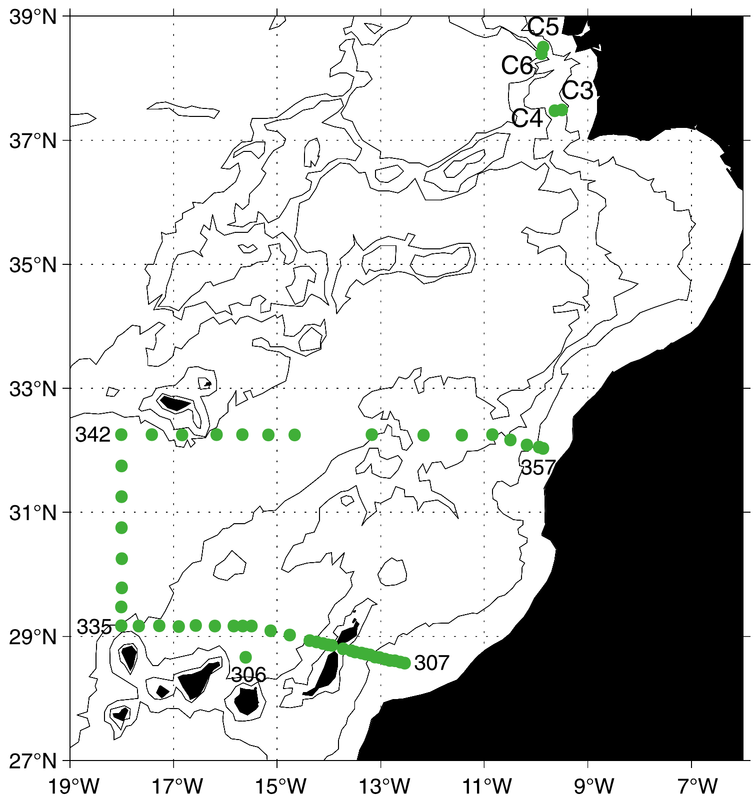
A. Cruise Narrative: AR26



A.1. Highlights

WHP Cruise Summary Information

WOCE section designation	**AR26**
Expedition designation (EXPOCODE)	**06MT42_1**
Chief Scientist(s) and their affiliation	**Müller, Thomas J./IfMK**
Dates	1998.06.16 - 1998.07.16
Ship	Meteor
Ports of call	Las Palmas - Lisbon
Number of stations	45
Geographic boundaries of the stations	38° 30.36 N 18° 1.3 E 9° 29.85 E 28° 20' N
Floats and drifters deployed	none
Moorings deployed or recovered	4

Contributing Authors:

T. J. Müller, M. Knoll, B. Lenz, F. Lopez-Laatzen, R. Santana, A. Cianca, M.G. Villagarcia, J. Godoy, M.J. Rueda, W. Breves, K.-D. Loquay, O. Zielinski, K. Pape, U. Scüßler, C. v. Oppen, C. Collado-Sánchez, V. Siruela-Matos, F.J. Martín-Muñoz, J.J. Herández-Brito, B. Heyden, W. Kühn, M. Spietz, S. Neuer, T. Freudenthal, M. Schroeter, J. Bollmann, H.-C. John, H. D. Behr

Institut für Meereskunde an der Universit t Kiel
D sternbrooker Weg 20
24105 KIEL, Germany

Phone: ++431 597 3799
Fax: ++431 597 3981
e-mail: tmueller@ifm.uni-kiel.de

METEOR-Cruise 42/1

Cruise Report

M42/1a: 16.06.-25.06.1998, Las Palmas - Las Palmas

M42/1b: 26.06.-16.07.1998, Las Palmas - Lisbon

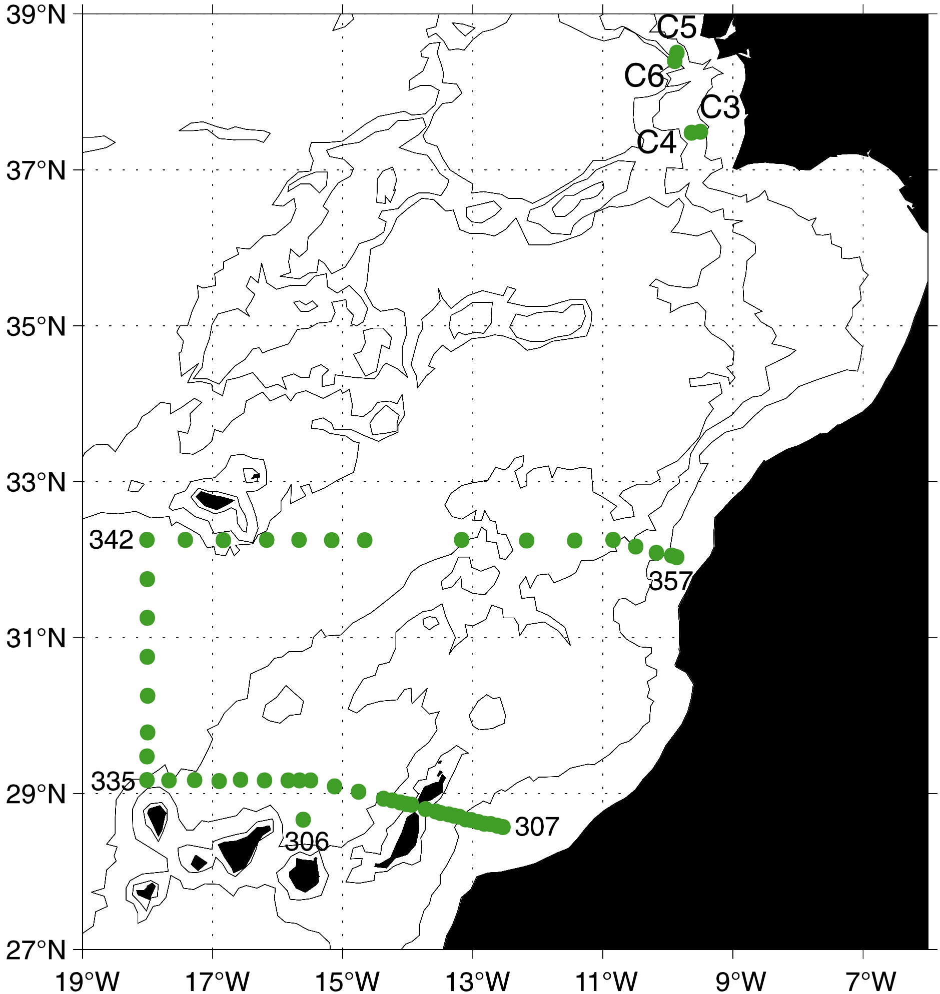
Abstract

Leg M42/1 was performed within two major projects of basic marine research. CANIGO (Canary Islands Azores Gibraltar Observations) is a multinational project funded by the European Union to investigate by field experiments and modelling the circulation and watermasses in the subtropical eastern North Atlantic and to determine the distribution and the fluxes of a diversity of parameters in this region. ESTOC is a European time series station that has been set up since 1994 in a joint effort of four institutes from Spain and Germany 60 nm north of Gran Canaria and Tenerife, and that serves as a background station for CANIGO. The aim of leg 42/1 was to exchange and set moorings with current meters and particle traps at selected positions at which currents and vertical particle fluxes are to be measured directly for several months. These moorings are part of a closed box of 45 stations north of the Canary Islands from which balanced fluxes will be calculated by using geostrophic currents that will be adjusted to absolute profiles of ADCP measurements.

Compiled by Thomas J. M ller
Institut f r Meereskunde an der Universit t Kiel
D sternbrooker Weg 20
24105 KIEL, Germany

Phone: ++431 597 3799
Fax: ++431 597 3981
e-mail: tmueller@ifm.uni-kiel.de

Station Locations for AR26, Müller, 1998



Provided by T.J. Müller

1 Research Objectives

The area north of the Canary Islands until the latitude of Madeira is characterized in the upper layers by recirculating branches of the North Atlantic s subtropical gyre that feed the Canary Current and that are influenced by upwelling events off the African coast. This leg of Meteor cruise 41 was aimed at studying the circulation and transports of water masses, the associated fluxes of bio-geochemical parameters in the water column in this area and their variability in space and time for the summer season. Three earlier cruises (Wefer and M ller, 1998; Knoll et al., in press) have been performed in winter with FS "Meteor" (M37/2, January 1997), and with FS "Poseidon" in spring (P237/3, April 1998) and in autumn (P233, September 1997). The work was embedded mainly in two major interdisciplinary and multinational projects: the European funded marine science and technology project CANIGO (Canary Islands Azores Gibraltar Observations) and the Spanish German ocean time series station ESTOC which is operational since 1994 ca. 100 Km north of Gran Canaria.

Methods included to use moored current meters and particle traps to study the vertical structure of the eastern boundary current and sedimentation rates of a diversity of bio-chemical parameters at two key sites (Fig. 1.1): (i) in an array of four moorings (EBC) east of Fuerteventura / Lanzarote, an area that is strongly influenced by upwelling and the associated current system, (ii) at the open ocean time series station ESTOC which serves also as a background station for CANIGO. A third mooring site is located at the more oligothophic station LP north of La Palma (29°45’ N, 018°00’ W) that was to be served later during leg M42/4.

To estimate the spatial structure and variability of fluxes in the recirculation regime, a hydrographic box of 45 stations was obtained north of the Canary Islands (Fig. 1.2) to estimate transports of waters masses and bio-chemical parameters. Classic hydrography along with direct current measurenments from lowered and ship mounted ADCP was used. Sampling included also DOC, Al and other trace metals, coccolithophores and diatoms, and zooplankton and fish larvae.

2 Participants / List of Institutions

For logistic reasons, the leg had two parts:

M42/1a: 16.06.-25.06.1998, Las Palmas - Las Palmas;(1)
embarked on 21 June in Arrecife

M42/1b: 26.06.-16.07.1998, Las Palmas - Lisbon

Personnel	Inst.	Responsibility	Leg(s)	
M ller, Dr. Thomas J.	IfMK	chief scientist	M42/1a	M42/1b
de Boer, Christjan, stud.	IfMK	phys. oceanogr	M42/1a	M42/1b
Carlsen, Dieter, TA	IfMK	moorings	M42/1a	
Dietze, Heiner, stud.	IfMK	phys. oceanogr.	M42/1a	M42/1b
Knoll, Michaela, Dr.	IfMK	phys. oceanogr.		M42/1b
Koy, Uwe, TA	IfMK	CTD,ADCP,moorings		M42/1b
Lenz, Bernd, Dipl.-Oz.	IfMK	phys. oceanogr.	M42/1a	M42/1b
Link, Rudolf, TA	IfMK	ADCP, CTD, moorings	M42/1a	M42/1b
Meyer, Peter, Dipl.-Ing.	IfMK	CTD, moorings	M42/1a	
Lopez-L., Federico, MSc.	IEO	phys. oceanogr	M42/1a	
Garcia-R., Carlos, MSc.	IEO	moorings	M42/1a	
Cisneros-A., Jesus, MSc.	ULPGC	moorings	M42/1a	
Neuer, Susanne, Dr.	GeoB	particle flux	M42/1a	
Freudenthal, Tim, Dipl.-Geol.	GeoB	particle flux		M42/1a
Schroeter, Marcel, Dipl.-Biol,	GeoB	particle flux	M42/1a	
v. Oppen, Caroline, Dr.	UBMCh	trace metals	M42/1a	
Deeken, Aloys, TA	UBMCh	trace metals	M42/1a	
Wilkop, Thomas, Stud.	UBMCh	trace metals	M42/1a	
Sch ssler, Uwe, Dr.	UBMCh	trace metals		M42/1b
Pape, Katja, TA	UBMCh	trace metals		M42/1b
Spietz, Matthias	IBGMH	DOC	M42/1a	
Heyden, Birgit	IBGMH	DOC		M42/1b
K hn, Wilfried Dr.	GeoB	DOC		M42/1b
Zielinski, Oliver, Dipl.-Phys.	UO	Bio-Optics		M42/1b
Breves, Wiebke	UO	Bio-Optics		M42/1b
Loquay, Klaus, TA	UO	Bio-Optics		M42/1b
Llinas, Octavio, Dr. (1)	ICCM	nutrient rec.	M42/1a	
Cianca-A., Andres, Msc.	ICCM	mar. chem.		M42/1b
Godoy, Juana, Msc.	ICCM	mar. chem.		M42/1b
Maroto, Leire	ICCM	mar. chem.		M42/1b
Rueda, Maria J. (1)	ICCM	mar. chem.	M42/1a	
Villagarcia, M., Dr.	ICCM	mar. chem.		M42/1b
Collado Sanchez, Cayetano, Dr.	ULPGC	trace metals		M42/1b
Munoz, Francisco J.M., MSc.	ULPGC	trace metals		M42/1b
Siruela Matos, Victor, MSc.	ULPGC	trace metals		M42/1b
Bollmann, J rg, Dr.	ETH	coccos		M42/1b
Martinez, Mara Dr.	ETH	coccos		M42/1b
Correira, Antonio, TA	IGM	diatomes		M42/1b
John, H.-C., Dr.	FIS	biol. oceanogr.		M42/1b
	Total		18	26

Institutes

ETH	Eidgen ssiche Technishe Hochschule, Z rich, CH
FIS	Forschungsinstitut Senckenberg, Taxonomische Arbeitsgruppe, D
GeoB	Universit t Bremen, FB 5 Geowissenschaften, D
IBGMH	Institut f r Biogeochemie und Meereschemie der Universit t Hamburg, D
ICCM	Instituto Canario de Ciencas Marinas, Telde de Gran Canaria, E
IEO	Instituto Espanol de Oceanografia, Sta. Cruz de Tenerife, E
IfMK	Institut f r Meereskunde an der Universit t Kiel, D
IGM	Instituto Geologico e Minero, Lisboa, P
UBMCh	Universit t Bremen, FB2 Chemie, Meereschemie, D
UL	Universidade de Lisboa, P
ULPGC	Universidad de Las Palmas, Las Palmas de Gran Canaria, E
UO	Universit t Oldenburg, Fachbereich Physik, D

3 Research Programme

Along the CANIGO and ESTOC scientific goals, METEOR cruise M42/1 was aimed at providing a data base for studying the circulation and water mass transports in the subtropical eastern North Atlantic north and east of the Canary Islands (Fig. 1.1, 1.2). The region encompasses the eastern boundary current system. Determining the variability of the circulation and associated bio-geochemical fluxes on time scales from days to annual and longer, and on spatial scales that include the mesoscale (30 Km) up to basin scale is included. The flow field, the water mass transports and the associated bio-geochemical fluxes in the region are strongly influenced by both, the recirculation of the subtropical gyre that feeds the Canary Current and the seasonally varying trade wind field with its impact on the upwelling system and the eastern boundary current system off Marocco.

To approach the problem, basicly two methods are used. First, at selected positions the vertical structure of currents and the vertical transport of particles are measured for a period of ca 18 months from January 1997 on to cover more than one season. The sites chosen (see Fig. 1.1) are the ESTOC position, an array of four moorings in the eastern boundary current sytem (EBC) east of Lanzarote and Fuerteventura that will be influenced strongly by upwelling events, and a more oligithrophic open ocean position north of La Palma (LP). Current meters and particle traps were exchanged, with a service of instruments scheduled for January 1998 from the German reserach vessel 'Poseidon'. During the first part of M42/1, it was planned to

- exchange the ESTOC current meter mooring (IFMK)
- to exchange the four moorings of array EBC (IFMK, IEO, ULPGC, GeoB)
- to measure the vertical particle flux in the upper 200 m near ESTOC and at the same time to perform incubation experiments (GeoB)
- to measure the concentraions and vertical fluxes of certain trace metals at the ESTOC, EBC and LP sites (UBMCh)

The mooring at site LP (29°45' N, 018°00' W, GeoB, IFMK) wasl exchanged later during leg M42/4.

Second, a closed box north and east of the Canary Islands is designed with 45 hydrographic stations spaced between 7 nm on and close to the shelf, and 40 nm in the deep basin. On each station, bottom deep CTD and lowered ADCP measurements and water sampling for dissolved oxygen, nutrients and chlorophyll analysis build the basic hydrographic measurements to determine the flow field and the water mass distribution. En-route, the upper ocean current profiles down to 200 m and the sea surface temperature and salinity are measured using a vessel mounted ADCP and a thermosalinograph in combimation with GPS positioning. These basic measurements on the box have already been perfomed during the other three seasons in January 1997 with 'Meteor' (M37/2), and in September 1997 and April 1998 with 'Poseidon' (P233 and P237/3, respectively). During the second part of M42/1 these and additional samples were taken and measurements were made to

- to determine the absolute flow field and with a CTD/rosette/ADCP system and with shipborne ADCP (IFMK)
- to provide water mass information from oxygen, nutrient and chlorophyll (ICCM)
- to use optical sensors attached to a CTD for biological interpretations (UO)
- to take samples for dissolved organic carbon DOC (IBGM)

- to take samples for coccolithophores and diatomees (ETH, UL)
- to measure aluminum and other metals in the water column (ULPGC)
- to detect fish larvae as tracers for intermediate water masses (FIS)

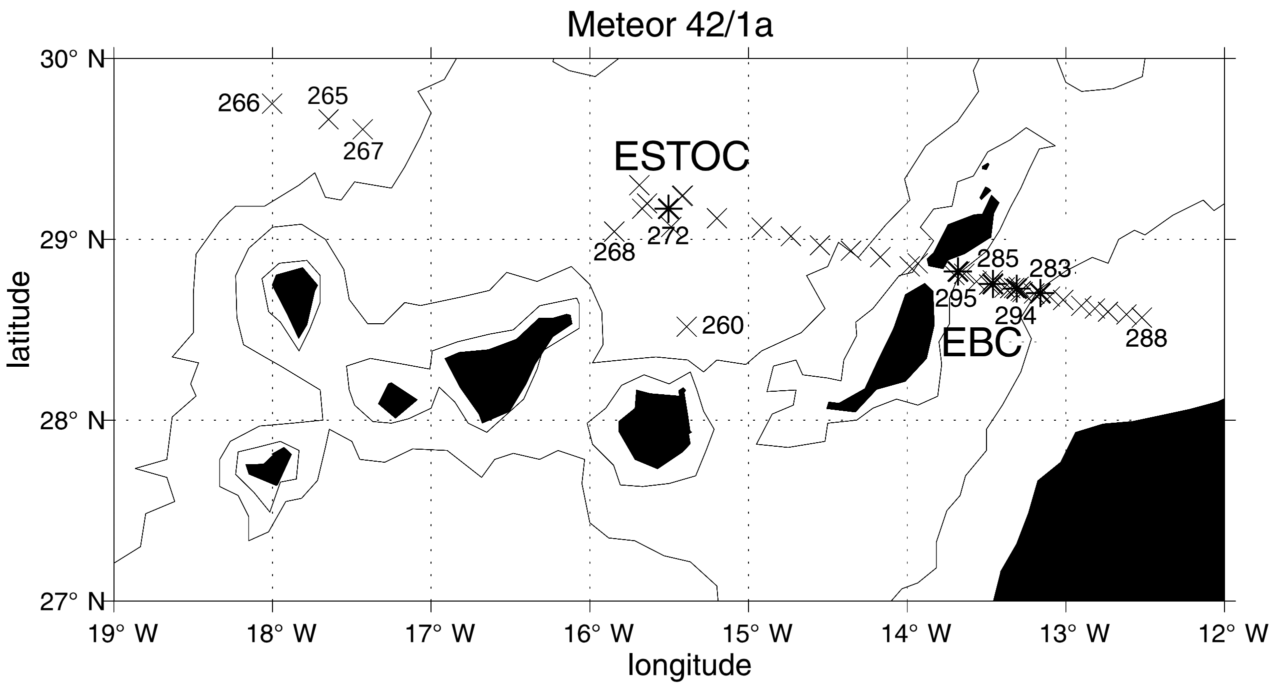


Figure 1.1: Staions and mooring positions during leg M42/1a

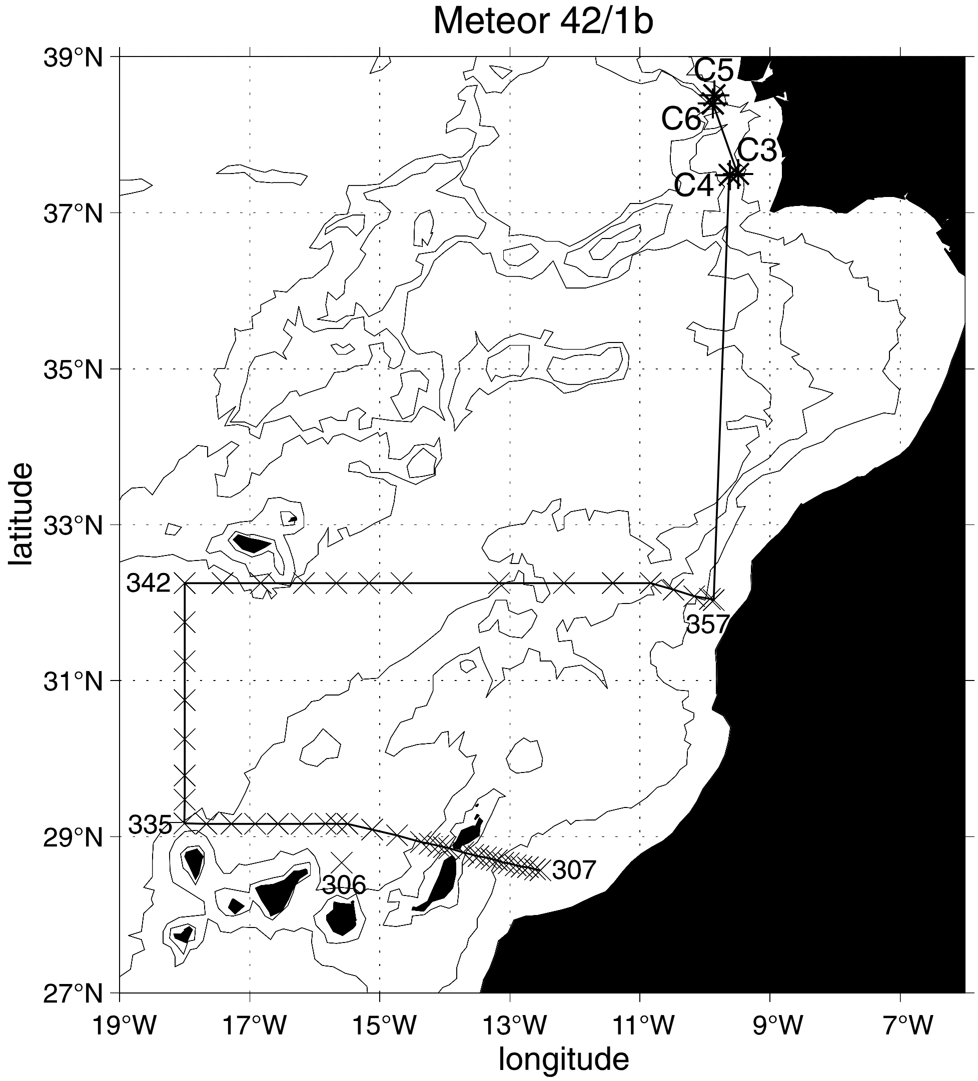


Figure 1.2: Stations during leg M42/1b

4 Narrative

For logistic reasons, the leg was divided into two parts. After loading of scientific equipment and embarking of the scientific party, 'Meteor' sailed from Las Palmas on the 26 June 1997 in the afternoon. This first part, leg M42/1a, was aimed at mooring and station work near the centre of the CANIGO array in the eastern boundary current system (EBC), at the ESTOC station and at the more oligotrophic CANIGO position LP north of the island of La Palma at 29°45' N, 018°00' W (see Fig. 1.1 for positions). At these stations, special water sampling was performed for trace metal analysis. Near ESTOC, an experiment was designed to determine the vertical flux of particles in theupper thermocline. Additional CTD stations between the mooring positions completed the hydrographic work. En-route, meteorological data, sea surface temperature and salinity, and the vertcal current profile down to 300 m dept was measured almost continuously.

About 3 hours after sailing for legM42/1a, we successfully performed a test station with a CTD/rosette system. Late in the evening, we arrived near ESTOC (29°10 N, 15°30 W, 3610 m water depth). At a position some 10 nm northeast of ESTOC two drifting moorings with one and three particle traps at 200 m (system T1), and 200 m, 300 m and 500 m (system T3), were deployed to measure for a few days the particle flux in the upper thermocline. Next, at ESTOC, the first casts with special bottles (GoFlo) and in-situ pumps (ISP) for trace metal sampling were obtained to achieve a densely sampled profile throughout the the water column. On 17 June, at ESTOC the current meter mooring V367-4 was recovered with no losses and a deep CTD/rosette cast was performed.

