Plymouth Marine Laboratory
Cruise Report

RRS CHARLES DARWIN
Cruise 83

13 December 1993 - 13 January 1994

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1. PERSONNEL

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Sinha, Bablu.		PML	
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Waddington, Ian.		IOSDL[5]	OMEX
Serrett, Pablo.		UO[6]	
Fraga, Santi	(Spanish Observer)	IEO[7]	
Putaud, Jean-Philipe		CFR[8]	OMEX
Chatwin, Paul.		UOP[9]	
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Thompson, Mark W.	3rd Officer
Baker, Jeff G.	Radio Officer
Bennett, Ian R.	Chief Engineer
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Holmes, Jason S.	3rd Engineer
Parker, Phil G.	Electrical Engineer
Drayton, Mike J.	CPO(D)
Harrison, Martin A.	PO(D)
Hebson, Harry R.	Seaman
Perkins, Joe R.	Seaman
Olds, Arthur E.	Seaman
Jones, Steve J.	Seaman
Elliot, Chris J.	Catering Manager
Peters, Kevin.	Chef

Edes, Richard A.	Mess Steward
Murphy, Ryan F.	Steward
Gale, Kim.	Steward
Pringle, Keith.	Motorman

2. SUMMARY: SCIENTIFIC OBJECTIVES

1. To determine flow and transport in the Eastern Boundary of the Sub Tropical Gyre.

2. To measure the exchange of water between the shelf and the ocean at selected locations along the continental slopes using current meters and satellite tracked drifting buoys.

3. To measure the strength and extent of the warm winter continental slope flow in the Bay of Biscay (Navidad).

4. Deployment of OMEX current meter moorings, Argos Buoys and ALACE floats.

5. To relate the biological distributions of chlorophyll 'a' and phytoplankton production to the measured physical structures.

In addition to funding from the scientsts' home institutions, equipment provided from the following sources is gratefully acknowledged:

1. OMEX
2. RVS
3. IOSDL
4. UK WOCE
5. MOD
6. EPSHOM
7. Woods Hole Oceanographic Institution

3. NARRATIVE

After a major mobilisation in loading three container loads of equipment from PML and another three from RVS *RRS Charles Darwin* sailed from Las Palmas at 1045 on Monday 13th December 1993 in good weather. The Pilot was disembarked at 1058 and the vessel was underway on passage at 1118. Courses were set around the North of Gran Canaria and Tenerife. Computer logging of all navigation, GPS and MX1107 satellite navigator to the RVS level ABC system was begun immediately, as was the relative navigation using the EM log. Logging of the Acoustic Doppler Current Profiler (ADCP) was also started and at 1415/347 continuous sampling and logging of surface parameters was begun (all times are GMT and the date is the day of year. Day numbers are shown on the track plot, Figure 3.1. 13th December 1993 is day 347, 13th January 1994 is day 13).

Regular XBT deployments commenced with the first probe at 1442/347 28°10.68'N 16°1.48'W as we steamed South West to the first CTD station (001). We were on station at 1900/347 in position 27°39.4'N 16°30'W and the CTD was deployed to 2026m. This was followed by a plankton net sampling and then the first ADCP vertical profile (designated LADCP) to a depth of 2000m. We then steamed South deploying XBT's 004 - 008 arriving at CTD station 002 the next morning at 0818/348, 26°06.0'N 16°29.89'W after deploying to 2012m the LADCP was deployed followed by a plankton net and Secchi disk. On completion the UOR was deployed for the first tow at 1330/348. During this UOR a zig-zag course West was set to enable the calibration of the ship's hull mounted ADCP. The calibration was completed by 1830 and marked by the launch of more XBT's (009/010). *RRS Charles Darwin* continued steaming 270° through the night completing XBT's 011-014 and at 0824/349 we began hauling the UOR arriving on station at 0906/349. CTD 003 was deployed to 2032m followed by a plankton net sample whilst on this station the PES fish was deployed. On completion the UOR was again deployed and steaming continued on course 267° towards the next station deploying XBT's en-route. During the afternoon we were inspected by a large school of dolphins.

