Institut für Meereskunde
an der Universität Kiel

30.07.1999

Cruise Report

Compiled by: Thomas J. Müller, B. Lenz

F.S.Poseidon **Cruise No.: 247**

Dates of Cruise: 06.01.1999 - 11.02.1999

Areas of Research: Physical, chemical and biological oceanography; bio-geochemical fluxes

Port Calls:	Pta. Delgada, Azores/Portugal	15.01.1999 -16.01.1999
	Las Palmas de Gran Canaria/Spain	28.01.1999 - 31.01.1999
	Arrecife de Lanzarote/Spain	03.02.1999
	Las Palmas de Gran Canaria/Spain	11.02.1999 - 15.02.1999

IFMK Department: Marine Physics

Chief Scientist: Dr. Thomas J. Müller

Number of Scientists: 10

Projects: EU MAST III Regional Seas Project CANIGO, MAS3-CT96-0060
KIEL276 mooring service
JGOFS time series station ESTOC (Spanish - German co-operation)

Cruise Report

This cruise report consists of 20 pages including cover:

1. Scientific Crew

P247/1: 06.01.-15.01.Kiel - Pta. Delgada
P247/2: 16.01.-28.01.Pta. Delgada - Las Palmas
P247/3: 31.01.-11.02.Las Palmas - Las Palmas
03.02., ca 18:00, Arrecife: disembarking (a) and embarking (b) 3 scientists

Personnel

		Inst.	P247/1	P247/2	P247/3
Müller, Thomas J.,	chief scientist	IFMK	----------------	----------------	----------------
Carlsen, Dieter	moorings	IFMK	----------------	----------------	
Koy, Uwe	CTD, moorings	IFMK			------>P248
Langer, Dr. Martin	foraminifers	UT		-----------	
Meyer, Peter	CTD, moorings	IFMK	----------------	----------------	
Schmidt, Sunke	Stud.	IFMK	----------------	----------------	----------------
Stewart, Iain	foraminifers	UE	----------------	----------------	
Schiebel, Ralf	foraminifers	UT		------------	
Sequeira, Sandra	phys. oc.	UA		------------	
Rathmeyer, Volker	particle traps; camera	GeoB			---------
Meinecke, Gerrit	Domest buoy	GeoB			---------(b)
Drünert, Frank	Domest buoy	GeoB/OHB			---------(b)
Cianca, Andres	O2, nuts, chloroph.	ICCM			---------
Maroto, Leire	O2, nuts, chloroph.	ICCM			---------
Barrera, Carlos	O2, nuts, chloroph.	ICCM			---------(b)
Lopez-L., Federico	moorings	IEO			---------(a)
Garcia-R., Carlos	moorings	IEO			---------(a)
Cisneros-A., Jesus	moorings	ULPGC			---------(a)
Zizah , Soukaîna	observer	INRH			----------
			5	8	10

Participating institutes and Principal Investigators (PI)

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2. Research Programme

This cruise was part of the European Mast-III CANIGO project (Canary Islands Azores Gibraltar Observations, contract number MAS3-CT96-0060) as well as the ESTOC programme (European Station for Time Series in the Ocean, Canary Islands). The CANIGO project started in 1996 and will run for 3 years, while the ESTOC programme, which started in 1994, will continue its observations on a long-term basis. In addition, it was planned to take a winter profile for total alkalinity close to the JGOFS stations L2 (47°N, 20°W) and L1 (33°N, 22°W), and to service a surface buoy near the ESTOC position within the DOMEST programme.

Within CANIGO subproject 1 *Circulation and Dynamics of Transports through the Eastern Boundary Current System*, we want to study the Eastern Boundary Current System in the eastern subtropical North Atlantic, characterize the Azores and Canary Current, determine the mesoscale variability in the region as well as seasonal and possibly interannual variations. The data set gathered within the field phase of the project will be input to nested circulation models. The long-term current meter moorings at the JGOFS time series station ESTOC (since 1994) and at KIEL276 (33°N, 22°W, since 1980) serve as background stations for CANIGO.

Sampling for coccolithophorids, diatoms and planktic foraminifera are part of the CANIGO subproject 3: *Particle flux and paleoceanography in the Eastern Boundary Current*, Task 3.1.2: *Flux of organisms*. The scientific goals are (a) to obtain a better understanding of the seasonal and interannual interaction between planktonic organisms and the physical environment in the Azores Front and along a WE-transect north of the Canary Islands and (b) to compare this interaction with the long-term variability of species composition and flux into the sedimentary archives.

The tasks for POSEIDON cruise 247 were:

- obtain winter profiles for total alkalinity close to the JGOFS stations L2 (nominally 47°N, 20°W) and L1 (33°N, 22°W). This programme had been added after the general cruise had been planned as optional under good wheather conditions.
- obtain winter profiles of planktic foraminifera and supporting hydrographic stations and ADCP sections in the Azores Front southwest of the Azores (CANIGO Tasks 3.1.2 and 1.1.2) and additional surface planktic foraminifera *en route.*
- recover the sound source moorings SQ2 and SQ3 that were set for EUROFLOAT in 1995 during P212 and that also served to track floats in CANIGO Task 1.2.5. Note that the sound source mooring SQ1, originally scheduled to be recovered during P247, was already recovered and reset by French colleagues from IFREMER in September 1998, and that mooring SQ4 now is to be recovered during the following cruise P248.
- recover and replace the current meter mooring KIEL276, operational since 1980 at 33°N, 22°W at JGOFS site L1, now with two particle traps in addition.
- recover and exchange the current meter mooring V367 at the ESTOC time series station, operational since 1994.
- recover the array EBC of four current meter moorings east of Lanzarote within CANIGO Task 1.3.3.: EBC2, EBC3 (with two particle traps in addition), EBC4 and EBC5. Reset moorings EBC3 and EBC4 and, in order to fill the gap between Lanzarote and ESTOC, set an additional mooring EBC6 west of Lanzarote.
- obtain one additional winter hydrographic section along 29°N within CANIGO Task 1.3.2.