We then steamed towards the position LP north of the island of La Palma at nominally 29°45 N, 18°00 W. We reached that position on 18 June, took the first of two trace metal casts wirth GoFlo and ISP, a deep CTD/rosette cast, and then the second casts with GoFlo and ISP.

While steaming again to the ESTOC station, we took near surface water for incubation experiments on deck. On 19 June, we searched successfully for the two drifting particle trap for recovery. Unfortunately, the system T1 had lost its current meter and its single trap at 200 m. The second system, T3 was recovered completely and reset again. One more cast for trace metal with GoFlo and ISP completed the sampling for trace metals near ESTOC. On 20 June, the ESTOC current meter mooring V367-5 was deployed and a deep CTD/rosette profile taken.

We then steamed to the position of the four CANIGO moorings that we exchanged in the eastern boundary current array EBC from 21 June to 23 June during day time. The four moorings all reach up to 150 m below the surface and carry a total of 23 current meters and 2 particle traps. During the night and between the moooring work, CTD stations on a section parallel to the mooring array and hydrocasts for trace metal near mooring EBC3 in the centre of the arry were obtained. On 21 June in the afternoon, two additional scientists from the ICCM embarked in Arrecife for the ESTOC June 1998 station work to be performed later.

Heading again for the ESTOC position, we took additional CTD stations down to 2000 m below the Mediterranean outflow water to achieve additional more detailed information on the thermocline circulation north of the Canary Islands. The drifting particle trap was successfully recovered on 24 June near ESTOC. Hydrocasts for trace metals with GoFlo in ISP and the June 1998 ESTOC station work completed the sampling programme during this part of M41/1. On the way from ESTOC to Las Palmas a NOAA surface drifter and 5 XBTs were launched.

’Meteor’ called in to Las Palmas on 25 June for personnel exchange. The groups from the IEO, ULPGC, GeoB, UBMCh and ICCM involved in mooring work, trace metals and the ESTOC station work disembarked. Embarking were groups from seven institutes from four nations.

’Meteor’ sailed from Las Palmas for Leg M42/1b on 26 June in the afternoon. Leg M42/1b was aimed to measure and sample important hydrographic, chemical and bilogical parameters on a closed box north of the Canary Islands (Fig. 1.2) for balance and flux calculations. En-route, the current profile down to 200 m and sea surface temperature and salinity were measured

After a test station late in the evening on the same day, station work started on 27 June east of Lanzarote and Fuerteventura on the shelf at 100 m water depth with a station spacing of 7 nm that was increased to 20 nm towards the ESTOC position. Each station consisted of a bottom deep CTD/rosette cast with sampling for dissolved oxygen, nutrients and chlorophyll. Attached to the CTD/rosette was an ADCP to measure the absolute current profile in the whole water column. Also on each station, another CTD with optical sensors attached took casts down to 1600 m. Samples for aluminum, coccolithophores and plankton were taken from the rosette bottles on roughly every other station. Deep plankton net hauls down to 1000 m and on some stations down to 2000 m were restricted to the continental shelf break and the adjacent deep basin with some additional hawls in the open ocean.

The box basicly consists of three CTD/rosette sections: the first runs almost zonally along mooring array EBC towards ESTOC and then to a position north of La Palma at 29°10 N, 18°00 W, the second meridionally towards Madeira until 32°15 N, the third then zonally onto the shelf until the 100 m bottom contour. A total of 45 stations were obtained on these three sections. The box was completed on 12 July at 32°02' N, 009°52' W at 100 m water depth on the Moroccan shelf.

We then set course to Lisbon. Off Portugal, four moorings were to be recovered for the University of Lisbon. Two of them (C3, C6) were retrieved without problems, but with one instrument being damaged. One mooring (C5) did not respond to the acoustic interrogation and release commands. After search courses being completed, this mooring had to be given up. We knew from the fourth mooring (C4) that the acoustic releaser would interrogate but not release; therefore its position was measured accurately (37°30.13' N, 009°37.76' W, 1570 m at 1696 m water depth) acoustically. Next, two dredge trials around the mooring were performed, however with no success at 8 Beaufort wind.

'Meteor' called in to Lisbon 16 July in morning.

5. Preliminary Results

5.1 Physical Oceanography

(T. J. M ller, M. Knoll, B. Lenz, F. Lopez-Laatzen)

Hydrography

Throughout the cruise, a MKIIIB Neil Brown CTD (internal IFMK no. NB4) was used together with a General Oceanics rosette sampler to which 21x10 l Niskin bottles were attached. The space for three more bottles on the rosette frame was needed to simultaneously lower a RDI 150 KHz narrow band acoustic Dopler profiler (lADCP) to measure directly the current shear in the water column.

The CTD's temperature and pressure sensors were calibrated at IFMK one month before the cruise. From in-situ comparisons with reversing electronic thermometers, it is expected that the drift in temperature was less than the resolution of the comparing sensors, i.e. less 1 mK, during the cruise. Accuracy therfore is close to the calibration accuracy, i.e. better 2 mK. Bottom distance estimates showed no significant drift of the pressure sensor besides the offset correction. Accuracy is then estimated to better 5 dbar for high (>3000 dbar) pressures.

Problems arose with the in-situ calibration of the conductivity cell. Firstly, the two Guildline AUTOSAL salinometers that were used subsequently (Table 5.1) showed problems with rinsing the cells. Consequently, many samples had to be omitted for the calculation of the calibration coefficients for the CTD's cell. The salinometers were calibrated with standard seawater batches P131 (K15=0.99984, S=34.9945, stations 304 - 335) and P132 (K15=0.99986, S=34.9945, stations 336 - 356) at the beginning and at the end of the cruise and frequently in between. Checks for drifts were conducted with substandards from the deep ocean (> 3000 m) at least two times per day. It turned out that the calibrations of AUTOSALs were stable to better 0.001 in salinity through the cruise.

Table 5.1.2: Salinometers during the cruise were AS6, AS4 and A6 again. Problems with cell flushing, in particular salinometer AS4, let us use A6 again.

AS6 from 28.06.-09.07. used, stations 304 - 332
AS4 from 07.07.-09.07. used, stations 333 - 339
AS6 from 09.07.-14.07. used, stations 340 - 356 (end)

The other problem that arose, was an extremely strong drift of the CTD's conductivity signal in addition to the usual linear correction (Fig. 5.1.1). Including a drift correction, a single calibration set of 6 parameters for the whole cruise gives a standard deviation of 0.005 for the salinity residuals, mostly due to bottle salinities. Despite the problems described above, the accuracy in the calibrated CTD salinity is estimated to be better 0.003.

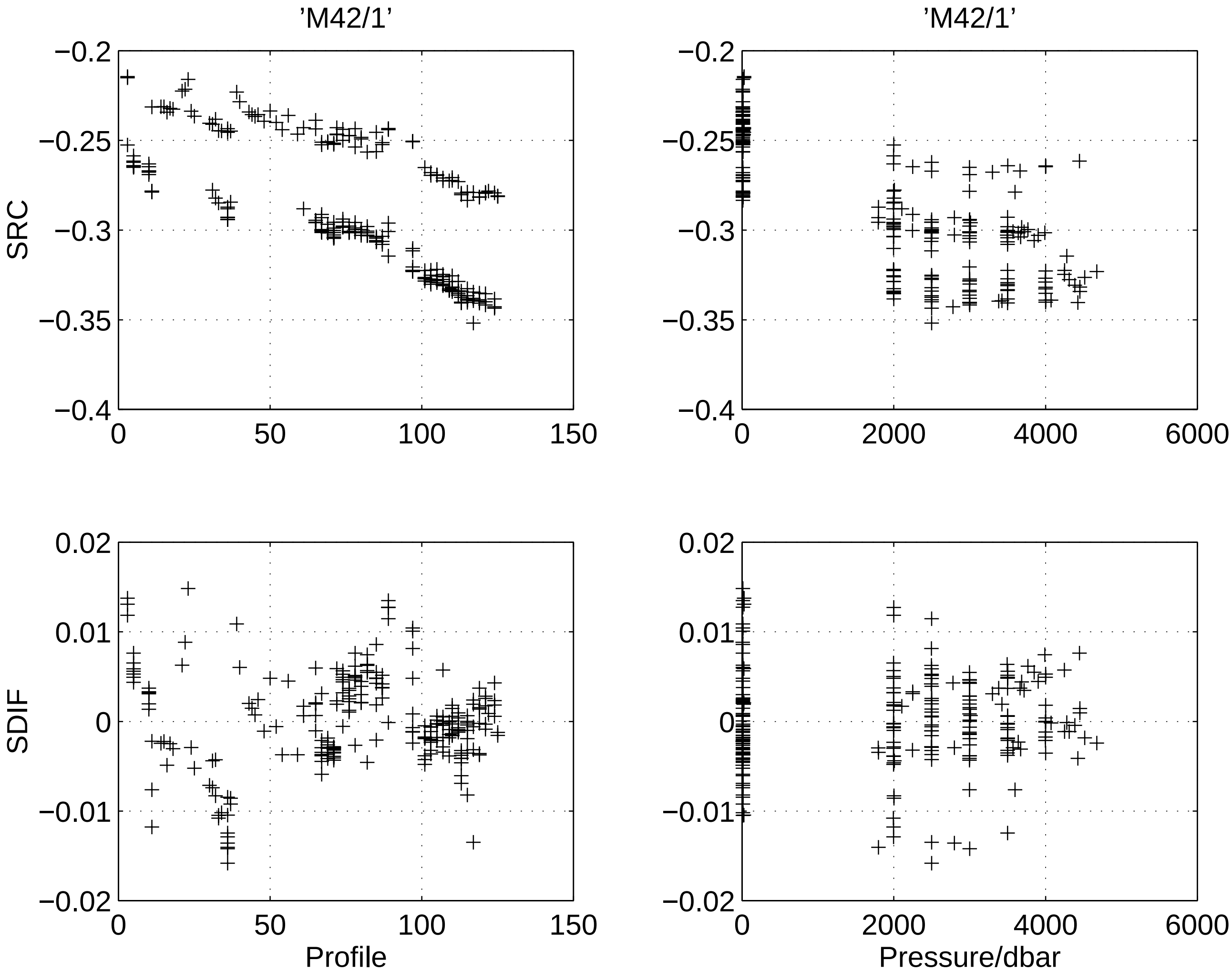


Figure 5.1.1: Salinity calibration of the CTD (internal IFMK no. NB4). Upper panel with pre-calibration salinity corrections needed to meet sample salinity (SCOR) versus profile (or cast) number (PROFILE, left) and pressure (PRESSURE, right). Note the unusual strong drift with the profile number. The lower panel shows the residuals after a single overall calibration with 6 parameters including drift correction was apllied to the CTD conductivity values. The standard deviation after calibration is 0.005 in salinity.

As an example, the salinity section along 29°N is shown in Figure 5.1.3. The salinity minimum which is indicated at 800 m east of Fuerteventura close to the bottom, is correlated with low oxygen values (see Sect. 5.2) and is a signal for rudiments of Antarctic Intermediate Water (AAIW). All other features are very common. Note the summer season upwelling off the African shelf.

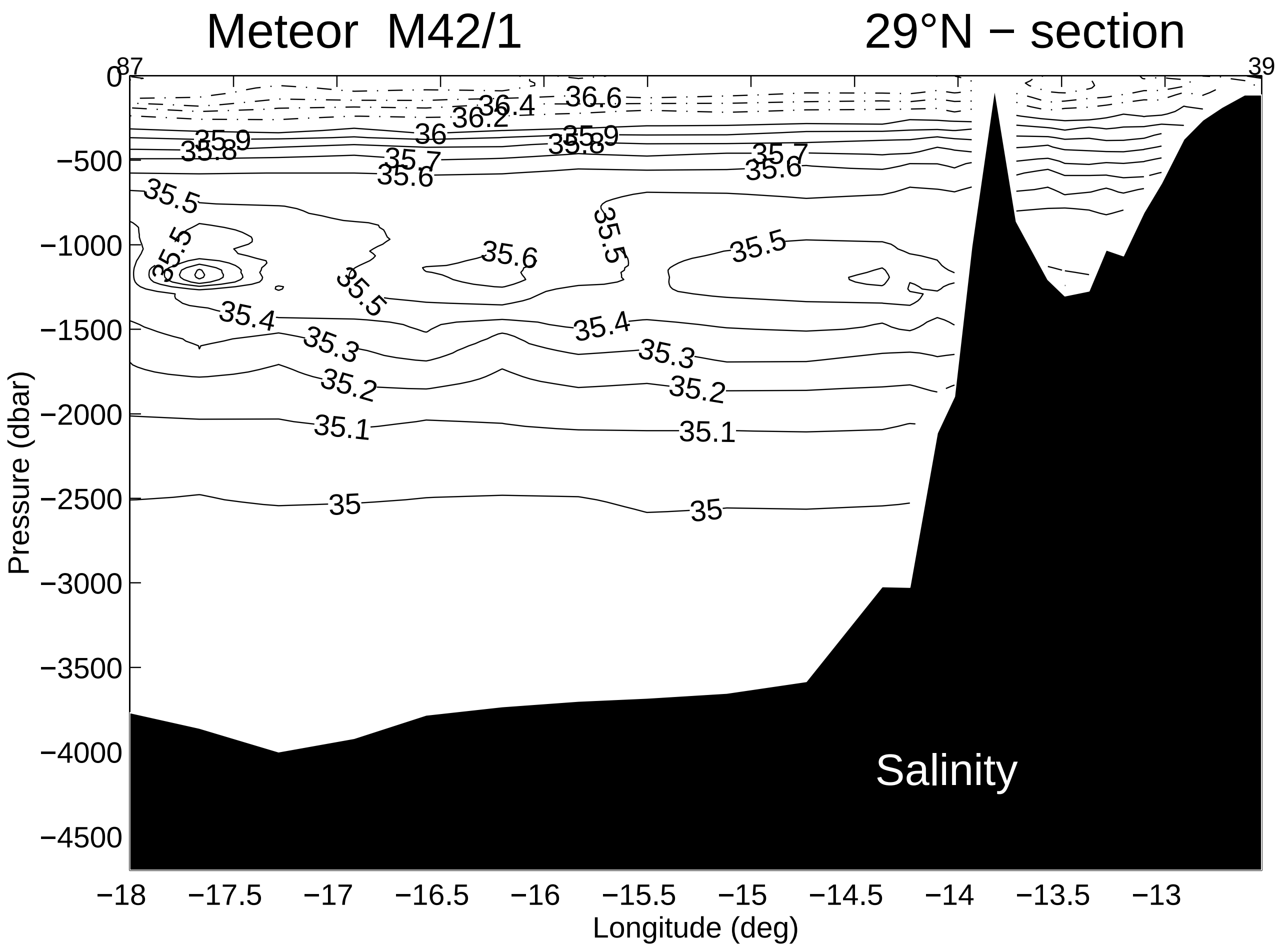


Figure 5.1.3: Salinity section along 29°N.

ADCP measurements
As navigational system a combined GPS/GLONASS receiver GG24 made by ASHTEC was used. Unfortunately, the non-optimal positions of the newly installed antennas for the ADU2 system (also from ASHTEC) did not yet allow to receive adequate good signals from this system during this leg.

While the (vessel mounted) vADCP worked during the whole cruise, the (lowered) lADCP in many profiles showed so far non-identified problems with sampling. Due to relatively small signals in the eastern basin, further data processing will need reduction of the tidal signal in the measurements.

5.2 Oxygen and Nutrients Measurements

(R. Santana, A. Cianca, M.G. Villagarcia, J. Godoy and M.J. Rueda.)

Sampling
Samples were taken at most stations of the second part of leg M42/1 along the sections of 29°N, 18°W and 31°N. Up to 21 sampling depths with the rosette water sampler attached to the CTD covered the water column, except for chlorophyll that

was sampled only between 200 m depth and the surface (see Tab. 7.3). Samples were taken for oxygen, nutrients and chlorophyll ªa analysis. Samples were collected immediately after the bottles were on board in the following order:

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

Oxygen and nutrient sampling observed the WOCE Hydrographic Programme procedures (WOCE, 1994)

Analysis
The samples for dissolved *oxygen* 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.

Nutrients were taken in polypropylene bottles which were cleaned and washed with HCl acid and were completely dried in advance, according to the instructions of 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 detectabl 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).

The automated procedure to determine *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, e.g., by NYDAHL (1976) and GARSIDE (1993).

The Ortho*phosphate* concentration is understood as the concentration of reactive phosphate (RILEY AND SKIRPOW,1975) and according to KOROLEFF (1983a) is a synonym of ªdissolved inorganic phosphate . The automated procedure to determine 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).

The determination of the soluble *silico* 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 were measured onboard using fluorimetric analysis that followed the methodology described by WELSCHMEYER (1994). A fluorometer TURNER 10-AU-000 was used.

Preliminary results
As an example we display the oxygen dtribution along the 29…Nþoth in a section (Fig. 5.4) and as Oxygen/Salinity correlation (Fig. 5.5). Most pronounced is a minimum at intermediate depths around 850 m. East of Fuerteventura it is correlated with a salinity minimum representing the presence of rudiments of Antarctic Intermediate Water (AAIW) that is transported northwards with the poleward undercurrent. In the west, it corresponds to the salinity maximum of the Mediterranean water core (MW) which during this cruise is strongest in the west and north of La Palma extends up to 850 m.

The high oxygen values found at surface near the African coast are due to the presence of the easterly winds, characteristic of this area in the summer season..

A signal of the Labrador Water appears in the section along 18…W (not shown here).

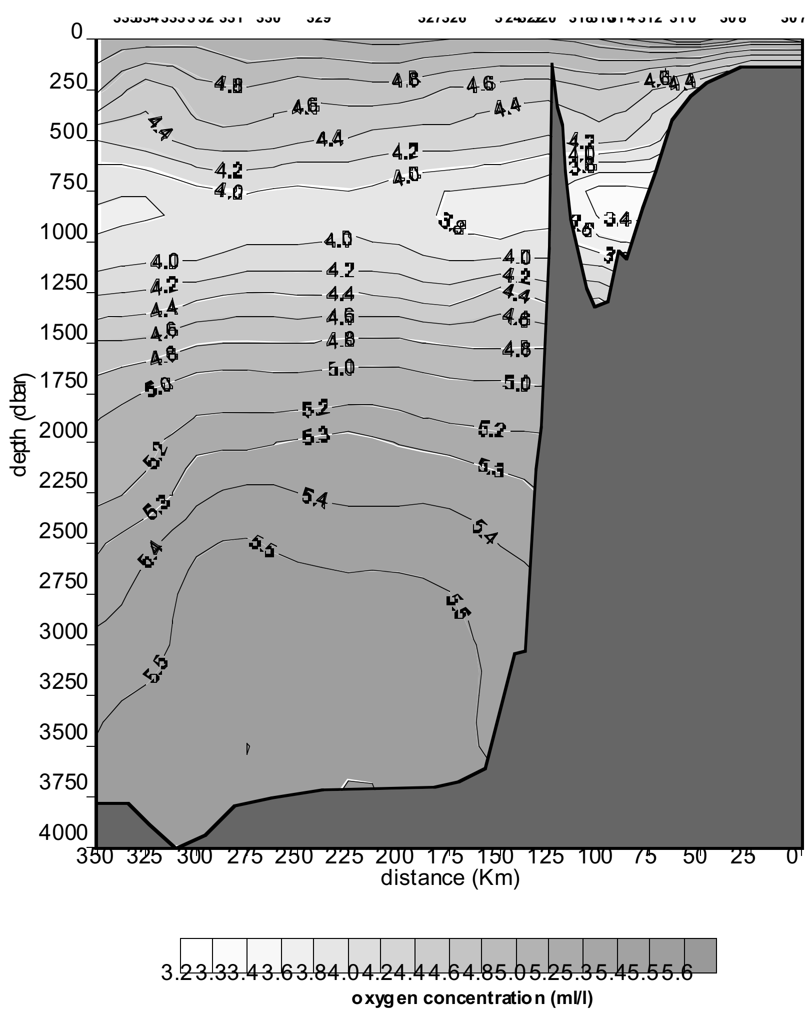


Figure 5.4: Distribution of dissolved oxygen along the 29…N section, Meteor 42/1b

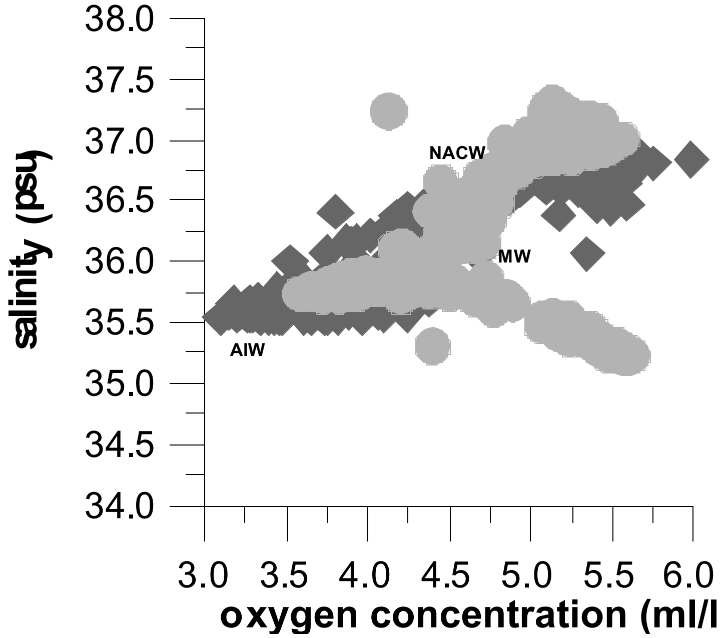


Figure 5.5: Oxygen versus salinity, 29…N,Meteor 42/1b. Dark symbols are from stations east of Fuerteventura Island, lighter dots are from west of Fuerteventura. The characteristics of water masses are indicated: Antarctic Intermediate Water (AAIW) with low oxygen values; North Atlantic Central Water (NACW) and the Mediterranean Water (MW) with higer salinity and slightly higher oxygen values. In the surface, low salinities and higher oxygen values are encountered in the shelf area due to upwelling.

5.3 Bio-optical measurements

(W. Breves, K.-D. Loquay and O. Zielinski)

Objective

The investigation of marine systems like the pelagic cycle in the northeastern Atlantic Ocean is an important pre-requisite for understanding global scale ecodynamics, e.g. the carbon flux. Recently, the application of bio-optical methods, using inherent molecular abilities, like fluorescence and absorption, has met with increasing interest in environmental monitoring. During this cruise a bio-optical *in situ* probing system, developed at the University of Oldenburg, was successfully applied as a part of CANIGO for the fourth time north of the Canary Islands (previous cruises: 0Jan 97, Apr 97, Apr 98). Additional measurements onboard with laboratory instruments provide complementary data on bio-optical parameters. The investigations are intended to quantify bio-geochemical fluxes in the water column and data will be used within biogeochemical/bio-optical models of this Canary Island region.

Bio-optical methods

Dissolved and particulate substances in seawater can be sensitively characterized with optical methods without additional sample treatment, and therefore very fast. Yellow substances (chromophoric dissolved organic matter, traditionally denoted as *Gelbstoff*) as a compound of marine dissolved organic matter (DOM), chlorophyll *a* and other phytoplankton pigments like phycoerythrin, fucoxanthin, and fucocyanin, and the aromatic amino acid tryptophan, bound to proteins in bacteria and algae can be measured with fluorescence methods. Furthermore, the attenuation coefficient is an optical parameter which depends sensitively on suspended and dissolved substances. Its measurement is of interest not only for the understanding of optical conditions in water, but it also allows for a fast determination of absorbing and scattering matter in the form of depth profiles, which can hardly be obtained with other methods in real time.

Instrumentation and sampling processing

The following lists of instrumentation and sampling procedures is based on the Documentation of Methodologies and Standard Protocols - University of Oldenburg , available at the CANIGO Data Centre: *http://www.marine.ie/datacentre/projects/CANIGO/* :

Laboratory Spectrofluorometer - LS 50 (UOL**A1**)

Laboratory Spectrophotometer - λ18 (UOL**A2**)

Bio-optical *in situ* probing system consisting of

CTD - Probe, OTS 1500 + Oxygen Sensor (UOL**A3**)

Multichannel *in situ* Fluorometer - MFL (UOL**A4**)

Polychromatic Transmissometer - PAAL (UOL**A5**)

Daylight Radiometer - RAD (UOL**A6**)

and an Underwater Central Unit (UOL**A7**) for the data uplink.