Just prior to arrival at the next CTD station the UOR was recovered and we hove to on station CTD 004 at 0517/350 in position 25°51.7'N 23°19.6'W. After deployment to 2031m another plankton net sample was completed prior to beginning another UOR tow along course 268°. XBT's 020 - 025 were deployed en route and the UOR was recovered just before midnight at 2352/350. At 0004/351 on arrival at 25°44.4'N 26°40.7'W CTD 005 was deployed to 2029m followed by a plankton sample at 100m. The UOR was then again deployed and *RRS Charles Darwin* continued on course 268° with XBT's deployed every 30' longitude. At 1813/351 the UOR was recovered and CTD 006 was deployed in position 25°37.2'N 29°59.9'W. On completion of the 100m plankton net the UOR was again deployed for the continued Westward steam. During this transect XBT's 032-038 were completed and the UOR was recovered at 0615/352. CTD 007 was deployed to 2029m in position 25°33.7'N 31°49.2'W. XBT deployments continued and we arrived at 1625/352 in position 25°29.7'N 33°19.8'W, for CTD 008, plankton net and Secchi disk.

This was the beginning of a very intensive period of working. An XBT survey of the area was carried out and 17 XBT's were deployed between 1927/352 and 0620/353. CTD 009 was deployed to 2533m at 0706/353 25°20.4'N 33°4.98'W. After a plankton net sample another three CTD casts (010-012) were conducted and on completion an Argos drifting buoy (1811) was deployed at 25°17.32'N 33°07.19'W at 1625/353. After a further XBT survey another Argos drifting buoy (3915) was deployed at 1753/353 25°17.33'N 33°15.93'W. After another short XBT survey the SeaSoar was prepared for launch, unfortunately the IOS winch had a hydraulic problem and the launch was delayed until 2300/353 but by 2340 was fully deployed and towing at 7 to 8 Kts. The whole of day 354 was spent doing the SeaSoar survey of the area A supplemented with the occasional XBT.