It should be noted that during this cruise, two more moorings with particle traps and current meters were in site at ESTOC, and at position LP (29°45'N, 018°W) north of La Palma, a site located well off the coastal and upwelling influence in an oligothrophic area in the open eastern Atlantic. For earlier cruises within ESTOC and CANIGO see the reports of Wefer and Müller (1998), Knoll et al. (1998) and Pfannkuche et al. (in press).

3. Narrative of cruise with technical details

After having brought aboard the scientific equipment, we sailed from IFM Kiel on 06 January at 08:30 as scheduled with 5 scientists and technicians being embarked. At 09:00 we took aboard a container with mooring equipment. At 10:30 we entered Kiel Canal and reached the outer ELBE1 light vessel at 21:10.

With fresh head winds up to 7 from the southwest we crossed the southern German Bight towards the English Channel which we entered in the evening of 07 January. The thermosalinograph was switched on, and surface plankton filtering for foraminifera started using the ship's pump. On 09 January 23:00, we passed Bishop's Rock. The vessel mounted Acoustic Doppler Current Profiler (vADCP) and the on-line registration PC-Log of GPS time, position, pitch and roll, of near surface temperature and salinity using a thermosalinograph, and the ship's meteorological station were switched on. The headwind had ceased but had caused a delay which did no longer allow to head towards the JGOFS station L2 at 47°N, 20°W. Instead, we set course to 46°N, 20°W, a position 60 nm south of and close enough to L2 to compare an alkalinity profile with CTD/rosette for the winter situation in the area of L2. In the night from 11 to 12 January the head wind increased again with the forecast not promising any improvement. Therefore, on 12 January in the morning, still 70 nm off position, with 5-6 m swell and 7 Beaufort wind we decided to skip the L2 winter profile in order not to risk further delay. We set course to Pta. Delgada where P247/1 finished on 15 January at 08:00 lt for bunker.

Kommentar [TJM1]:

In Pta. Delgada, two German scientists and a guest scientist from the University of the Azores in Horta embarked. On 16 January at 09:00 lt, we sailed for P247/2. South of the Azores while crossing the Azores Front, we obtained six bottom deep CTD profiles and multinet plankton sample profiles down to 2500 m. A trial with the so-called Rumohr corer that was attached to the CTD/rosette for taking ca 50 cm long sediment cores failed on all stations. It turned out that the corer is designed for water depth <3000m, and probably the samples slipped out of the corer on the long way up.

On 24 January, we reached the position of the long-term mooring KIEL276 at 33°N, 22°W in the northern Canary Basin 240 nm west of Madeira. Mooring V276-18 was recovered successfully. Five of 6 current meters have good data. The time-series was further continued by deploying mooring V276-19 on 25 January, which in addition has two particle traps. In between this mooring work, we recovered the sound source mooring V369/SQ2 which had been deployed in October 1995 during POSEIDON cruise 212 for the EUROFLOAT programme. Also, we obtained a deep CTD profile with sampling for the CO2 system.

Heading southeast, we reached the current meter mooring position of ESTOC on 27 January. Mooring V367-05 was recovered on the same day with all instruments having recorded good data. Mooring V367-06 was set the same day in the afternoon, now without an up-ward looking ADCP because after 5 years of measurements the vertical structure of the flow now is known to be dominated by the barotropic and 1st baroclinic modes which provides tools of vertical extrapolation of measurements. POSEIDON called in to Las Palmas on 28 January in the morning.

After having exchanged part of the scientific crew, we sailed on 31 January for ESTOC. On the way, six XBT profiles were obtained, and a drifting mooring T1 with a particle trap at 500 m depth was launched close to the ESTOC position. At ESTOC, the January 1999 station was obtained, and a drifting NOAA surface buoy was launched. On 01 February, we reached the EBC mooring array east of Lanzarote where mooring work was performed until 03 February: moorings EBC5-3 and V378-3/EBC2-3 were recovered; EBC4-3 and V377-3/EBC3-3 (with two particle traps) were exchanged; mooring EBC6-1 was set west of Lanzarote at 2000 m depth for the first time. On 03 February we called in to Arrecife for one hour to partly exchange personnel.

In between the mooring work at EBC, a CTD section along the mooring array had been begun. This section was continued towards ESTOC and then westward along 29°10'N until 22°W. The section has station spacing between 15 nm east of Lanzarote and 58 nm west of La Palma. On the way, the DOMEST buoy array near ESTOC with its data transmission link through underwater acoustics and satellite was to be served for a malfunction in the satellite link part. The drifting mooring T1 was recovered, however without the particle trap which was lost while drifting. After finishing the section, sound source mooring V370/SQ3 was recovered, and on the way back the station north of La Palma was repeated because of a severe malfunction of the rosette on this position earlier on the section. Also, the DOMEST buoy was serviced again without being able to complete the data link. An ADCP section running just north of the islands of Tenerife to Gran Canaria and Fuerteventura completed the work of this cruise. POSEIDON called in to Las Palmas on 11 February, where cruise P247 was finished.

