**Institut für Meereskunde**
**an der Universität Kiel**

**Date: 20.3.2003**

# Cruise Report

**Compiled by**: Thomas J. Müller

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**F.S.Poseidon** **Cruise No.: 283**

**Dates of Cruise:** 25.01. - 05.03.2002

**Areas of Research:** Physical; chemical, and biological oceanography

**Port Calls:** Southampton, UK, 30.01.-02.02.2002
Pta. Delgada, Azores, Portugal, 10.02. – 11.2.2002
Las Palmas, GC, Spain, 26.02.-01.03.2002
Las Palmas, GC, Spain, 05.03.-08.03.2002

**Institute:** Institut für Meereskunde, Kiel, Germany

**Chief Scientists:** P283/1-2: Prof Dr. Detlef Schulz-Bull
P283/1: Dr. Thomas J. Müller

**Number of Scientists:** 1 during leg P283/1
10 during leg P283/2
9 during leg P283/3

**Projects:** - Time series stations in the eastern Northeast Atlantic:
Mooring sites PAP, K276/L1, ESTOC, EBC
- Zoo- and phytoplankton in the Azores frontal zone and near ESTOC

**Cruise Report**

This cruise report consists of 15 pages including cover

1. Scientific crew
2. Research programme
3. Narrative of cruise with technical details
4. Scientific report and first results
5. Scientific equipment, instruments and moorings
6. Additional remarks
7. Appendix of maps with cruise tracks, diagrammes, list of stations etc.
   A. Station list

## 1. Scientific crew

P283/1: 25.01.-9.02.2003, Kiel – Southampton - Pta. Delgada, transit
P283/2: 11.2.-26.02.2003, Pta Delgada – Las Palmas
P283/3: 01.03.-05.03.2002, Las Palmas – Las Palmas

| **Name** | **Institute** | **Function** | **P283/1** | **P283/2** | **P83/3** |
|---|---|---|---|---|---|
| Schulz-Bull, Detlef | IOW | Chief scientist | | --------- | |
| Schmidt, Sunke | IFMK | Student | ---------- | --------- | -------- |
| Kirch, Anja | IFMK | Alkenones | | --------- | |
| Blanz, Thomas | IOW | Scientist | | --------- | |
| Werner, Martina | IFMK | Student | | --------- | |
| Hoffmann, Detlef | TUHH | Moorings | | --------- | |
| Sebastian, Lars | TUHH | Drifter | | --------- | |
| Maczewski, Bernd | TUHH | Drifter | | --------- | |
| Schiebel, Ralf | ETHZ | Foraminifers | | --------- | |
| Rickli, Jörg | ETHZ | Coccolithoph. | | --------- | |
| Müller, Thomas J. | IFMK | Chief scientist | | | -------- |
| Barrera, Carlos | ICCM | Chem., CTD | | | -------- |
| Cardona, Laura | ICCM | Chem | | | -------- |
| Villagarcia, Marimar | ICCM | Chem | | | -------- |
| Lopez-Laatzen, Federico | IEO | Moorings | | | -------- |
| Garcia, Carlos | IEO | Moorings | | | -------- |
| Barbero | ULPGC | pCO2 | | | -------- |
| John, Hans-Christian | DZMB | Zooplankton | | | -------- |
| Total | | | 1 | 10 | 9 |

*Institutions*

| | |
|---|---|
| IFMK | Institut für Meereskunde an der Universität Kiel, Kiel, Germany |
| IOW | Institut für Ostseeforschung, Rostock-Warnemünde, Germany |
| ICCM | Instituto Canario de Ciencias Marinas, Telde, GC, Spain |
| IEO | Instituto Espanol de Oceanografia, Sta. Cruz, TF, Spain |
| DZMB | Deutsches Zentrum für Marine Biodiversität, Aussenstelle Hamburg |
| ULPGC | Universidad de Las Palmas de Gran Canaria, Las Palmas, GC, Spain |
| TUHH | Technical University Hamburg-Harburg |
| ETHZ | Eidgen. Techn. Hochschule, Zürich, Switzerland |

*Chief scientists:*
*P283/1-2:*

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*P283/3:*

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## 2. Research programme

The main objectives of POSEIDON cruise 283 were to investigate long-term variability of hydrographic and flow conditions and vertical particle fluxes at the time series stations PAP (Porcupine Abyssal Plain, 49°N, 16°30'W), KIEL276/L1 (Madeira Abyssal Plain, 33°N, 22°W), ESTOC (north of the Canaries, 29°10'N, 015°30'W) and EBC (east and west of Lanzarote) by

- Exchanging particle traps at mooring site PAP
- Exchanging current meters and particle traps at site KIEL276 with additional CTD/rosette casts across the Azores Front
- Exchanging current meters at the ESTOC site with additional CTD/rosette casts for the March 2002 monthly station and north of the islands along (29°N section) including zooplankton profiles
- Recovering two IEO current meter moorings east and west of Lanzarote, sites EBC4 and EBC6, respectively

The work at PAP was included on a short time notice only, in order to substitute a British cruise that had been cancelled for logistic reasons before.