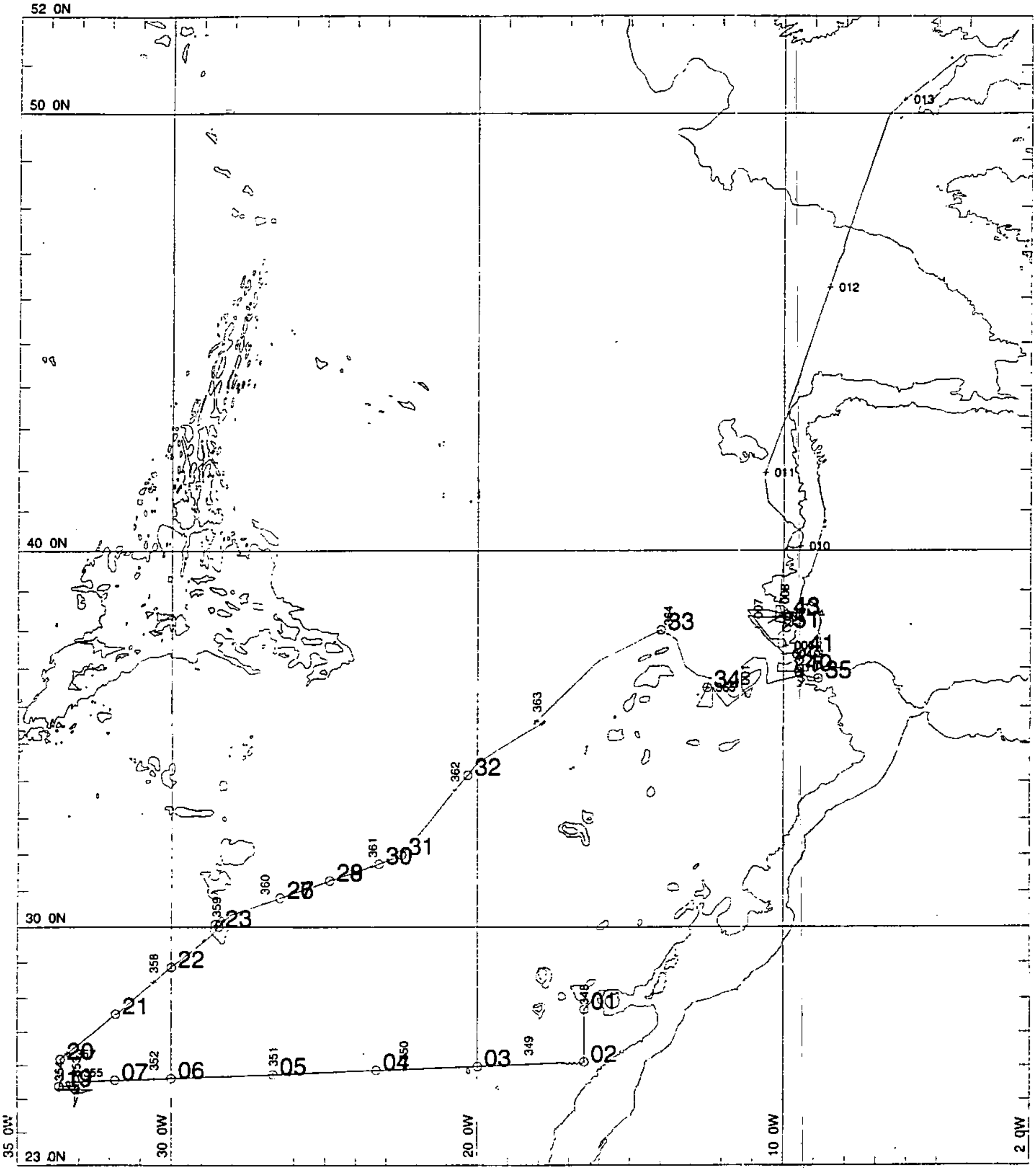


Figure 3.1. Ship's track.

Scaled to fit

By 0800/355 the survey was completed and SeaSoar was recovered. *RRS Charles Darwin* then steamed back for a series of CTD and LADCP deployments. Another Argos drifting buoy (3919) was deployed at 1517/355 25°23.08'N 33°02.97'W together with an ALACE float (No.269 Argos ID 21079). After watching the ALACE float sink (as planned!) the series of CTD and LADCP profiles continued until the completion of LADCP 8 at 1320/356. The ship then steamed to the last known position of Argos buoy 3346. This buoy had been deployed on CD66 on 7-3-92 and was still transmitting after 656 days. The buoy was sighted at 1745/356 and noosed at 1803 in position 26°10.44'N 33°36.07'W. Unfortunately the nylon line attaching the buoy to the drogue fouled on the ships rudder. However the line was cleared by 1958/356 and the complete buoy, rigging and drogue recovered intact. *RRS Charles Darwin* then set a course for the Great Meteor Tablemount (GMT) completing CTD stations 21 & 22 and XBT deployments 76 - 90 en-route.

During the steam to the GMT *RRS Charles Darwin* developed a fault in the main engine cooling water pipe. This necessitated a complete shutdown except for the emergency generator at 1036/358. Repairs were completed by 1236/358 and steaming continued. On arrival at the GMT the search for mooring rig 136 (deployed day 68/1992) began. Contact was established at 1415/358 and the release code was transmitted and execute confirmed at 1420, however there were no signs of surfacing (see Mooring report, Section 6.1, p15) and the search was abandoned at 1551/358. On completion of XBT's 86 - 90 *RRS Charles Darwin* hove to at the centre of GMT at 1758/358 to search for mooring rig 138 (deployed day 71/1992), contact was made but the rig failed to surface (see Mooring report, Section 6.1, p.15) and the search was abandoned due to darkness at 1934/358. The CTD (023) was deployed at 1938/358 to a depth of 265m followed by plankton net sampling and the deployment of Argos drifting buoy 3898 at 2223/358 in position 30°00.23'N 28°27.49'W. On completion an ADCP survey across the GMT was begun taking us through to Christmas morning. After CTD 024 at 0245/359 and Plankton net sampling a search for mooring rig 137 (deployed day 69/1992) was begun and contact was made at 0841/359 but again the rig failed to surface and reluctantly at 1307/359 the search for the GMT moorings was abandoned. Morale was lifted however by the efforts of the *RRS Charles Darwin's* catering staff who laid on a most splendid Christmas lunch of immense proportions. At 1642/359 the final CTD station (025) and plankton sampling took place on the GMT and course 071° was set for the Madeira Rise.