4. Scientific report and first results

4.1 Hydrography

T. J. Müller, Bernd Lenz

4.1.1 Methods

The basic device was a Conductivity-Temperature-Depth (CTD) recording Falmouth Scientific Instruments ICTD which was operated together with a General Oceanics rosette with 21x10 l Niskin bottles. An ADCP mounted in the ship's moon pool (vADCP) continuously measured current profiles down to ca 300 m. ADCP-measured currents will be converted to absolute currents using the a 3-dimensional GPS/GLONASS navigational system (ADU-4) made by Ashtec that includes pitch and roll estimates.

The CTD had a laboratory calibration for pressure and temperature sensors according to the standards of the World Ocean Circulation Experiment (WOCE). Bottle samples for salinity were taken to check for correct closing of the bottles, and from the mixed layer and from the deep ocean in low gradient zones (2000 m, 3000 m, 4000 m and 20 m above the bottom) to calibrate *in-situ* conductivity and salinity of the CTD. Salinity measurements were made with

a Guildline AUTOSAL 8400 A. After processing, calibration and averaging to 2 dbar intervals, the accuracies of the CTD data are expected to be better than 5 dbar for pressure, better 0.002 mK and better 0.002 in salinity. Preliminary data of potential temperature and salinity sections are described below.
Processing vADCP data is ongoing. A first analysis of the on-line data (PC-Log, see 'Narrative of cruise') yielded that due to a computer error a registration period of 19h (13 January, 15:00 to 14 January, 10:00) during P247/1 was lost. The same problem occurred at the beginning of leg 2. Fortunately a test to display TS data on a second PC *on-line* rescued most of the data. At the moment we fit together the data stored in different formats and fill the gaps.

4.1.2 Hydrography at the Azores Front
The marine system south of the Azores is dominated by the eastward flowing Azores Current (AC) and the Azores Front (AF). The AF, which separates colder and fresher water in the north from warm salty water in the south, is characterized by large meanders, embedded in a field of mesoscale eddies. The existence of the counter current below the AC in 500m depth was lately verified with Lagrangian measurements (CANIGO Task 1.2.5). App. B, Fig. B1 and Fig. B2, respectively, show the environment on both sides of the AF determined from CTD data. The deepening of isotherms and isohalines between St.2 (stations see App. A, Fig. A1) and St.3 is strongest in a depth between 150 dbar and 600 dbar. This corresponds to earlier observations that the transition at the AF is not necessarily strongest at the surface (Stramma and Müller, 1989), where we see an increase in temperature $\Delta T = 1°C$ and salinity $\Delta S = 0.3$, e.g. from thermosalinograph data (not shown here), only. Between St.3 and St.4 FS Poseidon crosses the AF a second time. While there are no significant changes in temperature and salinity at the surface, the front is still clearly visible in 150 dbar to 600 dbar.

4.1.3 CTD section 29°N
A hydrographic section including the sampling of chemical parameters (see Sec. 4.3) was carried out along 29°N between the African shelf and 22°W during P247/3. As a first result, the sections of potential temperature (App. B, Fig. B3) and salinity (App. B, Fig. B4) are shown. A well mixed surface layer decreases from 200m depth offshore to 100m west of Lanzarote. In the EBC area east of Lanzarote the influence of upwelling effects are clearly visible at St.25 with the coastal uprising of isotherms and isohalines in the upper 500m. In the deep eastern part of the EBC Antarctic Intermediate Water (AAIW) is detected in a depth of 800m-1000m, indicated by low salinty values <35.3. West of Lanzarote Mediterranean Water (MW) dominates in 1000m depth. Fragments of a Mediterranean eddy ('Meddy') are visible at St.43 with salinity values >35.9. Below the MW down to the sea floor the water column is dominated by North Atlantic Deep Water (NADW).
Further analysis will include ADCP measurements to derive estimates of absolute geostrophic current profiles.

4.2 Flux of organisms

4.2.1 Foraminifers and pteropods
Ralf Schiebel

As part of CANIGO planktic foraminifers and pteropods were sampled by multinet (100 µm mesh size) from the Azores current system to record the calcareous microfauna and mesofauna during the winter season. To determine the particulate calcareous flux of planktic foraminiferal and pteropod tests the water column was sampled from the base of the photic zone down to a depth of 2500 m. These data provide a comparison of winter and summer conditions. The latter were investigated during July 1997 (Arquipelago FCA97C), in August 1997 (Poseidon 231/3), and in August 1998 (Meteor 42/3). During Pos 247/2 four of the already existing locations south of the Azores (33°N-35°N and 29°W-32°W) and the JGOFS position L1 (33°N, 22°W) were sampled again. To record the Azores frontal system in its whole extension two additional sites were sampled at 33°36‘N, 26°09‘W and at 35°50‘N, 20°29‘W. The new data will be integrated into a data set on the spatial and temporal development and flux of the calcareous plankton in the Azores Frontal Zone (AFZ) area.

The planktic foraminiferal species assemblage during winter is significantly different from the summer assemblage. Across the frontal system south of the Azores as well as at the eastern sites the planktic foraminiferal fauna was dominated by *Globorotalia truncatulinoides* during January 1999. In contrast to August, 1997 and 1998, when *G. truncatulinoides* was found mainly in water depth between 200 m and 700 m, in January it occurred in the upper 100 m in large numbers. Only few specimens were recorded from below 200 m. *Turborotalia humilis*, which was absent during summer, was also frequent in the upper water column, and *Globigerina falconensis* was much more frequent than during August 1997 and 1998. Species which were present during summer and absent during winter are *Orbulina universa*, *Globorotalia scitula* and *G. hirsuta*, and *Globogerinoides sacculifer*. Pteropods were found only in small numbers. Most frequent were species from the genus *Limacina* (mainly *L. inflata*) and *Diacria*.