<u>The following sampling procedures were applied:</u>

for measurements of the laboratory spectrofluorometer LS50 from bottle samples

processing of gelbstoff fluorescence (UOL**B1**)

processing of chlorophyll *a* fluorescence (UOL**B2**)

processing of tryptophan fluorescence (UOL**B3**)

for measurements of the laboratory spectrophotometer λ18 from bottle samples

processing of gelbstoff absorbance (UOL**B5**)

for measurements of the bio-optical *in situ* probing system

processing of conductivity, temperature, pressure, oxygen and related parameters like salinity, potential temperature or density (UOL**B6**)

processing of gelbstoff fluorescence (UOL**B7**)

processing of chlorophyll *a* fluorescence (UOL**B8**)

processing of fucoxanthin from chlorophyll *a* fluorescence (UOL**B9**)

processing of tryptophan fluorescence (UOL**B10**)

processing of gelbstoff attenuation (UOL**B11**)

processing of seston attenuation (UOL**B12**)

processing of underwater light field parameters like downwelling and upwelling irradiance or PAR(z) (UOL**B13**)

Up- and downcast profiles with the bio-optical *in situ* probing system were measured down to 1500 m depth at 46 stations during the cruise, along with onboard laboratory measurements with samples from Niskin bottles taken at the following depths: 10-25-50-75-100-125-150-200-250-400-600-800-1000-1150-1500-2000-2500-3000-3500-4000 m (under-lined depth are taken regulary at all stations available). Bacteria samples have been taken at stations 312, 314, 326 and 335 and will be analysed by the IfM Kiel, Marine Chemistry Group.

Preliminary results

In the following we present some preliminary CTD and multichannel fluorometer (MFL) data. The transect along 29°N started on 26 June 1998 near the African shelf (station 307) and ended on 04 April 1998 north of La Palma (station 335). The salinity distribution (Fig.5.3.1) is displays the well known water masses and the coastal upwelling near the African shelf.

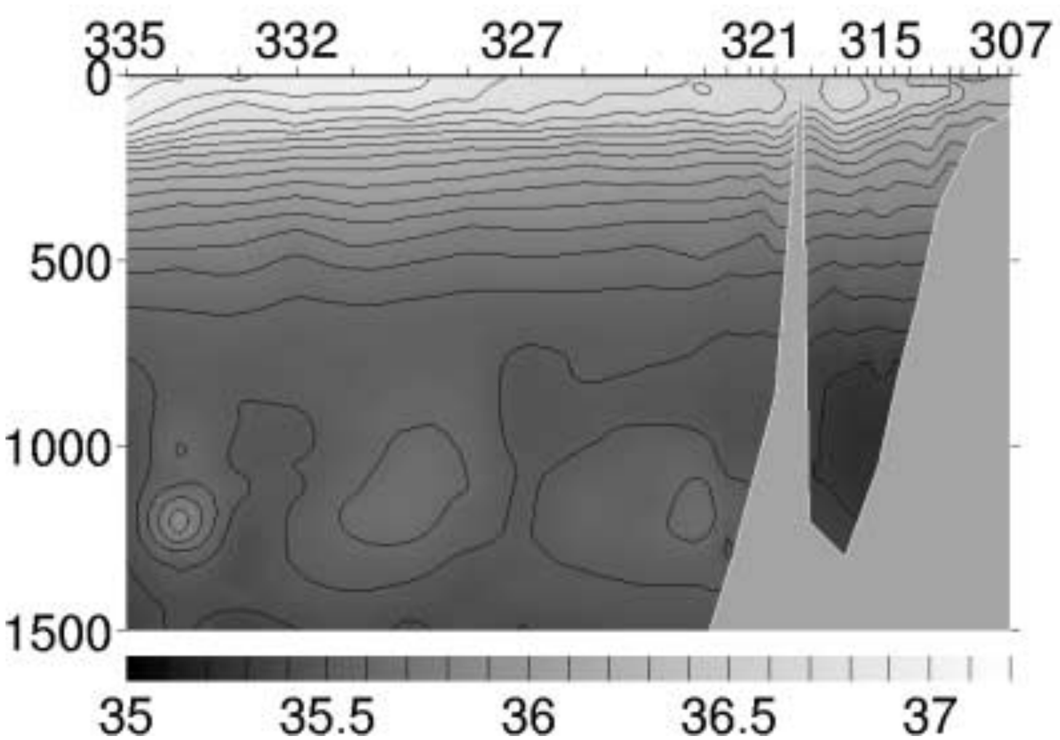


Fig. 5.3.1: Salinity distribution along the transect at latitude 29°N. On the upper x-axis station numbers are given and, on the y-axis the pressure in dbar is displayed.

The gelbstoff distribution along the souhtern transect is shown in Fig. 2, with the typical increase of gelbstoff contents with depth, due to photodegradation at the surface.

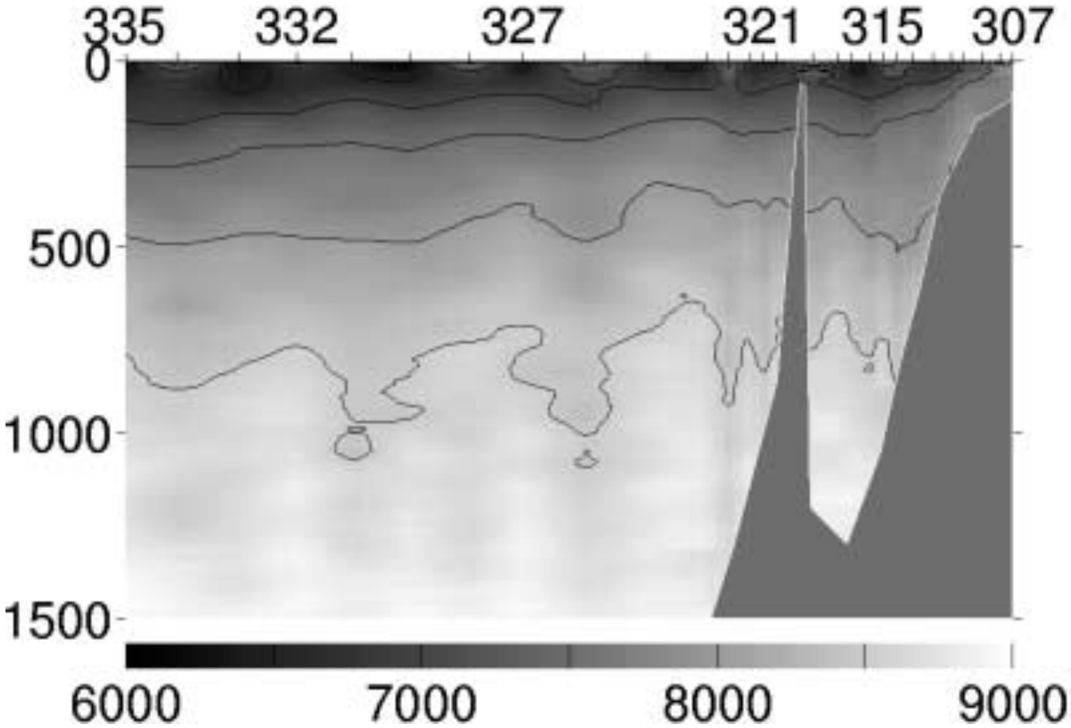


Fig. 5.3.2: Gelbstoff fluorescence distribution along the transect at latitude 29°N down to 1500 dbar. The higher signals at the surface were not caused by higher Gelbstoff concentrations but by straylight of solar radiation.

Fig. 5.3.2 shows the chlorophyll *a* fluorescence distribution along the transect. In the oligotrophic open ocean one can identify the deep chlorophyll maximum which is typical of the spring/summer situation in the region. Near the shelf and also near the island s west side, coastal upwelling took place and higher phytoplankton abundance could be observed.

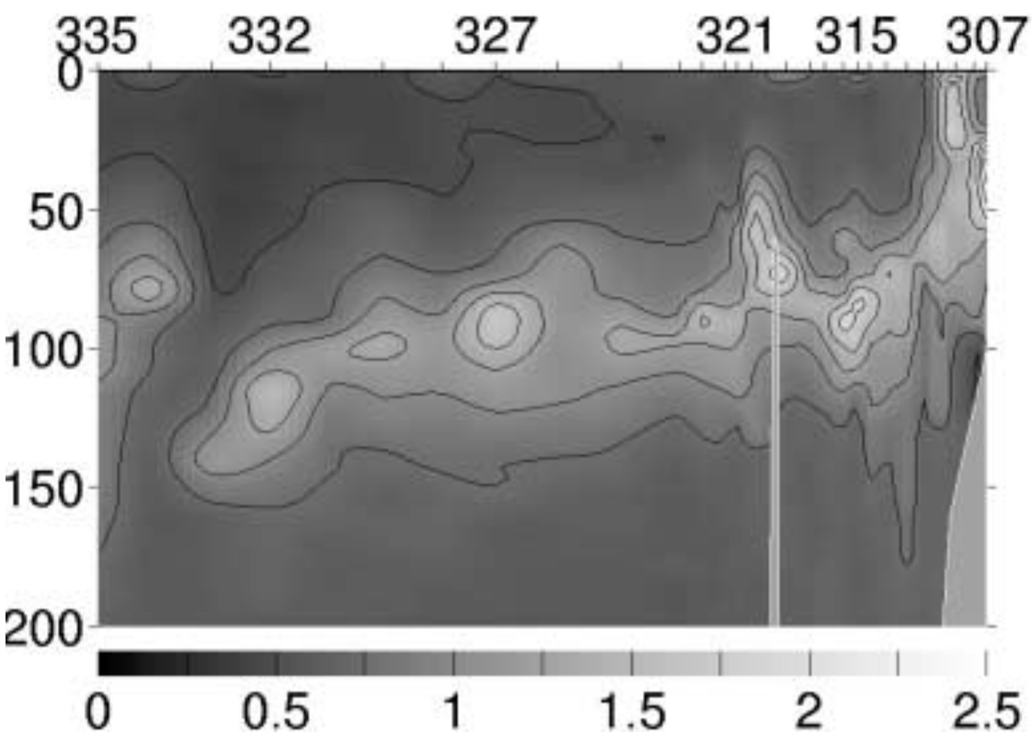


Fig. 5.3.3 Chlorophyll *a* fluorescence distribution in the upper layer along 29°N.

5.4 Interaction of particles and water
(K. Pape, U. Sch §ler, C. v. Oppen)

Background

Particle-water interaction is a key process in the biogeochemical cycling of chemical elements in the ocean. Uptake onto particulate matter and subsequent sinking mechanisms (scavenging) is the major control on the chemical composition of seawater. This mechanism maintains the concentrations of many elements in seawater rather low, many of which are, thus, called trace elements. The particulate matter itself consists of (i) suspended particulate matter (SPM) which is supposed to consist of almost non-sinkable biogenic and terrestrial detritus with a large surface area and (ii) the relatively fast sinking particles found in particle traps, responsible for the vertical transport to the sediments. The comparison of the trace element composition and the distributions in these three different phases (dissolved, SPM and trap material) are excepted to provide important clues on transport and sorption mechanisms as well as on the general geochemical behavior of these elements in the ocean. Many of the trace elements studied here are essential for marine life, and thus also in the generation of the biogenically induced particle flux within the water column. These trace elements cover a broad range of chemical properties, enabling to study biogeochemical processe in greater detail.

Within the collaborative CANIGO project, the Marine Chemistry Department of the University of Bremen, Germany (UBMC), conducts studies on the biogeochemistry of a suite of trace elements. These elements exhibit different behaviour in the ocean, as can bee seen, e.g. in the vertical profiles of their dissolved concentrations. In addition, input functions may vary strongly between individual elements. For the CANIGO study area, atmospheric inputs of mainly Saharan origin are especially important. This material carries many trace elements with it, that are partially released upon deposition in the ocean. Scavenging of dissolved trace elements and incorporation of particulate trace elements onto sinkable particles of mostly biogenic origin provides a pathway for the coupling of upper water processes influenced by atmospheric input and the deep sea.

During the firts part of the cruise, M42/1a, activities of the UBMC group focussed on particle-water interaction at three different stations along a zonal transect off the African Coast (stations EBC, ESTOC, LP). That part was dedicated to collect suspended particulate material as well as samples for dissolved trace elements in high vertical resolution.

During the second part cruise, M42/1b, we attempted to determine the background field in dissolved trace element concentrations around the three central stations mentioned above (viz. ESTOC), focussing on the upper 1000m of the water column. Samples were collected at four stations along the 29°N zonal transect in order to complete the station pattern of the preceedingpart.

The northern zonal transect 31°N was also covered with 4 stations to better characterize what may be regarded as the upstream component for the ESTOC area north of the Canary Islands. In addition, we used the M42/1b test station to collect one profile about 30 nm south of the ESTOC station to possibly relate variabilities observed previously to current findings at the ESTOC station. Another station was covered on the meridional transect SW of Madeira. The southwestern-most station of this cruise was used to collect some deep water for internal calibration purposes.

Sampling

Samples of dissolved trace elements were collected from discrete depths distributed over the whole water column using in-situ pumpuing systems during M42/1a, and from the upper 1000 m by means of 12x12 l GoFlo bottles attached to a rosette sampling device. All samples were collected rigorously applying clean sampling techniques to avoid contamination as far as possible. Sample processing was done under a clean bench inside a clean-air laboratory container onboard. Dissolved trace element samples were pressure-filtered with nitrogen gas through pre-cleaned 0.4˚ m polycarbonate membranes directly from the sampling bottles. Besides trace element sampling, water samples were analyzed for nutrients as well as for oxygen. The macro nutrients nitrate, phosphate and silicate were determined according to standard photometric procedures. Dissolved oxygen was analyzed by titration using the Winkler method. The only trace element to be determined onboard was dissolved Aluminium (Al) by a fluorescence method. All other dissolved trace elements will be analyzed onshore.

Preliminary results

Preliminary results for the distribution of dissolved Al show surface concentrations to be lowest close to the African coast in the EBC area (concentration range for surface waters 13-21 nM for the entire cruise). In this eastern area, a subsurface maximum at 150-200m was observed, whereas this signal progressively deminished farther to the west. In general, the profiles obtained indicate a slight increase in Al concentrations with depth within the upper 1000m of the water column. This pattern appears to be more pronounced along the northern transect (32°N) than at the southern transect (29°N).

5.5 Dissolved aluminium

(C. Collado-S nchez, V. Siruela-Matos, F.J. Mart n-Mu oz and J.J. Hern ndez-Brito)

Introduction

Aluminium distributions in Canary Islands region show a great variability (Gelado-Caballero et al˚, 1996). The area, major features are present that could affect the aluminium biogeochemical behaviour, such as elevated aeolian (dust) inputs from the Sahara desert, the proximity to areas of upwelling (150-200 Km) and mesoscale features that are induced by the effect of the islands on the the Canary Current. The aluminium distribution shows a latitudinal gradient from East to West. The study of the Al variations along these gradients and at fixed stations could give a better knowledge of the physical and biogeochemical processes that control the mesoescale distribution of aluminium in the area and its seasonal variability.

Objectives

The main objectives in the cruise were:

- to measure profiles of dissolved aluminium at ESTOC (European Station for Time Series in the Ocean Canary Islands) with high vertical resolution in the summer season
- to measure the aluminium distributions between the African coast and 18°W along two different latitudes in the summer season.
- to compare the summer profiles with the winter profiles of M37/2.

Sampling

Sampling was carried out using Niskin bottles provided with springs of silicone rubber. Samples were taken and manipulated wearing plastic gloves to avoid metal contamination. Samples were split into two parts. The first was stored at 150 ml polyethylene bottles and immediately frozen until the analysis at the shore-based laboratory. The second part was measured on board. The containers have been previously cleaned using conventional procedures in the trace metal assay.

Analysis of Al

The HPACSV (High Performance Adsorptive Cathodic Stripping Voltammtry) method (Hern ndez-Brito et al., 1994) was used to measure on board dissolved aluminium in seawater. Samples are prepared in Teflon cups of polarographic cell, containing 10 ml of water, 2Æ10-6 M DASA and 0.01 M BESThe solution is purged using nitrogen (3 minutes) to remove dissolved oxygen. The adsorption potential (-0.9 V) is applied to the working electrode, while the solution is stirred. After 40 s accumulation time, the stirring is stopped, and for 5 s the solution is allowed for to became quiet. The scanning is started at -0.9 V and terminated at -1.4 V. The scan is made using staircase modulation with a scan rate of 30 V/s and a pulse height of 5 mV. The DASA-Al peak appears at ca. -1.25 V. A standard addition procedure is used to quantify the aluminium concentration of the sample. Determinations were carried out in a flow bench class-100 to avoid contamination of the sample by dust particles.

The electrochemical system used has been designed to measure the instantaneous currents at short times with a low noise level (Hernandez-Brito et al., 1994b). Thus, the analytical time required for each sample is substantially reduced, allowing an increase of measurements on board. A PAR- 303A electrochemical cell with hanging mercury drop electrode (HMDE) was connected to a specially made computer-controlled potentiostat.

Preliminary results

More than 600 samples were analysed on board. Preliminary results show that the aluminium distribution in the water column appears to be related with the physical and biogeochemical processes in the sampling area. Aluminium distribution in the surface waters shows the same maximum concentrations as found during previous cruises at summer and fall at the area. These concentrations decrease from Africa coast to La Palma Island (Fig. 5.5.2).

Mid-depth aluminium distributions seem to be related to the water masses. Stations located west of Lanzarote show higher aluminium concentrations and no salinity minimum at this deepth. An aluminium maximum appears at intermediate waters

(1000-1300m) and it seems to be related with the intrusion of Mediterranean waters. A minimum in the aluminium distributions occurs below the Mediterranean waters. The aluminium concentration increases again at depths larger than 2500m. Stations close to the continental slope show higher aluminium near the bottom layer. This could indicate sediment dissolution or lateral transport of sediment in the deep layers. The profiles in the western most stations show no significant alterations near the bottom.

Fig. 5.5.1

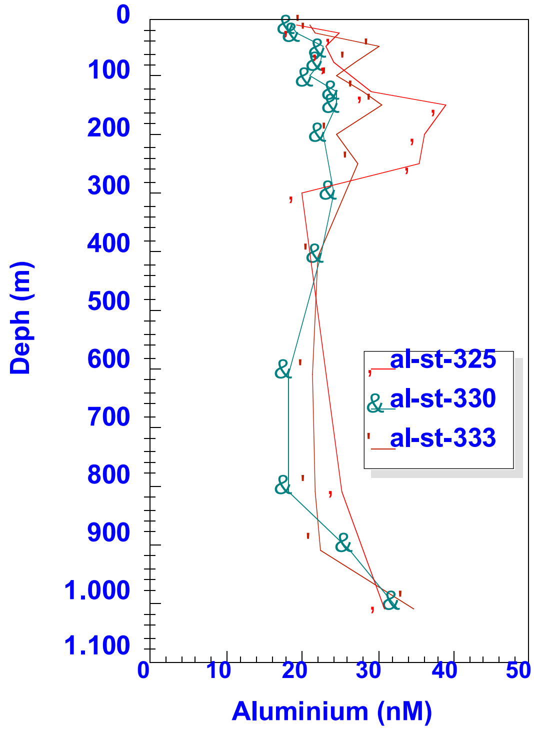
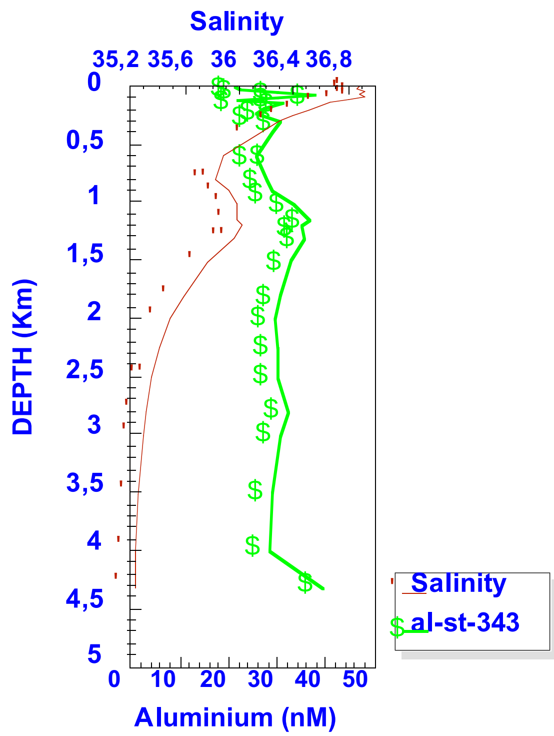


Fig. 5.5.2



5.6 Dissolved organic carbon (DOC) measurements

(B. Heyden, W. K hn, M. Spietz)

DOC is part of the oceanic carbon pool. Small changes in the DOC cycle may have a large impact on the global carbon cycle. Questions not yet answered are concerned with the nature of DOC and also the problems involved in its measurements (e.g. Suimara & Suzuki, 1988; Suzuki, 1993; Hedges & Lee, 1993).

The key issue during the Meteor cruise M42/1 was to determine the vertical distribution of DOC at the three stations ESTOC, EBC and LP (north of La palma), and on the two sections along 29°N and 32°N to measure the horizontal gradients from the coastal zone to the open sea. In order to resolve seasonal variations as compared to earlier cruises, the sampling was densest in the upper 200 m and in the shelf region.

At thirty nine stations (Tables 7.1 and 7.2), water samples were taken throughout the entire water column with a CTD/rosette. Samples for DOC measurements immediately after sampling were filtered under slight vacuum through precombusted Whatman GF/F filters. After filtration the DOC samples were preserved with phosphoric acid to reach pH=2 and stored in precombusted 10 ml glass ampoules at 5°C.
The samples will be analysed at the laboratories of the IBGM., Hamburg.

In addition to DOC, during M42/1a at ESTOC, EBC and LP also dissolved organic matter (DOM) was sampled and stored for later analysis at the IBGM, Hamburg.

5.7 Particle flux, production rates and plankton biomass

(S. Neuer)

Particle flux measurements with moored particle traps

Particle flux measurements at ESTOC (European Station for Time-series in the Ocean, Canary Islands) are carried out since fall of 1991. They show seasonal and short-term variability due to varying productivity and hydrographic conditions. In addition, this long-.term particle flux record indicates that a large portion of deep particle flux originates laterally. In CANIGO, additional particle traps were placed along the 29°N transect, north of La Palma (mooring LP) and between the eastern islands and the Moroccan shelf (moorings EBC2 and 3). Including the ESTOC position, these three main trap locations cover the productivity gradient from shelf region to the oligotrophic gyre. It is intended to distinguish the influence of autochtonous and allochtonous sources of particle flux along the transect.

The EBC2 and EBC3 particle traps are part of current meter moorings of the IfM Kiel. During the first two mooring periods since January 1997, each mooring carried a particle trap in 700 m depth. On June 21 and 22, the second set of moorings, EBC2-2 and EBC3-2, was recovered. The particle trap on EBC2 worked properly, the one on EBC3 did not rotate, and no samples are available. EBC3-3, which also carried an INFLUX current meter mooring 20 m below the trap, was re-deployed on June 23. Supplementing the particle trap on EBC2, a second trap was attached to the mooring line one in 500 and 700 m. By collocating two traps in different depths on one mooring line, it will now be possible to investigate vertical gradients in the particle flux at EBC as already at the ESTOC and LP locations.

Experiments with drifting particle traps

In addition to moored particle traps, experiments with drifting trap were carried out to determine particulate carbon flux that originates directly from the euphotic zone. Ideally, these sinking flux measurements need to be coupled with measurements of the standing stock and production rates of the plankton community in the euphotic zone (see next section on *plankton biomass and production rates*).

To study particle flux below the euphotic zone, two surface-tethered particle interceptor arrays were deployed northeast of the ESTOC station, one carrying one trap at 200 m (Trap I, 200 m drifter, Fig. 5.7.1), the other one three traps at 200, 300 and 500m depth (Trap III, 500 m drifter, Fig. 5.7.2). The traps were attached to a surface buoy carrying an ARGOS transmitter and a Radar reflector. The main buoyancy was located at about 30 m depth to avoid the wind-induced EKMAN layer.

The first deployment period (Trap III-1 and I-1) lasted from June. 16-19. During the deployment period, the 8mm steel wire of the surface array of I-1 was cut due to unknown reasons and only the surface buoy and two packages of fisher buoys could be recovered. The entire array below the surface was lost. In total, I-1 drifted 60 km (or 21 km/d) south-west, III-1 drifted only 12.6 km (4.4 km/d) to the west and remained at the same latitude (Fig. 5.3.3). The difference in drift verlocity can be explained by the lacking water resistance of the short drifter. Following the drift course, the loss of the array I-1 probably occurred in the evening of 18 June, one day before recovery.

