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Cruise Report
POSEIDON 375/1-2

Kiel – Lisbon - Las Palmas
18. 10 – 27. 10. 2008 / 28. 10. - 07. 11. 2008
Technical Report 1-2009

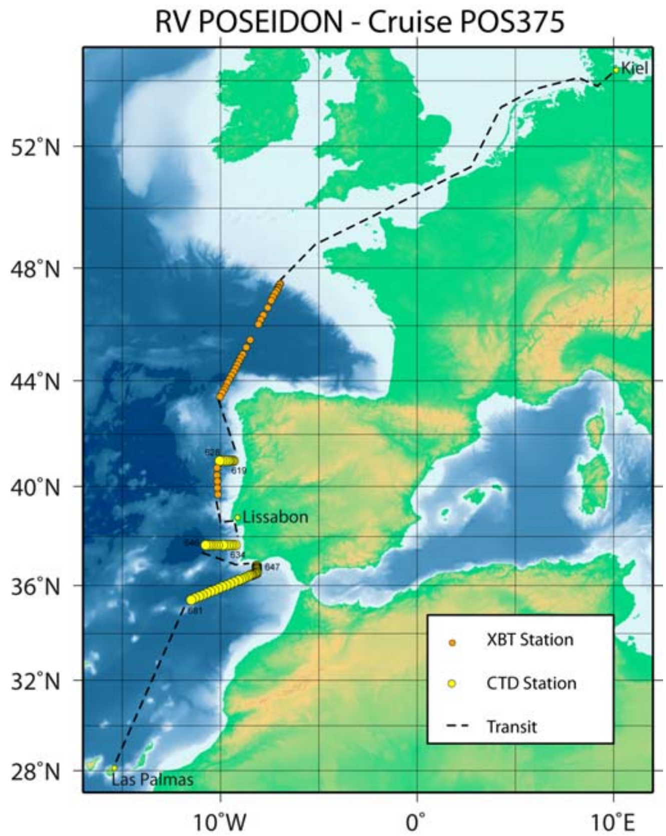
1. Background and aim of the cruise

The transit voyage of RV POSEIDON from Kiel to Las Palmas during early winter 2008 was used for practical student education. This “See- und Berufspraktikum” is part of the curriculum in the Bachelor programme in Geophysics and Oceanography at the University of Hamburg. The aim of the cruise was to familiarize the students of physical oceanography with the practical work onboard a research vessel. Besides handling the instruments, the students also analysed and interpreted the measured data.

The cruise followed a one-semester long preparation seminar during which the oceanography of the eastern North Atlantic was explored. The students studied the literature on this part of the ocean, analysed historical hydrographic data, and carried out rotating tank experiments and numerical modelling simulations. The scientific questions dealt with were:

- How does the Mediterranean Sea Water exiting the Strait of Gibraltar spread through the Gulf of Cadiz and along the Iberian Peninsula?
- What are the mixing rates in the tongue of the Mediterranean Sea water?
- What is the volume transport associated with the tongue?
- What is the role of synoptic scale eddies in the spreading and mixing of the Mediterranean Water?

Based on the preparation studies the students designed and planned the cruise programme. We carried out a hydrographic survey of the Mediterranean outflow plume off the Iberian Peninsula and west of the Strait of Gibraltar. During a short port call in Lisbon the student crew changed. In all 15 students were thus able to take part in the expedition.



Cruise track of RV POSEIDON cruise P375 with positions of expendable bathythermograph (XBT) and conductivity-temperature-depths (CTD) profiles marked.

Cruise participants of leg 1, RV POSEIDON cruise P375, Kiel – Lisbon

Cruise participants of leg 2, RV POSEIDON cruise P375, Lisbon – Las Palmas

2. Cruise participants

Leg 1: 18.10. – 27.10.2008	**Rank**	**Leg 2:** 27.10.2 - 07.11.2008	**Rank**
Detlef Quadfasel	Chief scientist	Detlef Quadfasel	Chief scientist
Dagmar Hainbucher	Scientist	Dagmar Hainbucher	Scientist
Andreas Welsch	Scientist	Andreas Welsch	Scientist
Elena Astakhova	Student	Gregor Halfmann	Student
Anna Friedrichs	Student	Fabian Große	Student
Nicole Herrmann	Student	Simon Schoof	Student
Julia Köhler	Student	Mareike Held	Student
Susanne Schneidereit	Student	Marketa Pokorna	Student
Kira Kalinski	Student	Johannes Lohse	Student
Marta Zygmuntowska	Student	Finn Hartwig	Student
		Valentin Born	Student

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Ship's crew

Michael Schneider	Captain
Theo Griese	Chief Mate
Bernhard Winscheid	2nd Mate
Hans-Otto Stange	Chief Engineer
Günther Hagedorn	2nd Engineer
Dietmar Klare	Electrician
Rüdiger Engel	SM
Joachim Mischker	Boatswain
Ralf Meiling	SM
Pedro Manuel Barbosa	AB
Ronald Kuhn	AB
Bernd Rauh	SM
Kai Riedel	SM
Johann Ennenga	Cook
Bernd Gerischewski	Steward

Briese Schiffahrts GmbH & Co. KG
Abt. Forschungsschifffahrt
Hafenstrasse 12
D-26789 Leer

3. Narrative

Leg 1: Kiel - Lisbon

Friday, 17.10.2008

Kiel

After the scientific equipment was loaded at the Seefischmarkt, Poseidon moved to its usual berth below the Institut für Meereskunde in Kiel. The scientists embarked during the afternoon.

Saturday 18.10.2008

Noon: Kiel Canal

The students arrived shortly after 8 a.m., embarked and made themselves familiar with their new home for the next ten days. The ship sailed from the port of Kiel at 10:07 a.m., passed Holtenau locks and entered the Kiel Canal. At 1 p.m. the chief mate gave an introduction to the safety regulations and the students had a guided tour around the vessel. Scientific work started with a course on surface bucket sampling. Because of a damaged crane FS Poseidon went alongside at 6:10 p.m. at Südmole in the port of Brunsbüttel. At 7 p.m. the scientific crew had a first meeting and the chief scientist gave an overview of the scientific programme of the cruise. Also the work schedule for the next days was laid out. After some discussion the following student projects were designed:

- A comparison of the surface temperature measured along the ship's track with climatological data
- Calibration of the thermosalinograph
- Fronts in the North Sea
- Sand waves and ripples in the North Sea and the Strait of Dover

Sunday 19.10.2008

Noon Position: 53° 53.7` N 009° 9.3` E
Air temperature: 12.4° C, wind: 4-5 Bft, water temperature: 12.8° C

In the morning Poseidon was still in the port of Brunsbüttel. The students had a meeting at 10 a.m. and further discussed their scientific projects. After the crane was finally repaired, Poseidon sailed from the port of Brunsbüttel at 1:28 p.m. The first watch started at 6:30 p.m. after having passed Vogelsand at the mouth of the River Elbe. But the weather was getting too bad for bucket sampling and the watches were cancelled in the evening.

Monday 20.10.2008

Noon Position: 53° 36.7' N 005° 10.9' E
Air temperature: 13.4° C, wind: SSW 7-8 Bft, water temperature: 14.3° C

The weather was still bad and the wind very strong. At least half of the students were seasick, but the others started taking bucket samples once every hour for calibration of the ship's thermosalinograph. Due to the bad weather the night watches were cancelled.

Tuesday 21.10.2008

Noon Position: 52° 04.0’ N   002° 50.1’ E
Air temperature: 11.2°C, wind: WNW 6 Bft, water temperature: 14.8° C

The first watch started again at 8 a.m. with bucket sampling. The watches change every four hours. It was decided to have regularly meetings for the students at 10 a.m. and 3 p.m. where they can discuss their scientific projects. The weather was getting better, so that everyone was able to take part in the programme. In the evening we passed the Strait of Dover, with the white cliffs shining pink in the sunset.

Wednesday 22.10.2008

Noon Position: 50° 14.3’ N   001° 40.3’ W
Air temperature: 12.8° C, wind: W 5-6 Bft, water temperature: 15.3° C

The weather was very good and the sun was shining. The whole scientific crew was in a good mood. The students were still doing bucket sampling. At 10:15 a.m. they got an introduction to ship’s navigation by the second mate. They also got introductions to the other oceanographic instruments and to the data analysis software.

Thursday 23.10.2008

Noon Position: 48° 55.3’ N   005°45.6’ W
Air temperature: 14.4° C, wind: SW 7-8 Bft, water temperature: 14.1° C

We were still running behind schedule because of bad weather conditions. Half of the students were seasick again, but they continued with bucket sampling nevertheless. In the morning a group of dolphins was observed. Around 1 p.m. the wind was getting too strong for the bucket sampling. The mood of the students worsened because of the imposed inactiveness.

Friday 24.10.2008

Noon Position: 46° 30.8’ N   007° 42.4’ W
Air temperature: 14.2° C, wind: N to E 3-5 Bft, water temperature: 15.3° C

After passing the shelf break at the exit of the English Channel at 4 a.m. we started with hourly XBT measurements. After some initial problems with the grounding the system worked fine and good data was obtained. Bucket sampling continued. A safety training – rehearsing emergency situations was carried out. During the day the wind turned to NE and Poseidon made good speed in the Bay of Biscayne.

Saturday 25.10.2008

Noon Position: 43° 38.0’ N   009° 52.2’ W
Air temperature: 17.5° C, Wind: NE 3-4 Bft, water temperature: 17.3° C

The weather during the day was very good and the sun was shining. The watches were still taking bucket samples along with the XBT measurements. In parallel the students worked on their projects. The XBT measurements ended at 2 p.m. when reaching the shelf break off Spain.

Sunday 26.10.2008

Noon Position: 40° 59.9’N 009° 33.0’W
Air temperature: 16.9° C, Wind: N 4Bft, water temperature: 17.9° C

During the night we passed Cap Finistèrre and reached the latitude of our first CTD section. The first CTD profile was taken in the morning at 7:30 a.m. at approximately 41° 00’N 009° 20’ W. We stopped the bucket sampling. From now on the watches were busy with CTD measurements which had to be carried out approximately every second hour. Just before lunch the students attended church in the chief scientist’s cabin. There were readings of poems by Ringelnatz and Goethe and a glass or two of well aged sherry. Also the girls had prepared a song called “Sieben kleine Forscherinnen” that had its premiere during mass. Later, en route, during one CTD station we tested ordained wrist-watches for their pressure limit of 900 m by strapping them to the CTD. The weather was similar as the day before, the sun was shining and the air temperature was pleasant. Again, we observed dolphins close to the ship.

Monday 27.10.2008

Noon Position: 39° 14.0’ N 010° 007.9’ W
Air temperature: 18.1° C, wind: 4 Bft, water temperature: 18.19° C

The last CTD profile ended at 3 a.m. and Poseidon sailed towards Lisbon. During passage the remaining five XBTs were launched every second hour. At 10:15 a.m. the students learned how to tie knots, professionally taught by the bosun, and at 3 p.m. they had a guided tour through the engine room. Later cabins and laboratories were cleaned and during a little party in the evening the students presented the results from their projects.

Tuesday 28.10.2008

Noon Position: Santa Apolónia, Lisbon

Poseidon went alongside at the Terminal de Passageiros de Santa Apolónia in Lisbon at 8 a.m. and after customs clearance the students of the first leg disembarked.

Leg 2: Lisbon – Las Palmas

The students of the second leg arrived already at 10 a.m., but due to the strong winds captain and chief scientist decided to stay in port overnight. So everybody used the free time for a tour around Lisbon. At 5 p.m. a first meeting with the students was held, announcing that Poseidon will sail the next morning after breakfast.