4.2.2 Molecular Biogeography of Planktic Foraminifera
Martin R. Langer

Comparative studies on DNA nucleotide sequences are an important tool in evolutionary, biogeographic, ecologic and paleobiologic inquiry that can be used in conjunction with the geologic record. The techniques are useful wherever genetic differentiation may have developed and reveal or confirm phylogenies and biogeographic and ecologic histories of fossilizable organisms with great success. During Poseidon cruise 247/2 (Azore Front, NW-Pacific) we have collected individual DNAs from a 112 single specimens of planktic foraminifera by multiple closing nets at depth between 2500 and the surface. Samples were transferred to Petri dishes and examined and cleaned under a stereo microscope. Living individuals were then picked and placed into clean glass dishes containing filtered seawater. Single individuals were then ground in 1.5 ml reaction tubes and genomic DANN was immediately extracted using either the DOC or the CTAB extraction protocols. Polymerase chain reaction (PCR) amplification of the partial foraminiferal SSU ribosomal rDNA subunit (18S) follows in a MJ Research Mini-Cycler using broad and foraminiferal specific primers. Total reaction volumes for PCR is 50 ul and consists of 35 ul double distilled water, 5 ul ThermoPolymerase Buffer, 0.5 ul 100mM $MgSO_4$, 0.2 mM dNTP mixture, 1 mM each primer and 1 unit Vent DNA Polymerase. The amplification profile consists of an initial cycle at 94°C for 2 minutes followed by 40 cycles of 35 sec at 94°C, 35 sec at 50°C and 2 minutes at 72°C and a final extension of 15 minutes at 72°C. this enables the amplification of an approximately 1000 base pair product that is located at the 3`end of the foraminiferal 18 S gene. PCR amplified products are cloned as blunt-end fragments ligated into the pUC 18 vector and transformed into E. coli DH5∝ strains.

4.2.3 Collection of planktic foraminifera for DNA analysis

Iain Stewart

Planktic foraminifera were collected during P247/1 and P247/2 from approximately 4 metres depth by pumping seawater through a 70 micron mesh net via the shipboard fire-hose system. The individual foraminifers were picked from the plankton samples and identified using a light microscope. Digital images of each individual were recorded using a video camera mounted on the microscope. Individual foraminiferal specimens collected for DNA analysis were crushed in 30µl of lysis buffer, incubated at 60ºC for 1 hour, then frozen at -20ºC. A total of 348 individuals were collected for DNA analysis, with at least 17 foraminiferal morphospecies having been identified. Further, bulk plankton samples were collected and preserved in ethanol. These samples shall be ashed for SEM analysis of foraminiferal test morphology.
The use of DNA analysis will determine the genetic structure of these planktic foraminiferal morphospecies along a transect crossing from transitional to subtropical water masses. An examination of foraminiferal genotype distribution patterns and bulk collected plankton samples also permits an investigation of genotype / morphotype realtionships.

4.3 Chemical oceanography

A. Cianca, L. Maroto, C. Barrera

4.3.1 Sampling and methods

Sampling

During P247/3 at each station and for each depth (except chlorophyll that is only sampled from 200 m to the surface), water samples were taken from 10 l Niskin bottles of the CTD/rosette to analyse oxygen, nutrients and chlorophyll ”a”. Samples were collected immediately after the bottles were on board from each depth. The sampling sequence was as follows:

- Oxygen was fixed first, then kept for further analysis at the laboratory.
- Nutrient samples were frozen immediately at -20°C for post-cruise analysis at the ICCM laboratory
- Chlorophyll samples were taken in polypropilene bottles filtering 0.5 litres inmediatelly, and the filters were frozen subsequently at -20°C for post-analysis at the ICCM laboratory

All samples were taken using the procedures established in the World Ocean Circulation Experiment (WOCE, 1994).

Dissolved Oxygen

The samples were analysed on board using the method described in WOCE (1994); bottles with 125 ml volume were used and the final titration point was detected using a Metrohm 665 Dosimat Oxygen Auto-Titrator Analyser. Conversion of volume units to mass units is done using the sample's potential temperature.

Nutrients

Nutrients were taken in polypropylene bottles which were previously cleaned and washed with HCl acid and were completely dry, according to the instructions in WOCE (1994). Samples were immediately frozen at -20°C, analysing them as soon as possible after arrival at the laboratory. Freezing the samples is a common practice. It does not or only in a non-significant way affect the nitrate+nitrite and the phosphate values (by a slight decrease) and is not noticeable in the silicate values (KREMLING AND WENCK,1986; MCDONALD AND MCLUNGHLIN, 1982).

The nutrient determination were performed with a segmented continuous-flow autoanalyser, a Skalar® San Plus System (ICCM). Conversion of volume units to mass units is done using laboratory temperature.

Nitrate+Nitrite

The automated procedure for the determination of nitrate and nitrite is based on the cadmium reduction method; the sample is passed through a column containing granulated copper-cadmium to reduce the nitrate to nitrite (WOOD ET AL.,1967), using ammonium chloride as pH controller and complexer of the cadmium cations formed (STRICKLAND and PARSONS, 1972). The optimal column preparation conditions are described by several authors (e.g. NYDAHL, 1976; GARSIDE**,** 1993).