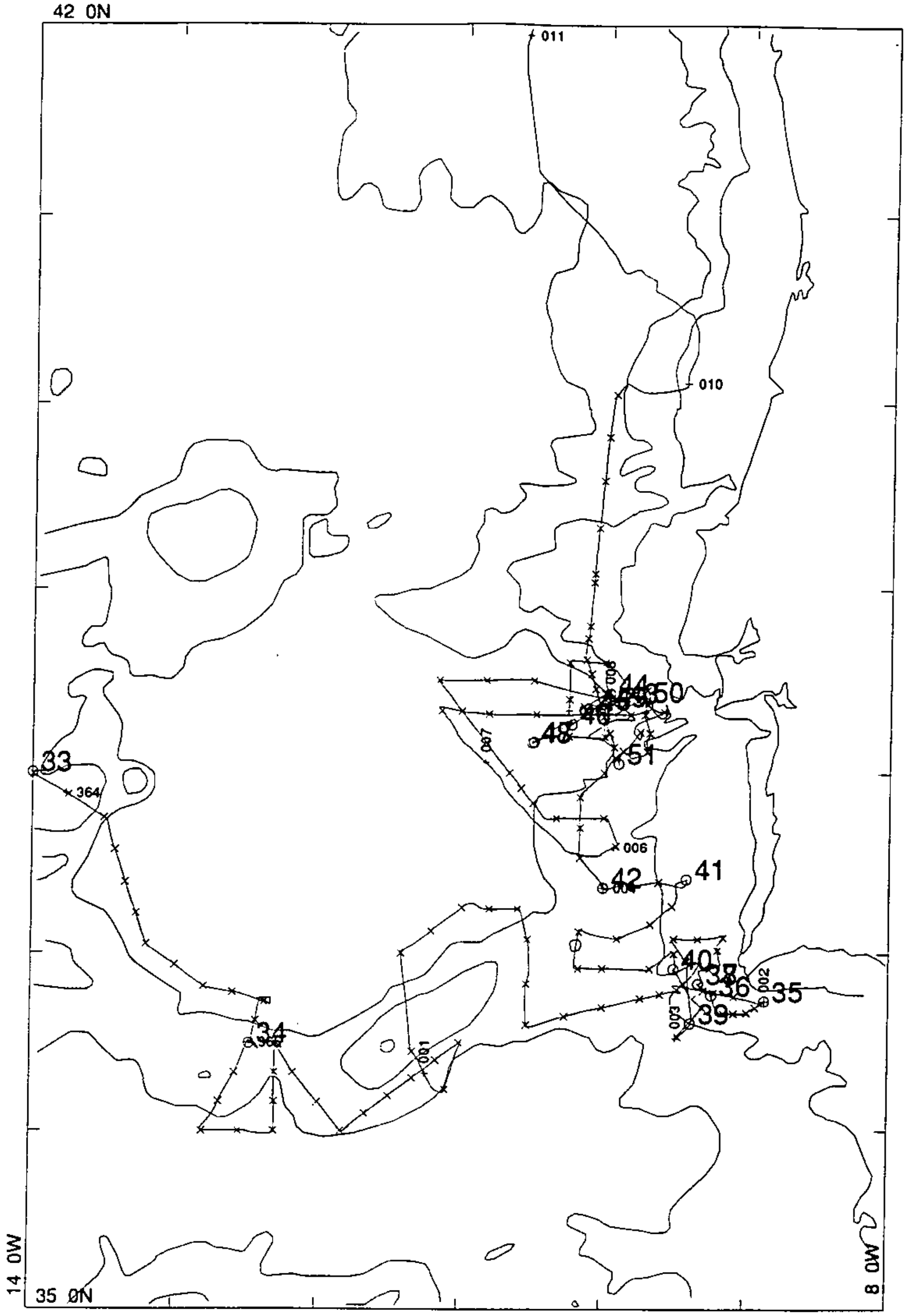
Steaming continued through boxing day (360) interrupted only by CTD, plankton and XBT stations and into monday (361). At 1051/361 the UOR was again deployed. At 1549/361 *RRS Charles Darwin* had to reduce speed so that the PES fish could be recovered due to a damaged fairing. The UOR was recovered at 0244/362 and CTD 032 and a plankton net sample followed at 0314/362, we were also able to re-deploy the PES fish. At 0443/362 Argos drifting buoy 20816 was deployed in position 34°30.0'N 20°18.7'W. The UOR was again deployed at 0459/362 and towed until 2221/362 during the same period XBT's 131 - 154 were deployed. During day 363 XBT's 156 -175 were deployed and CTD 033 was deployed at 2107/363 to 503m in position 37°59.96'N 13°59.95'W. During the morning of 364 the mooring team commenced stretching the mooring lines in preparation for the Tagus deployments. At 1306/364 a PES survey of the mooring site was carried out and at 1623/364 Tagus mooring rig 153 was deployed in 4339m in position 36°45.02'N 12°23.89'W. After survey Tagus mooring rig 151 was deployed at 1857/364 in 3520m in position 36°30.03'N 12°28.13'W. This was followed by CTD 034 and an XBT survey (187 - 193) of the mooring sites. At 1226/365 Tagus mooring rig 152 was deployed in 3770m at 36°29.92'N 12°17.58'W. On completion *RRS Charles Darwin* set a course of 147° for the Cape St Vincent mooring site. At midnight the New Year was welcomed in the traditional way with the scientists and crew gathering on the fore-deck to 'ring in the new' on the ship's bell.