During the second deployment period, only the 500 m trap was re-deployed from June 19-24. This time, the drifter drifted 29 km north-west with a speed of 6 km/d.

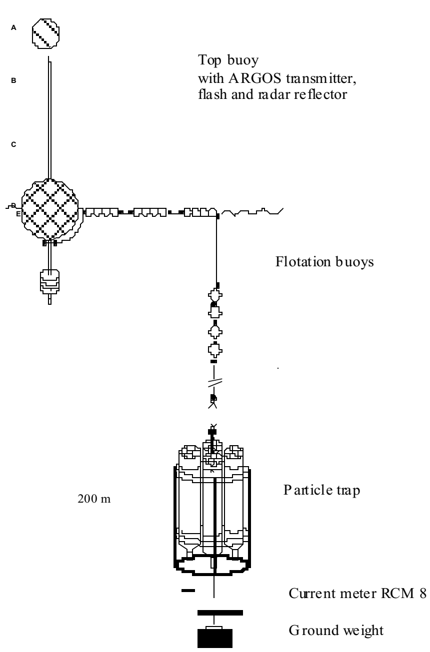


Fig. 5.7.1 Drifter I-1 carrying one trap at 200m depth.

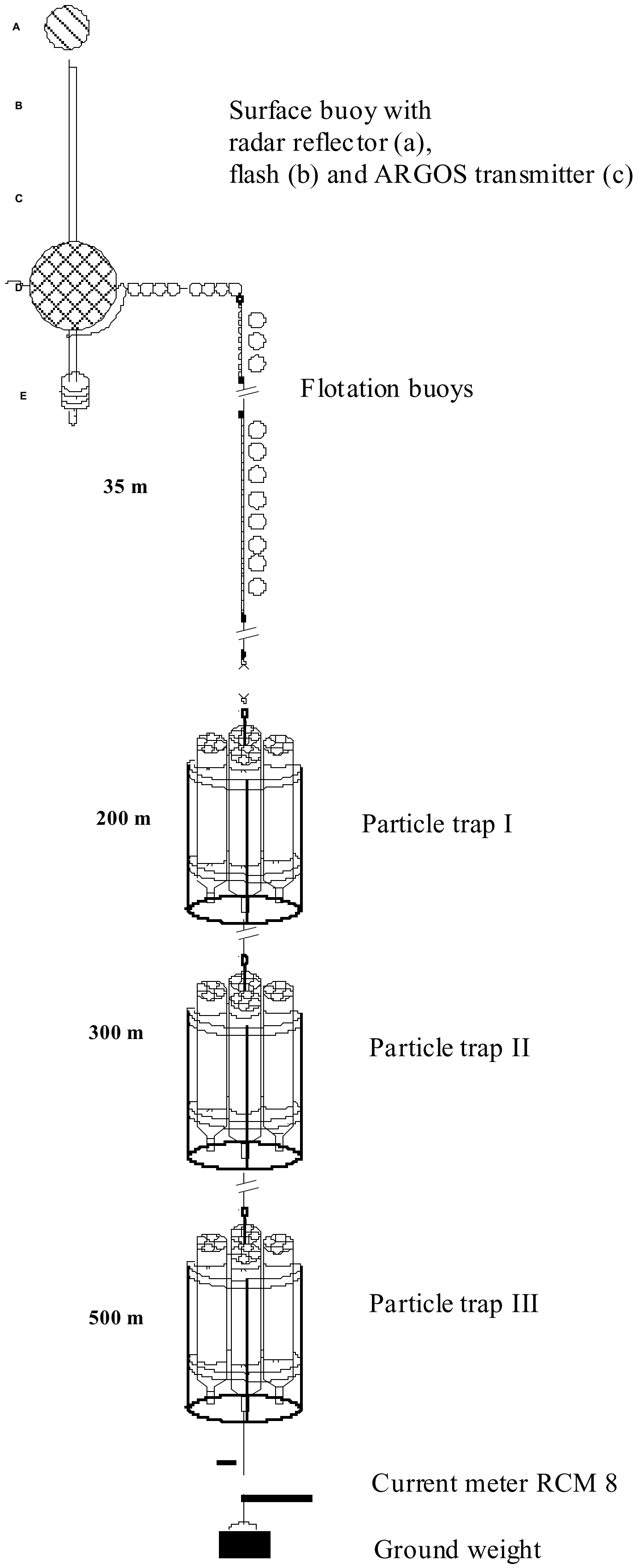


Fig 5.7.2 Drifter III carrying traps 200, 300 and 500 m depth.

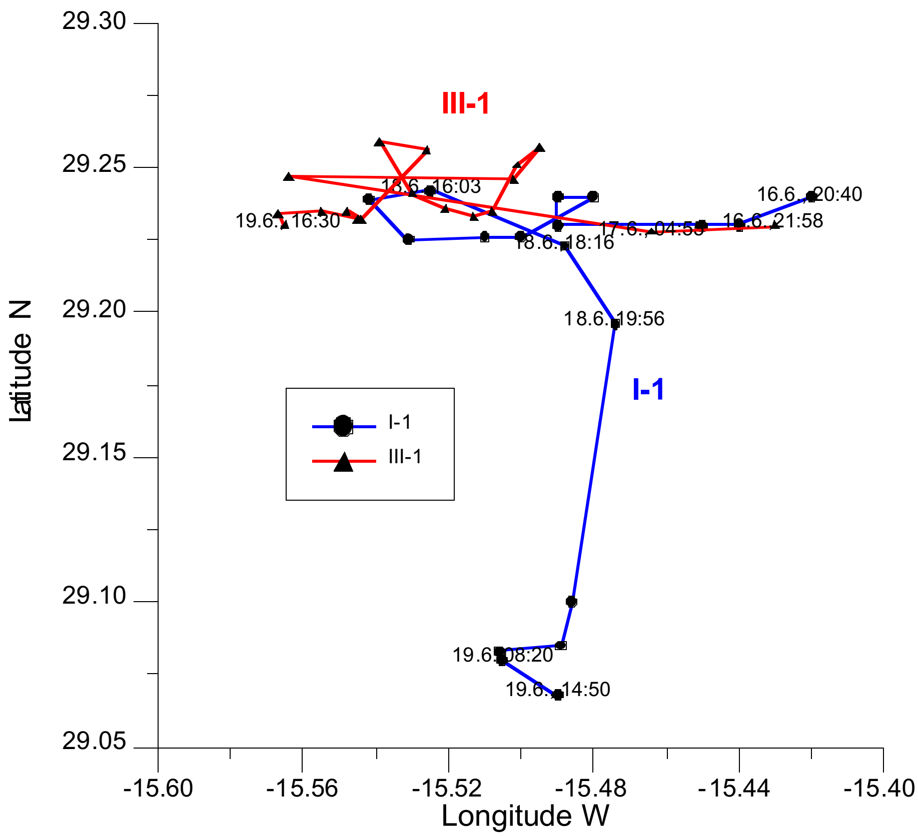


Figure 5.7.3 Drift course of drifters I-1 and III-1.

Plankton biomass and production rates

To quantify the plankton community in the euphotic zone during the trap deployments, samples were taken for chlorophyll, taxonomically characteristic pigments (analysed with High Pressure Liquid Chromatography, HPLC) and POC (Particulate organic carbon). All of the water samples were filtered on GF/F filters. While chlorophyll a was analysed onboard ship as an acetone extract using a Turner AU 10 fluorometer, POC and HPLC samples were kept frozen until analysis onshore.

Chlorophyll a as indicator of phytoplankton biomass showed the characteristic trend from highest values at the relatively eutrophic station EBC (in the proximity to the upwelling region) towards low values in the olitotrophic gyre regions (LP) (Fig. 5.7.4). All stations exhibited a deep chlorophyll maximum, located in 75m at EBC and ESTOC, and in 125 m depth at LP.

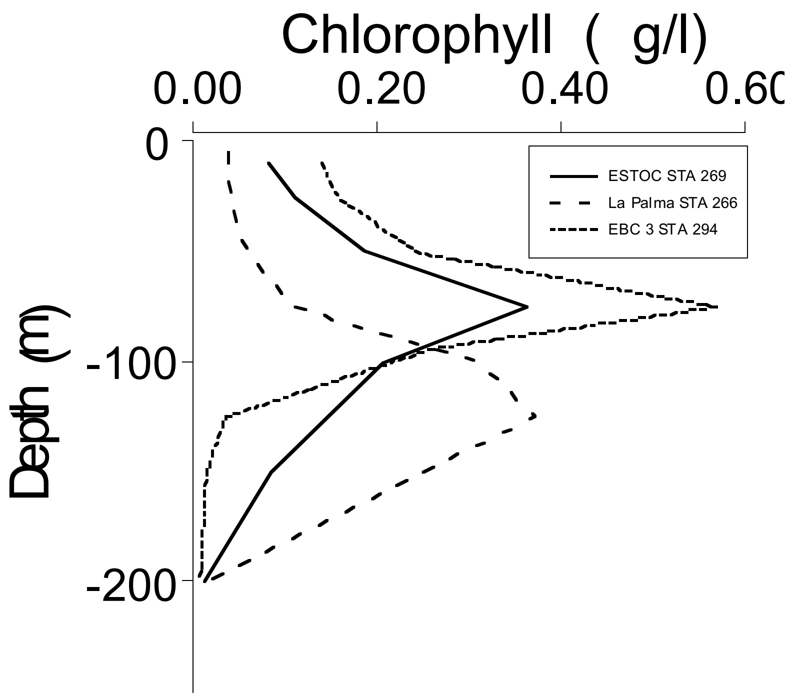


Figure 5.7.4 Chlorophyll profiles taken at EBC, ESTOC and LP.

To determine phytoplankton growth and microzooplankton grazing rates under close to in-situ conditions, dilution experiments were carried out twice at ESTOC (Stations 264 and 270) and EBC3 (Sta. 286) with water from 25 and 50 m depth in an on-deck incubator.

5.8 Stable nitrogen isotopes, nitrogen and carbon concentration of marine particles

(T. Freudenthal)

Introduction

The origin of organic matter may be characterized by its chemical composition. Especially the stable nitrogen isotopes allow valuable insights into the production and degradation history of organic particles. Low values of the stable nitrogen isotope ratio $\delta^{15}N$ and high concentrations of organic nitrogen and carbon are expected of material generated in an upwelling system. Higher $\delta^{15}N$ values, on the other hand, are typical of organic matter produced in oligotrophic systems. In addition, degradation of organic matter causes an enrichment of $\delta^{15}N$. In this study, the stable nitrogen isotope ratio as well as the organic nitrogen and carbon content of particulate (mainly suspended) material is determined and compared to the organic chemistry of fast sinking material sampled by particle traps, located along the 29°N productivity gradient transect.

Methods

Water from selected depths reaching from 10 m to near the sea floor was sampled on three sites along the 29° transect (EBC3, mesotrophic, ESTOC, oligotrophic, and LP, extremely oligotrophic) for the analysis of $\delta^{15}N$, total nitrogen (TN), total carbon (TC), organic nitrogen (ON), and organic carbon (OC) content of particles. For the analysis of $\delta^{15}N$ of filtered particles, 5 l of seawater were filtered from each depth onto precombusted GFF-filters. For the analysis of TN and TC content, respectively, ON and OC content, two liters of seawater were filtered onto precombusted GFF-filters. Filters were stored at —20°Cin the dark until further analysis on shore. $\delta^{15}N$ will be measured using a Finigan mass spectrometer. TN and TC will be measured using a carbon, hydrogen, nitrogen (CHN) -analyser. ON and OC will be measured on acidified filters using a CHN-analyser. Assuming that almost all of the nitrogen in suspended material is of organic origin, the comparison of TN and ON may indicate loss of organic material during acidification.

First results

Assuming that the coloration of the filters is an indicator of particle concentration, first results can be seen that are based solely on the optical impression of the filters. Confirming the productivity gradient along 29°N the concentration of suspended matter in comparable depths was highest at EBC3, and lowest at LP. The concentration was highest in surface waters, decreased in the upper 500m at EBC3, and in the upper 1500m at EBC and LP. At EBC3, a maximum of suspended matter was observed between 600 and 900m. This could be explained by lateral particle transport with a high productivity region like Cape Ghir area in the north or Cape Blanc area in the south being the source of the particles. At ESTOC, the concentration increased below 1500m with a maximum at 2500m. This observation supports the assumption of lateral particle transport being responsible for higher fluxes observed with the 3000m particle trap compared to the 700m and 1000m particle traps at ESTOC (S.Neuer, personal communication). Concentrations near the sea floor were low at all three sites. Resuspension of sedimental material seems to have a minor influence on the concentration of suspended matter. Elemental analysis has to be done to confirm these primary results.

5.9 The use of stable nitrogen and carbon isotopes to measure primary production

(M. Schroeter)

Introduction

Primary production, the uptake and assimilation of CO_2 by autotrophic plankton, can be divided into *new* and *regenerated* production. New production is based on the uptake of new nutrients (e.g. nitrate) that originate from outside the euphotic zone by processes such as upwelling or mixing. On the other hand, regenerated production is defined as a primary production fuelled by nutrients recycled in the productive euphotic zone, such as ammonia excreted by heterotrophic organisms.

New production eventually has to be exported as sedimenting particles (export production) to maintain a mass balance in the upper productive layers.

The 29°N transect covers distinct nutrient regimes, from extremly oligotrophic north of La Palma to eutrophic regions, close to the NW African upwelling system in the EBC region.
The aim of this study was to correlate the uptake and incorporation of $^{15}N-NO_3$ and $^{13}C-HCO_3$ł by phytoplankton to new and total primary production rates, respectively.

Methods

Discrete water samples were collected before dawn from nine optical depths (116, 93, 83, 53, 39, 21 and 8m), corresponding to 0.1, 0.5, 1, 6, 13, 34, 52, 66 and 100% of surface irradiance, respectively, to achieve a high resolution of the euphotic zone. Samples were incubated in bottles covered with neutral density filters of the corresponding light intensity on board (*simulated in-situ* incubation). Stable isotopes ($^{15}NO_3$, $^{15}NH_4$ and $H^{13}CO_3$) were added in trace concentrations in order to maintain the natural nutrient abundance. After about 12h, the experiments were stopped by filtering the samples onto precombusted GF/F filters. The incorporated isotopes and the particulare nitrogen and carbon contents (PON and POC) will be determined by mass spectrometry and elemental analyses in the laboratory. To normalize the primary production rates to biomass, samples for chlorophyll a and other phytoplankton pigments were taken for fluorometric and liquid chromatograhic analyses.

Also, the impact of nutrient ability on production rates (*Michaelis-Menten*-kinetics) was investigated by adding different nitrogen concentrations (0.1, 0.3, 0.5, 1.0 and 2.0 mol NO_3/l) to the incubation experiment.

First results

Profiles of primary production were taken at all main stations (ESTOC, LP and EBC). All stations were characterized by deep chlorophyll maxima and a lack of nutrients in the euphotic zone.
The analysis of the chlorophyll samples before and after the incubation experiments showed no photoinhibition except for one depth (St. 265, 21 m) indicating that the chosen light depths were appropriate for incubation.

5.10 **Coccolithophores, diatoms and planktic foraminifera**

(J. Bollmann)

Research programme

Sampling for coccolithophores, diatoms and planktic foraminifera during METEOR cruise 42/1 was part of the EC-MASTIII program CANIGO (PL950443) subproject 3: Particle flux and paleoceanography in the Eastern Boundary Current, Task 3.1.2 Flux of organisms. This cruise is the last cruise of several seasonal cruises within this project and represents the summer season.

The goals are (a) to obtain a better understanding of the seasonal and interannual interaction between planktic organisms and the physical environment 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.

Coccolithophores

During cruise M42/1, water casts of 10 litres were taken at 43 stations from the following depth levels: 0, 10, 25, 50, 75, 100, 125, 150, 200, 250, 300 meters. At 24 stations samples were taken along a zonal transect from the African coast to La Palma (29°N-section); six stations were sampled along the meridional transect from La Palma to Madeira (18°W), and 13 stations the zonal transect from Madeira towards the African coast (32°N).

Up to 10 litres of water were transferred the rosette Niskin bottles for each depth level into carboys after rinsing the carboys with tap water. Within one hour the water was filtered onboard through Nucleopore PC filters (0.8 m, 47 mm diameter) using a low-vacuum filtration device. Filtration was terminated if the filter became clogged and the amount of remaining water was measured. After filtration, the filters were rinsed with 50ml buffered destilled water (NH_4OH, PH8.5) in order to eliminate all traces of sea salt. Rinsed filters were transferred to labelled petri-dishes, dried immediately in an oven at 40°C for several hours.

Subsequent analyses will use a scanning electron microscope cell density (#/l) and to determine the taxonomic composition of the coccolithophore populations. In addition morphological features of *Gephyrocapsa* sp. and *Calcidiscus leptoporus* will be analysed.

Diatoms

Water samples for diatom analyses were taken at 15 stations along the 29°N section (African shelf to La Palma) from the following water depth levels: 0, 10, 25, 50, 75, 100, 125, 150, 200, 250, 300 meters. About 300 ml of sea water were transferred from rosette Niskin bottles into plastic bottles and stained with 30 ml Formol which was buffered to pH 8 with Hexamethyl-Tetramin .

In addition, at 15 stations a plankton net with 63 m mesh size was used to sample diatoms within the upper 100 m water column (integrated sampling; IGM Lisbon). The net was released to 100m water depth and was pulled with 0.3 m/s back to the surface. Subsequently the net was rinsed with sea water and the catch was transferred into a plastic bottle and stained with Glutardialdehyde.

Subsequent analyses will use a light microscope and if necessary a Scanning Electron Microscope (SEM), to determine the diatom standing stock and its assemblage composition.

Planktic foraminifera

Planktic foraminifera were collected with a multi-closing-net (mesh size 64 m) at five depth intervals (500-300, 300-150, 150-50, 50-25, 25-0) at 8 stations along the 29°-section (African shelf to La Palma) including the three stations close to the moorings at LP1, ESTOC and EBC2. The multinet-samples were preserved on board with a saturated solution of $HgCl_2$ and stained with Bengalrosa. In addition, sea water was taken at the base of each net-interval for stable isotope analyses ($\delta^{18}O$- and $\delta^{13}C$). These samples were preserved with $HgCl_2$ and the glass bottles were sealed with Paraffin to prevent the oxidation of organic matter. All samples were stored immediately in a refrigerator at 4°C.

In future analyses the assemblage composition of foraminifera will be determined. Stable isotope analyses of selected foraminifera species as well as the stable isotope composition of sea water will be performed.

5.11 Deep-sea ichthyoplankton abundance and diversity off NW Africa
(H.-C. John)

Sampling
During leg M42/1b, fish larvae were sampled along two zonal sections: ca 29°N and 32°N cross-slope near the African shelf. Vertical hauls were obtained on 28 stations with a Hydro-Bios Multinet MUV (Multinet vertical) with 0.25 m_ mouth opening and 300 mikrometer mesh size. The net was equipped with a CTD-system with real-time display on board. Retrieval speed was 0.7 m/s. Five net steps were available, and generally sampling was in 200 m depth intervals each, from 1000 m depth to the surface, or with somewhat finer strata near the surface when bottom depths were 800m or less. Across the continental slope between Morocco and west of Lanzarote, horizontal resolution was relative fine (5 - 7 nautical miles, stations 310 —320) in order to investigate fish larval patterns in relation to along-slope and cross-slope currents. For open ocean ichthyology, station spacing was wider (up to 60 miles, for details see table 5.11.1). At eight of the 28 stations, additionally three 200 m-strata between 1600 —1000 m depth plus a wider stratum 2000 —1600 m each were sampled. Net no. 5, which can not be closed, provided an integrated sample from 1000 m to the surface at each of these stations, too. There were no malfunctionings of the net, and also no losses of samples due to torn nets, resulting in a total of 36 hauls with 5 samples each.

Results
Preserving the samples, fish larvae or juveniles were observed in any of the 36 hauls and generally in all samples down to 600 m depth. Cyclothones (random identifications yielded so far at least 7 species) appeared to be centered in the 400 -600 m layer. However, ichthyoplankton occurred occasionally even deeper and down to 1200 m, whilst below that depth no fish was visible macroscopically.

The ten stations between Morocco and Lanzarote could be sorted already on board for ichthyoplankton, and sorted fish could be identified mikroscopically. Sorting was somewhat cumbersome due to high abundances of foraminifera in the uppermost layer.

Figure 5.11.1 shows the gross abundance of fish along this transect, and an abbreviated list of the species identified is given in table 5.11.2. Fish larval abundances were high above the upper continental slope with more than 150 fishes per squaremeter (Fig. 5.11.1), but not so above the slope of Lanzarote, nor in the waters in between. It must be emphasized that the sea bottom between Morocco and Lanzarote forms a sill of maximum depths of 1300 m only and is thus not an oceanic habitat, really. The decrease in abundance coincided approximately with the 1000 m isobath. As shown by table 5.11.2, coastal species occupy the rank places 1, 2 and 4.

Table 5.11.1: Inventory of ichthyoplankton sampling with the vertical multiple closing net MUV during M42/1b.