Phosphate

Orthophosphate concentration is understood as the concentration of reactive phosphate (RILEY AND SKIRPOW,1975). According to KOROLEFF (1983a), it is a synonym of ”dissolved inorganic phosphate”. The automated procedure for the determination of phosphate is based on the following reaction: ammonium molybdate and potassium antimony tartrate react in an acidic medium with diluted solution of phosphate to form an antimony-phospho-molybdate complex. This complex is reduced to an intensely blue-coloured complex, ascorbic acid. The complex is measured at 880nm. The basic methodology for this anion determination is given by MURPHY and RILEY (1962); the used methodology is the one adapted by STRICKLAND AND PARSONS (1972).

Silicate

The determination of the soluble silicon compounds in natural waters is based on the formation of the yellow coloured silicomolybdic acid; the sample is acidified and mixed with an ammonium molybdate solution forming molybdosilicic acid. This acid is reduced with ascorbic acid to a blue dye, which is measured at 810nm. Oxalic acid is added to avoid phosphate interference. The used method is described in KOROLEFF (1983b).

Phytoplankton pigments

Pigments were measured on board using fluorimetric analysis, following the methodology described by WELSCHMEYER (1994). The determination was achieved using a fluorometer TURNER 10-AU-000.

4.3.2 Preliminary results

The preliminary results of oxygen (0m - 5000m) and chlorophyll_a determination (upper 200m) are presented in App. B, Fig. B5 and Fig. B6, respectively. The presence of AAIW in the eastern EBC area is indicated by the lowest oxygen values (App. B, Fig.B5) corresponding to low salinity (Fig. B4). The core of this oxygen poor water mass is found in 700m depth. West of Lanzarote in a depth level between 800m and 1000m the minimum in oxygen which corresponds mainly to MW can be traced nearly 800km offshore.
The chlorophyll distribution (App. B, Fig.B6) at the surface show steadily increasing values to the east. East of Lanzarote the strong gradients indicate upwelling to a depth of 50m below the surface. The upper 50m are dominated by high chl_*a* values.

4.4 References

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5. Scientific equipment, instruments and moorings

Shipborne instruments

- CTD Neil Brown Mk.IIIB (IFMK code NB2) or Falmouth Scientific Instruments FSI ICTD (S/N 1323) equipped with a polarographic oxygen sensor (Beckman) and an *in-situ* fluorometer (down to 3000 m only, Haardt)
- GO-rosette including 12x10 l or 21x10 l Niskin bottles
- vessel-mounted Acoustic Doppler Current Profiler (RDI 150 kHz)
- HYDRO-BIOS Multinet 90 A, with 50x50 cm opening, and 100 micron mesh size
- salinometer (Autosal Guildline, IFMK code AS4)
- Metrohm 682 Titroprocessor
- Laboratory fluorometer
- Drifting particle trap, 500 m depth, 31.01. - 05.02.1999, trap lost; buoyancy returned

Moorings

set	date set
rec	date recovered
lat	latitude north
lon	longitude west
Wd	water depth [m]

ID/internal ID	**set**	**rec**	**lat**	**lon**	**Wd**
(P247/2)					
V276-18/K276	07.08.1997	24.01.1999	32°59.5’	021°59.9’	5217
V369/SQ2	13.10.1995	24.01.1999	32°43.1’	021°58.8’	5190
V276-19/K276,L1	25.01.1999		32°58.1’	022°00.5’	5216
V367-05/ESTOC	20.06.1998	27.01.1999	29°11.9’	015°38.4’	3616
V367-06/ESTOC	27.01.1999		29°09.5’	015°40.6’	3618

(P247/3)

EBC5-03	23.06.1998	01.02.1999	28°49.3’	013°40.2’	950
EBC4-03	22.06.1998	01.02.1999	28°45.3’	013°27.6’	1290
V377-03/EBC3	23.06.1998	01.02.1999	28°44.0’	013°19.1’	1210
EBC4-04	02.02.1999		28°45.5’	013°27.4’	1292
V377-04/EBC3	02.02.1999		28°44.1’	013°19.0’	1234
V378-03/EBC2	22.06.1998	02.02.1999	28°42.1’	013°09.7’	1000
EBC6-1	03.02.1999		29°00.3’	013°56.9’	1600
V370/SQ3	12.10.1995	08.02.1999	28°59.8’	022°02.0’	-99

6. Additional Remarks

We want to thank the crew of POSEIDON with captain Matthias Gross for their excellent help in gathering this data set.

7. Appendix

Appendix A

Cruise track and stations during P247: CTD (+), multinet (o) and moorings (*).

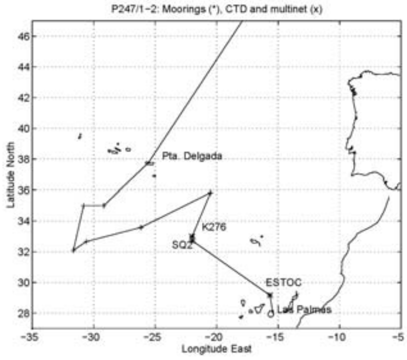

Fig. A1: P247/1-2, Kiel - Pta. Delgada, Pta. Delgada - Las Palmas

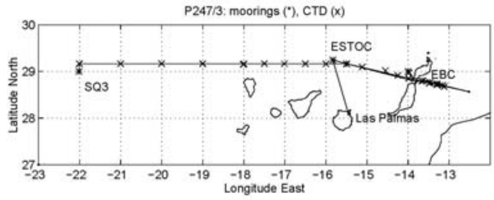

Fig. A2: P247/3, Las Palmas - Las Palmas; 6 XBTs were launched on the way from Las Palmas to ESTOC