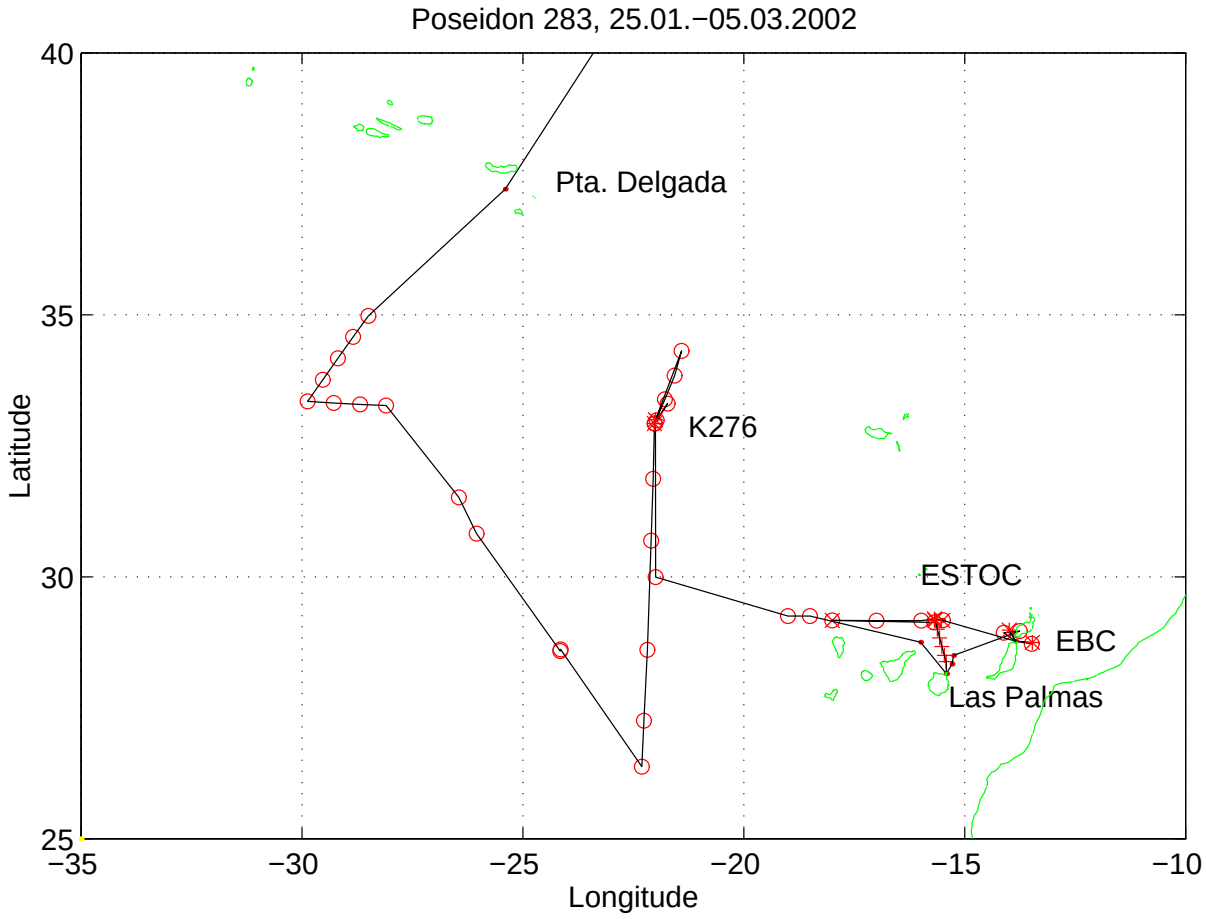


*Fig. 2.1: cruise track with time series mooring sites (*) K276, ESTOC, EBC and CTD/plankton net stations (o).*

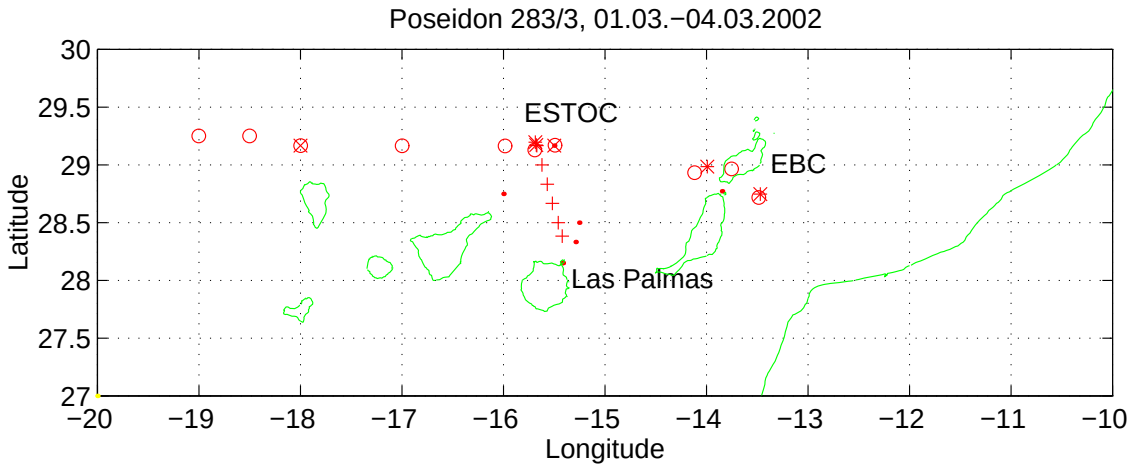


*Fig. 2.2:Positions of tTime series mooring sites (*) ESTOC and EBC, CTD stations (o), plankton net stations (x), and XBT casts (+) near the Canary Islands.*

## 3. Narrative of cruise with technical details

### 3.1 P283/1-2

Originally planned as a transit from Kiel to Pta. Delgada, POSEIDON sailed from Kiel on 25th January 2002, 5 days earlier than originally scheduled. The reason for earlier departure was that on a short notice from colleagues of the Southampton Oceanographic Centre, SOC, IFM Kiel was willing to help exchange a particle trap mooring at mooring site PAP in the Porcupine Abyssal Plain after a scheduled British cruise had been cancelled. It was clear that only 5 days more would not be sufficient for the additional transit and workload in case of bad wheather, but this was the maximum that IFM Kiel could offer.

Onboard was S. Schmidt from IFM Kiel to help the British colleagues with CTD/rosette and mooring work. After severe gale which forced POSEIDON to seek shelter already in the Elbe river, POSEIDON called in to Southampton on 30th January to take onboard the British colleagues and mooring equipment. However, wheather conditions and predictions were so bad, that the work at PAP had to be cancelled completely while still in port, and the vessel had to sailed on 02nd February solely for the transit reaching Pta. Delgada on 10th February.

After embarking in Pta. Delgada, POSEIDON sailed for leg P283/2 on 11th February. While heading towards the first station, the standard underway measurements began outside the EEZ of Portugal:

- precise navigational information from an Ashtech GG24 system
- heading, pitch and roll information from a 3-dimensional Ashtech ADU2 system
- sea surface temperature and salinity using a thermosalinograph
- standard meteorological parameters
- profiles of ocean currents down to ca. 300 m using a 150 kHz RDI ADCP system

In addition to these, the following measurements/sampling of seawater from the ship's intake line from approximately 4 m depth were done: temperature, salinity, oxygen, nutrients, POC, DOC, chlorophyll, planktonic organism and alkenones. All underway sampling systems were build up and were operated simultaneously, as possible, during the whole cruise.

On 12th February, the first way point at 35°N 28° 30'W was reached. During the southward transect towards 26° N 22° W, the Azores front was crossed. Intensive sampling with CTD stations, water profiles and multiple closing nets (MSN) were carried out. Planktic foraminifers and pteropods were sampled with a MSN of 100 µm mesh size. Sampling depths intervals were 0-20-40-60-80-100 m, 0-100-200-300-500-700 m. Below 700 to 1500 m depth, sampling intervals were chosen according to the depth-interval of the Mediterranean Sea Outflow Water. From each sample, foraminifers and pteropods were determined qualitatively before conservation. In total, 41 live planktic foraminifers were picked, classified, and processed for DNA analysis that will be carried out at Tübingen University. DNA analysis will be used as an ecologic and hydrographic tool that will be used in conjunction with the geologic record. Water samples from CTD-Rosette hauls were filtered for coccolithophores through a 0.8 µm Nucleopore filter. Samples were obtained from standard depths. In addition, thermocline depth and fluorescence maximum were sampled. Coccolithophores will be analyzed for their floral composition by scanning-electron-microscopy (SEM) at the Swiss Federal Institute of Technology (ETH) Zurich.

On 19th February, we reached the position of the long term mooring Kiel276 at 33°n, 22°W in the Canary basin. Mooring K276/21 was recovered successfully. Current meters and sediment traps had worked perfectly over the one year deployment time. The time series was continued further by deploying mooring K276/22 on February 22, again with current meters and sediment traps at 2000m and 3200m depth. On the way to the Canary Islands we passed the ESTOC station (CDT cast, no data due to corrupted file). POSEIDON called in to Las Palmas on 26th February where the scientific party disembarked besides S. Schmidt who stayed onboard for P283/3.

**3.2 P283/3**

Most of the scientific party of IFMK embarked 27th February in Las Palmas while S. Schmidt set forth the cruise. On 28th February, the scientific equipment was set up in port.

After embarkation of the scientific crew from DZMB, ICCM, IEO and ULPGC, the vessel sailed on schedule on 01st March at 08:15 from Las Palmas. While heading towards the ESTOC mooring site of mooring V367 at 29°10'N, 015°40'W, underway measurements began outside the 12 nm EEZ of Spain:

- precise navigational information from an Ashtech GG24 system
- heading, pitch and roll information from a 3-dimensional Ashtech ADU2 system
- sea surface temperature and salinity using a thermosalinograph
- standard meteorological parameters
- profiles of ocean currents down to ca. 300 m using a 150 kHz RDI ADCP system
- continuosly $pCO_2$ with water pumped from the moonpool
- 6 XBT profiles down to 760 m every 10 latitudinal minutes starting at 28°20'N, 015°17.30'W until the ESTOC mooring position V367.

