498-1	09	10	09	29	CTD - RO 12	heave stopped	31.00005	-21.99993	95 m
498-2	09	10	10	19	ROV	to water	30.99997	-22.00007	
498-2	09	10	12	51	ROV	heave started	31.00005	-21.99982	4982
498-2	09	10	14	30	ROV	on deck	31.00025	-21.99940	
498-3	09	10	16	03	CTD	to water	31.00018	-22.00003	10
498-3	09	10	17	07	CTD	on deck	31.00012	-21.99962	
499-1	09	11	07	59	CTD-Ro 12	to water	30.99977	-22.00013	10
499-1	09	11	09	15	CTD-Ro 12	slack stopped	30.99988	-21.99997	1953 m
499-1	09	11	10	36	CTD-Ro 12	on deck	30.99995	-22.00005	
499-2	09	11	11	03	ROV	to water	30.99993	-22.00003	
499-2	09	11	11	15	ROV	at depth	30.99985	-22.00008	500
499-2	09	11	11	50	ROV	on deck	30.99995	-22.00003	
499-3	09	11	13	45	Access point	to water	30.99998	-21.99995	
499-3	09	11	15	09	Access point	at depth	30.99985	-21.99988	4950
499-3	09	11	17	03	Access point	on deck	30.99968	-22.00035	
500-1	09	12	10	37	ROV	to water	32.67950	-22.03693	
500-1	09	12	12	16	ROV	heave started	32.67918	-22.03737	5149
500-1	09	12	13	38	ROV	on deck	32.67733	-22.03683	
501-1	09	13	00	05	CTD	to water	33.63287	-21.99947	
501-1	09	13	00	42	CTD	at depth	33.62977	-22.00037	1983
501-1	09	13	01	23	CTD	on deck	33.62537	-22.00370	
502-1	09	13	04	01	CTD	to water	33.86593	-22.00010	10
502-1	09	13	04	36	CTD	at depth	33.86352	-21.99673	2001
502-1	09	13	04	36	CTD	heave started	33.86350	-21.99672	2001
502-1	09	13	05	11	CTD	on deck	33.86232	-21.99433	
503-1	09	13	07	39	CTD-Ro 12	to water	34.11653	-22.00037	10
503-1	09	13	08	16	CTD-Ro 12	at depth	34.11623	-22.00002	1993

503-1	09	13	08	17	CTD-Ro 12	heave started	34.11620	-22.00003	1993
503-1	09	13	08	52	CTD-Ro 12	on deck	34.11610	-21.99970	
504-1	09	13	11	15	CTD-Ro 12	to water	34.36720	-22.00032	
504-1	09	13	11	54	CTD-Ro 12	at depth	34.36672	-21.99998	1973
504-1	09	13	12	28	CTD-Ro 12	on deck	34.36658	-21.99898	
504-1	09	13	12	28	CTD-Ro 12	station completed <b>end of science</b>	34.36660	-21.99897	