Appendix B

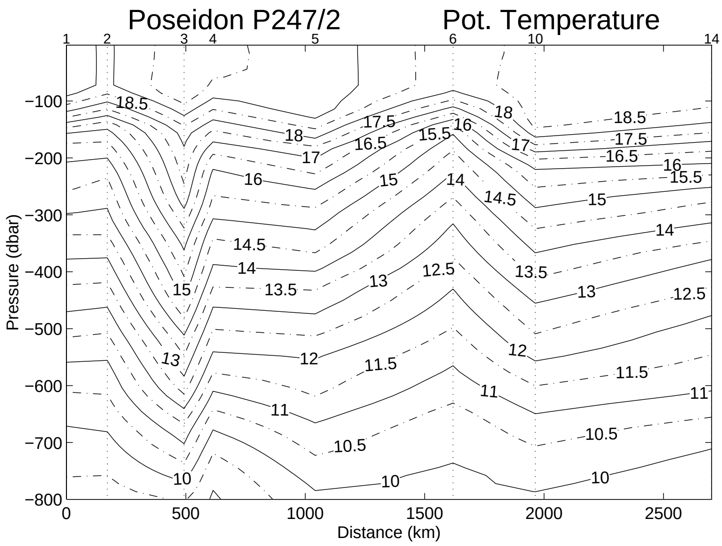

Fig. B1: CTD P247/2: Potential temperature (°C) as a function of distance, numbers at the top indicate station numbers

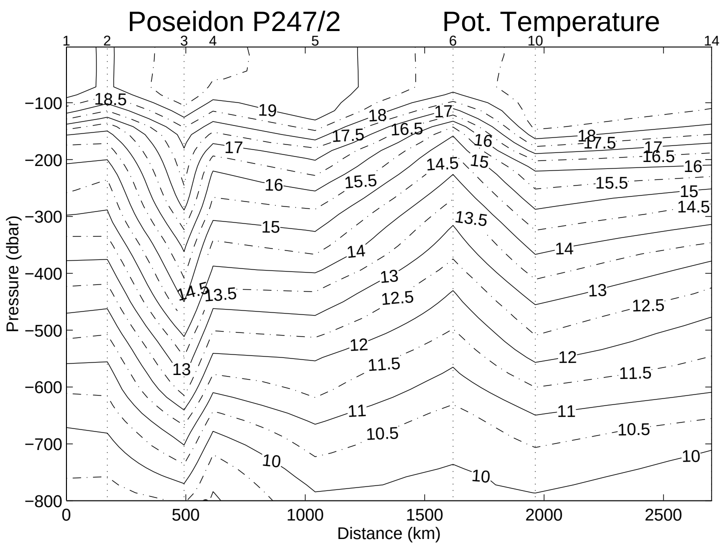

Fig. B2: CTD P247/2: Salinity as a function of distance

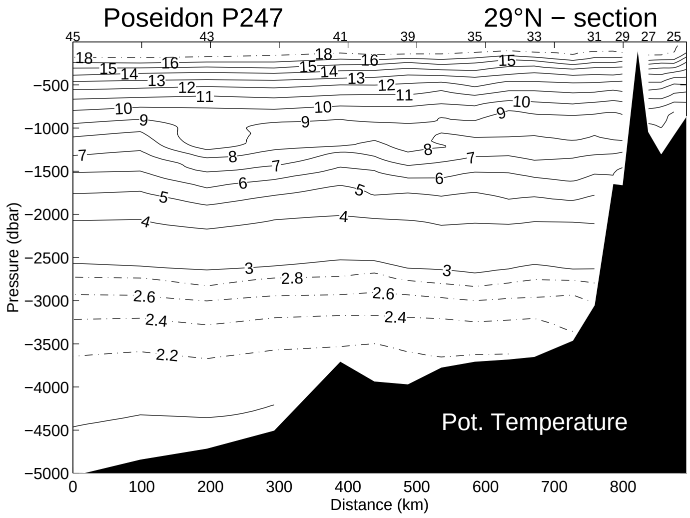

Fig. B3: Potential temperature (°C) along 29°N between 22°W and the African shelf