Within the ESTOC work, mooring V367-07, run by IFMK, was recovered with no problems in the late afternoon the same day (Stat. 127), and a CTD cast taken (Stat. 128). Continuous current meter records are now available from that position since September 1994. We then headed westward to the western position of the 29°N section at 29°1‘N, 018°00‘W which we reached on 2nd March. Here the section began, with low horizontal resolution this time due to limited time, with sampling of zooplankton profile down to 1000 m (Sta. 129) and a CTD/rosette cast down to 2000 m. Interrupted by two more CTD casts we again reached the ESTOC current meter mooring site at 29°10‘N, 015°40‘W on 3rd March. Here, the IEO launched a current meter mooring, and thus started to continue the measurements which were begun in September 1994 by IFMK.

By noon the same day, we reached the nearby ESTOC hydrographic station position (15°10‘N, 015°30‘W) where a deep zooplankton casts and the April 2002 CTD/rosette profile were taken, sampling also the water column at 24 selected depths for oxygen, nutrients and chlorophyll concentrations. The station was completed by launching a NOAA drifting buoy.

Steaming eastwards, we reached mooring site EBC4 east of Lanzarote, run by IEO, on 04th March. Here, mooring EBC4_6 was recovered early in the morning. The same day, mooring EBC6_4 was recovered west of Lanzarote. One of the main aims here is to monitor the Canary Current near the islands and also the poleward undercurrent as manifested in a nutrient maximum at mid-depths. Data are now available since January 1997 (EBC4) and July 2000 (EBC6).

After 2 more CTD/rosette casts west of Lanzarote on the 29°N section, POSEIDON called in to Las Palmas where cruise P283/3 finished on 05th March at 10:00 UTC.

Part of the scientific equipment was unloaded, and all scientists disembarked.

## 4. Scientific report and first results

### 4.1 Currents and water masses in the Azores frontal zone

Dominated by mesoscale events with strong barotropic components (Fig. 4.1.1), the flow is southwestward (Tab. 4.1.1) over from ner the surface (270 m) down to the deep sea (3000 m). This differs from the multi-year average where we have southeastward flow in the upper thermocline. The variability of the current is associated with fluctuations in the temperature signal although there is no significant coherence. At the end of record, a meddy seems to hit the site as indicated by a flow maximum at 1000 m and strongly increasing temperature (Fig. 4.1.2).

***Table 4.1.1:*** *flow statistics from mooring V276-21, low-pass filtered daily averaged data. SPD and DIR are current speed and direction; s is vector stability; u and v are East- and North components of flow; STD is standard deviation for respective mean; T is temperature; ITS denotes an integral time scale defined as first zero-crossing of the autocorrelation function; fluxes <uv>, <uT> and <vT> are covariances; $<uv>_d$ is the main direction of momentum flux. Units are cm/s and °C.*

| ID Depth | days | SPD | DIR | s | means STD u | means STD v | means STD T | ITS u | ITS v | ITS T | fluxes <uv> | fluxes $<uv>_d$ | fluxes <uT> | fluxes <vT> |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *V276-21* | | | | | | | | | | | | | | |
| 270 | 378 | 5.5 | 227 | 0.52 | -4.0 | -3.7 | 15.9 | 14 | 17 | 36 | 18 | 40 | 0.8 | 0.1 |
| | | | | | 7.3 | 7.7 | 0.5 | | | | | | | |
| 500 | 209 | 3.7 | 222 | 0.68 | -2.5 | -2.8 | 12.7 | 16 | 21 | 16 | 3 | 22 | 0.4 | 0.3 |
| | | | | | 3.3 | 4.2 | 0.2 | | | | | | | |
| 1000 | 378 | 2.4 | 250 | 0.51 | -2.2 | -0.8 | 9.2 | 11 | 9 | 10 | 7 | 24 | -1.1 | 0.3 |
| | | | | | 3.6 | 5.0 | 0.6 | | | | | | | |
| 1600 | 378 | 2.3 | 250 | 0.72 | -2.2 | -0.8 | 5.1 | 10 | 11 | 20 | 1 | 50 | -0.2 | 0.1 |
| | | | | | 2.0 | 1.9 | 0.4 | | | | | | | |
| 3000 | 378 | 1.7 | 237 | 0.69 | -1.4 | -0.9 | 2.8 | 14 | 13 | 19 | 1 | 67 | 0.0 | 0.0 |
| | | | | | 1.9 | 1.2 | 0.0 | | | | | | | |
| 5185 | 378 | --- | --- | --- | --- | --- | 2.4 | --- | --- | --- | --- | --- | --- | --- |
| | | | | | --- | --- | 0.0 | | | | | | | |

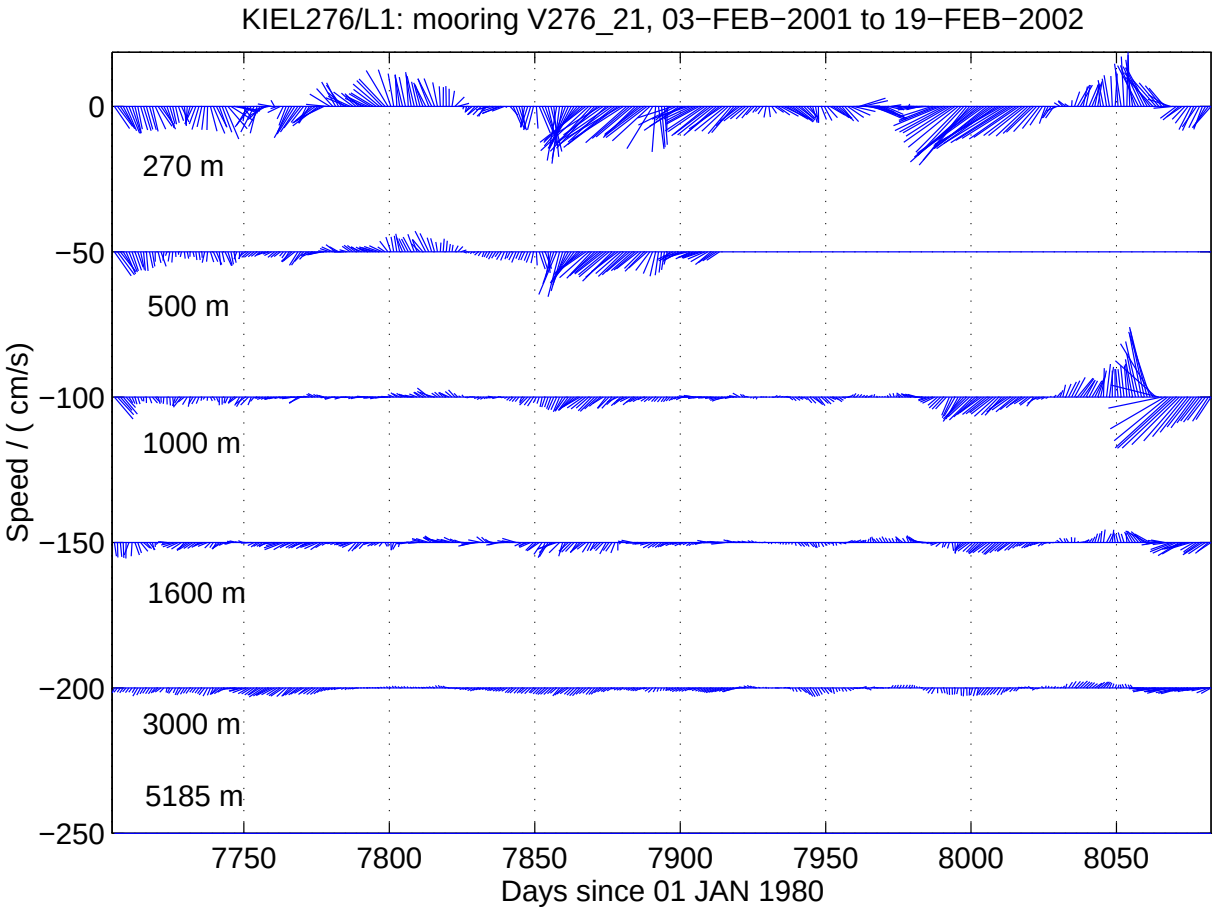


*Fig. 4.1.1: vector time series of low pass filtered daily averaged curents at site KIEL276/L1 for the time period February 2001 to February 2002.*