MUV #	Sta. #	Date	UTC	Lat. ° ´N	Long. ° ´W	Depth max.(m)
1	306	26.06.1998	21,10	28 40.0	15 35.4	1000
2	310	27.06.1998	19,56	28 37.0	12 49.0	250
3	311	27.06.2008	22,43	28 38.0	12 55.1	360
4	312	28.06.1998	3,08	28 39.6	13 01.1	600
5	313	28.06.1998	6,03	28 40.0	13 06.1	780
6	314	28.06.1998	9,44	28 49.9	13 12.1	1000
7	315	28.06.1998	15,22	28 43.1	13 17.0	1000
8	316	28.06.1998	21,26	28 44.0	13 22.0	1000
9	317	29.06.1998	2,27	28 45.0	13 29.0	1000
10	318	29.06.1998	8,11	28 46.0	13 34.0	1000
11	319	29.06.1998	13,00	28 48.1	13 43.1	836
12	320	29.06.1998	18,38	28 51.0	13 56.1	1000
13	322	30.06.1998	5,31	28 53.0	14 06.0	1000
14	324	30.06.1998	17,39	28 56.0	14 22.0	2000
15	324	30.06.1998	21,30	28 56.0	14 22.0	1000
16	327	01.07.1998	19,18	29 10.0	15 30.1	1000
17	327	01.07.1998	23,33	29 10.2	15 30.2	2000
18	331	03.07.1998	2,29	29 10.0	16 34.0	1000
19	331	03.07.1998	4,32	29 10.1	16 34.0	2000
20	332	03.07.1998	13,53	29 10.0	16 55.1	1000
21	332	03.07.1998	17,37	29 10.0	16 55.1	2000
22	333	03.07.1998	22,53	29 10.0	17 17.1	1000
23	333	04.07.1998	1,37	29 10.0	17 17.0	2000
24	335	04.07.1998	19,20	29 10.0	18 00.1	1000
25	335	04.07.1998	22,27	29 10.1	18 00.2	2000
26	342	07.07.1998	12,47	32 15.0	18 00.0	1000
27	343	07.07.1998	21,36	32 14.9	17 25.2	1000
28	344	08.07.1998	6,52	32 15.0	16 50.0	1000
29	345	08.07.1998	16,52	32 15.0	16 10.1	1000
30	349	09.07.1998	22,40	32 15.0	14 10.1	1000
31	351	10.07.1998	19,05	32 15.0	12 10.0	1000
32	351	10.07.1998	21,12	32 15.0	12 10.1	2000
33	353	11.07.1998	13,25	32 15.0	10 50.0	1000
34	353	11.07.1998	15,34	32 14.9	10 50.0	2000
35	355	12.07.1998	6,47	32 05.0	10 10.0	1000
36	356	12.07.1998	13,37	32 02.9	09 55.5	820

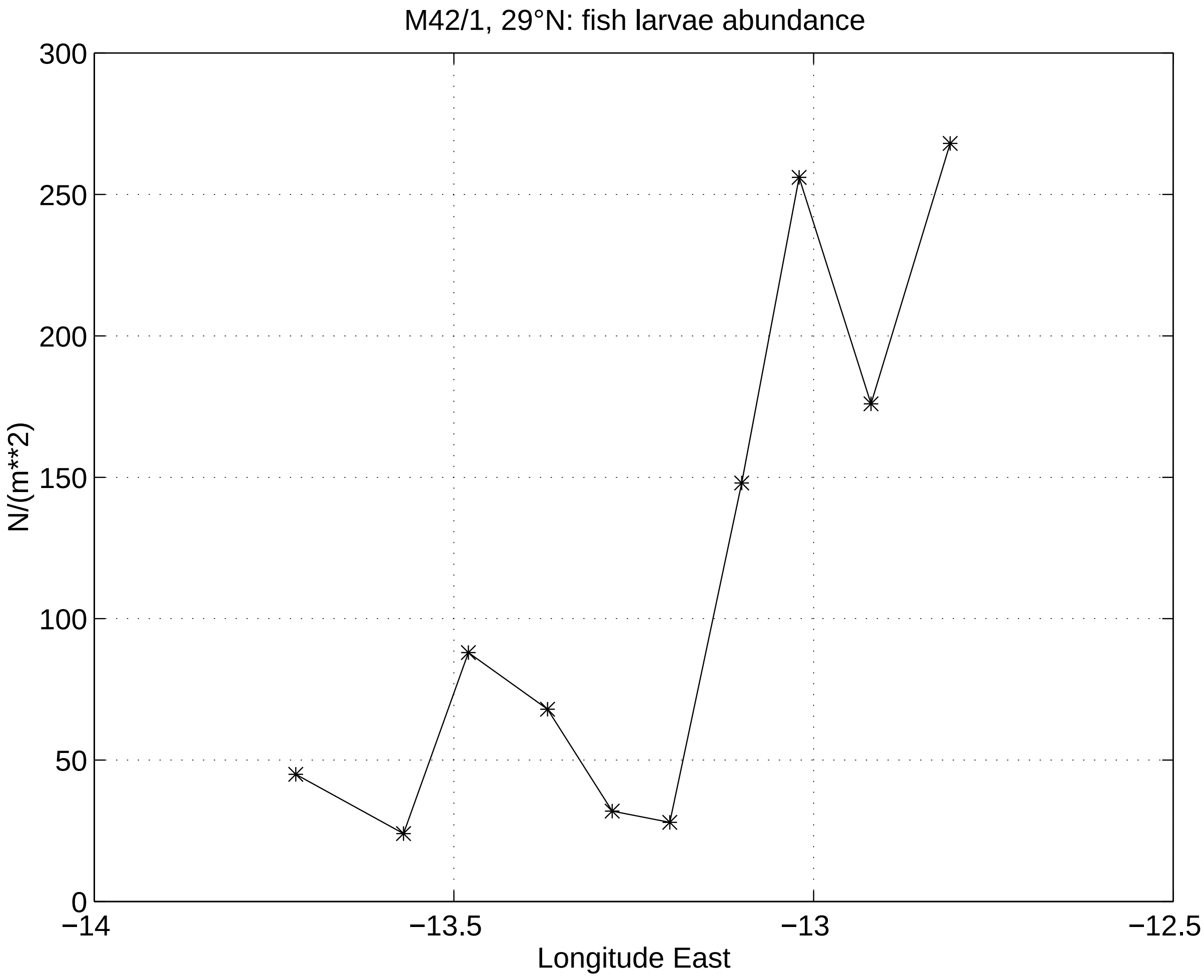


Fig. 5.11.1: The gross abundance of fish larvae (number of occurance N per m^2) between the shelf edge off Morocco and Lanzarote, plotted by geographical longitude

Table 5.11.2: Abbreviated list of fish species caught between the shelf edge of Morocco and Lanzarote

Rank	Taxon	Common name	Number
1	*Engraulis encrasicholus*	Anchovy	151
2	Gobiidae indet.	Gobies	33
3	*Cyclothone* (7 spp.)	----------	33
4	Blenniidae indet.	Blennies	19
5	*Ceratoscopelus maderensis*	Lanternfish	12
6	*Maurolicus muelleri*	Lightfish	12
7	Sternoptychidae	Hatchetfishes	6

Besides the species listed in table 5.11.2 above, the following rare taxa contributed 1 to 4 specimens each: Clupeiformes indet., *Vinciguerria attenuata*, *V. poweriae*, *Pollichthys mauli*, Stomiatoidei spp., *Benthosema* sp., *Myctophum nitidulum*, *Diaphus rafinesquei*, *Notoscopelus bolini*, Scopelarchidae indet., *Pagellus acarne*, Serranidae indet., *Callionymus* sp., *Trachurus trachurus*, *Lepidopus caudatus*, *Arnoglossus* sp., *Microchirus ocellatus*, Heterosomata indet., unidentifyable.

The identification of some presumed *Maurolicus muelleri* is uncertain. These tiny, completely unpigmented larvae have been tentatively assigned to *Maurolicus* due to the absence of internal transverse rugae in their intestines. However, they also bear similarities to *Ceratoscopelus maderensis*, in case its recently hatched larvae are devoid of any pigment. The remaining rank places are occupied by oceanic fish species, which, according to macroscopical investigation as well as sorting of nets 1 to 3 of haul no. 13 , become somewhat more abundant, and more species-rich west of Lanzarote above truly oceanic depths. A quick-look analysis of the integrated sample from 1000 m to the surface at station 353 on the northern transect yielded 8 cyclothones besides one *Argyropelecus hemigymnus*, *Sudis hyalina*, *Lobianchia dofleini* and *Serrivomer beani*, each.

The species list given above seems to be fairly typical for a Northwest African slope area during quiescent summer conditions. A more intensive summer upwelling situation would have yielded sardine (*Sardina pilchardus*) on one of the first rank places, but only scant anchovy larvae of larger sizes, originating from earlier spawning. A winter situation would have yielded (besides sardine) many larvae of horse mackerel (*Trachurus trachurus*), lanternfish *Myctophum punctatum*, *Maurolicus* and probably also hake (*Merluccius merluccius*). The oceanic fauna besides *C. maderensis*, of which the adults are associated with Mediterranean Outflow Water, includes mostly species of the subtropical-temperate complex, but no distinct tropical species except for one single *Cyclothone livida*. This latter species, if caught in larger numbers, might serve as a tracer for the intermediate poleward slope current in the passage east of Fuerteventura and Lanzarote, or within the archipelago, respectively, and the teleconnection of this current with the tropical Eastern Atlantic margin.

As shown in figure 5.11.2, the decrease of abundance above the shelf edge coincides with the change from coastal (neritic) species to oceanic ones. The boundary is fairly sharp, with only slight intrusion of single specimens of oceanic taxa onto the upper continental slope, as well as occurrence of single neritic specimens offshore (the questionable *Maurolicus* larvae were not counted as a separate taxon constructing this figure). The little overlap between neritic and oceanic groups maybe interpreted also as some evidence for little cross-shelf transport, i.e. little or no upwelling during the planktonic phase of most of the larvae caughts. Since weak upwelling was evident in the CTD-data, it must be emphasized that the CTD-data and fish larval data describe different time scales. The larval assemblage is estimated to be generally 1 to 2 weeks old, because among blennies, *C. maderensis*, gobies and the Lampanyctinae preflexion larvae prevailed, whilst anchovy was generally in or beyond notochord flexion. However, among blennies and flatfishes even some yolk-sac larvae were found of probably 4 — 5 days age, and the questionable *Maurolicus* must also be only few days old. The *M. nitidulum* caught above the slope (it is a high-oceanic species) was in early transformation and thus several weeks old, in which time it may have drifted onshore (and probably also downcurrent meridionally). Measurements for more precise ageing and grouping for cross-slope zonations of stages could not yet be done, neither have vertical distributions been calculated yet.

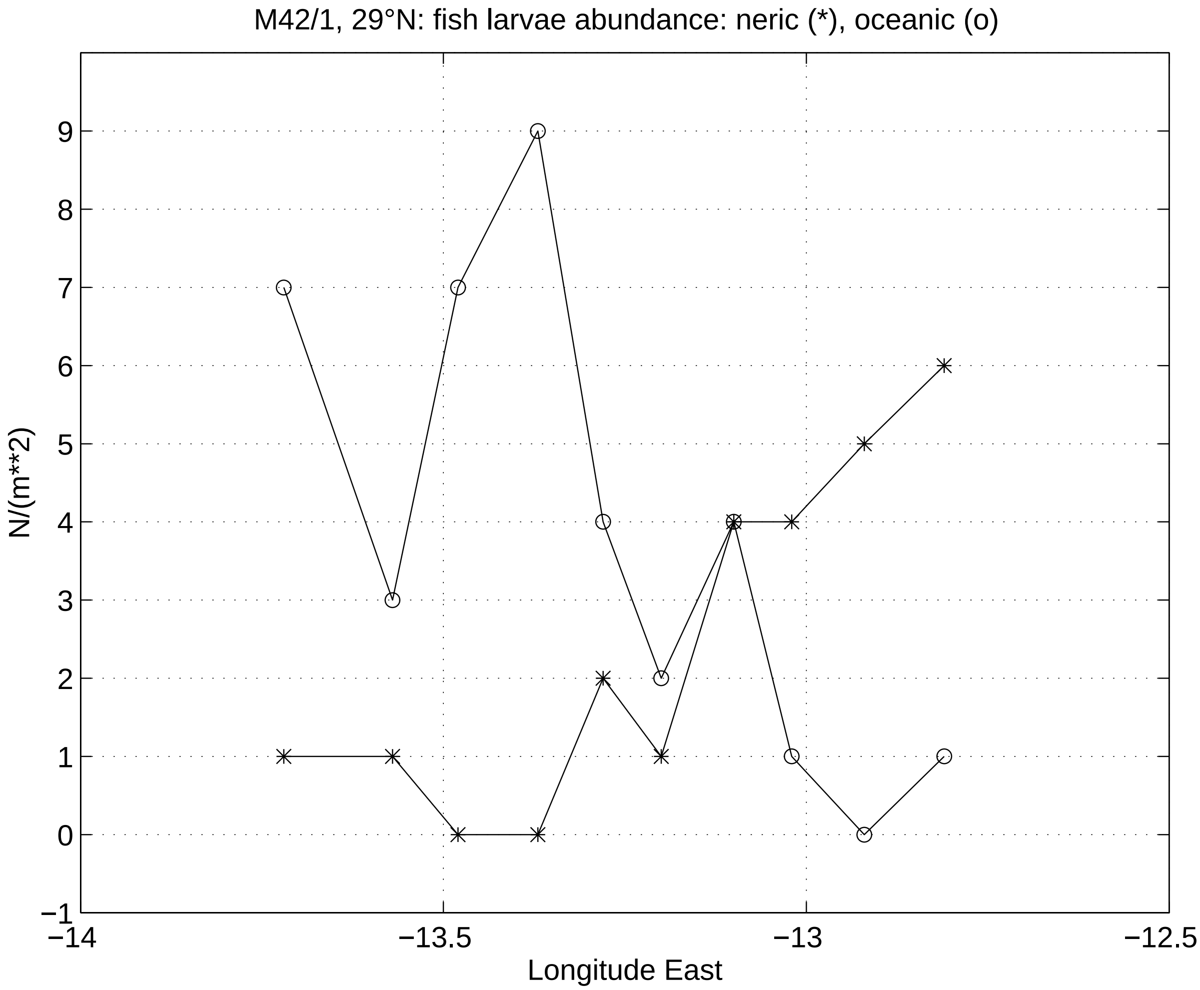


Fig. 5.11.2: The numbers of species per station, separated for coastal (neritic) and oceanic taxa (otherwise as for Fig. 5.11.1)

6. Ship's Meteorological Station
(H. D. Behr)

Cruise, course and weather
FS "Meteor" sailed from Las Palmas Tuesday, June 16, 1998 at noon, steering on northerly courses. There were light northeasterly winds at the first station ca. 80 nm northwest of Gran Canaria, originating from a high south of the Azores and a low over the western parts of the Saharan desert. The wind turned to North force 4 during the cruise until we reached the position LP north of La Palma. After station work at LP R/V Meteor sailed to station EBC east of Lanzarote. The African low had moved to the west in the meantime causing northeasterly winds of force 6, increasing to 8 for a while. After having finished station work east of Lanzarote R/V Meteor sailed westward again to station ESTOC north of Gran Canaria and after station work there R/V Meteor called in to Las Palmas again 25 June to exchange part of the scientific crew.

After having left Las Palmas on 26 June, the vessel steamed again to the array EBC east of Lanzarote to start the hydrographic work on the box north of the Canary Islands. The high near the Azores and the low over the Saharan desert were nearly stationary during the whole time. However, slight movements in their positions and changes in their intensities usually caused northeasterly wind increasing to force 7 in the afternoon decreasing winds to force 3 to 4 during the nights.

While approaching the easternmost station on the northern section 357, the Saharan low deepened significantly and moved westward towards the high near the Azores. This caused the northeasterly winds to increase to up to force 8 during the last part of this leg. At station 357 the wind was light and variable, but there was a lot of dust caused by Saharan sand in the air reducing the visibility.

After station work at 357 was finished at July 12 R/V METEOR started her transit to the port of Lisbon. On the way, four moorings were to be recovered which was disturbed by rough seas due to the strong winds.

In the morning of July 16, 1998 RV METEOR reached Lisbon.

Activities of the Ship's Weather Watch
On a daily basis, *weather reports* were compiled and published. Comments heron were presented on a regular basis to the ship's command and the chief scientist. The other participants of the cruise were informed through a bulletin or on special request. Special advice was given in some cases. The necessary data and weather maps were received from wireless stations (Pinneberg and Nairobi), as satellite pictures (METEOSAT 7 and NOAA 12, 14, and 15), and by fax (forecast charts from ECMWF or DWD) or by e-mail from the 'Deutscher Wetterdienst', Hamburg and Offenbach/Main.

The forecasts of weather conditions and height of sea and swell were based essentially on surface analyses charts of the Northern Atlantic Ocean between 60° N and 20° N. Surface observations of West-European and Northwest-African weather-stations and voluntary merchant ships were compiled by hand drawing in these charts and analyzed by hand.

Continously measured meteorological parameter were recorded, transferred to the ship's data collecting system, and on request were distributed to users through computer links or on disks. The sensors and meteorological equipment were maintained on a regular basis, some repairs were made.

Standard weather WMO observations were made every hour by the watch officer. Eight of them were transmitted into the WMO Global Telecommunication System (GTS); these also included additional eye observations done by meteorological staff.

Every day at 12 UTC one *radiosonde* was launched using the ASAP system by which the vertical profile of pressure, temperature, moisture, and horizontal wind up to an altitude of 20 to 25 km was determined. The prcesseded data of the records (TEMPS) were transmitted to the GTS of the WMO.

Determination of the net total radiation and atmospheric turbidity at sea
Information about the spatial and temporal distribution of the net total radiation and its components at the sea surface as well as atmospheric turbidity are important basic variables in meteorology and oceanography as well. Off Northwest Africa atmospheric dust that origins from the Saharian desert is an imprtant component of atmospheric turbity, and it also plays an important role in sedimentation in the ocean.

In a special research programme, the following radiation components were recorded during M42/1: direct solar radiation, sunshine duration, global solar radiation and UV-B global solar radiation as well as longwave thermal radiation of the atmosphere. Additional components that are necessary to establish a radiation balance as reflected solar radiation and ocean surface radiation were computed using numerical models that have been successfully tested earlier on research cruises in the Atlantic (Behr, 1990).

Atmospheric turbidity is expressed by a set of coefficients as follows:
- T_L: Linke-turbidity-coefficient, describing all radiative processes in the solar spectrum
- T_s: turbidity-coefficient, describing all radiative processes in the short-range part of the solar spectrum which provides information about the dust in the atmosphere
- T_r: turbidity-coefficient, describing all radiative processes in the red part of the solar spectrum which provides information about the water-vapor-content in the atmosphere.

Using an exponential decaying law that describes the turbidity effects as the effect of several (clear) Raleigh atmospheres, the coefficients T_L, T_s , and T_r can be computed by from
- the known extraterrestrial solar radiation received from a surface normal to the beam of the sun which depends on the distance sun - earth only
- the direct solar radiation received from a surface normal to the beam of the sun, e.g. measured with a Linke-Feussner-Actinometer
- the optical pathlength that depends on the solar elevation angle
- the optical thickness of the atmosphere

The data set of numerous measurements of direct solar radiation done with a Linke-Feussner-Actinometer revealed the spatial and temporal variation of the atmospheric turbidity during M42/1. As a first result, of the section along ca 29°N from EBC to LP (June, 16 to 30) will be shown here. There was clear air during nearly all the time, but a dusty event occurred from June 21 to 25 transporting sand from the Saharan desert. The pathways of the airmasses in 9 different pressure levels is revealed by figures 6.1 and 6.2 by backward trajectories. The trajectories started 108 hours before the day chosen in order to reveal the area the air originated from. From June 21 to 25, dusty air originated from the Saharan desert reached FS "Meteor" in all layers. The Linke-turbidity-factor is correspondingly high: 12 to 18 (see Fig. 6.3). The increasing content of dust can be seen by increasing values of T_s from 2 to 4. During all other days clear air originating from a maritime area was present in all layers of the atmosphere. The turbidity factors were correspondingly low. These findings correspond to former results found by Behr (1990, 1992).

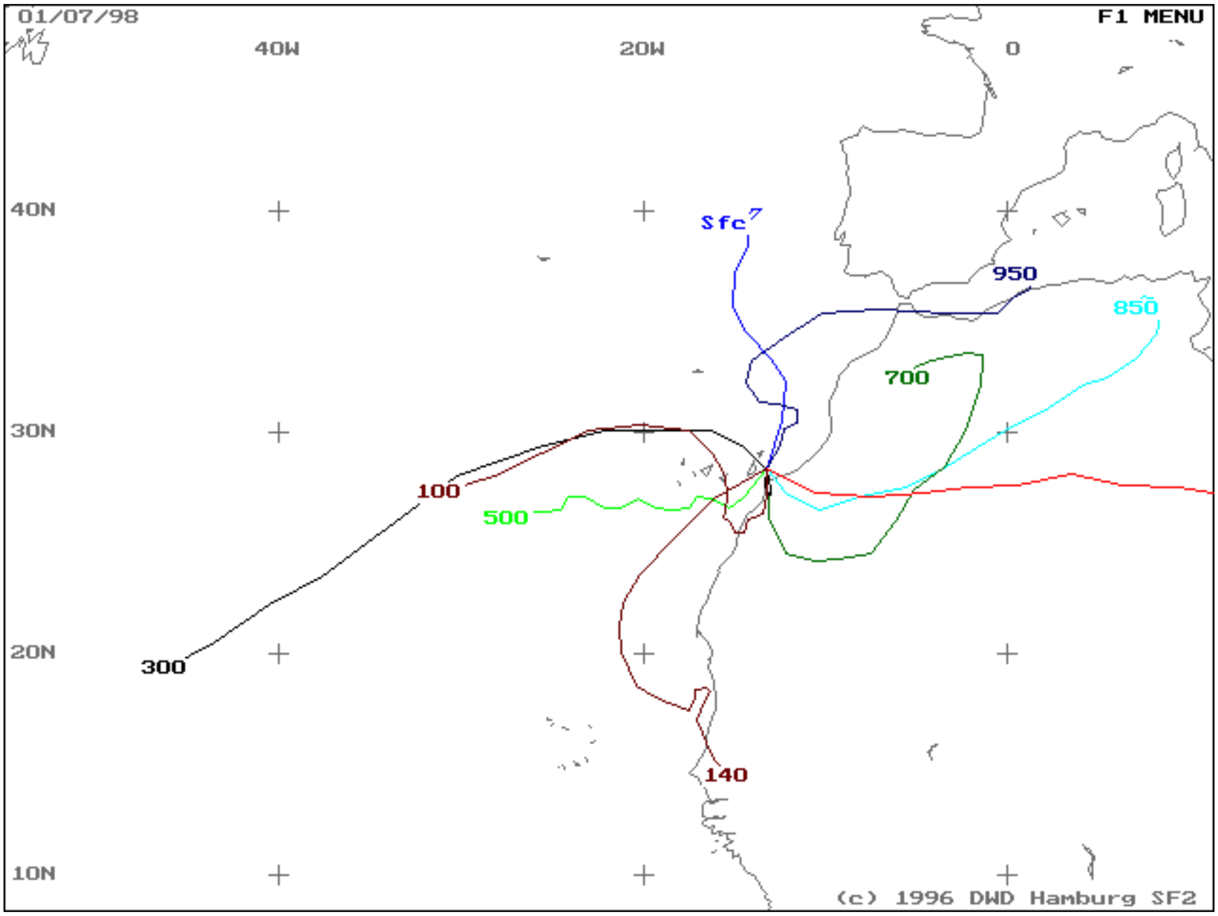


Fig. 6.1: Backward trajectories in different levels starting 108 hours ago and reaching the position of FS "Meteor" on June 21, 1998 00:00 UTC. The pressure levels used are indicated: surface, 950 hPa [0.5 km], 850 hPa [1.5 km], 700 hPa [3.0 km], 500 hPa [5.5 km], and 300 hPa [≈ 9 km], 140 hPa [≈14 km], 100 hPa [≈ 16 km], and 50 hPa [≈ 21 km].

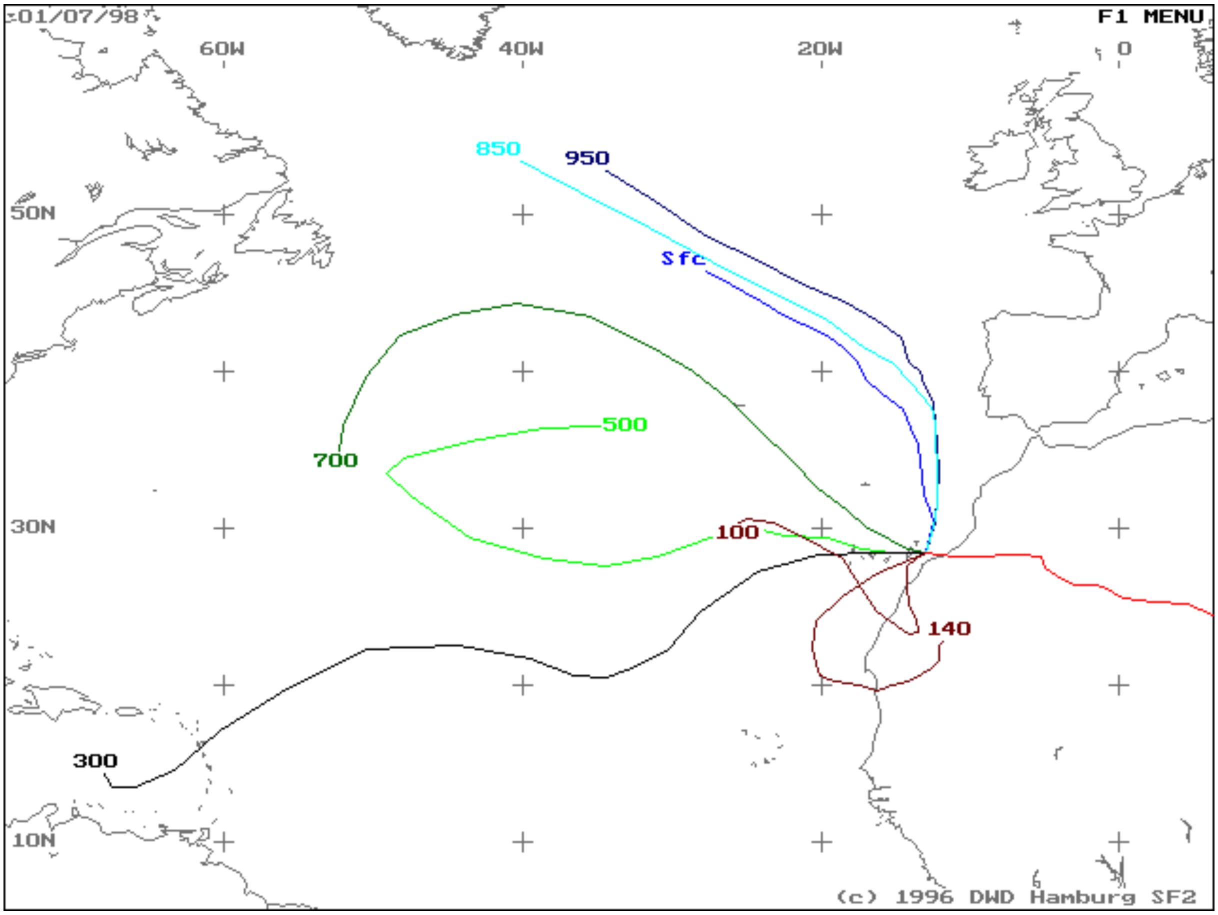


Fig. 6.2: Same as Fig. 2, but for June 28, 1998

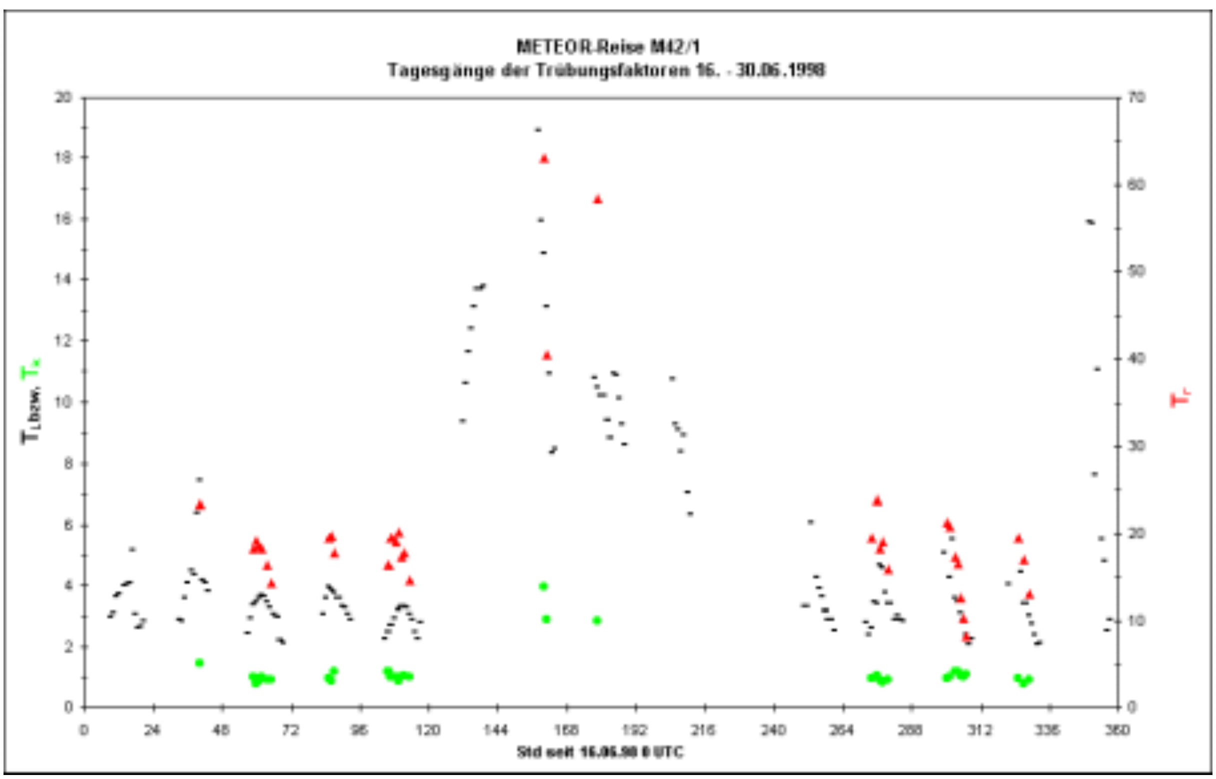


Fig. 6.3: Daily changes of the atmosheric turbidity coefficients T_L, T_k, and T_r along ca. 29°N (EBC to LP), June 16 to 30, 1998.