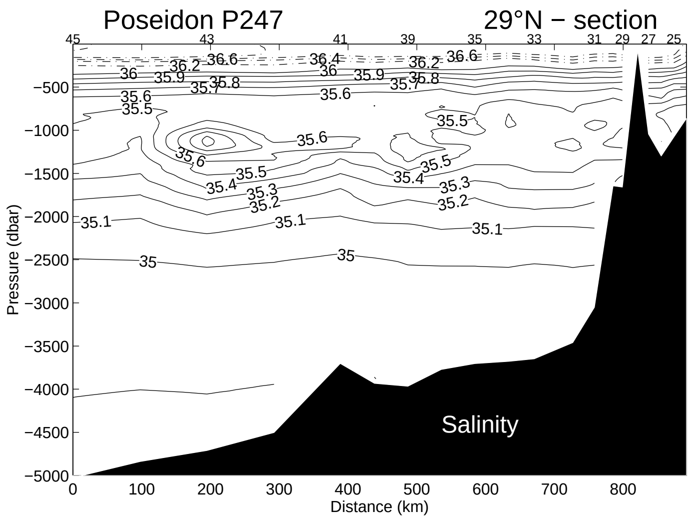

Fig. B4: Salinity along 29°N between 22°W and the African shelf

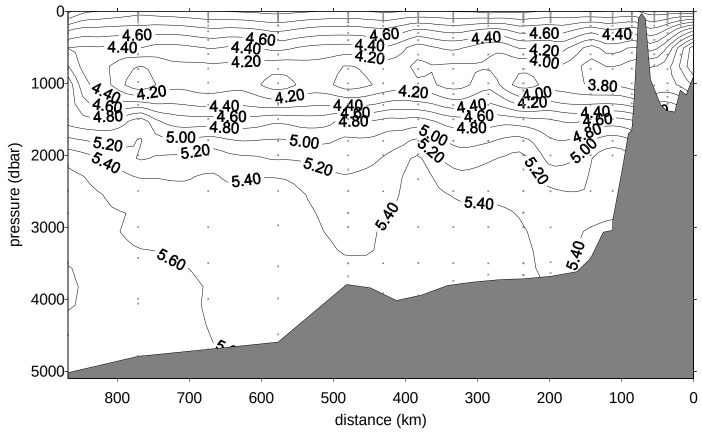

Fig. B5: Oxygen (ml/l) along 29°N between 22°W and the African shelf

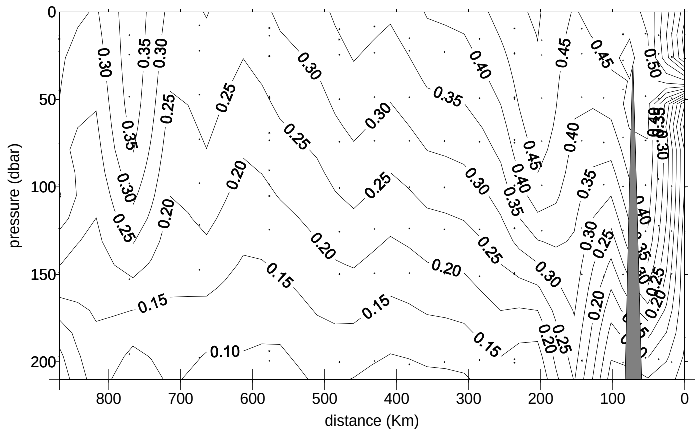

Fig. B6: Chlorophyll_a (µg/l) along 29°N between 22°W and the African shelf (upper 200m)

Appendix C.

Table C1: Station List P247

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POSEIDON 247 station and sample log

List of abbreviations:
St    : Station no.
C     : CTD cast no., monotonically increasing during the cruise;
        all casts to near bottom if not indicated else
Wd    : Water Depth
Instr : Type of instrumentation or mooring or equipment
        DTRAP :  Drifting particle trap
        MN    :  Multiple closing plankton net
        NB2   :  Neil Brown CTD, IFMK code NB2 with 12x12 l bottle rosette
        FSI   :  Falmouth Scientific CTD; IFMK code FSI1
                 with 24x10 l bottle rosette
        vADCP :  vessel mounted RDI ADCP, 150 KHz
        PC-LOG:  on-line log of GPS date, time, position, pitch & roll;
                 near-surface T, S; meteorological data
CS    : Core station with 2 casts for the ICCM