Wednesday 29.10.2008

Noon Position: 38° 25.2’N 009° 21.3’ W
Air temperature: 13.9° C, wind: NW 4, water temperature: 15.7° C

We departed from Lisbon at 8:48 a.m. Sailing along the coast, we headed to our first CTD station at a section south of Lisbon. At 10 a.m. the students had a meeting to receive first information about the procedures onboard. Afterwards, the second mate gave a safety instruction on how to act in an emergency case. During the day the students were introduced to the scientific equipment. At 4 p.m. they started with the watches and with the first CTD station at 4:30 p.m. On the section westward, they took CTD measurements every 10 nm. Some of the students became seasick.

Thursday 30.10.2008

Noon Position: 37° 39.7’ N 010° 15.0’W
Air temperature: 17.5° C, wind: WNW 7, water temperature: 17.4° C

CTD measurements continued during the night and day. Some of the students were still seasick. At 7 p.m. we had to stop work because the swell became too high. The barometer fell by up to 4 hPa per hour.

Friday 31.10.2008

Noon Position: 37° 39.9’ N 010° 45.9’ W
Air temperature: 15.3° C, Wind: NW to W 6, water temperature: 19.4°C

The weather this morning was grey and rainy, but we were able to start the CTD work again at 7:30 a.m. During the course of the day winds got stronger again, reaching up to 9 Bft. during the passage of a front. Because of the weather forecast we decided to stop the work on the section after 13 stations and proceeded to the south coast of Portugal. During the night, we only took bucket samples once every hour while going SE-ward.

At the seminar we discussed the data obtained so far and speculated, whether we had seen a Meddy at the offshore end of the section. Also, after some discussion the following student projects were designed:

- Ocean-atmosphere fluxes
- Transports in the deep boundary current
- Mixing in the boundary current
- Coastal upwelling and Chlorophyll distributions

Saturday 01.11.2008

Noon Position: 36° 43.9’ N 008° 09.0’ W
Air temperature: 15.1° C, wind: NE to E 3, water temperature: 17.7° C

The morning was nice, sea was fairly calm in shelter of the Portuguese coast. We arrived at the first station on the shelf at 9:20 a.m. The stations of this section are close together and kept the students busy the whole day.

Sunday 02.11.2008

Noon Position: 36° 20.6’ N 008° 42.5’ W
Air temperature: 14.6° C, wind: N 3, water temperature: 19.5°C

We were still continuing with CTD measurements in the boundary current section. The sea was very calm. Again, “mass” was celebrated in the chief scientist’s cabin. During the seminar the data collected on this section was discussed. We had apparently passed the high salinity boundary current and entered the offshore waters with lower salinities in the central waters.

Monday 03.11.2008

Noon Position: 35° 52.1’ N 010° 08.9’ W
Air temperature: 17.2° C, wind: N 5, water temperature: 19.9° C

We were still doing CTD measurements like yesterday. So far, we finished almost 30 stations. A crew member claimed to have seen dolphins. At night, we saw squids close to the ship.

Tuesday 04.11.2008

Noon Position: 35° 09.6’ N   011° 41.2’ W
Air temperature: 18.2° C, wind: NNW 6/7, water temperature: 20° C

This day Poseidon had her 33rd birthday! Also, presidential elections in the United States of America were held. At around 10 a.m. we finished our last station of the cruise, after which Poseidon set course for Las Palmas. It will take us two days to get there. At 10 a.m. the students got an introduction to navigation, which was given by the second mate. Afterwards, during lunch we celebrated Poseidon’s birthday with red and white wine. After our daily afternoon seminar, in which we made a diffusion experiment, we started with clearing and cleaning the laboratories. A student claimed to see a turtle floating by. Maybe, he had a glass too much during the birthday party.

Wednesday 05.11.2008

Noon Position: 32° 01.9’N   013° 21.8’ W
Air temperature: 19.8° C, wind: NE 3, water temperature: 20.1° C

One of the students had birthday. The watches had already been cancelled during the night. Everybody was still busy with clearing, cleaning, data analysis and interpretation. During noon the students had a guided tour through the engine rooms and in the evening we had a small birthday and farewell party.

Thursday 06.11.2008

Noon Position: 28° 55.1’ N   014° 58.5’ W
Air temperature: 21.6° C, wind: NEE 5, water temperature: 21.5° C

The students were still busy with the interpretation of their scientific work. There was still a persistent rumour that turtles orbit the ship. At 6:15 p.m. the Las Palmas pilot came on board and at 6:30 p.m. Poseidon was alongside.

Friday 07.11.2008

Noon Position: Las Palmas

The final packing was done and after breakfast the scientific crew disembarked the vessel.

4. Technical information

CTD/Rosette

Altogether 58 full depth standard hydrographic stations were occupied during the cruise, employing a SeaBird SBE911plus CTD-O2 sonde, attached to a SeaBird carousel 12 bottle water sampler. A fluorometer and a transmissiometer were also attached to the sonde. At all stations water samples were taken from up to 10 depth levels within the water column. The water samples were analysed onboard for salinity, using a Guildline Autosal salinometer and for oxygen using a Metrohn titroprocessor. One of the water bottles was also equipped with protected and unprotected reversing digital thermometers, providing temperature and pressure check values for the CTD sensors.

The sensor configuration of the CTD was as follows:

Sea-Bird SBE 9plus underwater unit, s/n
Sea-Bird 3 primary temperature sensor s/n 1294

Sea-Bird 4 primary conductivity sensor s/n 1106
Sea_Bird pressure sensor Digiquartz s/n 50633

Sea-Bird 3 secondary temperature sensor s/n 4324
Sea-Bird 4 secondary conductivity sensor s/n 1329
Altimeter s/n 1118
Wetlab CStar transmissometer s/n CST 376 DR
Sea-Bird 43 Oxygen sensor s/n 1171
Fluorometer, Seapoint s/n SCF 2423

Lowered Acoustic Doppler Current Profiler

Vertical profiles of horizontal currents were made with a lADCP-2 system attached to the rosette water sampler. The system consists of two ADCPs of the Workhorse type (WHM300) manufactured by RD Instruments. They operate at a frequency of 300 kHz.

Surface temperature and salinity

Underway temperature and salinity measurements were made with a SeaBird thermo-salinograph installed in the ship's port well.

Current measurements

Underway current measurements were taken with a vessel-mounted 75 kHz Ocean Surveyor (ADCP) from RDI, covering approximately the top 500-800 m of the water column.

Meteorological observations

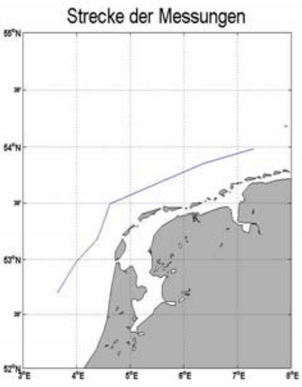
Meteorological measurements of wind speed, wind direction, air pressure, air temperature and global radiation were made with the ship's own meteorological system. This data and a lot more parameters (like navigation) were stored in the ships data system DATAVIS.

5. Student projects

The projects presented here were carried out by the students of leg 1 and leg 2 during their courses on the cruise.

Sand Ripples

Kira Kalinski, Nicole Herrmann, Susanne Schneidereit



It was discussed if and how sand ripples and topography can be detected by depth sounders. These measurements were carried out in the southern North Sea (Fig. 1).

Fig. 1: Location of the section along which the sand ripple measurements were carried out.

The water depth beneath the ship was measured with the 12 kHz deep sea echo sounder (Fig. 2). Additionally to this data of depth, time and position, information about pitch and roll was collected in order to exclude the effect of surface waves on the results.

Figure 3 shows the bottom topography along the ship's track after the noise induced by the surface waves were filtered out. At the beginning of the section it was very shallow and the tide waves of 1 – 4 m amplitude close to the East Frisian Islands can be detected quite well. Looking closer to the area around the Terschelling Plateau, a lot of small waves with amplitudes of 0.2 – 1 m and a wave length of approximately 50-80 m can be found (Figure 4). These are typical current ripples. Mega ripples are identified in the area between 6.6° and 6.7° E (fig. 5). They have amplitudes of approximately 2.5 – 3.5 m and wave lengths of some hundred meters.

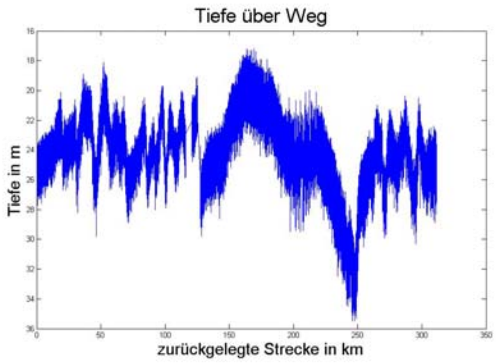


Fig. 2: Water depth beneath the ship including the effect of surface waves (y-axis: depth in m, x-axis: covered distance in km)

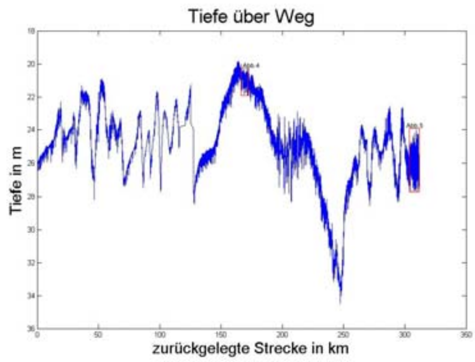


Fig. 3: Water depth beneath the ship excluding the effect of surface waves that were filtered out from the record on the left (y-axis: depth in m, x-axis: covered distance in km)

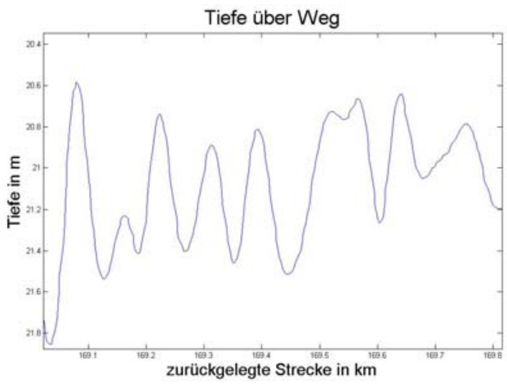


Fig. 4: Zoom in from Figure 3: current ripples.

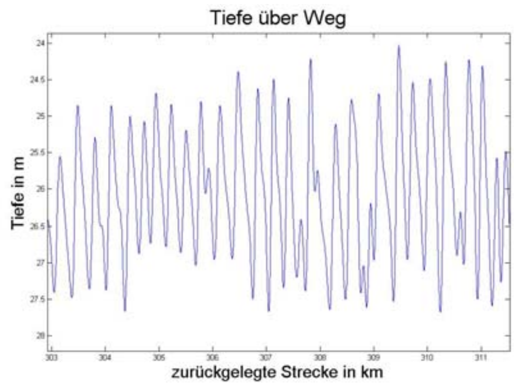


Fig. 5: Zoom in from Figure 3: mega-ripples.