On new years day at 1633/001 having deployed XBT's 195 - 215 the ship was hove to at 36°49.10'N 9°30.28'W ready to deploy the Cape St Vincent mooring rig 149 in 1506m depth. This was followed by an intensive survey of the area (see Figure 3.2) in which CTD (035 -042), LADCP (09-18), XBT (216-249) and plankton net deployments were made. At 1033/004 *RRS Charles Darwin* was in position 38°12.97'N 9°47.31'W ready for deployment of the Setubal/Lisbon Canyon mooring rig 146 in 2000m depth. Deployment was completed by 1350/004. Mooring rig 147 was deployed at 1910/004 in 2000m in position 38°24.50'N 9°45.85W.

At 0420/005 CTD 043 was deployed to 2039m followed by a series of XBT's (258 - 268) but throughout Wednesday (005) the weather was seriously deteriorating. By mid afternoon personnel were feeling distinctly unhappy but were able to continue XBT deployments. By 0001/006 the weather had deteriorated so badly with gale and storm force winds producing very rough and confused seas that science had to be suspended and *RRS Charles Darwin* was hove to in position 37°35.5'N 09°55.7'W to ride out the storm. Science was resumed at 0831/007 with the deployment of XBT 269 in position 38°20.12'N 11°8.60'W. At 1650/007 a RAFOS float (No.113) was deployed in position 38°27.08'N 09°42.07'W. This was followed by deployment of RAFOS floats 136 & 137. At 2152/007 Argos drifting buoy (5030) was deployed in position 38°25.17'N 09°57.18'W and at 2216/007 RAFOS float 131 was deployed nearby. This was followed by a series of CTDs (044 - 048) and LADCPs. On completion *RRS Charles Darwin* returned to the location of CTD 044 for the deployment of an Argos drifting buoy (5031) and two ALACE floats (293, 294). This was again followed by CTD (049 - 051) and LADCP profiles The CTD 051 position was only two miles from the current position of an Argos buoy which had been deployed during CD66 (day 71/1992) and so we took this opportunity to take a close look. XBT 281 was deployed alongside the buoy in position 38°04.90'N 09°55.15'W at 1034/009.

RRS Charles Darwin then proceeded Northward along the shelf edge deploying XBT's at regular intervals. The weather again began to deteriorate and at 0001/010 position 40°06.6'N 09°26.8'W it was deemed too rough to deploy further XBT's and at 0300/010 it became necessary for *RRS Charles Darwin* to heave to. By early evening the ship was able to make some slow progress and by late evening (2200/010) we were able to resume nearly full speed. By 0940/011 the weather had moderated sufficiently for XBT deployments to resume and XBT 297 was deployed at 43°40.23'N 09°46.24'W. The ship continued the somewhat rough homeward passage across the Bay of Biscay deploying XBT's at regular intervals. Another ALACE float (295) was deployed in the middle of the Biscay at 2237/011 in position 46°00.0'N 08°38.85'W with XBT 307 deployed alongside. The final XBT (315) was deployed at 1000/012 in position 48°0.84'N 07°39.84'W and was the last scientific deployment of the cruise.

There had been a request from the Rennell Centre to try and recover some moorings on their behalf from near Lundy. We could have achieved the ETA for the mooring site on the Thursday morning (013) but the very rough weather conditions made a survey of the site and an attempted recovery out of the question. After a two hour delay in the Bristol Channel for engine repairs, the Pilot was embarked at 1702/013 and *RRS Charles Darwin* moored alongside RVS Barry at 1830/013.