7. Stationlists

Table 7.1: Station list M42/1
METEOR cruise 42/1 station and sample log
Status: 28.11.1998

List of abbreviations:
St : Station no.
Pr : CTD profile no., monotonically increasing during the cruise
Wd : Waterdepth
Wl : maximum length of wire put out
Instr : Type of instrumentation or mooring or equipment
NB4 : Neil Brown CTD, IFMK internal code NB4, with 21x10 l bottle rosette
VXXX : Mooring no XXX
TX.Y : Drifting particle traps: X traps, Yth. deployement
GoFlo : Cast for trace elements with GoFlo bottles on rosette
ISP : Cast for trace elements with in-situ pumps
XBT : XBT profile
OS : Optical sensors with CTD
MN : Multiple closing plankton net, 500 m - surface
MUV : Multiple closing plankton net, fish larvae, 2000 m - 1000 m, 1000 m - surface
PN : Plankton net, 100 m surface
NOAA : surface drifter
sss : sun at starboard side

Parameter list for CTD/rosette:
A: lowered ADCP (lADCP, IFMK)), 150 KHz, on CTD/rosette
F: Fluorometer attached to CTD
R: General Oceanic rosette, 21x 10 l Niskin bottles
0: Gelbstoff (ICCM)
1: Dissolved oxygen (ICCM), 300 ml
2: Trace metals (ULPGC) in particular aluminium, 300 ml
3: Dissolved organic carbon (DOC, IBGMH), 300 ml
4: Nutrients (ICCM), 200 ml
5: Chlorophyll (ICCM), 1200 ml
6: Gelbstoff (UO), 1200 ml
7: Salt (IFMK), 500 ml
8: Diatomes (IGM), 300 ml
9: Coccolithophorides (ETH), >= 4000 ml
δ d: $d^{15}N$ or u: ^{15}N uptake or b: $d^{15}N$-Blank (GeoB)
D Dilution experiment (GeoB)
H High pressure liquid cromatography (HPLC, GeoB)
M Humin (IBGMH)
O TC total carbon (GeoB)
P TOC total organic carbon (GeoB)
Q POC particulate organic carbon (GeoB)
T Total nitrogen (TN, GeoB)
U Total organic nitrogen (TON, GeoB)
X: Dissolved organic matter (DOM, IBGMH)

Table 7.1 (continued)

Date UTC MMDD 1998	Time UTC hhmm	St	Pr	Latitude North GG MM.M	Longitude West GGG MM.M	Wd [m]	Wl [m]	Inst	Comments / Parameter index: F R A 0 1 3 4 5 7 δ D H M 0 P Q T U X (- not attached / sampled; parameters 0 to 9 see SAMPLE.DOC)
0616	1300								Sail from Las Palmas, begin of M42/1a
0616	1500	260	001	28 31.0	015 23.4	3560	0197	NB4	test CTD/rosette water for traps
0616	2056	261	-9	29 14.4	015 25.1	3606	-9	T1.1	drifting particle trap launched
0616	2157	261	-9	29 14.1	015 26.0	3606	-9	T3.1	drifting particle traps launched
0616	2217	261	002	29 14.1	015 26.3	3606	500	NB4	F R - - - - - 5 - - - - - - - - Q - - -
0616	2358	262	-9	29 10.1	015 30.2	3612	3600	ISP	
0617	0613	262	-9	29 10.0	015 30.1	3619	1000	GoFlo	
0617	0850	263	-9	29 10.1	015 40.2	3600	-9	V367-4	ESTOC mooring of IFMK recovered
0617	1242	264	-9	29 10.1	015 29.9	3612	3522	GoFlo	
0617	1611	264	003	29 10.1	015 29.7	3614	2975	NB4	F R - - - - - - 7 d D - - O P - T U -
0618	0435	265	004	29 39.8	017 38.8	4227	115	NB4	F R - - - - - - - u - - - - - - - - -
0618	0717	266	-9	29 45.0	018 00.2	4361	400	ISP	
0618	1013	266	-9	29 44.9	018 00.2	4360	4310	GoFlo	
0618	1444	266	005	29 45.0	018 00.3	4360	4394	NB4	- R - - - 3 - - 7 d - - M O P - T U -
0618	1819	266	-9	29 45.3	018 00.5	4363	4310	ISP	
0619	0034	266	-9	29 45.5	018 01.3	4364	800	GoFlo	- - - - - - - 5 - - - - - - - - - - -
0619	0430	267	006	29 36.5	017 25.9	4145	140	NB4	- R - - - - 4 - - u , 15N experiment
0619	1235	268	007	29 02.6	015 50.8	3624	200	NB4	- R - water for traps
0619	1450	269	-9	29 04.1	015 29.2	-9	-9	T1.1	recovery; trap and current meter lost
0619	1629	269	-9	29 14.5	015 33.8	-9	-9	T3.1	recovery
0619	1701	269	008	29 14.5	015 33.7	3614	499	NB4	- R - - - - - 5 - - - H - - - - - - -
0619	1854	270	-9	29 14.9	015 24.8	3604	-9	T3.2	drifting particle traps launched
0619	1905	270	009	29 14.7	015 24.7	3605	200	NB4	- R - - - - - 5 - - D - - - - - - - -
0619	2020	271	-9	29 09.7	015 30.1	3614	700	ISP	
0619	2306	271	-9	29 09.4	015 30.6	3614	800	GoFlo	
0620	0010	271	010	29 09.4	015 30.7	3614	3622	NB4	- R - - - 3 - - 7 d - - - O P - T U X
0620	0300	271	-9	29 09.6	015 31.5	3614	3200	ISP	
0620	1106	272	-9	29 11.9	015 38.4	3621	-9	V367-5	ESTOC mooring of IFMK set
0620	1142	272	011	29 10.0	015 39.9	3623	3622	NB4	- R - - - - - - 7 - - - - - - - - - -
0621	0137	273	-9	28 42.9	013 17.0	1023	400	ISP	
0621	0350	273	012	28 43.0	013 17.0	1017	200	NB4	F R - - - - 4 - - u - - - - - - - - -
0621	0510	274	-9	28 42.2	013 09.8	998	-9	V378-2	EBC2 mooring of IFMK recovered
0621	0826	275	-9	28 46.4	013 27.6	1276	-9	ECB4-2	mooring of IEO recovered
0621	1025	276	-9	28 48.6	013 38.4	1037	-9	EBC5-2	mooring of IEO recovered
0621	1200	277	013	28 48.2	013 42.2	906	901	NB4	F R - no samples
0621	1643	278	014	28 46.0	013 33.8	1196	1198	NB4	F R - - - - - - 7 - - - - - - - - - -
0621	1816	279	015	28 45.0	013 28.9	1282	1279	NB4	F R - - - - - - 7 - - - - - - - - - -
0621	2000	280	016	28 44.0	013 23.1	1344	1329	NB4	F R - - - - - - 7 - - - - - - - - - -
0621	2325	281	-9	28 43.8	013 21.0	1192	1167	ISP	
0622	0134	281	-9	28 43.8	013 21.1	1190	801	GoFlo	
0622	0241	281	017	28 43.8	013 21.1	1191	1097	NB4	F R - - - 3 - - 7 u , 13C uptake
0622	0509	282	018	28 42.0	013 12.0	1054	1046	NB4	F R - - - - - - 7 - - - - - - - - - -
0622	0757	283	-9	28 42.1	013 09.7	1006	-9	V378-3	EBC2 mooring of IFMK set
0622	1057	284	-9	28 44.3	013 17.9	1180	-9	V377-2	EBC3 mooring of IFMK recovered
0622	1232	-9	-9	28 43.9	013 19.5	1177	-9	XBT	test
0622	1457	285	-9	28 45.3	013 27.6	1296	-9	EBC4-3	mooring of IEO set
0622	1724	286	019	28 41.0	013 06.0	824	820	NB4	F R - - - - - - 7 - - - - - - - - - -
0622	1850	287	020	28 39.9	013 01.0	631	628	NB4	F R - - - - - 5 7 b D - - - - - - - -
0622	2218	288	021	28 34.0	012 31.2	101	91	NB4	F R - - - - - - 7 - - - - - - - - - -
0622	2325	289	022	28 35.1	012 37.1	106	96	NB4	F R - - - - - - 7 - - - - - - - - - -
0623	0028	290	023	28 36.0	012 44.1	170	162	NB4	F R - - - - - - 7 - - - - - - - - - -
0623	0131	291	024	28 37.0	012 49.0	253	246	NB4	F R - - - - - - 7 - - - - - - - - - -
0623	0236	292	025	28 37.9	012 54.1	355	348	NB4	F R - - - - - - 7 - - - - - - - - - -
0623	0502	293	026	28 43.0	013 17.0	1010	125	NB4	F R - - - - - - - u - - - - - - - - -
0623	0544	293	-9	28 43.5	013 17.0	1106	1078	GoFlo	
0623	0832	294	-9	28 44.0	013 19.1	1188	-9	V377-3	EBC3 mooring of IFMK set
0623	0922	294	027	28 45.2	013 18.9	1275	1270	NB4	F R - - - - 4 5 - d - - - O P - T U X
0623	1317	295	-9	28 49.3	013 40.2	974	-9	EBC5-3	mooring of IEO set
0623	1529	296	028	28 51.0	013 59.0	1583	1581	NB4	F R - - - - - - 7 - - - - - - - - - -
0623	1734	297	029	28 52.0	013 56.0	1054	1056	NB4	F R - - - - - - 7 - - - - - - - - - -
0623	2054	298	030	28 54.1	014 10.2	2264	2012	NB4	F R - - - - - - 7 - - - - - - - - - -
0623	2328	299	031	28 56.2	014 21.2	3003	1996	NB4	F R - - - - - - 7 - - - - - - - - - -
0624	0200	300	032	28 58.0	014 33.0	3349	1990	NB4	F R - - - - - - 7 u - - - - - - - - -
0624	0447	301	033	29 01.0	014 44.0	3516	1982	NB4	F R - - - - - - 7 - - - - - - - - - -
0624	0709	302	034	29 03.9	014 55.0	3565	1987	NB4	F R - - - - - - 7 - - - - - - - - - -
0624	1245	303	-9	29 17.9	015 41.3	-9	-9	T3.2	recovered
0624	1312	303	035	29 17.9	015 41.1	3624	507	NB4	F R - - - - - 5 - - - - - - - - Q - - -
0624	1520	304	-9	29 10.0	015 30.0	3614	2000	ISP	
0624	1904	304	036	29 10.4	015 30.2	3612	3648	NB4	- R - 0 1 - 4 5 7 - - - - - - - - - -
0624	2157	304	-9	29 10.5	015 30.2	3614	200	PN	Plankton net of IEO
0624	2222	-9	-9	29 10.6	015 30.0	3613	-9	NOAA	drifter launched

Table 7.1 (continued)

Date UTC MMDD 1998	Time UTC hhmm	St	Pr	Latitude North GG MM.M	Longitude West GGG MM.M	Wd [m]	Wl [m]	Inst	Comments / Parameter index: F R A 0 1 2 3 4 5 6 7 8 9 (- not attached / sampled; parameters 0 to 9 see SAMPLE.DOC)
0625	0000	305	037	29 07.0	015 12.0	3589	1989	NB4	- R - - - - - - - - - 7 - -
0625	0211	-9	-9	29 00.0	015 13.4	3692	-9	XBT	
0625	0302	-9	-9	28 50.0	015 15.0	3593	-9	XBT	
0625	0352	-9	-9	28 40.0	015 16.9	3577	-9	XBT	
0625	0442	-9	-9	28 30.0	015 18.6	3487	-9	XBT	
0625	0532	-9	-9	28 20.0	015 20.4	3153	-9	XBT	
0625	0718	-9	-9	-9 -9	-9 -9	-9	-9		Port of Las Palmas, end of M42/1a
0626	1600	-9	-9	-9 -9	-9 -9	-9	-9		Sail from Las Palmas, begin of M42/1b
0626	1901	306	-9	28 40.0	015 35.3	3583	1003	GoFlo	
0626	2015	306	038	28 40.0	015 35.3	3582	999	NB4	F R A, test ok, substandard
0626	2112	306	-9	28 39.9	015 35.5	3582	999	MUV	test ok
0626	2212	306	-9	28 39.8	015 35.6	-9	100	PN	test ok
0626	2229	306	-9	28 39.7	015 35.7	3583	100	MN	test ok
0626	2255	306	-9	28 39.5	015 35.8	3584	1600	OS	test ok
0627	1450	307	039	28 34.1	012 32.0	102	88	NB4	F R - - 1 2 3 4 5 6 7 8 9
0627	1516	307	-9	28 33.9	012 32.2	102	94	OS	
0627	1618	308	040	28 34.9	012 36.9	104	98	NB4	F R - - 1 2 3 4 5 6 7 - -
0627	1644	308	-9	28 34.8	012 37.0	105	95	OS	sss
0627	1749	309	041	28 36.5	012 43.5	181	174	NB4	F R - - 1 2 3 4 5 6 7 - -
0627	1817	309	-9	28 36.5	012 43.6	174	165	OS	sss
0627	1922	310	042	28 37.0	012 49.2	254	249	NB4	F R - - 1 2 3 4 5 6 7 8 9
0627	1954	310	-9	28 36.9	012 49.5	254	248	MUV	
0627	2024	310	-9	28 36.6	012 49.7	-9	100	PN	
0627	2042	310	-9	28 36.5	012 50.3	254	250	OS	
0627	2152	311	043	28 38.0	012 54.7	367	363	NB4	F R A - 1 2 3 4 5 6 7 - 9
0627	2241	311	-9	28 38.0	012 55.2	367	367	MUV	
0627	2315	311	-9	28 38.0	012 55.5	383	360	OS	
0628	0030	312	-9	28 39.6	013 00.9	617	601	GoFlo	
0628	0205	312	044	28 39.7	013 01.0	623	622	NB4	F R A - 1 2 3 4 5 6 7 - 9
0628	0305	312	-9	28 39.6	013 01.1	623	594	MUV	
0628	0350	312	-9	28 39.7	013 01.4	636	620	OS	
0628	0500	313	045	28 40.0	013 06.1	800	802	NB4	F R A - 1 2 - 4 5 6 7 - -
0628	0601	313	-9	28 40.0	013 06.1	796	722	MUV	
0628	0651	313	-9	28 40.0	013 06.1	800	790	OS	
0628	0828	314	046	28 42.0	013 12.0	1060	1052	NB4	F R A - 1 2 3 4 5 6 7 8 9
0628	0944	314	-9	28 42.0	013 12.2	1061	990	MUV	
0628	1043	314	-9	28 41.9	013 12.2	1061	1045	OS	
0628	1137	314	-9	28 42.0	013 12.3	-9	100	PN	
0628	1157	314	-9	28 42.0	013 12.4	1064	500	MN	
0628	1256	314	047	28 42.0	013 12.4	1064	300	NB4	F R - - - - - - - - - - 9
0628	1410	315	048	28 43.0	013 17.0	1035	1019	NB4	F R A - 1 2 3 4 5 6 7 8 -
0628	1521	315	-9	28 43.0	013 17.0	1017	987	MUV	
0628	1620	315	-9	28 43.1	013 17.0	1064	1000	OS	sss; ship is drifting SSW, 1.2 Kn
0628	1724	315	-9	28 43.0	013 17.0	1023	500	MN	
0628	1817	315	-9	28 43.0	013 17.0	1016	100	PN	
0628	1838	315	049	28 43.0	013 17.0	1016	301	NB4	F R - - - - - - - - - - 9
0628	1957	316	050	28 44.0	013 22.0	1261	1257	NB4	F R A 0 1 2 3 4 5 6 7 - -
0628	2125	316	-9	28 43.9	013 22.0	1259	988	MUV	
0628	2229	316	-9	28 43.9	013 22.0	1267	1250	OS	
0628	2330	316	051	28 43.9	013 22.0	1256	300	NB4	F R - - - - - - - - - - 9
0629	0101	317	052	28 45.0	013 29.0	1289	1285	NB4	F R A - 1 2 3 4 5 6 7 - -
0629	0223	317	-9	28 45.0	013 29.0	1290	989	MUV	
0629	0323	317	-9	28 45.0	013 29.0	1289	1250	OS	
0629	0422	317	053	28 45.0	013 29.0	1290	300	NB4	F R - - - - - - - - - - 9
0629	0536	318	-9	28 46.1	013 34.0	1196	1001	GoFlo	
0629	0647	318	054	28 46.0	013 34.0	1195	1191	NB4	F R A - 1 2 3 4 5 6 7 8 -
0629	0808	318	-9	28 46.0	013 34.0	1193	987	MUV	
0629	0911	318	-9	28 46.2	013 34.1	1191	1180	OS	
0629	1006	318	-9	28 46.3	013 34.3	-9	100	PN	
0629	1021	318	055	28 46.4	013 34.2	1185	300	NB4	F R - - - - - - - - - - 9
0629	1151	319	056	28 48.0	013 43.1	850	847	NB4	F R A - 1 2 3 4 5 6 7 - 9
0629	1258	319	-9	28 48.2	013 43.1	835	828	MUV	
0629	1345	319	-9	28 48.2	013 43.2	833	820	OS	
0629	1730	320	057	28 51.1	013 56.0	1000	997	NB4	F R A - 1 2 3 4 5 6 7 8 -
0629	1837	320	-9	28 51.0	013 56.1	1023	989	MUV	
0629	1940	320	-9	28 50.7	013 56.3	1131	1040	OS	
0629	2048	320	-9	28 51.1	013 56.2	1027	500	MN	
0629	2143	320	-9	28 51.1	013 56.3	-9	100	PN	
0629	2202	320	058	28 51.0	013 56.5	1027	300	NB4	F R - - - - - - - - - - 9
0629	2310	321	059	28 52.0	014 01.0	1876	1876	NB4	F R A - 1 2 3 4 5 6 7 - -
0630	0102	321	-9	28 52.0	014 01.0	1876	1500	OS	
0630	0215	321	060	28 52.0	014 01.0	1875	301	NB4	F R - - - 2 - - - - - - 9

Table 7.1 (continued)