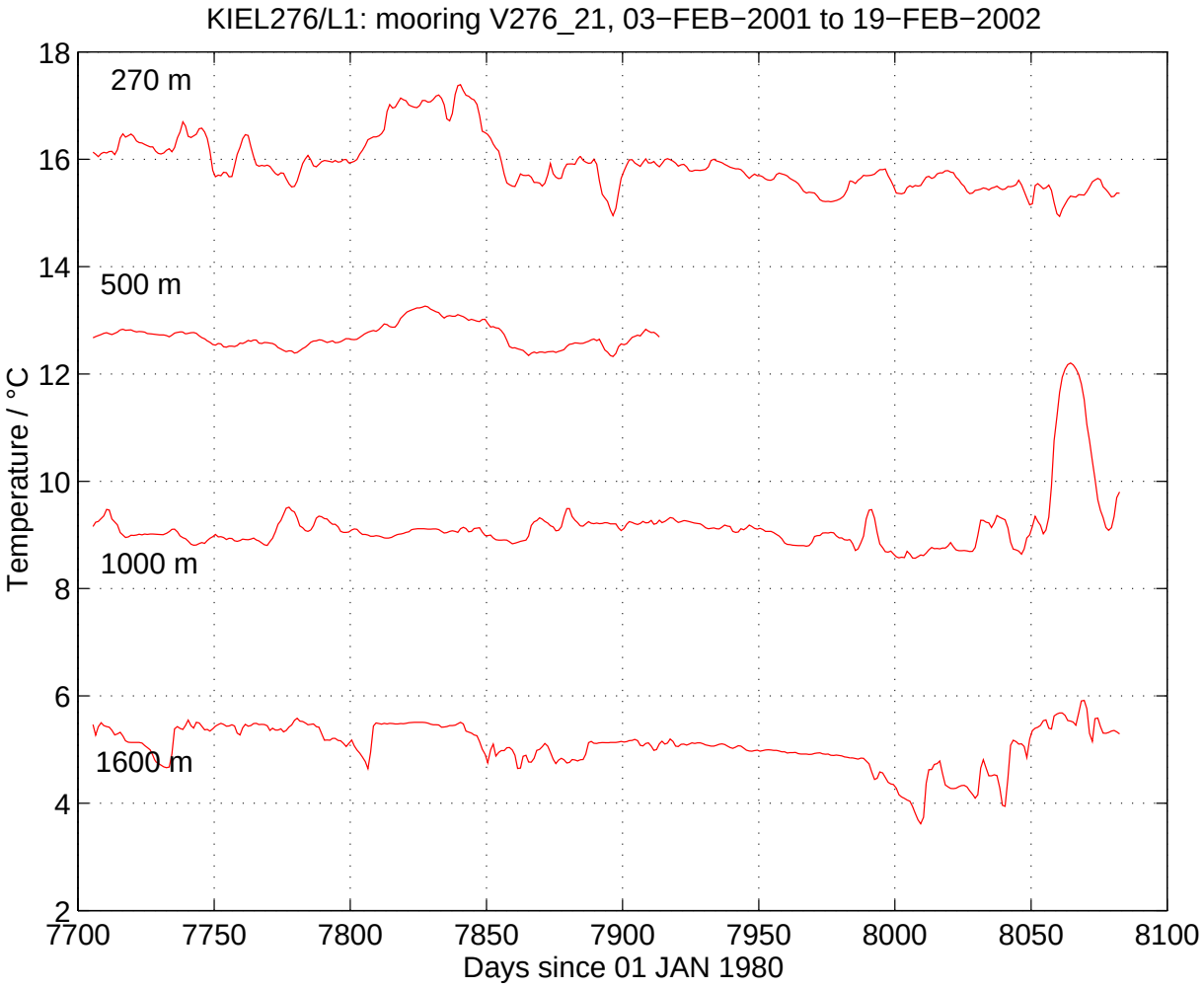


*Fig. 4.1.2: time series of low pass filtered daily averaged temperature at site KIEL276/L1 for the time period February 2001 to February 2002.*

## 4.2 Currents and water masses at ESTOC

Even more than at KIEL276, the flow (Fig. 4.2.1) is dominated by mesoscale motion with no significant mean in the 23-months current records at depths from 300 m on (Tab. 4.2.1). Note a long-term fluctuation in the temperature signal which can be traced down to 2000 m. and which cannot be explained by mooring motion (less 5 m at 300 m).

***Table 4.2.1:*** *flow statistics from ESTOC mooring V376-07, low-pass filtered daily averaged data. SPD and DIR are current speed and direction; s is vector stability; u and v are East- and North components of flow; T is temperature; STD is standard deviation for respective mean; ITS denotes an integral time scale defined as first zero-crossing of the autocorrelation function; fluxes <uv>, <uT> and <vT> are covariances; $<uv>_d$ is the main direction of momentum flux. Units are cm/s and °C.*

| ID | days | | | | means | | | ITS | | | fluxes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| depth | | | | | Std | | | | | | | | | |
| | | SPD | DIR | s | u | v | T | u | v | T | <uv> | $<uv>_d$ | <uT> | <vT> |
| V376-07 | | | | | | | | | | | | | | |
| 292 | 399 | 0.9 | 106 | 0.16 | 0.9 | -0.2 | 14.9 | 28 | 16 | 18 | -2 | -80 | -0.3 | -0.5 |
| | | | | | 5.1 | 4.1 | 0.2 | | | | | | | |
| 522 | 687 | 0.7 | 64 | 0.20 | 0.6 | 0.3 | 11.9 | 27 | 13 | 37 | -1 | -73 | 0.0 | 0.0 |
| | | | | | 3.2 | 2.9 | 0.1 | | | | | | | |
| 822 | 687 | 1.0 | 24 | 0.32 | 0.4 | 1.0 | 9.6 | 25 | 13 | 16 | -2 | -70 | 0.0 | -0.1 |
| | | | | | 3.0 | 2.3 | 0.2 | | | | | | | |
| 1222 | 687 | 0.5 | 32 | 0.22 | 0.3 | 0.4 | 7.7 | 21 | 12 | 22 | -1 | -54 | 0.0 | -0.1 |
| | | | | | 1.9 | 1.7 | 0.2 | | | | | | | |
| 2022 | 687 | 0.2 | 7 | 0.13 | 0.0 | 0.2 | 4.2 | 20 | 15 | 64 | -1 | -46 | 0.0 | 0.0 |
| | | | | | 1.4 | 1.4 | 0.1 | | | | | | | |
| 3572 | 687 | 0.2 | 37 | 0.13 | 0.1 | 0.1 | 2.5 | 18 | 16 | 30 | 0 | -53 | 0.0 | 0.0 |
| | | | | | 1.1 | 1.0 | 0.0 | | | | | | | |