Variability of the sea surface temperature in the North Sea

Elena Astakhova, Marta Zygmuntowska

On the cruise of POSEIDON cruise 375 seas surface temperature (SST) measurements were taken with a thermosalinograph in the southern North Sea. This data was compared with climatological monthly means of the years 1971 – 1993. The climatological means (fig. 6) were calculated from data made available by the Bundesamt für Seeschifffahrt und Hydrographie

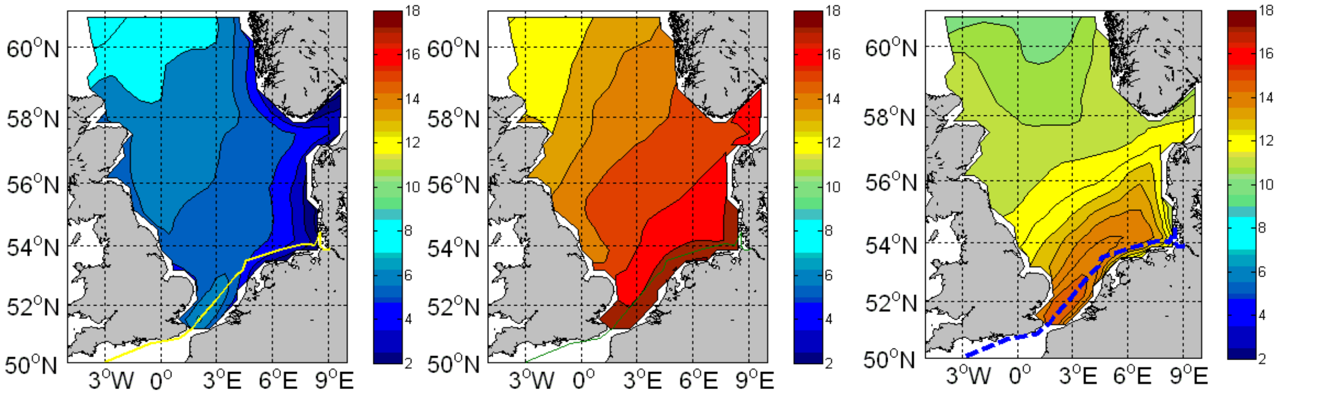


Fig. 6: Climatological monthly mean SST for February, August and October (data source: BSH). Marked colour line: Route of RV POSEIDON during the cruise.

In October, the inflow of warm Atlantic water through the English Channel is evident whereas the German Bight is mainly influenced by atmospheric forcing. The POSEIDON cruise 375 proceeded from the Elbe estuary along the German and Dutch coast to the English Channel. The temperature differs along this way from 12° C to 16° C (Figure 7).

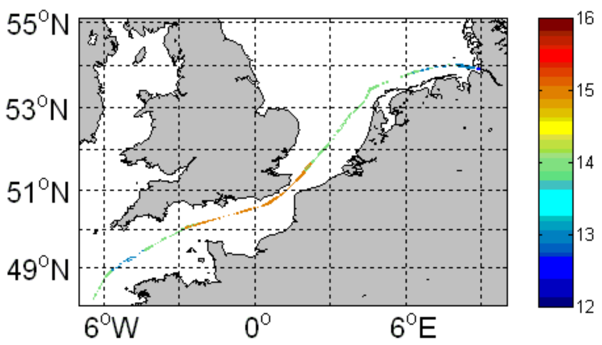


Fig. 7: Hourly Means of SST along the cruise track of RV POSEIDON

A comparison of the measured data with the climatological mean for October shows differences (Figure 8). In the area of the German Bight the POSEIDON SST is approximately 1° C higher than the October mean whereas in the western area it is slightly colder. This increase in SST might confirm the observed trend of the SST in the North Sea of the last decades. But it is not a significant result.

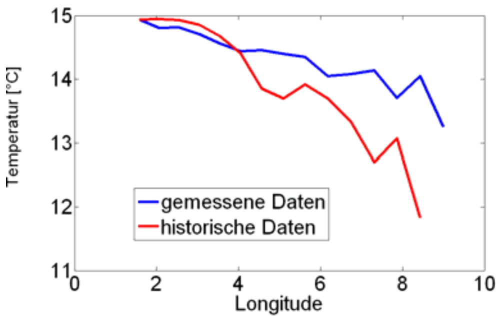


Fig. 8: Hourly mean of SST along the cruise track (blue), climatological mean for October from BSH data set (red)

Fronts in the North Sea

Julia Köhler, Anna Friedrichs

Surface temperature and salinity values (Figure 9) measured by a thermosalinograph have been used to calculate gradients of temperature and salinity and therewith, identify possible fronts in the southern North Sea. The data, sampled every second, has been averaged to 5 minute means.

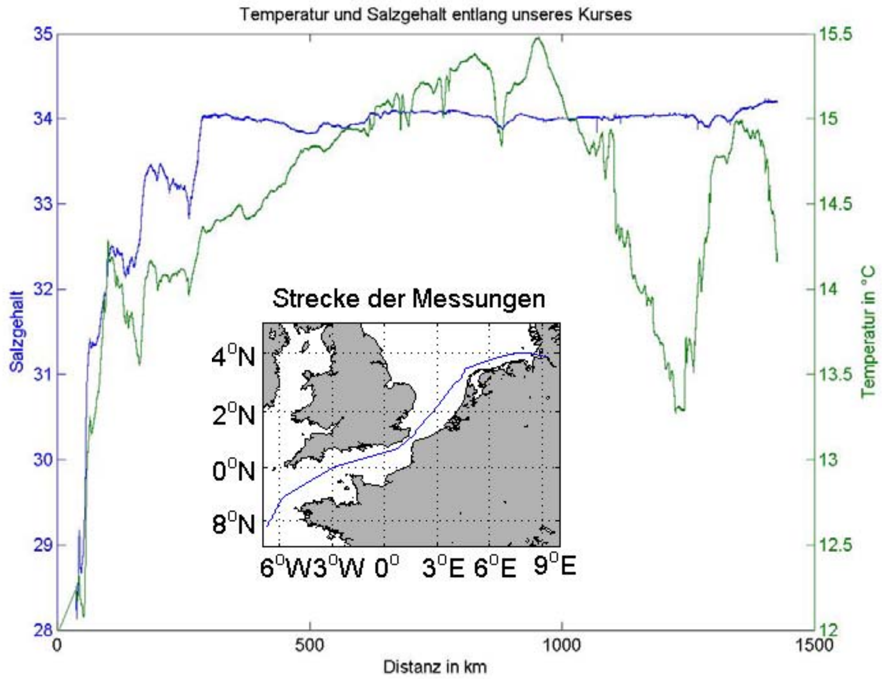


Fig. 9: Temperature (green) and salinity (blue) along the track of POSEIDON cruise 375.

Along the track an increase of temperature from the mouth of the river Elbe to the English Channel from 12.1°C to 15.5° C can be identified. In between temperature decreases caused by freshwater input (Ems, Ijsselmeer, Thames, Rhine, etc.) can bee seen. An increase of salinity is also obvious until the English Channel is reached. Here the salinity is more or less constant until it is again slightly increasing in the Atlantic.

Temperature gradients (fig. 10a) are of the order of 0.16 K/km on the first 220 km and between -0.18 K/km and +0.19 K/km on the last part of the track starting at 1060 km. In between the gradients are small. Also the probability distribution (fig. 10b) shows an accumulation of gradients between -0.025 K/km and +0.025 K/km.

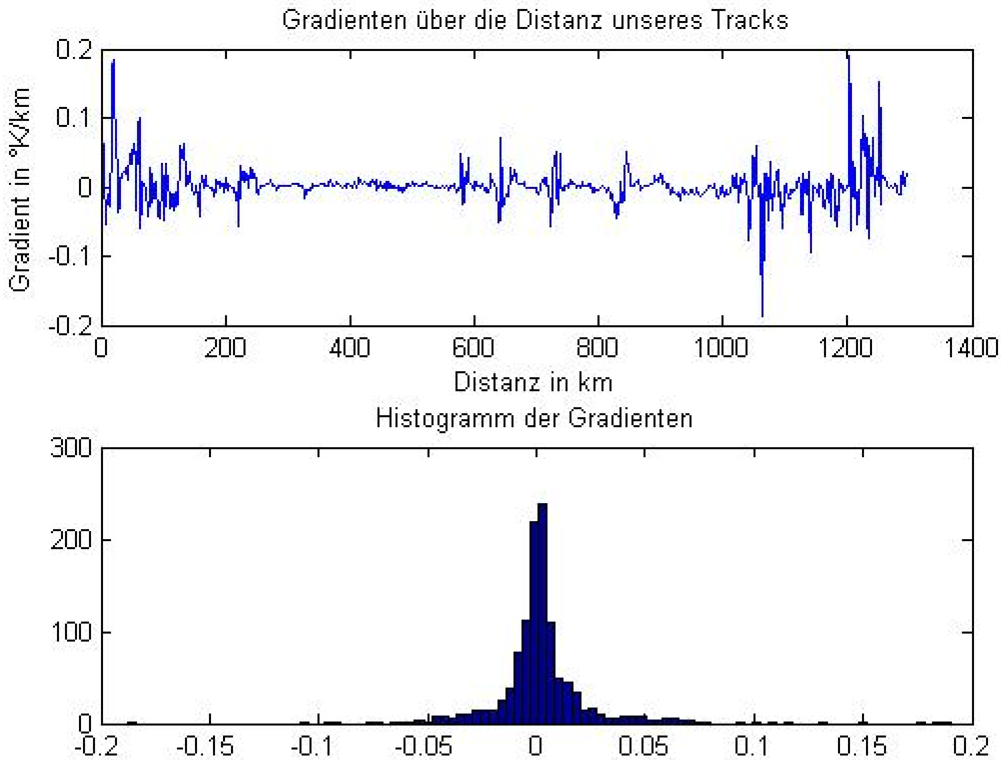


Fig. 10: a) Temperature gradients along the cruise track. b) Probability distribution of the gradients above.

Comparison of near surface lADCP data with calculated currents using the Ekman theory

Gregor Halfmann, Fabian Große

For the calculation of Ekman currents, the meteorological data from the DATAVIS system was used. Information about the absolute wind (direction, amplitude) was extracted every 10 seconds. This information was averaged over the two inertia periods which always start before the beginning of the appropriate lADCP measurement. The result was then used as forcing for the Ekman currents, given by:

$$u(z)=\frac{\sqrt{2}}{\rho_0 fD_E}e^{z/D_E}\left[\tau^x\cos\left(\frac{z\cdot\pi}{D_E}-\frac{\pi}{4}\right)-\tau^y\sin\left(\frac{z\cdot\pi}{D_E}-\frac{\pi}{4}\right)\right] \quad (1.1),$$

$$v(z)=\frac{\sqrt{2}}{\rho_0 fD_E}e^{z/D_E}\left[\tau^x\sin\left(\frac{z\cdot\pi}{D_E}-\frac{\pi}{4}\right)+\tau^y\cos\left(\frac{z\cdot\pi}{D_E}-\frac{\pi}{4}\right)\right] \quad (1.2).$$

where ρ_0 is the density of water (here: mean density of surface layer of the appropriate CTD profile), f the Coriolis parameter, D_E the Ekman depth, x and y the components of the wind stress τ and z the water depth. The Ekman depth was estimated for the particular profile and has a value of about 70 m.

To compare lADCP data with purely wind induced currents (calculated with the formula 1.1 and 1.2), geostrophic currents have to be subtracted from the lADCP data.

Fig. 11: Ekman spiral calculated from theory (left) and observed (right) on station 644.

Figure 11 shows an example from our calculation. North-westerly winds of about 10 m/s had prevailed during the two days before station 644 was occupied and both, the observed and modelled surface current showed a deviation to the right of about 40° T. The observed spiral was not so clear, with the current vectors turning much less than expected. Also at the bottom of the mixed layer, assumed to be 70 m, the observed velocity increased again.

The Mediterranean Undercurrent: Structure (and Mass Transports)

J. Lohse, S. Schoof

The Mediterranean Sea Water (MW) enters the Atlantic through the Strait of Gibraltar into the Gulf of Cadiz and occupies the eastern North Atlantic at depths around 1000m. Basically, the outflowing MW assumes two different forms, one as an eastern boundary slope current, also called the Mediterranean Undercurrent, and one as isolated anticyclonic vortices, which are referred to as Mediterranean Water eddies or meddies (Serra, 2004). Both forms are of fundamental importance for the spreading of MW in the Atlantic. While the meddies transport the characteristics of the MW westward, the Undercurrent runs northward along the Portugese coast.