Date UTC MMDD 1998	Time UTC hhmm	St	Pr	Latitude North GG MM.M	Longitude West GGG MM.M	Wd [m]	Wl [m]	Inst	Comments / Parameter index: F R A 0 1 2 3 4 5 6 7 8 9 (- not attached / sampled parameters 0 to 9 see SAMPLE.DOC)
0630	0338	322	061	28 53.0	014 06.0	2093	2095	NB4	F R A - 1 2 3 4 5 6 7 - -
0630	0529	322	-9	28 53.0	014 06.0	2096	992	MUV	
0630	0629	322	-9	28 53.0	014 06.0	2098	1500	OS	
0630	0745	322	-9	28 53.0	014 06.0	-9	500	MN	
0630	0837	322	062	28 53.1	014 06.1	2111	300	NB4	F R - - - - - - - - - - 9
0630	1001	323	063	28 54.5	014 14.0	2980	2980	NB4	F R A - 1 2 - 4 5 6 7 - -
0630	1228	323	-9	28 54.6	014 14.0	2968	1500	OS	
0630	1338	323	064	28 54.4	014 14.0	2964	301	NB4	F R - - - - - - - - - - 9
0630	1508	324	065	28 56.0	014 22.0	2977	2985	NB4	- R A - 1 2 3 4 5 6 7 - -
0630	1736	324	-9	28 56.0	014 22.0	2975	1967	MUV	
0630	1922	324	-9	28 55.2	014 22.4	2930	1500	OS	sss
0630	2055	324	066	28 56.0	014 22.0	2975	298	NB4	- R - - - - - - - - - - 9
0630	2128	324	-9	28 56.0	014 22.1	2976	988	MUV	
0701	0020	325	-9	29 01.0	014 44.0	3517	1000	GoFlo	
0701	0137	325	067	29 01.0	014 44.0	3515	3517	NB4	- R - - 1 2 3 4 - 6 7 - -
0701	0410	325	-9	29 01.0	014 44.0	3524	1500	OS	
0701	0520	325	-9	29 01.0	014 44.0	3523	100	PN	
0701	0539	325	068	29 01.0	014 44.0	3524	300	NB4	F R - - 1 2 3 4 5 6 - 8 9
0701	0814	326	069	29 05.5	015 07.0	3596	3605	NB4	- R - - 1 2 3 4 - 6 7 - -
0701	1101	326	-9	29 05.5	015 07.7	3580	1500	OS	
0701	1210	326	070	29 05.5	015 07.7	3851	3607	NB4	- R A - 1 2 3 4 5 6 - - 9
0701	1644	327	071	29 10.0	015 30.0	3628	3639	NB4	- R A 0 1 2 3 4 - 6 7 - -
0701	1919	327	-9	29 10.0	015 30.0	3631	989	MUV	
0701	2016	327	-9	29 10.0	015 30.0	3631	1500	OS	
0701	2125	327	-9	29 10.0	015 30.0	3631	500	MN	
0701	2225	327	-9	29 10.0	015 30.1	-9	100	PN	
0701	2242	327	072	29 10.2	015 30.2	3629	300	NB4	- R - 0 1 2 3 4 5 6 7 8 9
0701	2333	327	-9	29 10.2	015 30.4	3613	1965	MUV	
0702	0229	328	073	29 10.0	015 40.0	3621	3596	NB4	- R A - - - - - - - - - -
0702	0911	329	-9	29 10.1	015 50.1	3645	1500	OS	
0702	1124	329	074	29 10.0	015 50.1	3628	3652	NB4	- R A - 1 2 3 4 - 6 7 - -
0702	1455	329	075	29 10.0	015 50.0	3642	300	NB4	- R - - 1 2 3 4 5 6 - - 9
0702	1723	330	076	29 10.0	016 12.1	3658	3683	NB4	- R A - 1 2 - 4 - 6 7 - -
0702	2004	330	-9	29 10.1	016 12.2	3659	1500	OS	
0702	2110	330	077	29 10.0	016 12.0	3659	300	NB4	- R - - 1 2 - 4 5 6 - - 9
0702	2341	331	078	29 10.0	016 34.0	3705	3733	NB4	- R A - 1 2 3 4 - 6 7 - -
0703	0228	331	-9	29 10.0	016 34.0	3705	989	MUV	
0703	0327	331	-9	29 10.0	016 34.0	3705	1500	OS	
0703	0431	331	-9	29 10.0	016 34.0	3705	1967	MUV	
0703	0616	331	079	29 10.0	016 34.0	3706	301	NB4	- R - - 1 2 3 4 5 6 - 8 9
0703	0700	331	-9	29 10.0	016 34.0	3723	500	MN	
0703	0749	331	-9	29 10.0	016 34.0	3724	100	PN	
0703	0949	332	-9	29 10.1	016 55.0	3839	1000	GoFlo	
0703	1106	332	080	29 10.0	016 55.0	3854	3862	NB4	- R A - 1 2 3 4 - 6 7 - -
0703	1350	332	-9	29 10.0	016 55.0	3838	987	MUV	
0703	1450	332	-9	29 10.0	016 55.0	3838	1500	OS	
0703	1600	332	081	29 10.0	016 55.2	3839	300	NB4	- R - - 1 2 3 4 5 6 - - 9
0703	1635	332	-9	29 10.0	016 55.0	3838	1968	MUV	
0703	2001	333	082	29 10.0	017 17.0	3934	3946	NB4	- R A 0 1 2 3 4 - 6 7 - -
0703	2251	333	-9	29 10.0	017 17.0	3916	987	MUV	
0703	2350	333	-9	29 10.0	017 17.0	3915	1500	OS	
0704	0056	333	083	29 10.0	017 17.0	3933	299	NB4	- R - 0 1 2 3 4 5 6 - - 9
0704	0135	333	-9	29 10.0	017 17.0	3916	1968	MUV	
0704	0322	333	084	29 10.0	017 17.0	3916	2976	NB4	- R -, substandard
0704	0718	334	085	29 10.0	017 40.0	3788	3813	NB4	- R A - 1 2 3 4 - 6 7 - -
0704	1008	334	-9	29 10.0	017 40.0	3785	1500	OS	
0704	1122	334	086	29 10.2	017 40.0	3791	300	NB4	- R - - 1 2 3 4 5 6 - - 9
0704	1346	335	-9	29 10.2	018 00.3	3771	2782	GoFlo	
0704	1616	335	087	29 10.1	018 00.0	3696	3725	NB4	- R A - 1 2 3 4 - 6 7 - -
0704	1937	335	-9	29 10.0	018 00.2	3695	989	MUV	
0704	2034	335	-9	29 10.1	018 00.1	3698	1500	OS	
0704	2141	335	088	29 10.0	018 00.2	3696	300	NB4	- R - - 1 2 3 4 5 6 - - 9
0704	2225	335	-9	29 10.0	018 00.0	3694	2000	MUV	
0705	0219	336	089	29 28.5	018 00.0	4203	4242	NB4	- R A - 1 - - 4 - 6 7 - -
0705	0527	336	-9	29 28.5	018 00.0	4205	1500	OS	
0705	0633	336	090	29 28.5	018 00.0	4205	302	NB4	- R - - 1 2 - 4 5 6 - - -
0705	0733	336	-9	29 28.5	018 00.0	4204	4235	FSI,	test on 12x12 l rosette
0705	1247	337	091	29 47.0	018 00.0	4413	4391	NB4	- R A 0 1 2 3 4 - 6 7 - -
0705	1559	337	-9	29 47.0	018 00.0	4369	1500	OS	
0705	1726	337	-9	29 47.0	018 00.0	4371	500	MN	
0705	1816	337	092	29 47.1	018 00.0	4372	304	NB4	- R - 0 1 2 3 4 5 6 - 8 9
0705	1854	337	-9	29 47.0	018 00.0	-9	100	PN	
0705	2202	338	093	30 15.0	018 00.0	4483	4541	NB4	- R A - 1 2 - 4 - 6 7 - -

```
0706 0121 338  -9 30 15.1  018 00.1  4492 1500 OS
0706 0239 338 094 30 15.0  018 00.1  4494  300 NB4    - R - - 1 2 - 4 5 6 - - 9
```

Table 7.1 (continued)

Date UTC MMDD 1998	Time UTC hhmm	St	Pr	Latitude North GG MM.M	Longitude West GGG MM.M	Wd [m]	Wl [m]	Inst	Comments / Parameter index: F R A 0 1 2 3 4 5 6 7 8 9 (- not attached / sampled parameters 0 to 9 see SAMPLE.DOC)
0706	0611	339	095	30 45.0	018 00.0	4542	4582	NB4	- R A - 1 2 - 4 - 6 7 - -
0706	1007	339	-9	30 45.2	018 00.1	4544	1500	OS	
0706	1119	339	096	30 45.2	018 00.0	4543	300	NB4	- R - - 1 2 - 4 5 6 7 - 9
0706	1509	340	-9	31 15.1	018 00.0	4576	1000	GoFlo	
0706	1624	340	097	31 15.0	018 00.0	4577	4608	NB4	- R A - 1 2 - 4 - 6 7 - -
0706	1944	340	-9	31 15.1	018 00.2	4577	1500	OS	
0706	2100	340	098	31 15.1	018 00.1	4577	300	NB4	- R - - 1 2 - 4 5 6 - - 9
0707	0101	341	099	31 45.0	018 00.0	4555	4603	NB4	- R A 0 1 2 - 4 - 6 7 - -
0707	0423	341	-9	31 45.0	018 00.0	4554	1500	OS	
0707	0529	341	100	31 45.0	018 00.0	4555	300	NB4	- R - 0 1 2 - 4 5 6 - - 9
0707	0917	342	101	32 15.0	018 00.0	4424	4473	NB4	- R A - 1 2 3 4 - 6 7 - -
0707	1245	342	-9	32 15.0	018 00.0	4425	976	MUV	
0707	1349	342	-9	32 15.2	018 00.0	4425	1500	OS	
0707	1500	342	102	32 15.1	018 00.0	4424	301	NB4	- R - - 1 2 3 4 5 6 - - 9
0707	1834	343	103	32 15.0	017 25.0	4222	4264	NB4	- R A - 1 2 - 4 - 6 7 - -
0707	2136	343	-9	32 15.0	017 25.0	4222	1000	MUV	
0707	2232	343	-9	32 15.0	017 25.0	4221	1500	OS	
0707	2345	343	104	32 15.0	017 24.9	4221	300	NB4	- R - - 1 2 - 4 5 6 - - 9
0708	0330	344	105	32 15.0	016 50.0	3580	3603	NB4	- R A 0 1 2 3 4 - 6 7 - -
0708	0610	344	-9	32 15.0	016 50.0	3580	988	MUV	
0708	0709	344	-9	32 15.0	016 50.0	3581	1500	OS	
0708	0821	344	106	32 14.9	016 49.9	3578	300	NB4	- R - 0 1 2 3 4 5 6 - - 9
0708	1235	345	-9	32 15.0	016 10.0	4302	1000	GoFlo	
0708	1350	345	107	32 15.0	016 10.0	4303	4345	NB4	- R A - 1 2 3 4 - 6 7 - -
0708	1651	345	-9	32 15.0	016 10.0	4303	993	MUV	
0708	1753	345	-9	32 14.6	016 10.3	4303	1500	OS	sss
0708	1904	345	108	32 14.1	016 10.6	4335	300	NB4	- R - - 1 2 3 4 5 6 - - 9
0708	1943	345	-9	32 14.1	016 10.8	4331	95	GoFlo	
0708	2315	346	109	32 15.0	015 40.1	4353	4397	NB4	- R A - 1 - - 4 5 6 7 - -
0709	0508	347	110	32 15.0	015 10.0	4366	4414	NB4	- R A 0 1 2 3 4 - 6 7 - -
0709	0815	347	-9	32 15.0	015 10.0	4366	1500	OS	
0709	0922	347	111	32 15.0	015 10.0	4367	300	NB4	- R - 0 1 2 3 4 5 6 - - 9
0709	1235	348	112	32 15.0	014 40.0	4362	4408	NB4	- R A - 1 - - 4 5 6 7 - -
0709	1819	349	-9	32 15.0	014 10.0	4334	1009	GoFlo	
0709	1928	349	113	32 15.0	014 10.0	4334	4375	NB4	- R A - 1 2 3 4 - 6 7 - -
0709	2238	349	-9	32 15.0	014 10.0	4334	992	MUV	
0709	2340	349	-9	32 15.0	014 10.0	4325	1500	OS	
0710	0054	349	114	32 15.0	014 10.0	4336	301	NB4	- R - - 1 2 3 4 5 6 - - 9
0710	0646	350	115	32 15.0	013 10.0	3998	4032	NB4	- R A - 1 2 3 4 - 6 7 - -
0710	0946	350	-9	32 15.0	013 10.0	3999	1500	OS	
0710	1056	350	116	32 15.0	013 10.0	4002	301	NB4	- R - - 1 2 3 4 5 6 - - 9
0710	1620	351	117	32 15.0	012 10.0	3385	3406	NB4	- R A - 1 2 3 4 - 6 7 - -
0710	1903	351	-9	32 15.0	012 10.0	3384	990	MUV	
0710	2000	351	-9	32 15.0	012 10.0	3385	1500	OS	
0710	2111	351	-9	32 15.0	012 10.1	3385	1969	MUV	
0710	2301	351	118	32 15.0	012 10.0	3386	301	NB4	- R - - 1 2 3 4 5 6 - - 9
0711	0330	352	119	32 15.0	011 25.0	3340	3368	NB4	- R A 0 1 2 3 4 - 6 7 - -
0711	0605	352	-9	32 15.0	011 25.0	3340	1500	OS	
0711	0712	352	120	32 15.0	011 25.0	3340	300	NB4	- R - - 1 2 3 4 5 6 - - 9
0711	0754	-9	-9	32 15.1	011 25.0	3350	-9	NOAA	drifter launched
0711	1057	353	121	32 15.0	010 50.0	3239	3256	NB4	- R A - 1 2 3 4 - 6 7 - -
0711	1323	353	-9	32 15.0	010 50.0	3240	988	MUV	
0711	1425	353	-9	32 14.7	010 50.0	3244	1500	OS	
0711	1535	353	-9	32 15.0	010 50.0	3239	1969	MUV	
0711	1718	353	122	32 15.0	010 50.0	3239	303	NB4	F R - - 1 2 3 4 5 6 7 8 9
0711	1757	353	-9	32 15.0	010 50.0	3242	100	PN	
0711	2017	354	-9	32 10.0	010 29.0	2778	1000	GoFlo	
0711	2129	354	123	32 10.0	010 29.0	2772	2771	NB4	F R A, no samples
0711	2344	354	-9	32 10.0	010 29.0	2791	1500	OS	
0712	0055	354	-9	32 10.0	010 29.0	2791	100	PN	
0712	0118	354	124	32 10.0	010 29.0	2776	2775	NB4	F R A - 1 2 3 4 5 6 7 8 9
0712	0524	355	125	32 05.0	010 10.0	1482	1477	NB4	F R A - 1 2 3 4 - 6 7 - -
0712	0645	355	-9	32 05.0	010 10.0	1484	988	MUV	
0712	0743	355	-9	32 05.0	010 10.0	1478	1460	OS	
0712	0855	355	126	32 05.0	010 10.0	1477	304	NB4	F R - - 1 2 3 4 5 6 - 8 9
0712	0933	355	-9	32 05.0	010 10.0	1478	100	PN	
0712	1112	356	-9	32 03.0	009 55.5	829	807	GoFlo	
0712	1228	356	127	32 03.0	009 55.5	863	886	NB4	F R A 0 1 2 3 4 5 6 7 8 9
0712	1335	356	-9	32 03.0	009 55.5	888	813	MUV	
0712	1429	356	-9	32 02.8	009 55.7	1014	990	OS	sss
0712	1523	356	-9	32 02.8	009 55.7	1071	500	MN	
0712	1615	356	-9	32 02.7	009 55.8	1086	100	PN	
0712	1710	357	128	32 02.0	009 52.0	113	108	NB4	F R - - 1 2 3 4 5 6 - 8 9

```
0712 1737 357  -9 32 02.0  009 52.0   116  106 OS
0712 1753 357  -9 32 02.0  009 52.0   121  100 PN
```

Table 7.1 (continued)

Date UTC MMDD 1998	Time UTC hhmm	St	Pr	Latitude North GG MM.M	Longitude West GGG MM.M	Wd [m]	Wl [m]	Inst	Comments / Parameter index F R A 0 1 2 3 4 5 6 7 8 9 - not attached / sampled parameters 0 to 9 see SAMPLE.DOC
0714	0838	358	-9	37 29.3	009 37.7	1739	-9	C4	start positioning of mooring C4
0714	1001	358	-9	37 30.12	009 37.75	1696	-9	C4	release confirmed; range=1626 m
0714	1005	358	-9	37 30.12	009 37.75	1696	-9	C4	release confirmed; range=1625 m
0714	1010	358	-9	37 30.12	009 37.75	1696	-9	C4	release confirmed; range=1627 m
0714	1013	358	-9	37 30.12	009 37.75	1696	-9	C4	mooring not recovered
0714	1112	359	-9	37 29.77	009 29.85	1289	-9	C3	mooring recovered
0714	1816	360	-9	38 23.88	009 52.80	-9	-9	C6	mooring recovered
0714	2042	361	-9	38 30.36	009 51.12	1802	-9	C5	several release command not confirmed
0715	0420	358	-9	37 30.12	009 37.75	1696	-9	C4	2 dredge trials around C4 not successful
0716	0600	-9	-9	-9 -9	-9 -9	-9	-9		Port of Lisboa, end of M42/1

Table 7.2: Sampling M42/1, Stat. 260 to 357

Samples: **0**-Gelbstoff **1**-oxygen **3**-DOC **4**-nutrients **5**-chlorophyll **7**-salinity **d,u,b** ^{15}N
M Humin **O,P,Q** TC,TOC, POC **T,U** TN,TON **X** (DOM) H HPLC

	Station/cast (water depth)							
Pres (dbar)	**260/1** (1000 m)	**261/2** (3607 m)	**264/3** (3613 m)	**265/4** (4228 m)	**266/5** (4360 m)	**267/6** (4146 m)	**268/7** (3624 m)	**269/8** (1060 m)
8				--u-----		--u-----		
10		-5----Q-						-5------
20				--u-----				
25		-5----Q-	-7------					-5------
39				--u-----				
50		-5----Q-	-7------		37dMOPTU			-5------
53				--u-----				
75		-5----Q-						-5------
83				--u-----		--u-----		
93				--u-----		--u-----		
100		-5----Q-						-5------
116				--u-----		--u-----		
125								
150								-5------
200		-5----Q-	-7d-OPTU		37dMOPTU			-5------
300		------Q-						
400								
500		------Q-						
600								
700			-7d-OPTU		37dMOPTU			
750								
800								
850								
900								
1000			-7d-OPTU					
1100								
1200					37dMOPTU			
1300								
1500					37-M----			
1800								
2000			-7d-OPTU		37dMOPTU			
2250								
2500					37dMOPTU			
2800								
3000			-7d-OPTU		37dMOPTU			
3300								
3500					37dMOPTU			
4000					37dMOPTU			
Bottom					37dMOPTU			

Table 7.2: Sampling M42/1 (continued)

Samples: **0**-Gelbstoff **1**-oxygen **3**-DOC **4**-nutrients **5**-chlorophyll **7**-salinity **d,u,b** ^{15}N
M Humin **O,P,Q** TC,TOC, POC **T,U** (TN,TON) **X** (DOM) H HPLC

	Station/cast (water depth)							
Pres (dbar)	**270/9** (3605 m)	**271/10** (3615 m)	**272/11** (3623 m)	**273/12** (1017 m)	**277/13** (909 m)	**278/14** (1196 m)	**279/15** (1283 m)	**280/16** (1335 m)
8				--u-----				
10	-5------		-7------			-7------	-7------	-7------
20				--u-----				
25								
39				--u-----				
50		3-dOPTUX						
53				--u-----				
75	-5------							
83				--u-----				
93				--u-----				
100	-5------							
116				--u-----				
125								
150								
200		3-d----X						
300								
400		3-d----X						
500								
600		3-d----X						
700								
750								
800		3-d----X						
850								
900								
1000			-7------					
1100		3-d----X						
1200		3-dOPTUX						
1300								
1500		3-dOPTUX						
1800								
2000		3-d----X	-7------					
2250		3-dOPTUX						
2500		3-dOPTUX						
2800								
3000		3-d----X	-7------					
3300		3-dOPTUX						
3500								
4000								
Bottom		3-dOPTUX	-7------			-7------	-7------	-7------

Table 7.2: Sampling M42/1 (continued)

Samples: **0**-Gelbstoff **1**-oxygen **3**-DOC **4**-nutrients **5**-chlorophyll **7**-salinity **d,u,b** ^{15}N
M Humin **O,P,Q** TC,TOC, POC **T,U** (TN,TON) **X** (DOM) H HPLC

	Station/cast (water depth)							
Pres (dbar)	**281/17** (1191 m)	**282/18** (1056 m)	**286/19** (816 m)	**287/20** (629 m)	**288/21** (102 m)	**289/22** (106 m)	**290/23** (169 m)	**291/24** (252 m)
8	-7u-----							
10		-7------	-7------	-57-----	-7------	-7------	-7------	-7------
20								
25				-57-----				
39	-7u-----							
50				-57-----				
53	37u-----							
75				-5------				
83	-7u-----							
93								
100	37u-----			-5------				
116								
125								
150				-5------				
200	3-------							
300	3-------							
400	3-------							
500	3-------							
600								
700	3-------							
750								
800								
850								
900								
1000	3-------							
1100	3-------							
1200								
1300								
1500								
1800								
2000								
2250								
2500								
2800								
3000								
3300								
3500								
4000								
Bottom	37------	-7------	-7------	-7------	-7------	-7------	-7------	-7------

Table 7.2: Sampling M42/1 (continued)

Samples: **0**-Gelbstoff **1**-oxygen **3**-DOC **4**-nutrients **5**-chlorophyll **7**-salinity **d,u,b** ^{15}N
M Humin **O,P,Q** TC,TOC, POC **T,U** (TN,TON) **X** (DOM) H HPLC

	Station/cast (water depth)							
Pres (dbar)	**292/25** (354 m)	**293/26** (1003 m)	**294/27** (1274 m)	**296/28** (1590 m)	**297/29** (1054 m)	**298/30** (2245 m)	**299/31** (3001 m)	**300/32** (3349 m)
8		--u-----						
10	-7------		-5d0PTUX	-7------	-7------	-7------	-7------	-7------
20		--u-----						
25			-5------					
39		--u-----						
50			-5d0PTUX					
53		--u-----						
75			-5------					
83		--u-----						
93								
100			-5d0PTUX					
116								
125			-5------					
150			-5------					
200			-5d0PTUX					
300			--d0PTUX					
400			--d0PTUX					
500			--d0PTUX					
600			4-d0PTUX					
700			4-d0PTUX					
750			4-------					
800			4-d0PTUX					
850			4-------					
900			4-d0PTUX					
1000			4-d0PTUX					
1100			--d0PTUX					
1200			--d0PTUX					
1300								
1500								
1800								
2000						-7------	-7------	-7------
2250								
2500								
2800								
3000								
3300								
3500								
4000								
Bottom	-7------		--d0PTUX	-7------	-7------			

Table 7.2: Sampling M42/1 (continued)

Samples: **0**-Gelbstoff **1**-oxygen **3**-DOC **4**-nutrients **5**-chlorophyll **7**-salinity **d,u,b** ^{15}N
M Humin **O,P,Q** TC,TOC, POC **T,U** (TN,TON) **X** (DOM) H HPLC

Station/cast (water depth)								
Pres (dbar)	**301/33** (3517 m)	**302/34** (3564 m)	**303/35** (3625 m)	**304/36** (3613 m)	**305/37** (3590 m)			
8								
10	-7------	-7------		01--4--7	-7------			
20								
25				01--4--7				
39								
50				01--4--7				
53								
75				01--4--7				
83								
93								
100				01--4--7				
116								
125								
150				01--4--7				
200				01--4--7				
300				01--4--7				
400				01--4--7				
500								
600				01--4--7				
700								
750								
800				01--4--7				
850								
900								
1000				01--4--7				
1100								
1200				01--4--7				
1300				01--4--7				
1500				01--4--7				
1800				01--4--7				
2000	-7------	-7------		01--4--7	-7------			
2250								
2500				01--4--7				
2800				01--4--7				
3000				01--4--7				
3300								
3500				01--4--7				
4000								
Bottom								

Table 7.2: Sampling M42/1 (continued)

Samples: **0**-Gelbstoff **1**-oxygen **2**-tracers **3**-DOC **4**-nutrients **5**-chlorophyll **6**-bio-optics **7**-salinity **8**-diatoms **9**-coccolithophorids

	Station/cast (water depth)							
Pres (dbar)	**307/39** (102 m)	**308/40** (104 m)	**309/41** (180 m)	**310/42** (252 m)	**311/43** (366 m)	**312/44** (623 m)	**313/45** (800 m)	**314/46,47** (1060 m)
Bucket	––––––––89			––––––––89	–––––––––9	–––––––––9		––––––––89
10	–123456789	–1234567––	–123456–––	–123456789	–1234567–9	–1234567–9	–12–4567––	–1–3456789
20								
25	–123456–89	–123456–––	–123456–––	–123456–89	–12345–––9	–123456––9	–12–456–––	–1––45––89
40								
50	–123456–89	–123456–––	–123456–––	–123456–89	–123456––9	–123456––9	–12–456–––	–123456–89
60								
75	–123456–89	–123456–––	–123456–––	–123456–89	–12345–––9	–123456––9	–12–456–––	–12–45––89
80								
100			–123456–––	–123456–89	–123456––9	–123456––9	–12–456–––	–123456–89
125			–123456–––	–123456–89	–12–45–––9	–12–45–––9	–12–45––––	–12345––89
150			–123456–––	–123456–89	–123456––9	–123456––9	–12–456–––	–123456–89
175								
200				–123456–89	–123456––9	–123456––9	–12–456–––	–12–45––89
225								
250					–1234–6––9	–12–4–6––9	–12–4–6–––	–1234–6–89
275								
300					–1234–6––9	–1234––––9	–12–4–––––	–12–4–––89
400						–1234–6–––	–12–4–6–––	–1234–6–––
500						–1234–––––	–12–4–––––	–12–4–––––
600						–12–4–6–––	–12–4–6–––	–1234–6–––
700								–12–4–––––
800							–12–4–6–––	–1234–6–––
900								–12–4–––––
1000								–1234–6–––
1150								
1200								
1300								
1500								
1800								
2000								
2250								
2500								
2800								
3000								
3500								
4000								
4250								
Bottom	–123456789	–1234567––	–12345–7––	–1234–6789	–1234––7––	–1234––7––	–12–4––7––	–12–4––7––

Table 7.2: Sampling M42/1 (continued)

Samples: **0**-Gelbstoff **1**-oxygen **2**-tracers **3**-DOC **4**-nutrients **5**-chlorophyll
6-bio-optics **7**-salinity **8**-diatoms **9**-coccolithophorids