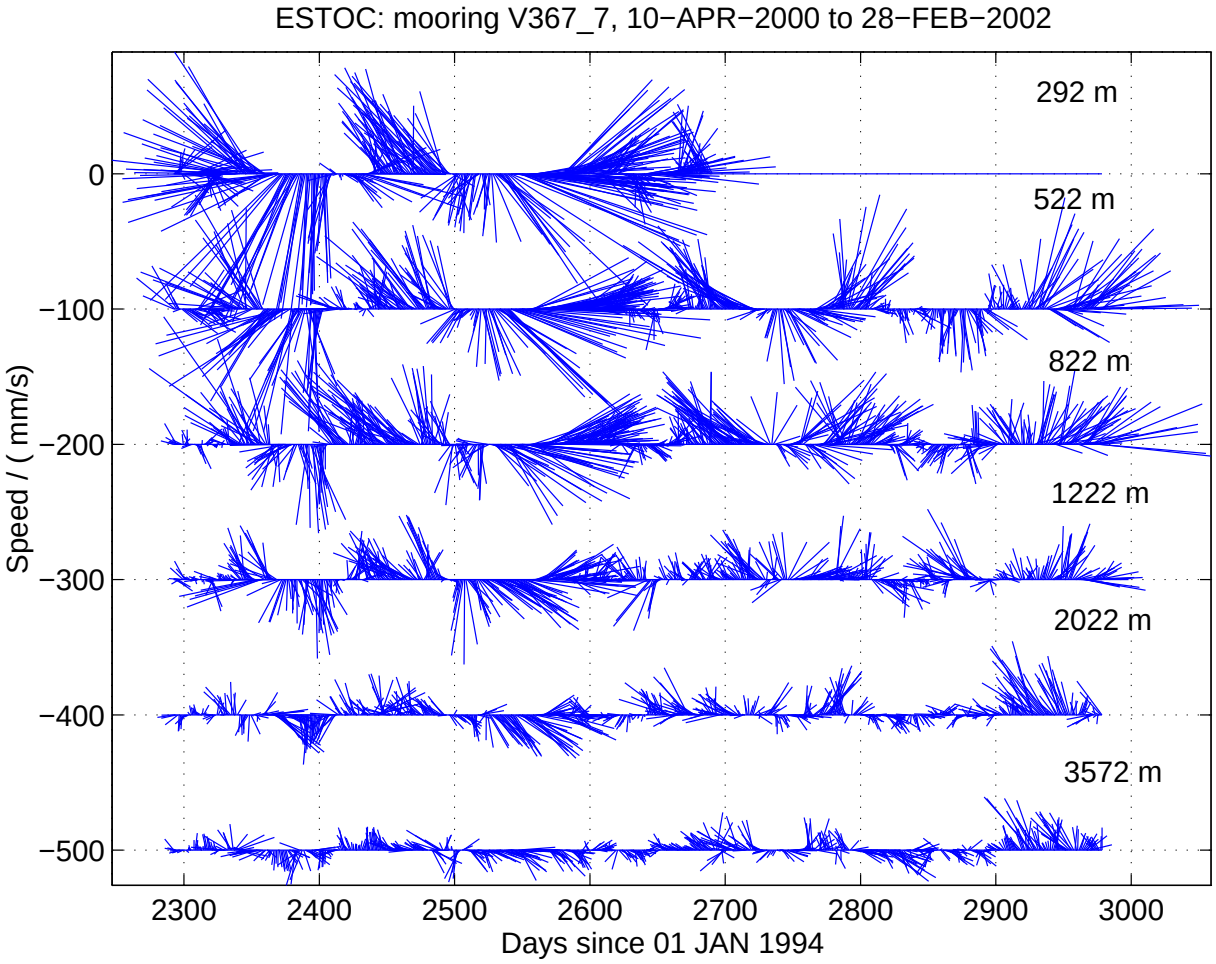


*Fig. 4.2.1: vector time series of low pass filtered daily averaged currents at ESTOC for the 23 months record, April 2000 to March 2002.*

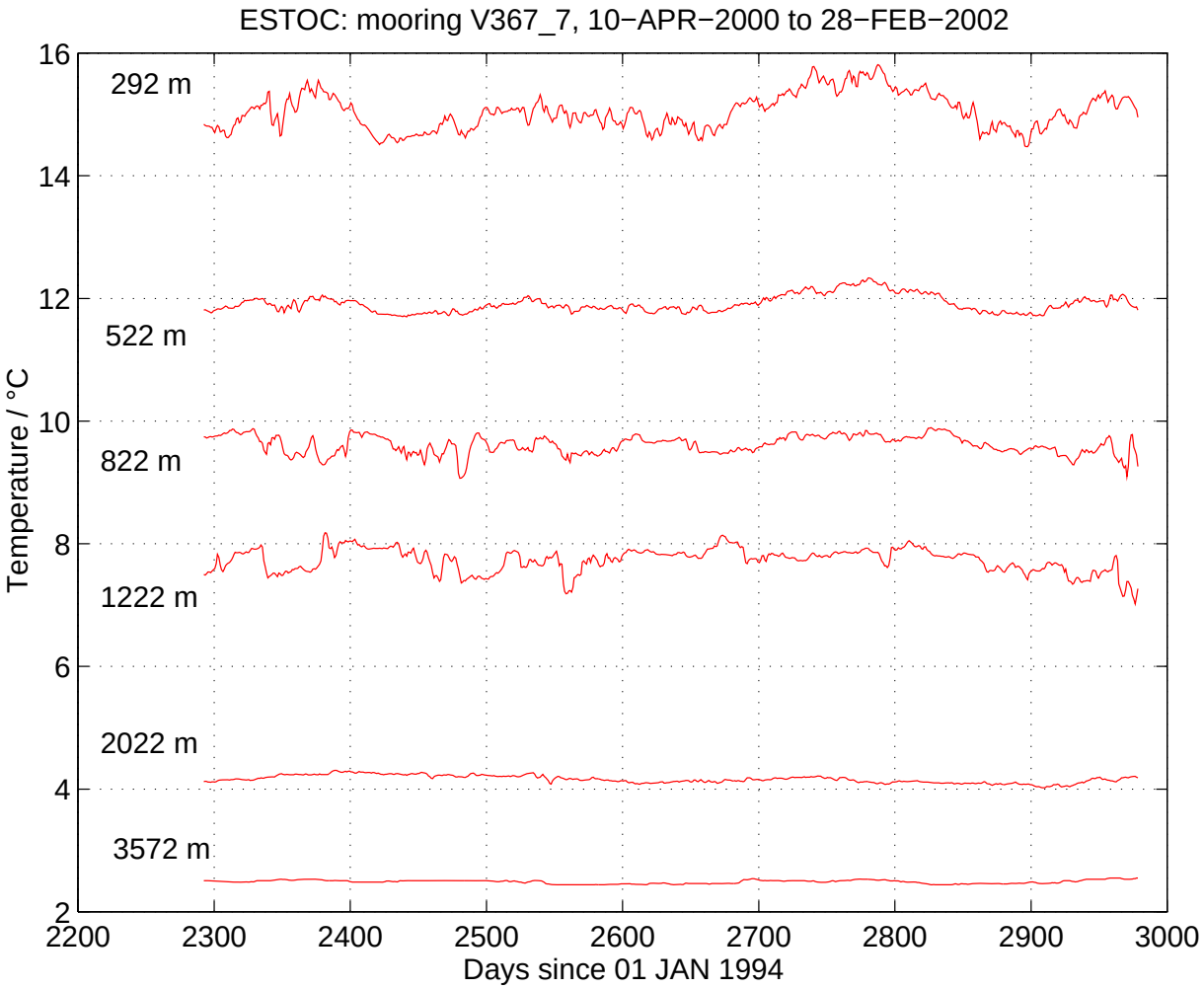


*Fig. 4.2.2: time series of low pass filtered daily averaged temperatur at ESTOC for the 23 months record, April 2000 to March 2002.*