During our cruise with Poseidon from Oct 18th until Nov 7th we did CTD measurements combined with lADCP measurements in the area of the Gulf of Cadiz and further north near the eastern coast of Portugal. Due to bad weather, we were only able to measure three sections, which are referred to as sections 1 to 3 from north to south in the following text. Section 1 starts at 41°00'N / 9°20'W and ends at 41°00'N / 10°11'W (stations 619-628), section 2 is between 37°40'N / 9°15'W and 37°41'N / 10°46'W (stations 634-646) and section 3 between 36°50'N / 8°09'W and 35°25'N / 11°30'W (stations 647-681).

The aim of this investigation was to detect the Mediterranean Undercurrent in the three sections and calculate its geostrophically balanced velocities. These can then be compared to the velocities measured by the lADCP at each station. If the results of the velocity calculations are reasonable and of sufficient accuracy, it might finally be possible to give an estimate of mass transports in the Undercurrent.

The temperature and salinity anomalies of the Undercurrent can clearly be seen in the particular plots for each section. Near the coast, the MW reaches the ocean bottom, while it occupies depths from 900m up to 1400m further off the coast (Figure 13).

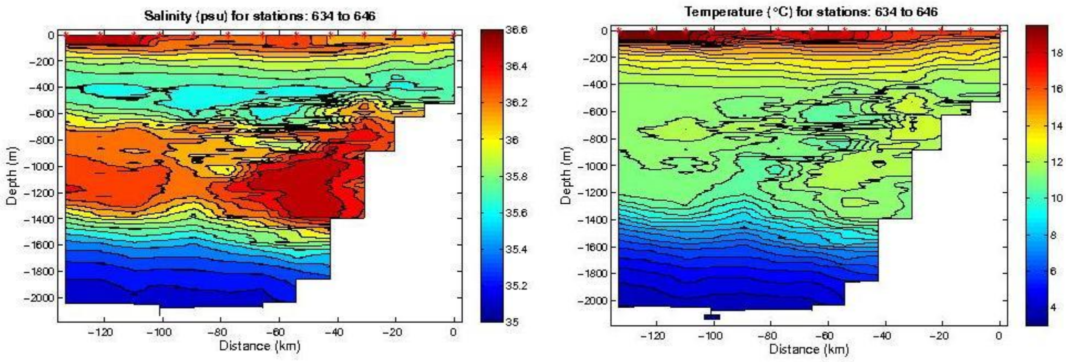


Fig. 13: Salinity and temperature distribution for section 2

The measured CTD data up to the sea surface were extrapolated, assuming a mixed layer at the top and therefore using the temperature and salinity values of the lowest measured pressure value for each pressure value above. Then the geopotential anomalies were calculated for each station and depth, which are necessary for calculating the geostrophically balanced velocity between two different stations relative to the sea surface.

To compare the resulting velocities with the lADCP data, velocity-depth-graphs for each station interval are plotted, showing the depth from surface down to 2100m and the geostrophic velocity together with the lADCP measured velocity. Since the geostrophic velocity is calculated between two stations, the lADCP velocity is averaged over both stations. Two examples are shown in Figure 14.

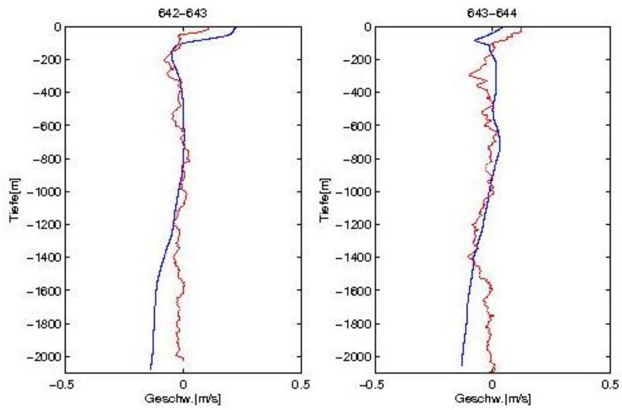


Fig. 14: Geostrophic velocities (blue) between stations compared to averaged lADCP profiles (red). Negative flow is in northward direction. Layer of no motion assumed to be in 500m.

Different choices of the layer of no motion lead to different results. Figure 15 shows the results for section 2 with an assumed layer of no motion in 500m and 2000m respectively

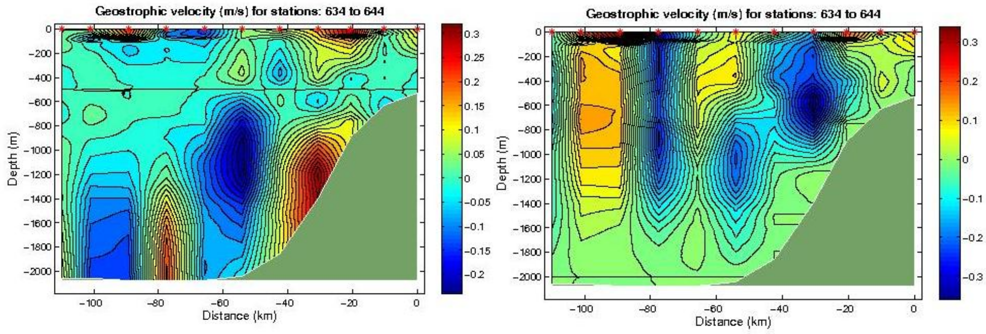


Fig. 15: Geostrophic velocities for section 2 in respect to different layers of no motion at 500 and 2000m. Negative flow is in northward direction

Figure 16 shows the geostrophic velocity in section 3 with the layer of no motion at 500m. A northward flowing undercurrent is at least partly visible between 600 and 1200m in depth and 20 and 45 km in distance.

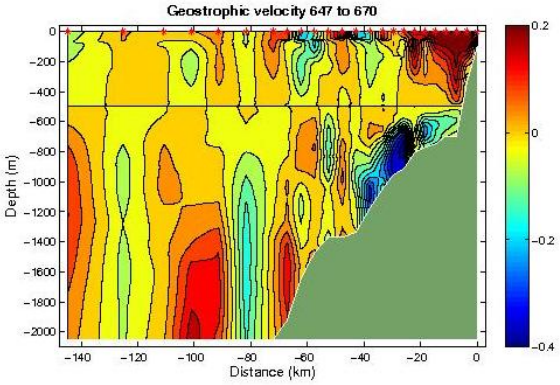


Fig. 16: Geostrophic velocities for section 3 in respect to layer of no motion at 500m. Negative flow is in northward direction

The section of the geostrophically calculated velocities shows strong vertical and horizontal gradients in each part of the section. This might be caused by small-scale internal waves. Although it is possible to identify a northward undercurrent in the data (see blue structures at 600m, 25km and 1100m, 50km), the values do not allow for further reasonable calculations of mass transport yet.

Coastal Upwelling along the west coast of Portugal with reference to chlorophyll concentration

Finn Hartwig, Mareike Held

The data are CTD measurements taken between Oct. 25th, 2008 and Nov. 4th, 2008 on POSEIDON cruise 375. During this period, we measured along three sections, consisting of 10 to 31 stations. In the following, we will refer to stations 619 – 628 as section 1, stations 634-646 as section 2 and stations 647-681 as section 3.

One indicator for recognizing upwelling is phytoplankton. Phytoplankton needs two conditions for a good production: light and nutrients. Since surface water is usually nutrient depleted, there is generally no high biological activity. Upwelling regions are therefore an exception: when water from lower levels, rich on nutrients, upwells close to the coast, both conditions are fulfilled. The phytoplankton finds excellent conditions to prosper. Meteorological data given by the NWS/NCEP Ocean Prediction Center shows the Atlantic surface analysis and states that the wind direction off the west coast changed from west to north three days before the first section and seven days before measurements were taken for the second section. Wind strength is given between first 7-5BFT and later 3-5BFT. Thus, the conditions for finding phytoplankton along the west coast are theoratically given. Measurements verify this suggestion (fig. 17). The profiles of temperature show a warm surface layer (red). Deeper layers are colder (blue). Close to the coast in the east, water from large depth upwells to the surface which can be seen for every section. The effect of upwelling seems to be the largest for the second section. But different aspects have to be considered: a) Because of inertia, the upwelling needs time to develop. In case of the first section the wind blew only for three days from north but for section 2 the northern winds started seven days before the measurements. b) In case of section 3, wind blowing from the north does not have such a large coast parallel component as at the west coast. This reduces the upwelling effect in this region. c) Measurements started not always at the same distance to the coast.

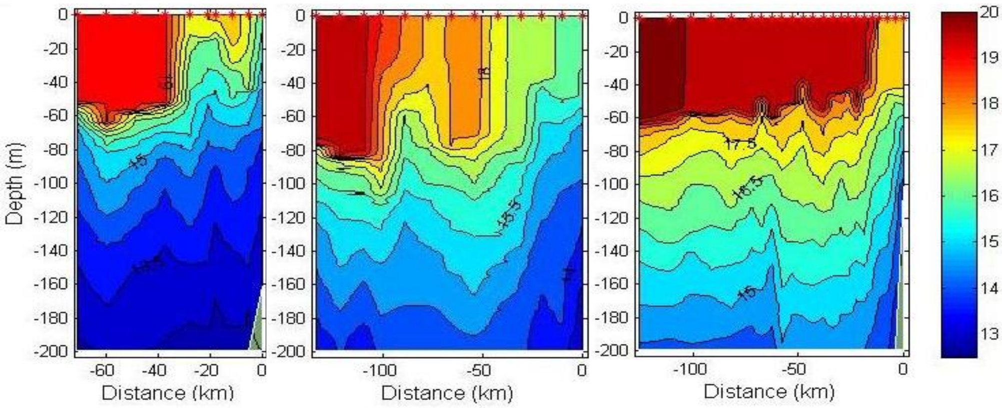


Fig. 17: Temperature distribution (°C) of section 1 (a), section 2 (b) and section 3 (c)

The profiles of fluorescence (Fig. 18) show concentrations mostly at upwelling regions on the east where phytoplankton meets the two essential conditions for biological activity: light and nutrients. This verifies the theory: upwelling provides nutrients in the surface layer. The combination of nutrients and light in the upwelling region is therefore perfect for biological activity. Conspicuous in every profile is a fluorescence maximum underneath the surface layer, which is expected to be poor of nutrients, at a depth between 50 and 70 meters. One possible explanation is that this depth provides enough nutrients as well as enough light for biological activity, whereas above, there is too little nutrients and underneath too little light.

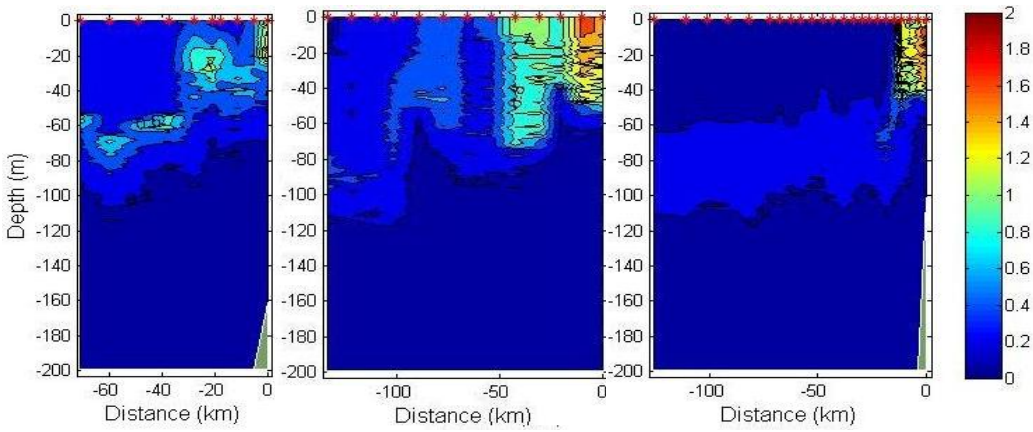


Fig. 18: Fluorescence distribution of section 1 (a), section 2 (b) and section 3 (c)

Transmission, the property of light's permeability, strongly depends on the suspended sediment concentration and phytoplankton. Fluorescence is an indicator for the water's clorophyll concentration and therefore also for the water's phytoplankton concentration.