	Station/cast (water depth)							
Pres (dbar)	**315/48,49** (1019 m)	**316/50,51** (1260 m)	**317/52,53** (1290 m)	**318/54,55** (1192 m)	**319/56** (890 m)	**320/57,58** (1001 m)	**321/59,60** (1880 m)	**322/61,62** (2100 m)
Bucket	––––––––89	–––––––––9	–––––––––9	––––––––8–	–––––––––9	––––––––89	–––––––––9	–––––––––9
10	–123456789	01234567–9	–1234567–9	–123456789	–1234567–9	–12345678–	–1234567–9	–1234567–9
20							––2–––––––	
25	–12–45––89	012–45–––9	–12–45–––9	–12–45––89	–123456––9	–123456–89	–12–45–––9	–12–45–––9
40							––2–––––––	
50	–123456–89	0123456––9	–123456––9	–123456–8–	–123456––9	–123456–89	–123456––9	–123456––9
60							––2–––––––	
75	–12–45––89	012–45–––9	–12–45–––9	–12–45––89	–123456––9	–123456–89	–12–45–––9	–12–45–––9
80							––2–––––––	
100	–123456–89	0123456––9	–123456––9	–123456–89	–123456––9	–123456–89	–123456––9	–123456––9
125	–12345––89	012–45–––9	–12–45–––9	–12–45––89	–123456––9	–12–45––89	–––––––––9	–––––––––9
150	–123456–89	0123456––9	–123456––9	–123456–89	–123456––9	–123456–89	–123456––9	–123456––9
175							––2–––––––	
200	–12–45––89	012–45–––9	–12–45–––9	–12–45––89	–12–45–––9	–123456–89	–12–45–––9	–12–45–––9
225							––2–––––––	
250	–1234–6–89	01234–6––9	–1234–6––9	–1234–6–89	–1234–6–––		–1234–6––9	–1234–6––9
275							––2–––––––	
300	–12–4–––89	012–4––––9	–12–4––––9	–12–4–––89	–12–4––––9	–12–4–––89	–––––––––9	–––––––––9
400	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––	–1234–6–––	–1234–6–––	–1234–6–––	–1234–6–––
500	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	–12–4–––––	–12–4–––––		
600	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––	–1234–6–––	–1234–6–––	–1234–6–––	–1234–6–––
700	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	–12–4–––––	–12–4–––––		
800	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––	–1234–6–––	–1234–6–––	–1234–6–––	–1234–6–––
900	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––		–12–4–––––		
1000	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––		–1234–6–––	–1234–6–––	–1234–6–––
1150		012–4–––––	–12–4–––––	–12–4–––––			–1234–6–––	–1234–6–––
1200		01234–6–––	–1234–6–––					
1300							–12–4–––––	–12–4–––––
1500							–1234–6–––	–1234–6–––
1800							–1234–6–––	–12–4–6–––
2000								–1234–6–––
2250								
2500								
2800								
3000								
3500								
4000								
4250								
Bottom	–12–4––7––	012–4––7––	–12–4––7––	–12–4––7––	–12–4––7––	–12–4––7––	–12–4––7––	–12–4––7––

Table 7.2: Sampling M42/1 (continued)

Samples: **0**-Gelbstoff **1**-oxygen **2**-tracers **3**-DOC **4**-nutrients **5**-chlorophyll **6**-bio-optics **7**-salinity **8**-diatoms **9**-coccolithophorids

	Station/cast (water depth)							
Pres (dbar)	**323/63,64** (2967 m)	**324/65,66** (2980 m)	**325/67,68** (3525 m)	**326/69,70** (3601 m)	**327/71,72** (3632 m)	**328/73** (3639 m)	**329/74,75** (3647 m)	**330/76,77** (3676 m)
Bucket	–––––––––9	–––––––––9	––––––––89	–––––––––9	––––––––89		–––––––––9	–––––––––9
10	–12–4567–9	–1234567–9	–1–3456789	–1234567–9	0123456789		–1234567–9	–12–4567–9
20					012–4––7––			
25	–12–45–7–9	–12–45–7–9	–12–45––89	–12–456––9	0123456789		–12–456––9	–12–456––9
40					012–4––7––			
50	–12–456––9	–123456––9	–123456–89	–123456––9	0123456789		–123456––9	–12–456––9
60					012–4––7––			
75	–12–45–––9	–12–45–––9	–12–45––89	–12–456––9	0123456789		–12–456––9	–12–456––9
80					012–45–7––			
100	–12–456––9	–123456––9	–123456–89	–123456––9	0123456789		–123456––9	–12–456––9
125	–––––––––9	–––––––––9	–12–45––89	–12–456––9	0123456789		–12–456––9	–12–456––9
150	–12–456––9	–123456––9	–123456–89	–123456––9	0123456789		–123456––9	–12–456––9
175					012–4––7––			
200	–12–45–––9	–12–45–––9	–12–45––89	–12–45–––9	012345–789		–12–45–––9	–12–45–––9
225					012–4–––––			
250	–12–4–6––9	–1234–6––9	–1234–6–89	–1234–6––9	01–34–6789		–1234–6––9	–12–4–6––9
275					012–4–––––			
300	–––––––––9	–––––––––9	–12–4–––89	–12–4––––9	01234––789		–12–4––––9	–12–4––––9
400	–12–4–6–––	–1234–6–––	–1234–6–––	–1234–6–––	01234–67––		–1234–6–––	–12–4–6–––
500								
600	–12–4–6–––	–1234–6–––	–1234–6–––	–1234–6–––	01234–67––		–1234–6–––	–12–4–6–––
700								
800	–12–4–6–––	–1234–6–––	–1234–6–––	–1234–6–––	01234–67––		–1234–6–––	–12–4–6–––
900			–12–4–––––	–12–4–––––	open		–12–4–––––	–12–4–––––
1000	–12–4–6–––	–1234–6–––	–1234–6–––	–1234–6–––	01234–67––		–1234–6–––	–12–4–6–––
1150	–12–4–6–––	–1234–6–––	–1234–6–––	–1234–6–––	01234–67––		–1234–6–––	–12–4–6–––
1200			–12–4–––––	–12–4–––––	012–4––7––		–12–4–––––	–12–4–––––
1300	–12–4–––––	–12–4–––––	–12–4–––––	–12–4–––––	012–4––7––		–12–4–––––	–12–4–––––
1500	–12–4–67––	–1234–67––	–1234–67––	–1234–67––	01234–67––		–1234–67––	–12–4–67––
1800	–12–4–––––	–12–4–––––	–12–4–––––	–12–4–––––	012–4––7––		–12–4–––––	–12–4–––––
2000	–12–4–67––	–1234–6–––	–1234–67––	–1234–67––	01234–67––		–1234–67––	–12–4–67––
2250	–12–4–––––	–12–4–––––	–12–4–––––	–12–4–––––	012–4––7––		–12–4–––––	–12–4–––––
2500	–12–4–67––	–1234–67––	–1234–67––	–1234–67––	01234–67––		–1234–67––	–12–4–67––
2800			–12–4–––––	–12–4–––––	012–4––7––		–12–4–––––	–12–4–––––
3000		–1234–67––	–1234–67––	–1234–67––	01234–67––		–1234––7––	–12–4––7––
3500			–1234–67––	–1234–67––	01234–67––		–1234––7––	–12–4––7––
4000								
4250								
Bottom	–12–4––7––	–12–4––7––	–12–4––7––	–12–4––7––	012–4––7––		–12–4––7––	–12–4––7––

Table 7.2: Sampling M42/1 (continued)

Samples: **0**-Gelbstoff **1**-oxygen **2**-tracers **3**-DOC **4**-nutrients **5**-chlorophyll
6-bio-optics **7**-salinity **8**-diatoms **9**-coccolithophorids

	Station/cast (water depth)							
Pres (dbar)	**331/78,79** (3723 m)	**332/80,81** (3856 m)	**333/82-84** (3938 m)	**334/85,86** (3794 m)	**335/87,88** (3720 m)	**336/89,90** (4224 m)	**337/91,92** (4388 m)	**338/93,94** (4517 m)
Bucket	––––––––89	–––––––––9	–––––––––9	–––––––––9	–––––––––9		––––––––89	
10	–123456789	–1234567–9	01234567–9	–1234567–9	–1234567–9	–12–4567––	0123456789	–12–4567–9
20					–12–4–––––			
25	–12–456–89	–12–456––9	012–456––9	–12–456––9	–12–456––9	–12–45––––	012–456–89	–12–456––9
40					–12–4–––––			
50	–123456–89	–123456––9	0123456––9	–123456––9	–123456––9	–12–456–––	0123456–89	–12–456––9
60					–12–4–––––			
75	–12–456–89	–12–456––9	012–456––9	–12–456––9	–12–456––9	–12–45––––	012–456–89	–12–456––9
80					–12–4–––––			
100	–123456–89	–123456––9	0123456––9	–123456––9	–123456––9	–12–456–––	0123456–89	–12–456––9
125	–12–456–89	–12–456––9	012–456––9	–12–456––9	–12–456––9	–12–45––––	012–456–89	–12–456––9
150	–123456–89	–123456––9	0123456––9	–123456––9	–123456––9	–12–456–––	0123456–89	–12–456––9
175					–12–4–––––			
200	–12–45––89	–12–45–––9	012–45–––9	–12–45–––9	–12–45–––9	–12–45––––	–12–45––89	–12–45–––9
225					–12–4–––––			
250	–1234–6–89	–1234–6––9	01234–6––9	–1234–6––9	–1234–6––9	–12–4–6–––	01234–6–89	–12–4–6––9
275					–12–4–––––			
300	–12–4–––89	–12–4––––9	012–4––––9	–12–4––––9	–12–4––––9	–12–4–––––	012–4–––89	–12–4––––9
400	–1234–6–––	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––	–1––4–6–––	01234–6–––	–12–4–6–––
500								
600	–1234–6–––	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––	–1––4–6–––	01234–6–––	–12–4–6–––
700								
800	–1234–6–––	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––	–1––4–6–––	01234–6–––	–12–4–6–––
900	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	–1––4–––––	012–4–––––	–12–4–––––
1000	–1234–6–––	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––	–1––4–6–––	01234–6–––	–12–4–6–––
1150	–1234–6–––	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––	–1––4–6–––	012–4–6–––	–12–4–6–––
1200	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	–1––4–––––	01234–––––	–12–4–––––
1300	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	–1––4–––––	012–4–––––	–12–4–––––
1500	–1234–67––	–1234–67––	01234–67––	–1234–67––	–1234–67––	–1––4–67––	01234–67––	–12–4–67––
1800	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	–1––4–––––	012–4–––––	–12–4–––––
2000	–1234–67––	–1234–67––	01234–67––	–1234–67––	–1234–67––	–1––4––7––	01234–67––	–12–4–67––
2250	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	–1––4–––––	012–4–––––	–12–4–––––
2500	–1234–67––	–1234–67––	01234–67––	–1234––7––	–1234–67––	–1––4––7––	01234–67––	–12–4–67––
2800	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	–1––4–––––	012–4–––––	–12–4–––––
3000	–1234–67––	–1234–67––	01234–67––	–1234––7––	**open**	–1––4–––––	01234–67––	–12–4–67––
3500	–1234–67––	–1234–67––	01234–67––	–1234––7––	–1234–67––	–1––4––7––	01234–67––	–12–4–67––
4000						–1––4––7––	01234–67––	–12–4–67––
4250							012–4–––––	–12–4–––––
Bottom	–12–4––7––	–1234––7––	01234––7––	–12–4––7––	–12–4–––––	–1––4––7––	01234––7––	–12–4––7––

Table 7.2: Sampling M42/1 (continued)

Samples: **0**-Gelbstoff **1**-oxygen **2**-tracers **3**-DOC **4**-nutrients **5**-chlorophyll **6**-bio-optics **7**-salinity **8**-diatoms **9**-coccolithophorids

	Station/cast (water depth)							
Pres (dbar)	**339/95,96** (4568 m)	**340/97,98** (4594 m)	**341/99,100** (4566 m)	**342/101,-2** (4438 m)	**343/103,-4** (4236 m)	**344/105,-6** (3597 m)	**345/107,-8** (4320 m)	**346/109** (4353 m)
Bucket	–––––––––9	–––––––––9	–––––––––9	–––––––––9	–––––––––9	–––––––––9	–––––––––9	
10	–12–4567–9	–12–4567–9	012–4567–9	–1234567–9	–12–4567–9	01234567–9	–1234567–9	–1––4567––
20								
25	–12–456––9	–12–456––9	012–456––9	–12–456––9	–12–456––9	012–456––9	–12–456––9	–1––45––––
40								
50	–12–456––9	–12–456––9	012–456––9	–123456––9	–12–456––9	0123456––9	–123456––9	–1––456–––
60								
75	–12–456––9	–12–456––9	012–456––9	–12–456––9	–12–456––9	012–456––9	–12–456––9	–1––45––––
80								
100	–12–456––9	–12–456––9	012–456––9	–123456––9	–12–456––9	0123456––9	–123456––9	–1––456–––
125	–12–456––9	–12–456––9	012–456––9	–12–456––9	–12–456––9	012–456––9	–12–456––9	
150	–12–456––9	–12–456––9	012–456––9	–123456––9	–12–456––9	0123456––9	–123456––9	–1––456–––
175								
200	–12–45–––9	–12–45–––9	012–45–––9	–12–45–––9	–12–45–––9	012–45–––9	–12–45–––9	–1––456–––
225								
250	–12–4–6––9	–12–4–6––9	012–4–6––9	–1234–6––9	–12–4–6––9	01234–6––9	–1234–6––9	
275								
300	–12–4––––9	–12–4––––9	012–4–––––	–12–4––––9	–12–4––––9	012–4––––9	–12–4––––9	
400	–12–4–6–––	–12–4–6–––	012–4–6–––	–1234–6–––	–12–4–6–––	01234–6–––	–1234–6–––	–1––4–6–––
500								
600	–12–4–6–––	–12–4–6–––	012–4–6–––	–1234–6–––	–12–4–6–––	01234–6–––	–1234–6–––	–1––4–6–––
700								
800	–12–4–6–––	–12–4–6–––	012–4–6–––	–1234–6–––	–12–4–6–––	01234–6–––	–1234–6–––	–1––4–6–––
900	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	
1000	–12–4–6–––	–12–4–6–––	012–4–6–––	–1234–6–––	–12–4–6–––	01234–6–––	–1234–6–––	–1––4–6–––
1150	–12–4–6–––	open	012–4–6–––	–1234–6–––	–12–4–6–––	01234–6–––	–1234–6–––	–1––4–6–––
1200	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	
1300	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–1––4–––––
1500	–12–4–67––	–12–4–67––	012–4–67––	–1234–67––	–12–4–67––	01234–67––	–1234–67––	–1––4–67––
1800	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	
2000	–12–4–67––	–12–4–67––	012–4–67––	–1234–67––	–12–4–67––	01234–67––	–1234–67––	–1––4–67––
2250	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–1––4–––––
2500	–12–4–67––	–12–4–67––	012–4–67––	–1234–67––	–12–4–67––	01234–67––	–1234–67––	–1––4––7––
2800	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	
3000	–12–4–67––	–12–4–67––	012–4–67––	–1234–67––	–12–4–67––	01234–67––	–1234–67––	–1––4––7––
3500	–12–4–67––	–12–4–67––	012–4–67––	–1234–67––	–12–4–67––	01234–67––	–1234–67––	–1––4––7––
4000	–12–4–67––	–12–4–67––	012–4–67––	–1234–67––	–12–4–67––		–1234–67––	–1––4––7––
4250	open	–12–4–––––	012–4––7––	–12–4–––––			–12–4–––––	
Bottom	open	–12–4––7––	open	–1234––7––	–12–4––7––	open	–12–4––7––	open

Table 7.2: Sampling M42/1 (continued)

Samples: **0**-Gelbstoff **1**-oxygen **2**-tracers **3**-DOC **4**-nutrients **5**-chlorophyll **6**-bio-optics **7**-salinity **8**-diatoms **9**-coccolithophorids

	Station/cast (water depth)							
Pres (dbar)	**347/110,11** (4366 m)	**348/112** (4362 m)	**349/113,14** (4334 m)	**350/115,16** (4000 m)	**351/117,18** (3385 m)	**352/119,20** (3342 m)	**353/121,22** (3234 m)	**354/124** (2791 m)
Bucket	–––––––––9		–––––––––9	–––––––––9	–––––––––9	–––––––––9	––––––––89	––––––––89
10	01234567–9	–1––4567––	–1234567–9	–1234567–9	–1234567–9	01234567–9	–123456789	–123456789
20								
25	012–456––9	–1––45––––	–12–456––9	–12–456––9	–12–456––9	0123456––9	–123456–89	–12345––89
40								
50	0123456––9	–1––456–––	–123456––9	–123456––9	–123456––9	0123456––9	–123456–89	–123456–89
60								
75	012–456––9	–1––45––––	–12–456––9	–12–456––9	–12–456––9	0123456––9	–123456–89	–12345––89
80								
100	0123456––9	–1––456–––	–123456––9	–123456––9	–123456––9	0123456––9	–123456–89	–123456–89
125	012–456––9		–12–456––9	–12–456––9	–12–456––9	0123456––9	–123456–89	–12345––89
150	0123456––9	–1––456–––	–123456––9	–123456––9	–123456––9	0123456––9	–123456–89	–123456–89
175								
200	012–45–––9	–1––456–––	–12–45–––9	–12–45–––9	–12–45–––9	012345–––9	–12345––89	–12345––89
225								
250	01234–6––9		–1234–6––9	–1234–6––9	–1234–6––9	01234–6––9	–1234–6789	–1234–6–89
275								
300	012–4––––9		–12–4––––9	–12–4––––9	–12–4––––9	01234––––9	–1234––789	
400	01234–6–––	–1––4–6–––	–1234–6–––	–1234–6–––	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––
500								
600	01234–6–––	–1––4–6–––	–1234–6–––	–1234–6–––	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––
700								
800	01234–6–––	–1––4–6–––	–1234–6–––	–1234–6–––	–1234–6–––	01234–6–––	–1234–6–––	
900	012–4–––––		–12–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––
1000	01234–6–––	–1––4–6–––	–1234–6–––	–1234–6–––	–1234–6–––	01234–6–––	–1234–6–––	–1234–6–––
1150	01234–6–––	–1––4–6–––	–1234–6–––	–1234–6–––	–1234–6–––	01234–6–––	–1234–6–––	–1234–––––
1200	012–4–––––		–12–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––
1300	012–4–––––	–1––4–––––	–12–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––
1500	01234–67––	–1––4–67––	–1234–67––	–1234–67––	–1234–67––	01234–67––	–1234–67––	–1234–67––
1800	012–4–––––		–12–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	–12–4–––––
2000	01234–67––	–1––4–67––	–1234–67––	–1234–67––	–1234–67––	01234–67––	–1234–67––	–1234–67––
2250	012–4–––––	–1––4–––––	–12–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	
2500	01234–67––	–1––4–67––	–1234–67––	–1234–67––	–1234–67––	01234–67––	–1234–67––	–1234–67––
2800	012–4–––––		–12–4–––––	–12–4–––––	–12–4–––––	012–4–––––	–12–4–––––	
3000	01234–67––	–1––4––7––	–1234–67––	–1234–67––	–1234–67––	01234–67––	–1234–67––	
3500	01234–67––	–1––4––7––	–1234–67––	–1234–67––				
4000	01234–67––	–1––4––7––	–1234–67––	–1234–67––				
4250	open		–12–4–––––					
Bottom	012–4––7––	–1––4––7––	–1234––7––	–12–4––7––	–1234––7––	012–4––7––	open	–12–4––7––

Table 7.2: Sampling M42/1 (continued)

Samples: **0**-Gelbstoff **1**-oxygen **2**-tracers **3**-DOC **4**-nutrients **5**-chlorophyll **6**-bio-optics **7**-salinity **8**-diatoms **9**-coccolithophorids

	Station/cast (water depth)							
Pres (dbar**)**	**355/125,26** (1492 m)	**356/127** (864 m)	**357/128** (114 m)					
Bucket	––––––––89	––––––––89	––––––––89					
10	–123456789	0123456789	–123456–89					
20								
25	–123456–89	0123456–89	–123456–89					
40								
50	–123456–89	0123456–89	–123456–89					
60								
75	–123456–89	0123456–89	–123456–89					
80								
100	–123456–89	0123456–89	–123456–89					
125	–123456–89	0123456–89						
150	–123456–89	0123456–89						
175								
200	–12345––89	012345––89						
225								
250	–1234–6–89	01234–6–89						
275								
300	–1234–––89	01234–––89						
400	–1234–6–––	01234–6–––						
500		012–4–––––						
600	–1234–6–––	01234–6–––						
700		012–4–––––						
800	–1234–6–––	01234–6–––						
900	–12–4–––––							
1000	–1234–6–––							
1150	–1234–6–––							
1200	–12–4–––––							
1300	–12–4–––––							
1500								
1800								
2000								
2250								
2500								
2800								
3000								
3500								
4000								
4250								
Bottom	–1234––7––	012–4––7––	–12–45–––9					

Table 7.3 GeoB Station List METEOR M42/1a

GeoB #	Meteor #	Date 1998	Equipment	Time	Latitude	Longitude	Water depth (m)	Comments
5401-1	260	16.06	KWS/CTD	15:15	28°30,97	15°23,42		water for traps
5402-1	261	16.06	Trap I-1	20:56	29°14,35	15°25,13	3606	Trap I-1 deployed
5402-2	261	16.06	Trap III-1		29°14,06	15°26,02	3606	Trap III-1 (200, 300, 500 m) deployed
5402-3	261	16.06	KWS/CTD	16:56	29°14,10	15°26,26	3606	500, 300, 200, 100, 75, 50, 25, 10m POC 200, 100, 75, 50, 25, 25, 10m Chl
5403-1	264	17.06	KWS/CTD	16:06	29°10,12	15°29.68	3613	Dilution-experiment, 3000, 2000, 1000, 700, 200m d^{15}N, TN, TC, TON, TOC
5404-1	265	18.06	KWS/CTD	04:38	29°39.84	17°38.83	4230	116, 93, 83, 53, 39, 21, 8m ^{15}N-uptake
5405-1	266	18.06	KWS/CTD	14:35	29°44,98	18°0,35	4360	4446, 4000, 3500, 2500, 2000, 1500, 1200, 700, 200, 50m, d^{15}N, TN, TC, TON, TOC
5405-2	266	19.06	KWS (Chemie)		29°45,5	18°1,33	4364	200, 125, 100, 75, 30, 15, 10m Chl
5406-1	267	19.06	KWS/CTD	04:32	29°36,44	17°25.86	4146	114, 92, 83, 6m, ^{15}N-uptake 6m ^{15}N-nutrient experiment
5407-1	268	19.06	KWS/CTD	12:35	29°02.59	15°50.83	3624	water for traps
5408-1	269	19.06	Trap I-1	14:50	29°04.10	15°29.20		Trap I-1 recovered, trap and current-meter lost
5408-2	269	19.06	Trap III-1		29°14,06	15°33,90		Trap III-1 recovered
5408-3	269	19.06	KWS/CTD		29°14,49	15°33,78	3614	200, 150, 100, 75, 50, 25, 10m, Chl 100, 75, 50, 25, 10m, HPLC
5409-1	270	19.06	Trap III-2	18:40	29°14,92	15°24,83	3604	Trap III-2 deployed
5409-2	270	19.06	KWS/CTD		29°14,78	15°24,68	3605	Dilution-experiment 100, 75, 50, 25, 10m, Chl
5410-1	271	20.06	KWS/CTD	00:08	29°09,50	15°30,65	3615	3663, 3300, 3000, 2500, 2000, 1500, 1200, 1100, 800, 600, 400, 200, 50m, d^{15}N, TN, TC, TON, TOC
5411-1	273	21.06	KWS/CTD	04:27	28°42,98	13°17,07	1017	116, 93, 83, 53, 39, 21, 8m ^{15}N-uptake

5412-1	274	21.06	EBC2-2	05:10	28°41,9	13°10,2		particle trap recovered
5413-1	281	22.06	KWS/CTD	05:03	28°43,75	13°21,07	1191	83, 53, 39, 8m ^{13}C- and ^{15}N-uptake
5414-1	284	22.06	EBC3-2	11:20				particle trap recovered, trap did not rotate
5415-1	286	22.06	KWS/CTD	17:22	28°40,97	13°06,02	816	Dilution -experiment 150, 100, 75, 50, 25, 10m Chl $d^{15}N$-Blank
5416-1	293	23.06	KWS/CTD	05:17	28°43,04	13°17,07	1093	83, 53, 39, 21, 8m ^{15}N-uptake
5417-1	294	23.06	EBC3-3	07:30	28°44,0	13°19,1	1310	500, 700m particle traps deployed
5417-2	294	23.06	KWS		28°45,19	13°19,1	1274	1250, 1200, 1100, 1000, 900, 800, 700, 600, 500, 400, 300, 200, 95, 50, 10m $d^{15}N$, TN, TC, TON, TOC 200, 150, 125, 95, 75, 50, 25, 10m Chl
5418-1	300	24.06	KWS/CTD	02:02	28°58,04	14°33,00	3349	^{15}N-uptake
5419-1	303	24.06	Trap III-2	12:45	29°17,0	15°40,9	3604	Trap III-2 recovered
5419-2	303	24.06	KWS/CTD		29°17,91	15°40,96	3625	500, 300, 200, 150, 100, 75, 50, 25, 10m POC 200, 150, 100, 75, 50, 25, 10m Chl
5420-1	304	24.06	KWS/CTD	19:06	29°10,03	15°30,07	3613	ESTOC-Station June 1998 O2, nutrients, Gelbstoff, metals, salinity Chl<200m

8. Concluding Remarks

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