### 4.3 Planktic foraminifers in the eastern subtropical Atlantic

The preliminary investigation of planktic foraminifers at the Azores Font region south of the Azores and at the Canary Current region southwest and northeast of the Canary Islands is summarized as follows: In the upper 700 m of the water column, the dominant live species were *Globorotalia truncatulinoides* and *Globorotalia inflata*, most abundant between 200-700 m depth, at both stations. *Globigerinoides ruber, Globigerinoides sacculifer, Globorotalia scitula, Globorotalia hirsuta, Globigerinita glutinata, Globigerina flaconensis, Globigerina bulloides, Orbulina universa*, and *Hastigerina pelagica* were present. In contrast to January 1999, the fauna is much more diverse, which points towards return of the spring/summer-fauna, and waning winter conditions. In January (1999), south of the Azores, in addition to *G. truncatulinoides, Turborotalita humilis* was frequent.

At depths larger than 700 m live planktic foraminifers were rare, and small-sized, empty foraminiferal tests were most frequent at 1100-1300 m and 950-1200 m depth, at station #12 and 24, southwest and northeast of the Canary Islands, respectively. The maximum frequency of small empty tests coincides to the lower horizon of the Mediterranean outflow water (MSW), and may display an accumulation of tests due to decelerating settling velocity at the high-viscous lower MSW layer. Empty shells of pteropods were rare and found at both stations and all depths.

## 5. Scientific equipment, instruments and moorings

### 5.1 Moorings

During P283/2, the long term current meter and sediment trap mooring K276/21 was recovered and mooring K276/22 was launched. During P283/3, the ESTOC current meter mooring V367_7 (IFMK) was recovered and replaced by an IEO mooring. Also, two IEO moorings east and west of the Island of Lanzarote (EBC4_6 and EBC6_4) were recovered.

***Table 1:*** *P283/3 moorings recovered (R) and launched (L) with number of Acoustic Doppler Current Profiler (ADCP), Aandearaa RCM9/8/5/4 current meters, and particle traps*

| Site | Date | Position | W.-Depth / m | ID | Instruments, depth/m | Remarks |
|---|---|---|---|---|---|---|
| **Kiel276/L1** | 19Feb02 | 32°55.50‘N 022°1.50‘W | 5217 | V276_21 /IFMK | ADCP: 200 RCM8: 270, 500, 1000, 1600, 3000, 5185 Traps: 2000 (2), 3050 | R |
| | 22Feb02 | 32°52.10’N 022°02.20’W | 5220 | V276_22 /IFMK | RCM8: 270, 500, 1000, 1600, 3000, 5185 Traps: 2000, 3050 | L |
| **ESTOC** | 01Mar02 | 29°09.50‘N 015°40.60‘W | 3616 | V367_07 /IFMK | RCM9: 232 RCM8: 292, 522, 822, 1222, 2022, 3572 | R |
| | 03Mar02 | 29°10.3‘N 015°40.6‘W | 3618 | ESTOC01 /IEO | RCM9: 232 RCM8: 292, 522, 822, 1222, 2022, 3572 | L |
| **EBC4** | 04Mar02 | 28°43.9’ 013°28.2’ | 1282 | EBC4_06 /IEO | RCM4: 170 RCM8: 320, 540, 890, 1250 | R |
| **EBC6** | 04Mar02 | 28°59.1‘ 013°59.5‘ | 1750 | EBC6_04 /IEO | RCM5: 160 RCM8: 310, 530, 880, 1240, 1560 | R |

### 5.2 CTD/rosette and salinometer

#### 5.2.1 CTD and bottle salinity

For the CTD-measurements, an ICTD of Falmouth Scientific Inc. was used during P283/2, and a Neil Brown MKIIIB during P283/3. Pressure and temperature sensors have a pre-cruise calibration in the laboratory, CTD salinity has an in-situ calibration using bottle data. The calibration procedures including data processing are described in Müller (1999).

No post-cruise laboratory calibration of the pressure and temperature sensors was possible before publishing this report. Therefore, the expected accuracies of these sensors (as known from observed possible drifts in the calibration history) are slightly less than usual. Salinity calibration as compared to bottle salinities will be not affected by these small scale

uncertainties in pressure and temperature accuracies; it is expected to better 0.003 on the IPSS78-scale.

The results of CTD calibration for this cruise are summarized in table 5.2.1.1.

***Table 5.2.1.1:*** *CTD calibration during P283*

| | **P283/2** | **P283/3** |
|---|---|---|
| **CTD-type** | FSI | MKIIIB<br>(IFMK code NB2) |
| | | |
| **Pressure** | | |
| Calibration date | Nov 2000 | Dec 2000 |
| Accuracy, full range | 3 dbar | 5 dbar |
| | | |
| **Temperature, ITS90** | | |
| Calibration date | Mar 2001 | Dec 2000 |
| Accuracy | 0.003 | 0.004 |
| | | |
| **Salinity, IPSS78** | | |
| Salinometer | Autosal IFMK AS6 | Autosal IFMK AS6 |
| Standard Seawater Batch | P139<br>K15=0.99993<br>S=34.9973 | P139<br>K15=0.99993<br>S=34.9973 |
| In-situ acuracy | 0.003 | 0.003 |

**5.2.2: Oxygen, nutrients and chlorophyll sampling on the ESTOC station (#038)**
Standard ESTOC depths and procedures were used. All samples were analyzed after the cruise at the ICCM according to the ESTOC standards (WOCE, 1994).

## 5.3 Underway measurements

### 5.3.1 Navigational data

An Ashtech made GG24 unit merges positionings from high rate GPS data with high precision GLONASS data. A problem occured with the date from GG24 which is offset into the past. This offset is constant and can be removed. The UTC time is ok.

Three dimensional GPS data from an Ashtech ADU2 are used to estimate heading, pitch and roll. A check of the September 1997 antenna calibration while in port during a later cruise, between P261 and P262 in July 2000, gave no corrections.

Both, GG24 and ADU2 data are input for the standard vmADCP data acquisition and for the underway logging system PC-Log (see 5.3.2)

### 5.3.2 PC-Log

A PC-based programme package, PC-Log, is used to log consecutively the data streams from navigational units, the ship's meteorological sensors, the deep sea echosounder and from the thermosalinograph. Standard ouput format is binary, but ASCII transformation is an option .

### 5.3.3 Meteorological data
The meteorological sensors (wind speed and direction, temperature, humidity, surface air pressure, near surface water temperature) are set up and maintained by the German Wheather Sevice (DWD), Seewetterdienst, Hamburg, Germany. Data are transferred on a regular scale into the Global Telecommunication System (GTS) for analysis by WMO partners. The digital output is also transferred to the PC-Log system.The sensors were maintained in late December 2001 before Poseidon sailed from Kiel.