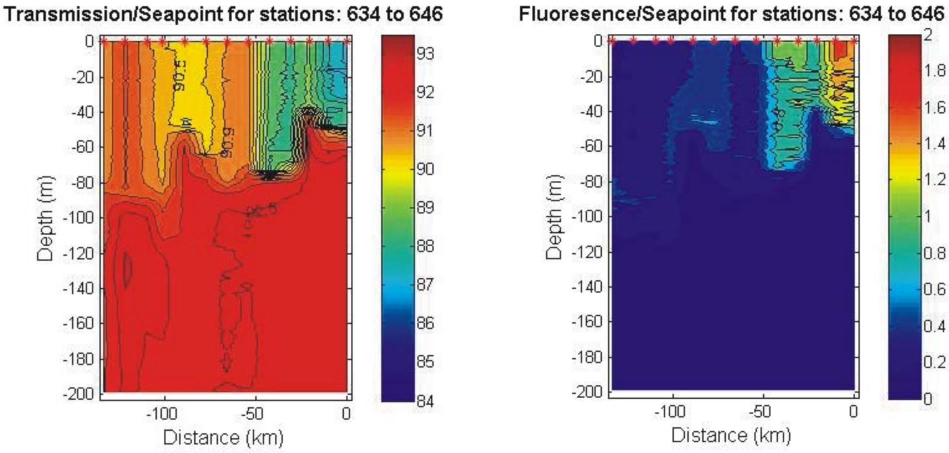


Fig. 19: a) Transmission and b) fluorescence from station 634 to 646

The maxima in fig. 19b) correlate well with the minima in figure 19a). One explanation would be that the transmission strongly depends on the phytoplankton concentration, which absorbs light. Of course, there is always the possibility for more sediments and non-fluorescence plankton that absorb light. Here, this does not seem to be the case. In fig.19b), the maximal fluorescence is located at the same position as the maximum oxygen concentration (fig.20). This could lead to the conclusion that both strongly depend on each other. Nevertheless, the oxygen profile shows more maxima than the fluorescence profile.

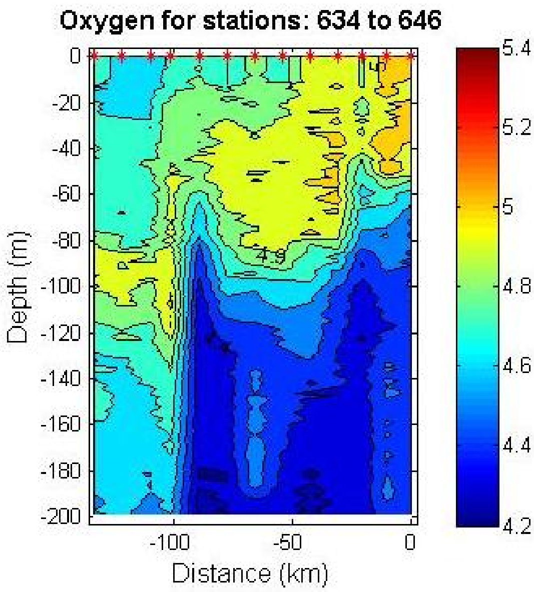


Fig. 20: Oxygen distribution (mg/l) for stations 634 to 646

According to the results, fluorescence is a reliable indicator for coastal upwelling. Transmission, on the contrary, is not as reliable. Although our exploration resulted in good correlation of fluorescence and transmission, the latter depends on too many different factors, such as suspended particles or zooplankton. Oxygen also depends on many factors, e.g. consumption.

Hydrograpy of the Undercurrent along the Portuguese Coast

Born Valentin, Pokorná Markéta

As a deep outflow from the Strait of Gibraltar salty Mediterranean Water flows into the eastern North Atlantic and is deflected as a result of earth rotation to the north, forming a boundary current along the Portuguese coast. Due to topography eddies ("meddies", Mediterranean eddies) are separated irregularly which carry water of the same characteristics as the Mediterranean outflow (warm and salty in comparison to the surrounding water).

The width of a boundary current is depending on the Rossby Radius which again, is depending on latidude (fig. 21). Hence, this leads to a dependency of the width of a boundary current on latitude.

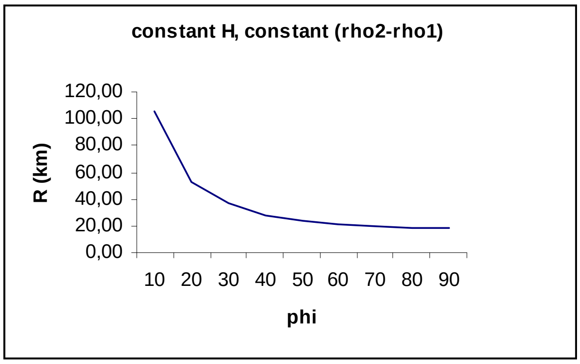


Fig. 21: Dependency of the Rossby Radius on latitude

With the formula for the Rossby Radius:

$$R_0 = \frac{c}{f} = \frac{\sqrt{g' \times h}}{f}$$

with f = Coriolis parameter and g' = reduced gravity

The following for the width of Rossby Radii can be concluded:

Latitude N	rho1 (kg/m³)	rho2 (kg/m³)	H (m)	R (km)
40.0	27.4	26.2	600	28.3
37.6	27.8	27.0	600	24.4
36.5	27.5	26.5	600	27.9

Table 1: Estimate of the Rossby Radius for different latitudes

As the width of a boundary current scales with the Rossby Radius, the boundary current along the Portuguese coast should have a width of approximately 50 km.

On all sections (fig. 22, a – c) a clear signature of the boundary current can be seen.

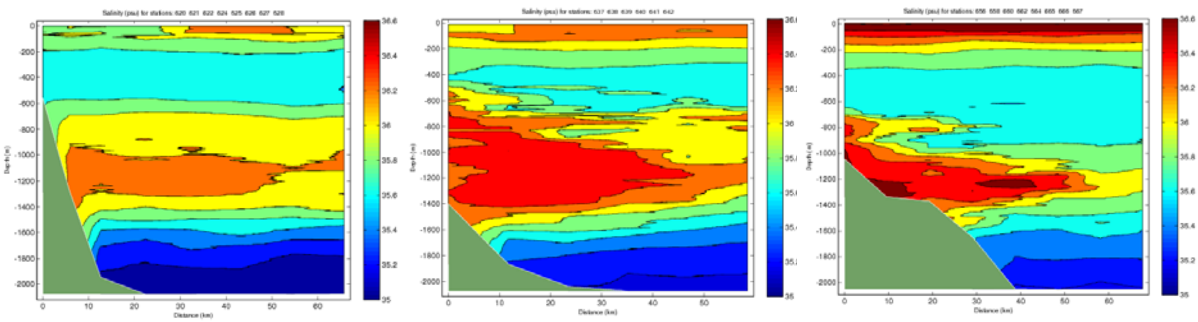


Fig.22: Sections of salinity along the Portuguese coast. a) stations 620-628, b) 637-64 and c) 656 - 667

The extent of the boundary current and its characteristics at the positions of the sections a) – c) (above) are summarized in table 2:

Latitude N	Depth of core (m)	S max (PSU)	rho (kg/m³)	T (°C)	expanse (km^2)
40.0 (a)	1200	36.2	27.6	11	44.8
37.6 (b)	1100	36.5	27.6	11	47.5
36.5 (c)	1200	36.6	27.8	12	28.8

Table 2: Characteristics of the boundary current at section a), b) and c)

Additionally, the mean salinity of the boundary current was calculated by averaging the salinity between the two densities (27.6 – 28.0 kg/m³) which border the current in order to investigate the mixing. It gets obvious (fig. 23) that the mean salinity decreases from south to north and also decreases with increasing distance from the coast.

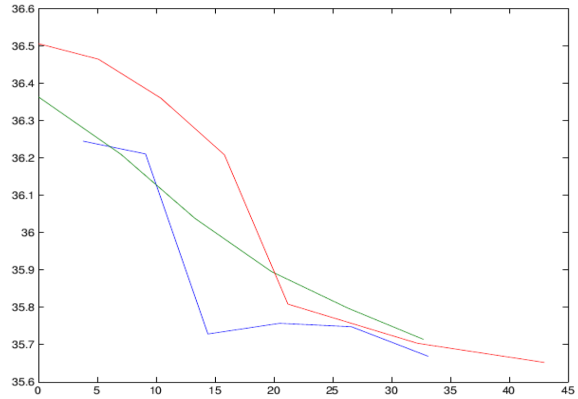


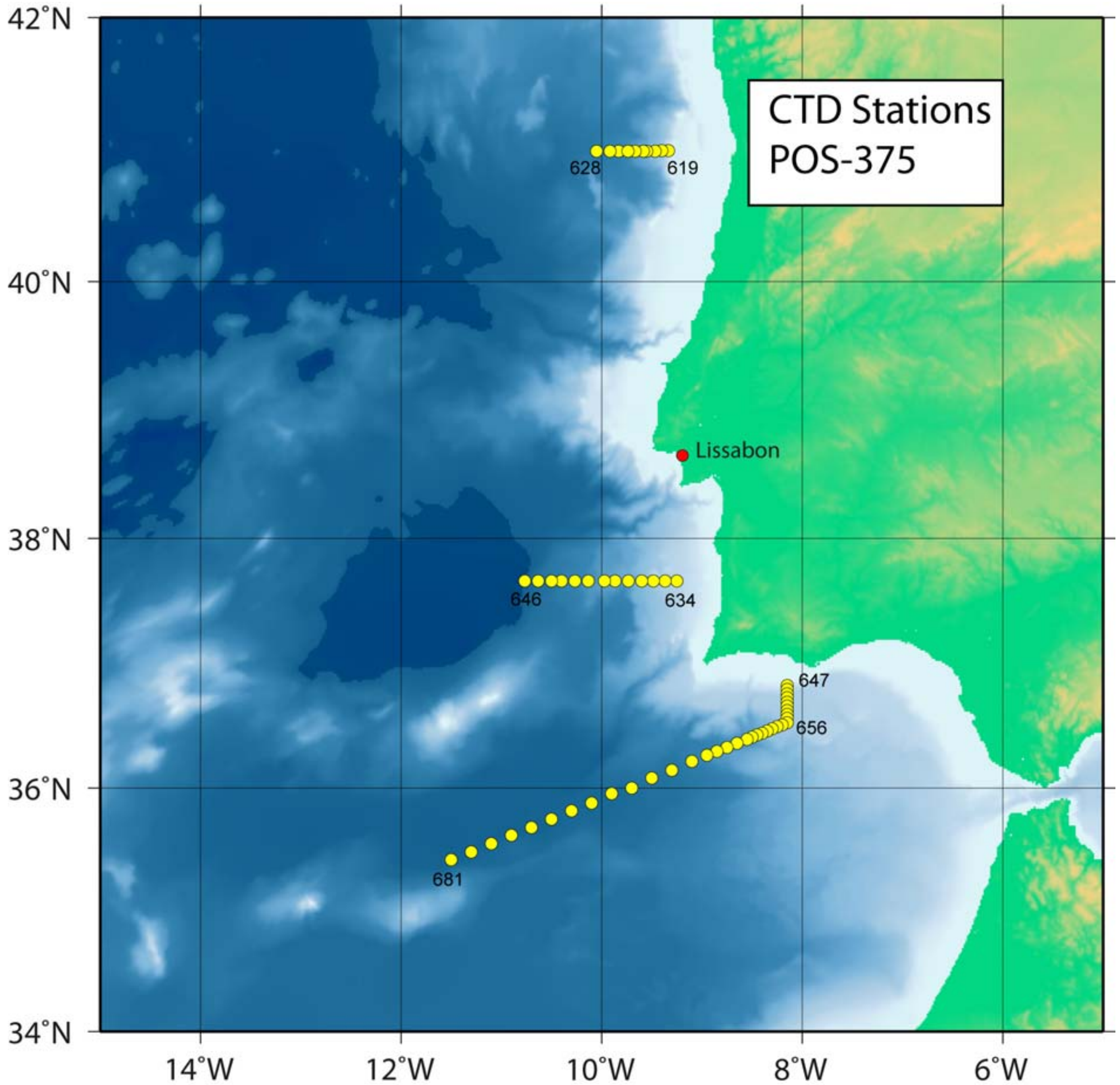
Fig. 23: Mean salinity (psu, y-axis) of the boundary current in dependency from the distance to the 1000 m islonine (nm, x.axis), red: section c), green: section b), blue: section a)

Acknowledgements

We like to thank Captain Michael Schneider and his crew of RV POSEIDON for their support of the measurement programme and for their patience with the students most of whom had been on a research vessel for the first time in their career.