Additional sensors on and samples taken from CTD/rosette:
  1 F Fluorometer attached to CTD
  2 A self-contained lowered RD Instruments ADCP S/N 599 attached to CTD/rosette
  3 W self-contained lowered RD Instruments WorkHorse ADCP attached to rosette
  4 O oxygen
  5 N nutrients
  6 C chlorophyll
  7 S salt
  8 R Ruhmor single corer attached to CTD/rosette frame
  9 CO2 Alkalinity profile for CO2 system
```

Date 1999 UTC MMDD	Time UTC hhmm	St	C	Latitude North GG MM.MM	Longitude West GGG MM.MM	Wd [m]	Inst	
0106	0830							sail from IFM Kiel begin of P247/1
0110	0900							start PC-LOG; start vADCP
0115	0847							vADCP off,; PC-LOG off
0115	0945							Pta. Delgada; end of P247/1
0116	1055							sail from Pta. Delgada begin of P247/2
0116	1130							start vADCP; start PC-Log
0117	1030	001	001	35 00.09	029 11.04	3616	NB2	R, S
							MN	100 m, 700 m, 2500 m
0118	0515	002	-99	35 00.00	031 00.0	3031	MN	100 m, 700 m, 2500 m
0118	1120	002	002	34 57.7	031 04.3	3135	NB2	S
0119	1105	003	-99	32 06.0	031 39.0	4187	MN	100 m, 700 m, 2500 m
0119	1212	003	003	32 07.14	031 41.57	4245	NB2	R, S
0119	2130	004	004	32 40.01	030 34.76	3293	NB2	R, S
0119	2310	004	-99	32 40.2	030 33.1	3236	MN	100 m, 700 m, 2500 m
0121	0518	005	-99	33 35.0	026 10.0	4765	MN	100 m, 700 m, 2500 m
0121	1135	005	005	33 36.2	026 07.9	4766	NB2	
0122	2210	006	-99	35 50.0	020 30.0	5203	MN	100 m, 700 m, 2500 m
0123	0718	006	006	35 49.4	020 25.8	5217	FSI	A, S
0124	0130	007	-99	33 05.0	022 00.0	5226	MN	100 m, 700 m, 2500 m
0124	0900	008	-99	32 59.5	021 59.9	5217	V276-18	recover mooring K276
0124	1600	009	-99	32 43.1	021 58.8	5190	V369	recover mooring SQ2
0124	2025	010	007	33 00.06	021 59.97	5217	FSI	A, CO2, S; near K276/L1
0125	1008	011	-99	32 58.1	022 00.5	5216	V276-19	set mooring K276/L1
0127	0950	012	-99	29 11.9	015 38.4	3616	V367-05	recover mooring; ESTOC
0127	1258	013	-99	29 09.5	015 40.6	3618	V367-06	set mooring; ESTOC
0127	1830	014	008	29 08.0	015 41.8	3618	FSI	A, S; near ESTOC
0128	0857							vADCP off,; PC-LOG off
0128	1000							Las Palmas; end of P247/2

Date	Time	St	Pr	Latitude	Longitude	Wd	Inst	
1999								
UTC	UTC			North	West			
MMDD	hhmm			GG MM.MM	GGG MM.MM	[m]		
0131	0900							sail from Las Palmas;
								begin of P247/3
0131	0945							start vADCP; start PC-LOG
0131	1049	-99	-99	28 20	015 26.0	3117	XBT	1
0131	1150	-99	-99	28 30	015 31.0	3539	XBT	2
0131	1200	015	009	28 30.4	015 31.1	3543	FSI	500 m; water for traps
0131	1339	-99	-99	28 40	015 35.2	3882	XBT	3
0131	1446	-99	-99	28 50	015 39.5	3595	XBT	4
0131	1550	-99	-99	29 00	015 43.5	3614	XBT	5
0131	1648	-99	-99	29 09	015 47.5	3623	XBT	6
0131	1809	016	010	29 03.41	015 47.50	3622	FSI	200 m; launch drifting trap T1
0131	2018	017	011	29 09.95	015 30.01	3609	FSI	O, N, C, S;
								ESTOC Jan 1999 station;
								PN; launch NOAA buoy
0201	1110	018	-99	28 49.3	013 40.2	950	EBC5-03	recover mooring
0201	1400	019	-99	28 45.3	013 27.6	1290	EBC4-03	recover mooring
0201	1450	020	-99	28 44.0	013 19.1	1210	V377-03	recover mooring
0201	2009	021	012	28 40.5	013 07.1	844	FSI	O, N, C, S
0202	0922	022	-99	28 45.5	013 27.4	1292	EBC4-04	set mooring
0202	1308	023	-99	28 44.1	013 19.0	1234	V377-04	set mooring
0202	1532	024	-99	28 42.1	013 09.7	1000	V378-03	recover mooring
0202	1902	025	013	28 42.98	013 17.97	1103	FSI	O, N, C, S, FL
0202	2150	026	014	28 45.02	013 29.01	1277	FSI	O, N, C, S, FL
0203	0052	027	016	28 47.52	013 40.03	1022	FSI	O, N, C, S, FL
0203	0845	028	-99	29 00.3	013 56.9	1600	EBC6-01	set mooring
0203	1053	029	017	28 58.31	013 58.67	1597	FSI	O, N, C, S, FL
0203	1800							Arrecife pilot;
								change of personnel
0203	2035	030	018	28 50.96	013 59.00	1567	FSI	O, N, C, S
0204	0015	031	019	28 54.93	014 15.04	3008	FSI	O, N, C, S
0204	0420	032	020	29 01.19	014 32.99	3390	FSI	O, N, C, S
0204	1005	033	021	29 05.85	015 07.09	3580	FSI	O, N, C, S
0204	1541	034	022	29 09.85	015 29.88	3609	FSI	O, N, C, S; 800 m; CS
0204	1712	034	023	29 09.56	015 29.79	3609	FSI	O, N, C, S; CS
0204	2303	035	024	29 09.92	016 00.08	3627	FSI	O, N, C, S
0205	0600	036	-99	29 10.7	015 55.6	3640		service SBU buoy of DOMEST
0205	1421	037	-99	29 17.1	016 27.1	3718		recover T1; trap lost
0205	1518	038	025	29 09.99	016 30.09	3697	FSI	O, N, C, S
0205	2107	039	026	29 10.00	017 00.76	3883	FSI	O, N, C, S
0206	0325	040	027	29 10.04	017 30.06	3851	FSI	O, N, C, S
0206	0911	041	028	29 09.94	017 59.97	3692	FSI	O, N, C, S, 800 m; CS
0206	1111	041	029	29 09.00	018 00.63	3661	FSI	O, N, C, S; CS
0206	1919	042	030	29 09.89	019 00.06	4410	FSI	O, N, -, S; 6 bottles open
0206	1919	042	030	29 09.89	019 00.06	4410	FSI	O, N, -, S; 6 bottles open
0207	0507	043	031	29 10.12	020 00.26	4593	FSI	O, N, C, S
0207	1415	044	032	29 09.99	021 00.01	4716	FSI	O, N, C, S
0207	2302	045	033	29 10.04	022 00.05	4892	FSI	O, N, C, S; 800 m; CS
0208	0027	045	034	29 09.98	022 00.35	4893	FSI	O, N, C, S; CS
0208	0825	046	-99	28 59.8	022 02.0	-99	V370	recover mooring SQ3
0209	0755	047	035	29 10.02	019 00.01	4411	FSI	O, N, C, S; 2000 m;
								repeat upper part of St.42
0210	0600	048	-99	29 10.56	015 55.74	3640		mooring SBU of DOMEST;
								releaser position
determined								
								SBU buoy served
0210	1359	049	036	28 51.1	015 59.1	3552	FSI	500 m; test WH
0211	0200							vADCP profile finished;
0211	0730							vADCP off; PC-LOG off
0211	0800							Las Palmas; end of P247/3