### 5.3.4 Deep sea echosounder
A 12 kHz echosounder by ELAC provides depth information, both as standard graph and as digital output. The sound velocity converting travel times to sounding depths was 1500 m/s. The digital output was input to the PC-Log system.

### 5.3.5 Thermosalinograph
The digital output of the thermosalinograph raw data is transferred to the PC-Log system where it is converted to physical units for temperature and salinity. The accuracy is 0.05 K and 0.2 for temperature and salinity, respectively. Delayed-mode corrections with near surface CTD data while on station, improve the accuracy estimates to 0.02 K and 0.15 for temperature and salinity, respectively.

### 5.3.6 vmADCP
The vessel mounted ADCP usually used *en route*, is a standard 150 kHz instrument made by RDI. Unfortunately, due to an instrumental problem, no data could be acquired during the whole cruise.

## 5.4 Plankton sampling
Planktic foraminifers and pteropods were sampled with a multiple closing net (MSN), 100 um mesh size. Water samples from CTD-Rosette hauls were filtered for coccolithophores through a 0.8 µm Nucleopore filter at 200 mbar suction.

## 6. Additional remarks
We would like to thank Captain Classen and his crew for their advise and help during this cruise.

## 7. Appendices
A. Station list

## 8. References
Müller, T.J. (1999): Determination of salinity. *In*: Grasshoff, K, K. Kremling and M. Ehrhardt (editors): Methods of Seawater Analysis, Wiley-VCH, 600 pp.

WOCE (1994): WOCE operations manual, WHP office report, whp 91.1, WOCE report no. 68/91.

## Appendix A: P283 station and sample log

**POSEIDON cruise 283/2-3, 11.02.-05.03.2002**
Pta. Delgada - Las Palmas - Las Palmas
**Station and sample log**

**Status:** 18.-MAR-2003

**Remark:** P283/1 was transit from Kiel via Southampton to Pta. Delgada only.

**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
Wl : length of wire, instrumental depth
Instr : Type of instrumentation or mooring or equipment with symbol
It
VXXX : 1 mooring
NB2 : 2 Neil Brown CTD, IFMK code NB2, 24x10 l bottle rosette
FSI : 2 Falmouth Scientific CTD; IFMK code FSI, O2 and fluorescence senors,
12x12 l bottle GO rosette
XBT : 3 Sippican Deep Blue, 760 m
MUV : 5 Multiple closing plankton net
TSG : 4 Ship's thermosalinograph, 4 m, made by ME, Kiel, Germany
vADCP : 4 vessel mounted RDI ADCP, 150 KHz, 4 m
PC-LOG: 4 on-line log of GPS date, time, position, pitch & roll
(ASHTEC GPS/GLONASS & ADU2), near-surface T, S from the TSG;
meteorological data of the ship's meteorological sensors
bio : bio-geochemical under way sampling:
T, S, O2, nutrients, POC, DOC, Cla, plankton, alkenones

Additional sensors / samples with CTD/rosette:
OC : 2 oxygen sensor on CTD (Beckmann type, oxygen current and temperature)
F : 3 Fluorometer on CTD
O2 : 4 dissolved oxygen samples
N : 5 nutrient samples
Cla: 6 chlorophyll samples
S : 7 salinity samples

**Year 2002**

| Date UTC MM | Time UTC DD | hh | mm | St | C | Latitude North GG | MM.MM | Longitude East GGG | MM.MM | Wd m | Wl m | It | Instrument / Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 25 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | 4 | sail Kiel, begin P283/1 |
| 01 | 30 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | 4 | berth Southampton |
| 02 | 02 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | 4 | sail Southampton |
| 02 | 10 | -9 | -9 | -9 | -9 | 37 | 24.00 | -025 | -24.00 | -9 | -9 | 4 | berth Pta. Delgada; end P283/1 |
| 2 | 11 | -9 | -9 | -9 | -9 | 37 | 24.00 | -025 | -24.00 | -9 | -9 | 4 | sail Pta. Delgada; begin P283/2 |
| 2 | 12 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | 4 | PC-log and bio on |
| 2 | 12 | 12 | 23 | 1 | 1 | 34 | 59.00 | -028 | -30.00 | 3500 | 1517 | 2 | FSI |
| 2 | 12 | 22 | 40 | 2 | 2 | 34 | 34.90 | -028 | -50.47 | 3340 | 510 | 2 | FSI |
| 2 | 12 | 22 | 40 | 2 | 3 | 34 | 34.90 | -028 | -50.47 | 3340 | 165 | 2 | FSI |
| 2 | 13 | 2 | 38 | 3 | 4 | 34 | 10.40 | -029 | -11.27 | 3434 | 514 | 2 | FSI |
| 2 | 13 | 6 | 20 | 4 | 5 | 33 | 45.80 | -029 | -31.77 | 3274 | 498 | 2 | FSI |
| 2 | 13 | 10 | 5 | 5 | 6 | 33 | 20.93 | -029 | -52.45 | 2255 | 498 | 2 | FSI |
| 2 | 13 | 14 | 10 | 6 | 7 | 33 | 19.04 | -029 | -16.89 | 2676 | 498 | 2 | FSI |
| 2 | 13 | 17 | 48 | 7 | 8 | 33 | 17.38 | -028 | -41.19 | 2602 | 498 | 2 | FSI |
| 2 | 13 | 21 | 40 | 8 | 9 | 33 | 16.28 | -028 | -5.96 | 2796 | 524 | 2 | FSI |
| 2 | 14 | 11 | 0 | 9 | 10 | 31 | 31.04 | -026 | -26.90 | 5335 | 991 | 2 | FSI |
| 2 | 14 | 17 | 0 | 9 | 11 | 30 | 49.49 | -026 | -3.09 | 4892 | 498 | 2 | FSI |
| 2 | 15 | 10 | 0 | 11 | 12 | 28 | 34.95 | -024 | -9.40 | 5156 | 5195 | 2 | FSI |
| 2 | 15 | 17 | 50 | 12 | 13 | 28 | 36.76 | -024 | -8.74 | 5145 | 302 | 2 | FSI |
| 2 | 16 | 11 | 3 | 12 | 14 | 26 | 22.52 | -022 | -18.46 | 4836 | 1585 | 2 | FSI |
| 2 | 16 | 23 | 0 | 13 | 15 | 27 | 15.23 | -022 | -15.85 | 4871 | 496 | 2 | FSI |
| 2 | 17 | 9 | 0 | 14 | 16 | 28 | 36.35 | -022 | -11.11 | 4871 | 1977 | 2 | FSI |
| 2 | 18 | 9 | 46 | 15 | 17 | 30 | 41.45 | -022 | -6.01 | 4871 | 1983 | 2 | FSI |
| 2 | 18 | 21 | 0 | 16 | 18 | 31 | 52.16 | -022 | -3.03 | 5039 | 496 | 2 | FSI |