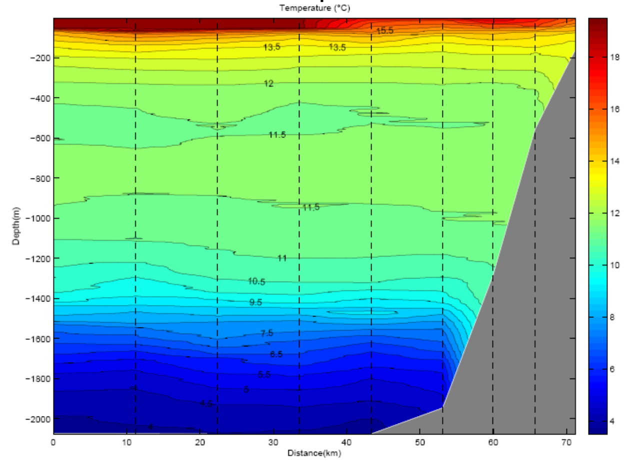
Financial support for the cruise was provided by the University of Hamburg.

Appendix 1a: Location of CTD stations during POSEIDON cruise P375

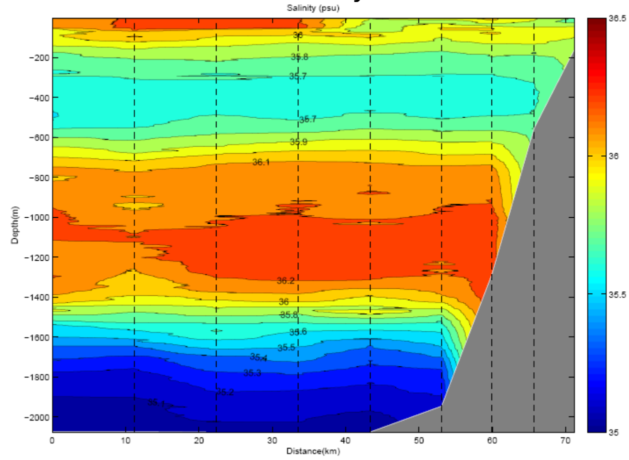


Appendix 1b: Vertical distribution of temperature, salinity, dissolved oxygen and density at the northern section

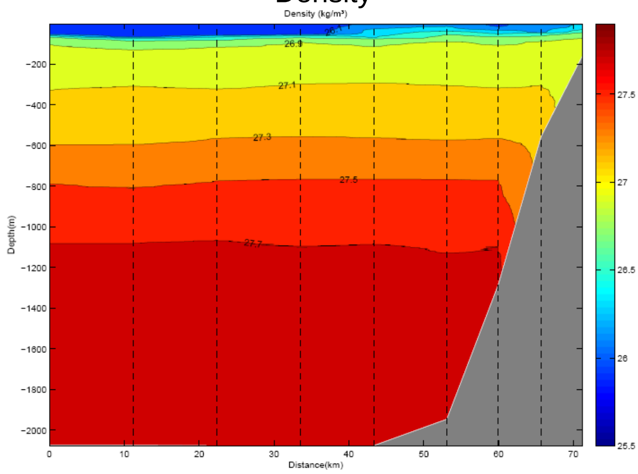
Pot. temperature



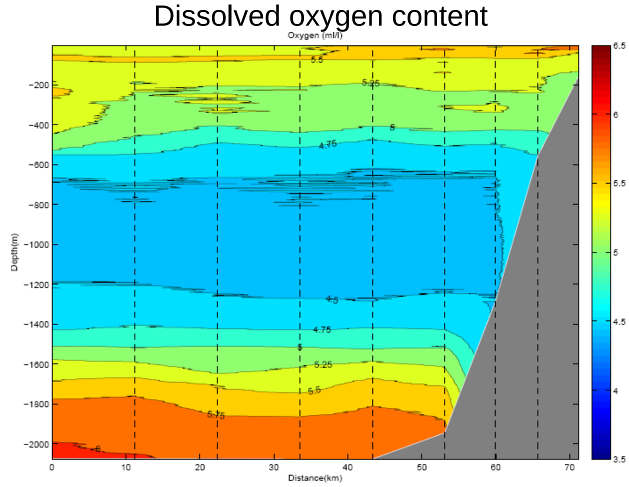
Salinity



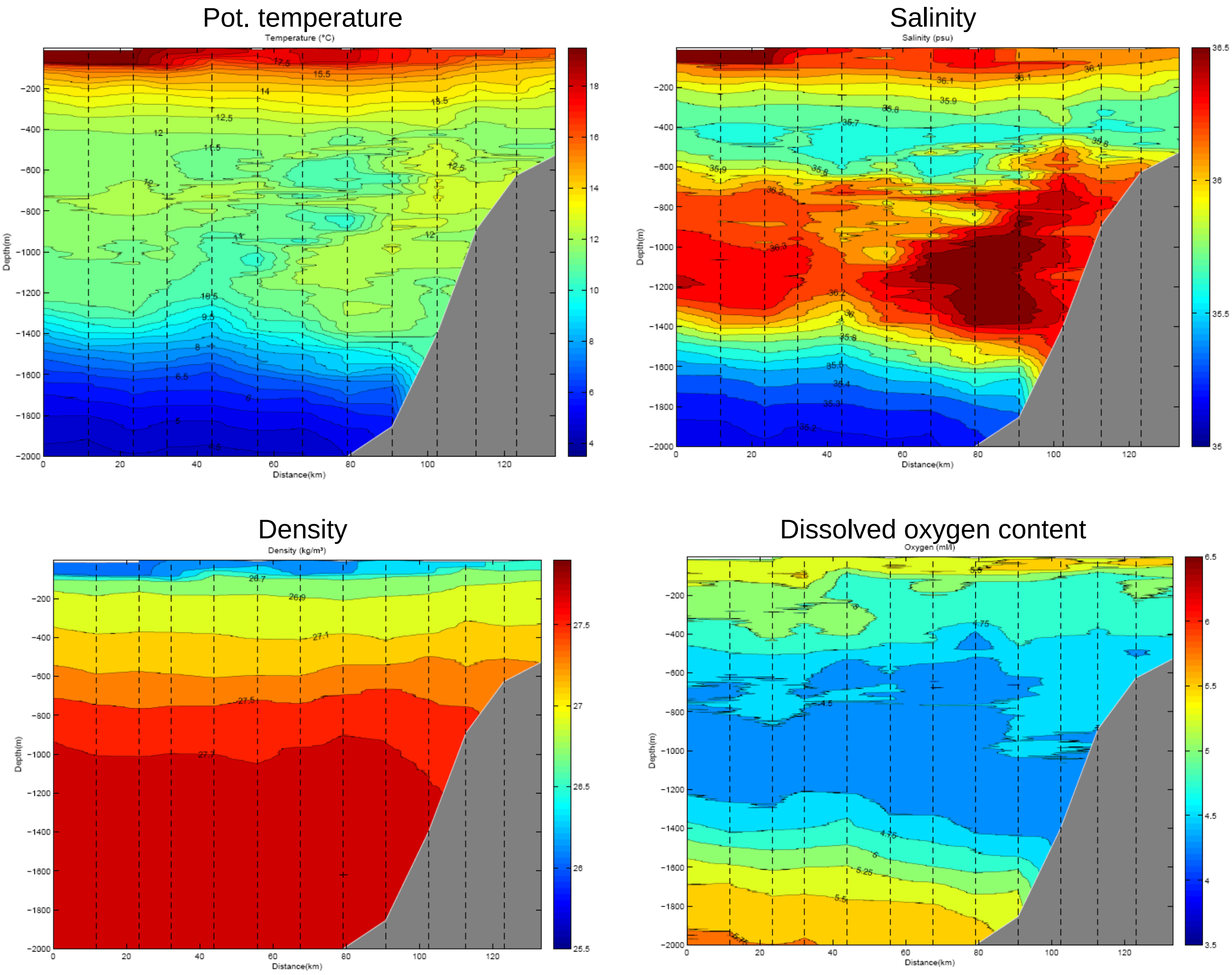
Density



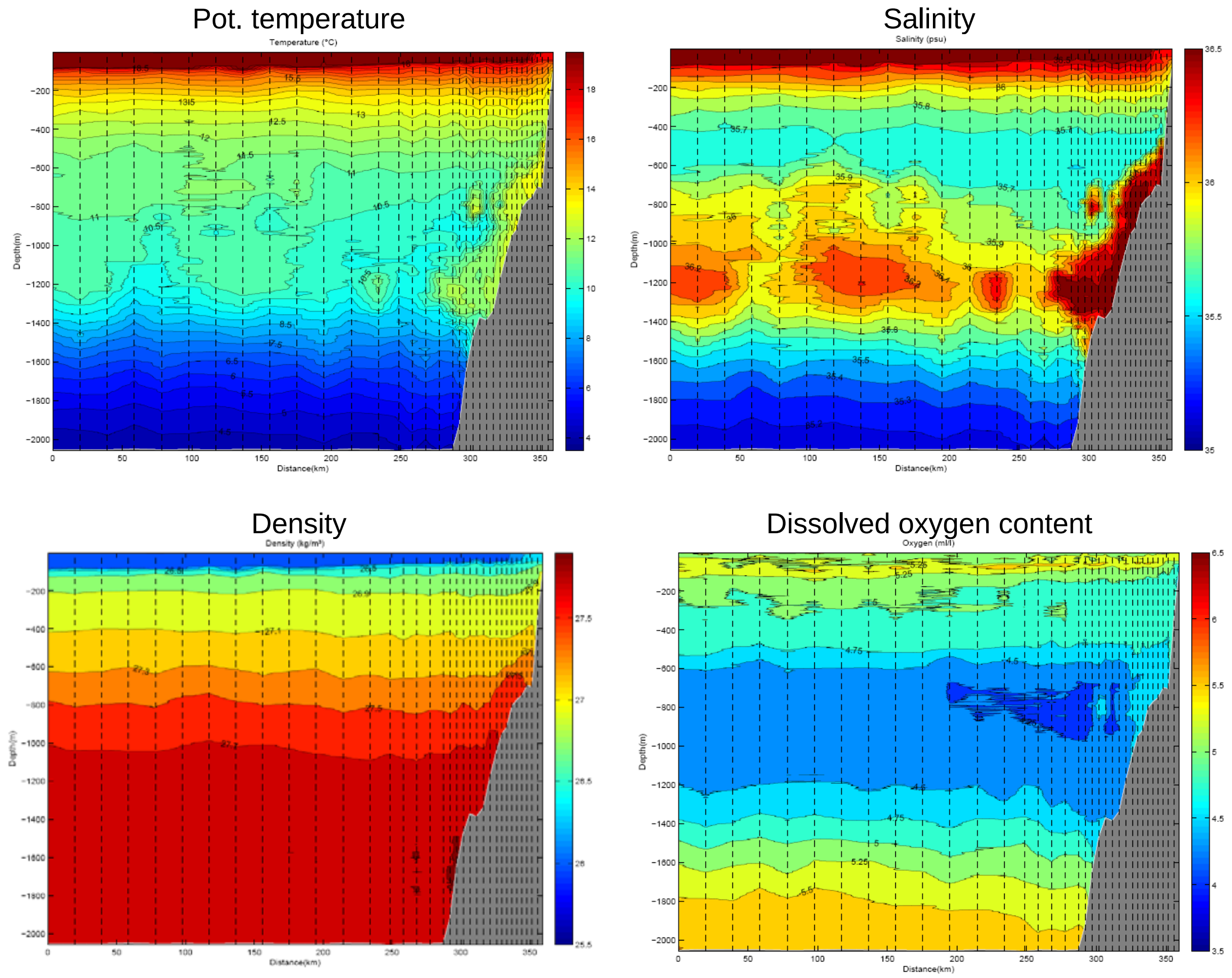
Dissolved oxygen content



Appendix 1c: Vertical distribution of temperature, salinity, dissolved oxygen and density at the central section