**Year 2002**

| Date UTC MM | Time UTC DD | hh | mm | St | C | Latitude North GG | MM.MM | Longitude East GGG | MM.MM | Wd m | Wl m | It | Instrument / Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 19 | 09 | 13 | -9 | -9 | 32 | 55.5 | -022 | -1.5 | 5217 | -9 | 1 | mooring V276-21 recovered |
| 2 | 19 | 17 | 20 | 17 | 19 | 32 | 55.48 | -022 | -1.31 | 5239 | 5274 | 2 | FSI |
| 2 | 20 | 10 | 50 | 18 | 20 | 32 | 59.32 | -021 | -58.44 | 5239 | 993 | 2 | FSI |
| 2 | 20 | 18 | 0 | 19 | 21 | 33 | 18.35 | -021 | -43.66 | 5239 | 496 | 2 | FSI |
| 2 | 21 | 9 | 20 | 20 | 22 | 32 | 55.80 | -022 | -1.31 | 5235 | 599 | 2 | FSI |
| 2 | 21 | 14 | 40 | 21 | 23 | 33 | 23.35 | -021 | -47.06 | 5235 | 621 | 2 | FSI |
| 2 | 21 | 19 | 20 | 22 | 24 | 33 | 50.56 | -021 | -34.06 | 9999 | 599 | 2 | FSI |
| 2 | 21 | 23 | 58 | 23 | 25 | 34 | 18.70 | -021 | -24.56 | 9999 | 597 | 2 | FSI |
| 2 | 22 | -9 | -9 | -9 | -9 | 33 | 0.0 | -22 | -0.0 | 5217 | -9 | 1 | mooring V276-22 launched |
| 2 | 23 | 10 | 23 | 24 | 26 | 29 | 59.68 | -021 | -59.68 | 5200 | 1487 | 2 | FSI |
| 2 | 24 | 16 | 5 | 25 | 27 | 29 | 15.04 | -019 | -0.07 | 4463 | 1979 | 2 | FSI |
| 2 | 24 | 21 | 40 | 26 | 28 | 29 | 15.01 | -018 | -30.07 | 4463 | 1983 | 2 | FSI |
| 2 | -9 | -9 | -9 | -9 | -9 | 28 | 45 | -016 | -0 | -9 | -9 | 4 | waypoint off Tenerife |
| 2 | 26 | 08 | 36 | -9 | -9 | 28 | 09 | -015 | -25 | -9 | -9 | 4 | call in to Las Palmas; end of P283/2 |
| 03 | 01 | 08 | 15 | -9 | -9 | 28 | 09 | -015 | -25 | -9 | -9 | 4 | sail from Las Palmas; begin of P283/3 |
| 01 | 01 | 11 | 00 | -9 | -9 | 99 | 99.99 | 999 | 99.99 | -9 | 4 | 4 | start PC-LOG; |
| 01 | 01 | 11 | 00 | -9 | -9 | 99 | 99.99 | 999 | 99.99 | -9 | 4 | 4 | start TS-graph |
| 01 | 01 | 11 | 00 | -9 | -9 | 99 | 99.99 | 999 | 99.99 | -9 | 4 | 4 | start pCO2 |
| 03 | 01 | 10 | 22 | -9 | 1 | 28 | 23 | -015 | -25.30 | -9 | 750 | 3 | XBT 1 |
| 03 | 01 | 11 | 09 | -9 | 2 | 28 | 30 | -015 | -27.70 | -9 | 750 | 3 | XBT 2 |
| 03 | 01 | 12 | 13 | -9 | 3 | 28 | 40 | -015 | -31.10 | -9 | 750 | 3 | XBT 3 |
| 03 | 01 | 13 | 17 | -9 | 4 | 28 | 50 | -015 | -34.10 | -9 | 750 | 3 | XBT 4 |
| 03 | 01 | 14 | 22 | -9 | 5 | 29 | 00 | -015 | -37.30 | -9 | 750 | 3 | XBT 5 |
| 03 | 01 | 15 | 25 | -9 | 6 | 29 | 10 | -015 | -40.30 | -9 | 750 | 3 | XBT 6 |
| 03 | 01 | 10 | 00 | 127 | -9 | 29 | 10.3 | -015 | -40.6 | 3618 | -9 | 1 | mooring V367-07 recovery |
| 03 | 01 | 19 | 00 | 128 | 29 | 29 | 07.8 | -015 | -41.5 | 3618 | 3629 | 2 | NB2 |
| 03 | 02 | 10 | 38 | 129 | 31 | 29 | 10.02 | -017 | -59.88 | 3691 | 3735 | 2 | NB2, O2, N, Cla, S |
| 03 | 02 | 14 | 30 | 129 | -9 | 29 | 10.0 | -018 | -00.0 | 3691 | 1000 | 5 | MUV, 1000 m |
| 03 | 02 | 20 | 14 | 130 | 32 | 29 | 09.95 | -016 | -59.89 | 3884 | 2000 | 2 | NB2, O2, N, Cla, S |
| 03 | 03 | 04 | 04 | 131 | 33 | 29 | 09.89 | -015 | -59.13 | 3630 | 2000 | 2 | NB2, O2, N, Cla, S |
| 03 | 03 | 08 | 12 | 132 | -9 | 29 | 11.8 | -015 | -41.2 | 3620 | -9 | 1 | ESTOC: IEO current meter mooring |
| 03 | 03 | 13 | 00 | 133 | -9 | 29 | 10.0 | -015 | -30.0 | 3608 | 2000 | 5 | ESTOC: MUV, 2000 m |
| 03 | 03 | 13 | 55 | 133 | 34 | 29 | 10.23 | -015 | -29.60 | 3608 | 3629 | 2 | ESTOC: MAR 2002 station<br>NB2, O2, N, Cla, S |
| 03 | 03 | 17 | 00 | 133 | -9 | 29 | 10.0 | -015 | -30.0 | 3608 | 1000 | 5 | ESTOC: MUV, 1000 m |
| 03 | 03 | 18 | 00 | 133 | -9 | 29 | 10.0 | -015 | -30.0 | 3608 | -9 | 4 | NOOA drifting buoy launched |
| 03 | 04 | -9 | -9 | -9 | -9 | 28 | 46.36 | -013 | -50.77 | -999 | -9 | 4 | Estrecha |
| 03 | 04 | 06 | 00 | 134 | 36 | 28 | 43.11 | -013 | -29.06 | 1280 | -9 | 2 | NB2, O2, N, CLa, S |
| 03 | 04 | 08 | 00 | 135 | -9 | 28 | 44.9 | -013 | -28.2 | 1282 | -9 | 1 | mooring EBC4-6 recovery |
| 03 | 04 | -9 | -9 | -9 | -9 | 28 | 46.36 | -013 | -50.77 | -999 | -9 | 4 | Estrecha |
| 03 | 04 | 13 | 00 | 136 | -9 | 28 | 59.1 | -013 | -59.5 | 1750 | -9 | 1 | mooring EBC6-4 recovery |
| 03 | 04 | -9 | -9 | -9 | -9 | 28 | 46.36 | -013 | -50.77 | -999 | -9 | 4 | Estrecha |
| 04 | 03 | 15 | 03 | 137 | 37 | 28 | 56.01 | -014 | -07.08 | 2450 | 2135 | 2 | NB2, O2, N, Cla, S |
| 04 | 03 | 18 | 59 | 138 | 38 | 28 | 57.93 | -014 | 14.83 | 3005 | 2000 | 2 | NB2, O2, N, Cla, S |
| 03 | 05 | 08 | 30 | -9 | -9 | 28 | 30 | -015 | -15.22 | -9 | -9 | 4 | TSG off; |
| 03 | 05 | 08 | 30 | -9 | -9 | 28 | 30 | -015 | -15.22 | -9 | -9 | 4 | pCO2 off; |
| 03 | 05 | 08 | 30 | -9 | -9 | 28 | 20 | -015 | -17.30 | -9 | -9 | 4 | PC-LOG off |
| 03 | 05 | 10 | 00 | -9 | -9 | 28 | 09 | -015 | -25 | -9 | -9 | 4 | Las Palmas; end P283/3 |