Appendix 1d: Vertical distribution of temperature, salinity, dissolved oxygen and density at the southern section



Appendix 2: List of stations P375

Stat No.	Date	Time (UTC)	Latitude	Longitude	Depth (m)	Type
587	24.10.2008	03:13	47° 28,51' N	006° 57,52' W	836,0	XBT
588	24.10.2008	03:36	47° 26,07' N	006° 59,45' W	n. a.	XBT
589	24.10.2008	03:41	47° 25,61' N	006° 59,81' W	n. a.	XBT
590	24.10.2008	04:29	47° 20,78' N	007° 03,60' W	n. a.	XBT
591	24.10.2008	04:34	47° 20,30' N	007° 03,97' W	n. a.	XBT
592	24.10.2008	04:39	47° 19,78' N	007° 04,38' W	n. a.	XBT
593	24.10.2008	05:27	47° 15,20' N	007° 07,95' W	n. a.	XBT
594	24.10.2008	05:32	47° 14,77' N	007° 08,28' W	n. a.	XBT
595	24.10.2008	05:36	47° 14,35' N	007° 08,61' W	n. a.	XBT
596	24.10.2008	06:28	47° 08,55' N	007° 13,15' W	n. a.	XBT
597	24.10.2008	07:34	47° 00,13' N	007° 19,70' W	n. a.	XBT
598	24.10.2008	08:34	46° 52,75' N	007° 25,42' W	4454,0	XBT
599	24.10.2008	10:28	46° 38,39' N	007° 36,55' W	4591,0	XBT
600	24.10.2008	12:33	46° 22,52' N	007° 48,78' W	4591,0	XBT
601	24.10.2008	14:30	46° 12,18' N	007° 56,74' W	4740,0	XBT
602	24.10.2008	16:24	46° 02,87' N	008° 03,83' W	4774,0	XBT
603	24.10.2008	18:30	46° 46,71' N	008° 16,13' W	n. a.	XBT
604	24.10.2008	20:35	45° 29,91' N	008° 28,86' W	n. a.	XBT
605	24.10.2008	22:32	45° 13,99' N	008° 40,89' W	n. a.	XBT
606	25.10.2008	00:30	44° 58,92' N	008° 52,20' W	n. a.	XBT
607	25.10.2008	01:31	44° 51,05' N	008° 58,09' W	n. a.	XBT
608	25.10.2008	02:29	44° 43,58' N	009° 03,66' W	n. a.	XBT
609	25.10.2008	03:30	44° 35,75' N	009° 09,52' W	n. a.	XBT
610	25.10.2008	04:24	44° 28,57' N	009° 14,86' W	n. a.	XBT
611	25.10.2008	05:25	44° 20,78' N	009° 20,64' W	n. a.	XBT
612	25.10.2008	06:26	44° 12,95' N	009° 26,43' W	n. a.	XBT
613	25.10.2008	07:35	44° 04,18' N	009° 32,92' W	n. a.	XBT
614	25.10.2008	08:30	43° 56,88' N	009° 38,32' W	n. a.	XBT
615	25.10.2008	09:48	43° 46,69' N	009° 45,84' W	n. a.	XBT
616	25.10.2008	10:30	43° 41,17' N	009° 49,84' W	n. a.	XBT
617	25.10.2008	11:26	43° 34,03' N	009° 55,07' W	n. a.	XBT
618	25.10.2008	12:27	43° 25,95' N	010° 00,97' W	n. a.	XBT
619	26.10.2008	07:40	41° 00,09' N	009° 20,08' W	159,0	CTD/Ro to water
		07:51	41° 00,12' N	009° 20,07' W	158,0	Heave CTD/Ro
		07:56	41° 00,12' N	009° 20,07' W	159,0	CTD/Ro on deck
619-2	26.10.2008	07:57	41° 00,13' N	009° 20,07' W	158,0	CTD/Ro to water
		08:05	41° 00,21' N	009° 20,07' W	160,0	Heave CTD/Ro
		08:10	41° 00,15' N	009° 20,07' W	158,0	CTD/Ro on deck
620	26.10.2008	08:46	41° 00,03' N	009° 24,00' W	545,0	CTD/Ro to water
		09:21	41° 00,04' N	009° 23,91' W	535,0	Heave CTD/Ro
		09:33	41° 00,05' N	009° 23,89' W	545,0	CTD/Ro on deck
621	26.10.2008	10:09	40° 59,96' N	009° 28,11' W	1254,0	CTD/Ro to water
		10:48	41° 00,01' N	009° 28,52' W	1271,0	Heave CTD/Ro
		11:23	41° 00,06' N	009° 29,34' W	1288,0	CTD/Ro on deck
622	26.10.2008	12:06	40° 59,96' N	009° 33,01' W	1943,0	CTD/Ro to water
		12:45	40° 59,97' N	009° 33,05' W	1949,0	Heave CTD/Ro
		13:25	40° 59,96' N	009° 33,07' W	1949,0	CTD/Ro on deck
623	26.10.2008	13:59	40° 59,97' N	009° 35,02' W	2087,0	CTD/Ro to water
		14:21	40° 59,96' N	009° 34,99' W	2086,0	Heave CTD/Ro
		14:37	40° 59,97' N	009° 35,00' W	2084,0	CTD/Ro on deck
624	26.10.2008	15:25	40° 59,97' N	009° 40,00' W	2295,0	CTD/Ro to water
		16:05	40° 59,94' N	009° 40,00' W	2301,0	Heave CTD/Ro
		16:46	40° 59,94' N	009° 40,00' W	2299,0	CTD/Ro on deck

625	26.10.2008	17:43	40° 59,97' N	009° 47,01' W	2809,0	CTD/Ro to water
		18:20	40° 59,98' N	009° 46,99' W	2810,0	Heave CTD/Ro
		19:02	41° 00,01' N	009° 46,96' W	2810,0	CTD/Ro on deck
626	26.10.2008	20:04	40° 59,94' N	009° 55,01' W	3384,0	CTD/Ro to water
		20:46	41° 00,00' N	009° 54,98' W	3404,0	Heave CTD/Ro
		21:33	41° 00,01' N	009° 55,00' W	3404,0	CTD/Ro on deck
627	26.10.2008	22:56	40° 59,96' N	010° 02,99' W	n. a.	CTD/Ro to water
		23:37	41° 00,08' N	010° 02,87' W	n. a.	Heave CTD/Ro
	27.10.2008	00:25	41° 00,14' N	010° 02,71' W	n. a.	CTD/Ro on deck
628	27.10.2008	01:38	40° 59,99' N	010° 10,97' W	n. a.	CTD/Ro to water
		02:15	41° 00,02' N	010° 10,94' W	n. a.	Heave CTD/Ro
		02:53	41° 00,04' N	010° 10,99' W	n. a.	CTD/Ro on deck
629	27.10.2008	05:00	40° 44,07' N	010° 10,52' W	n. a.	XBT
630	27.10.2008	07:00	40° 26,27' N	010° 10,00' W	n. a.	XBT
631	27.10.2008	09:06	40° 11,83' N	010° 09,57' W	n. a.	XBT
632	27.10.2008	11:00	39° 57,20' N	010° 09,15' W	n. a.	XBT
633	27.10.2008	13:02	39° 41,05' N	010° 08,67' W	n. a.	XBT
634	29.10.2008	17:14	37° 39,97' N	009° 15,09' W	528,0	CTD/Ro to water
		17:31	37° 39,95' N	009° 15,10' W	527,0	Heave CTD/Ro
		17:45	37° 39,99' N	009° 15,14' W	529,0	CTD/Ro on deck
635	29.10.2008	19:05	37° 39,97' N	009° 22,01' W	624,0	CTD/Ro to water
		19:24	37° 39,92' N	009° 21,99' W	625,0	Heave CTD/Ro
		19:40	37° 39,91' N	009° 21,94' W	624,0	CTD/Ro on deck
636	29.10.2008	20:48	37° 39,95' N	009° 29,08' W	872,0	CTD/Ro to water
		21:11	37° 39,98' N	009° 29,07' W	884,0	Heave CTD/Ro
		21:39	37° 39,99' N	009° 28,95' W	860,0	CTD/Ro on deck
637	29.10.2008	22:54	37° 39,99' N	009° 36,04' W	1395,0	CTD/Ro to water
		23:29	37° 40,13' N	009° 35,99' W	1406,0	Heave CTD/Ro
	30.10.2008	00:06	37° 40,38' N	009° 35,70' W	1364,0	CTD/Ro on deck
638	30.10.2008	01:24	37° 39,99' N	009° 44,01' W	n. a.	CTD/Ro to water
		02:12	37° 40,02' N	009° 43,99' W	n. a.	Heave CTD/Ro
		02:48	37° 40,06' N	009° 44,00' W	n. a.	CTD/Ro on deck
639	30.10.2008	04:05	37° 40,02' N	009° 51,99' W	2026,0	CTD/Ro to water
		04:44	37° 40,16' N	009° 52,08' W	2035,0	Heave CTD/Ro
		05:31	37° 40,27' N	009° 52,17' W	2046,0	CTD/Ro on deck
640	30.10.2008	06:36	37° 39,96' N	009° 59,99' W	2512,0	CTD/Ro to water
		07:20	37° 39,98' N	009° 59,94' W	2512,0	Heave CTD/Ro
		08:05	37° 40,05' N	010° 59,96' W	2490,0	CTD/Ro on deck
641	30.10.2008	09:16	37° 39,97' N	010° 07,95' W	2822,0	CTD/Ro to water
		09:58	37° 40,02' N	010° 07,92' W	n. a.	Heave CTD/Ro
		10:49	37° 40,06' N	010° 07,93' W	n. a.	CTD/Ro on deck
642	30.10.2008	12:16	37° 39,98' N	010° 15,98' W	n. a.	CTD/Ro to water
		12:58	37° 40,00' N	010° 19,97' W	n. a.	Heave CTD/Ro
		13:48	37° 40,03' N	010° 15,88' W	n. a.	CTD/Ro on deck
643	30.10.2008	15:20	37° 39,99' N	010° 23,98' W	n. a.	CTD/Ro to water
		16:04	37° 40,00' N	010° 23,90' W	n. a.	Heave CTD/Ro
		16:49	37° 40,05' N	010° 23,93' W	n. a.	CTD/Ro on deck
644	30.10.2008	17:54	37° 39,96' N	010° 29,98' W	n. a.	CTD/Ro to water
		18:50	37° 40,12' N	010° 30,13' W	n. a.	Heave CTD/Ro
		19:24	37° 40,23' N	010° 30,35' W	n. a.	CTD/Ro on deck
645	31.10.2008	07:00	37° 40,01' N	010° 37,97' W	n. a.	CTD/Ro to water
		08:12	37° 40,17' N	010° 38,01' W	n. a.	Heave CTD/Ro
		09:05	37° 40,56' N	010° 38,00' W	n. a.	CTD/Ro on deck
646	31.10.2008	12:13	37° 40,12' N	010° 45,94' W	n. a.	CTD/Ro to water
		12:57	37° 40,64' N	010° 45,90' W	n. a.	Heave CTD/Ro
		13:42	37° 41,16' N	010° 45,90' W	n. a.	CTD/Ro on deck
647	01.11.2008	09:22	36° 50,00' N	008° 09,01' W	101,0	CTD/Ro to water
		09:30	36° 49,99' N	008° 09,03' W	103,0	Heave CTD/Ro
		09:40	36° 50,00' N	008° 09,03' W	102,0	CTD/Ro on deck

648	01.11.2008	10:04	36° 48,02' N	008° 08,98' W	339,0	CTD/Ro to water
		10:17	36° 48,00' N	008° 09,04' W	342,0	Heave CTD/Ro
		10:26	36° 48,01' N	008° 09,08' W	344,0	CTD/Ro on deck
649	01.11.2008	10:51	36° 45,98' N	008° 08,96' W	700,0	CTD/Ro to water
		11:10	36° 46,00' N	008° 08,99' W	700,0	Heave CTD/Ro
		11:26	36° 46,01' N	008° 09,00' W	685,0	CTD/Ro on deck
650	01.11.2008	11:53	36° 43,97' N	008° 08,97' W	692,0	CTD/Ro to water
		12:18	36° 43,96' N	008° 08,90' W	692,0	Heave CTD/Ro
		12:34	36° 43,99' N	008° 09,10' W	691,0	CTD/Ro on deck
651	01.11.2008	13:11	36° 42,00' N	008° 09,00' W	743,0	CTD/Ro to water
		13:28	36° 41,99' N	008° 09,01' W	743,0	Heave CTD/Ro
		13:49	36° 42,02' N	008° 08,99' W	743,0	CTD/Ro on deck
652	01.11.2008	14:20	36° 39,98' N	008° 08,99' W	764,0	CTD/Ro to water
		14:41	36° 39,96' N	008° 08,98' W	765,0	Heave CTD/Ro
		14:59	36° 39,98' N	008° 08,99' W	765,0	CTD/Ro on deck
653	01.11.2008	15:30	36° 38,01' N	008° 08,99' W	800,0	CTD/Ro to water
		15:51	36° 38,07' N	008° 09,04' W	796,0	Heave CTD/Ro
		16:09	36° 38,11' N	008° 09,09' W	794,0	CTD/Ro on deck
654	01.11.2008	16:42	36° 35,98' N	008° 08,94' W	907,0	CTD/Ro to water
		17:05	36° 35,99' N	008° 08,97' W	904,0	Heave CTD/Ro
		17:21	36° 35,96' N	008° 08,97' W	907,0	CTD/Ro on deck
655	01.11.2008	17:50	36° 34,02' N	008° 09,00' W	944,0	CTD/Ro to water
		18:14	36° 33,96' N	008° 09,01' W	945,0	Heave CTD/Ro
		18:31	36° 33,98' N	008° 09,06' W	945,0	CTD/Ro on deck
656	01.11.2008	19:04	36° 31,99' N	008° 08,99' W	1034,0	CTD/Ro to water
		19:31	36° 32,04' N	008° 09,06' W	1035,0	Heave CTD/Ro
		19:50	36° 32,01' N	008° 09,09' W	1037,0	CTD/Ro on deck
657	01.11.2008	20:27	36° 30,99' N	008° 11,92' W	1162,0	CTD/Ro to water
		20:51	36° 30,97' N	008° 11,94' W	1164,0	Heave CTD/Ro
		21:20	36° 30,97' N	008° 12,00' W	1166,0	CTD/Ro on deck
658	01.11.2008	21:56	36° 29,98' N	008° 14,92' W	1322,0	CTD/Ro to water
		22:24	36° 29,99' N	008° 14,97' W	1324,0	Heave CTD/Ro
		22:51	36° 30,01' N	008° 14,97' W	1323,0	CTD/Ro on deck
659	01.11.2008	23:22	36° 28,98' N	008° 17,96' W	1366,0	CTD/Ro to water
		23:50	36° 29,00' N	008° 17,95' W	1369,0	Heave CTD/Ro
	02.11.2008	00:21	36° 29,03' N	008° 17,92' W	1371,0	CTD/Ro on deck
660	02.11.2008	01:00	36° 28,00' N	008° 20,98' W	1376,0	CTD/Ro to water
		01:31	36° 28,03' N	008° 20,93' W	1385,0	Heave CTD/Ro
		01:58	36° 28,02' N	008° 20,94' W	1380,0	CTD/Ro on deck
661	02.11.2008	02:39	36° 26,97' N	008° 24,02' W	1511,0	CTD/Ro to water
		03:10	36° 26,96' N	008° 24,05' W	1517,0	Heave CTD/Ro
		03:37	36° 27,00' N	008° 24,06' W	1509,0	CTD/Ro on deck
662	02.11.2008	04:17	36° 26,02' N	008° 27,04' W	n. a.	CTD/Ro to water
		04:51	36° 26,06' N	008° 27,07' W	1652,0	Heave CTD/Ro
		05:26	36° 26,13' N	008° 27,04' W	1632,0	CTD/Ro on deck
663	02.11.2008	06:02	36° 24,99' N	008° 30,02' W	1936,0	CTD/Ro to water
		06:39	36° 25,03' N	008° 30,01' W	1923,0	Heave CTD/Ro
		07:13	36° 25,04' N	008° 30,03' W	1942,0	CTD/Ro on deck
664	02.11.2008	07:45	36° 24,01' N	008° 33,05' W	2467,0	CTD/Ro to water
		08:31	36° 24,11' N	008° 33,03' W	2457,0	Heave CTD/Ro
		09:10	36° 24,18' N	008° 32,98' W	2360,0	CTD/Ro on deck
665	02.11.2008	10:10	36° 21,95' N	008° 39,02' W	2724,0	CTD/Ro to water
		10:49	36° 22,03' N	008° 38,99' W	2723,0	Heave CTD/Ro
		11:29	36° 22,02' N	008° 38,99' W	2721,0	CTD/Ro on deck
666	02.11.2008	12:27	36° 19,99' N	008° 45,03' W	2883,0	CTD/Ro to water
		13:08	36° 19,97' N	008° 44,97' W	2882,0	Heave CTD/Ro
		13:44	36° 19,95' N	008° 44,99' W	n. a.	CTD/Ro on deck
667	02.11.2008	14:44	36° 18,00' N	008° 50,97' W	n. a.	CTD/Ro to water
		15:28	36° 18,00' N	008° 50,97' W	n. a.	Heave CTD/Ro
		16:02	36° 18,02' N	008° 50,89' W	3011,0	CTD/Ro on deck
668	02.11.2008	17:00	36° 15,96' N	008° 57,03' W	n. a.	CTD/Ro to water

		17:41	36° 16,02' N	008° 57,02' W	n. a.	Heave CTD/Ro
		18:16	36° 16,00' N	008° 57,04' W	n. a.	CTD/Ro on deck
669	02.11.2008	19:35	36° 13,01' N	009° 06,01' W	3361,0	CTD/Ro to water
		20:16	36° 13,02' N	009° 05,95' W	3385,0	Heave CTD/Ro
		20:56	36° 13,04' N	009° 05,86' W	3385,0	CTD/Ro on deck
670	02.11.2008	22:33	36° 08,93' N	009° 17,98' W	4006,0	CTD/Ro to water
		23:11	36° 09,00' N	009° 17,99' W	4039,0	Heave CTD/Ro
		23:46	36° 09,00' N	009° 17,99' W	4104,0	CTD/Ro on deck
671	03.11.2008	01:25	36° 04,97' N	009° 30,06' W	4057,0	CTD/Ro to water
		02:10	36° 04,97' N	009° 30,17' W	4056,0	Heave CTD/Ro
		02:52	36° 05,03' N	009° 30,12' W	4058,0	CTD/Ro on deck
672	03.11.2008	04:25	36° 00,98' N	009° 42,02' W	n. a.	CTD/Ro to water
		05:08	36° 01,03' N	009° 42,02' W	n. a.	Heave CTD/Ro
		05:46	36° 01,06' N	009° 42,03' W	n. a.	CTD/Ro on deck
673	03.11.2008	07:24	35° 57,00' N	009° 54,00' W	n. a.	CTD/Ro to water
		08:03	35° 57,02' N	009° 54,00' W	n. a.	Heave CTD/Ro
		08:45	35° 57,09' N	009° 53,95' W	n. a.	CTD/Ro on deck
674	03.11.2008	10:24	35° 52,94' N	010° 06,01' W	n. a.	CTD/Ro to water
		11:03	35° 53,06' N	010° 05,80' W	n. a.	Heave CTD/Ro
		11:33	35° 53,10' N	010° 05,71' W	n. a.	CTD/Ro on deck
675	03.11.2008	13:10	35° 48,99' N	010° 17,98' W	n. a.	CTD/Ro to water
		13:49	35° 49,01' N	010° 17,96' W	n. a.	Heave CTD/Ro
		14:29	35° 49,03' N	010° 17,97' W	n. a.	CTD/Ro on deck
676	03.11.2008	16:18	35° 44,99' N	010° 29,98' W	n. a.	CTD/Ro to water
		17:00	35° 45,01' N	010° 29,93' W	4804,0	Heave CTD/Ro
		17:50	35° 45,02' N	010° 29,94' W	n. a.	CTD/Ro on deck
677	03.11.2008	19:27	35° 41,00' N	010° 42,01' W	n. a.	CTD/Ro to water
		20:05	35° 41,03' N	010° 41,93' W	4909,0	Heave CTD/Ro
		20:49	35° 41,02' N	010° 41,89' W	n. a.	CTD/Ro on deck
678	03.11.2008	22:28	35° 36,95' N	010° 53,97' W	4908,0	CTD/Ro to water
		23:07	35° 36,99' N	010° 53,93' W	4912,0	Heave CTD/Ro
		23:52	35° 37,04' N	010° 53,91' W	4915,0	CTD/Ro on deck
679	04.11.2008	01:40	35° 33,00' N	011° 05,99' W	4816,0	CTD/Ro to water
		02:22	35° 33,00' N	011° 05,93' W	4816,0	Heave CTD/Ro
		03:01	35° 33,02' N	011° 05,84' W	4816,0	CTD/Ro on deck
680	04.11.2008	05:06	35° 29,00' N	011° 17,95' W	4821,0	CTD/Ro to water
		05:46	35° 29,00' N	011° 17,89' W	4821,0	Heave CTD/Ro
		06:18	35° 29,05' N	011° 17,78' W	n. a.	CTD/Ro on deck
681	04.11.2008	08:05	35° 25,00' N	011° 29,99' W	4818,0	CTD/Ro to water
		08:42	35° 25,11' N	011° 29,98' W	n. a.	Heave CTD/Ro
		9:24	35° 25,35' N	011° 29,80' W	n. a.	CTD/Ro on deck