MERCATOR PROJECTION

GRID NO. 1

SCALE 1 TO 3000000 (NATURAL SCALE AT LAT. 40)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

cd83 chart.dkg.g

Figure 3.2. Survey of Portuguese slope.

4. COMPUTING REPORT

The RVS three level ABC computing system was used on cruise CD83. Level A interfaces performed the acquisition and time stamping of data from measuring sensors and instruments. The data files were continuously updated and archived to tape with level B. Three level C unix workstations were available to process and graphically display the data.

Navigation and some real time data processing and presentation used the RVS data format and programmes. In particular, near real-time 2 and 3-dimensional contour mapping of eddy features were produced utilising data from both ctd and xbt deployments, thus enabling the accurate location of the optimum positions for the deployment of satellite tracked and self contained drifters. Novel navigation was employed to post process the data positions to allow for assumed advection of the eddy features within the sub-tropical gyre.

Most CTD, ADCP and XBT processing was done using the PSTAR suite of programmes, details are contained in the relevant sections of this report.

The Seasoar level A interface gave a particular problem, rejecting most of the data with a severe check on the pressure gradient. The data was recovered from the Syplus backup tape after considerable effort, the details and future recommendations are detailed in the RVS internal report.

This was an exciting and stimulating cruise despite being absent from home during the holiday period. A welcome contrast from the repressive atmosphere at RVS engendered by the current situation.

Rob Lloyd RVS

5. ARGOS BUOY REPORT

During *RRS Charles Darwin* cruise 83, 7 Argos satellite tracked drifting buoys, 4 ALACE floats, 4 RAFOS floats and 5 submersible Argos beacons were deployed (tables 5.1, 5.3, 5.4). The 5 beacons are being used to monitor the long term current meter moorings in case of premature surfacing and also to provide location information during planned recovery. All buoys, floats and beacons operate on the standard Argos transmit frequency of 401.650 MHz + or - 4 KHz.

All buoys and beacons were switched on prior to deployment to check correct functioning and to provide additional calibration data. Data was received on board *RRS Charles Darwin* by use of a portable GONIO 400 receiver which is able to identify the transmitting ptt, give a position fix for the buoy, provide direction finding to the buoys and also read the data channels. The aerial for the GONIO receiver was fitted to a pole on top of the bridge deckhead as clear of obstructions as was possible. Subsequent deployments showed that ranging/detection was possible at up to 3 or 4 kilometers from Metocean buoys and slightly less from others. In addition we were able to receive daily position fixes on *RRS Charles Darwin* from the Argos satellites via RVS and the Inmarsat link. RVS used the JANET via PSS and TRANSPAC to access the data once a day from the ground station in Toulouse. The data was then downloaded to a file which was then transmitted over Inmarsat to the *Darwin*. This link worked very well throughout the cruise.

The drogues used during this cruise were all manufactured 'In House' at PML. All Talurit splices used in the PVC covered stainless steel strops were made of copper to reduce corrosion. Much attention was also paid to all joints to ensure there was no undue freedom of movement which might cause excessive wear to components. All shackles were given extra security by having lock pins inserted and hammering over all pin ends.

All buoys were deployed using the same method in that the buoy was streamed first from aft with the ship just moving ahead. Once the drogue tether was fully paid out and the slack taken up the drogue was carefully paid out using a retaining line to ensure no fouling of the drogue either on it's own components or the ship. Once paid out the ship stood by to observe the drogue sink and to acquire calibration data.

5.1 Deployment of IDB Buoy 1811 & Moonraker Buoy 3915

Buoy 1811 was supplied by Industrial Development Bangor (UCNW) Ltd. and was of the fibreglass mushroom design, equipped with sensors for sea surface temperature and battery voltage monitoring. This buoy was also fitted with a Balmoral elastomer collar to provide extra buoyancy and protection and a 15 month battery pack. This buoy was drogued and deployed on day 353 in position 25°17.32'N 33°07.19'W.

Buoy 3915 was supplied by Moonraker Technology Ltd. of Tasmania and was their standard MRT-112A fitted with sensors for sea surface temperature, battery monitoring, drogue loss indication and a 12 month battery pack. This buoy had a factory fitted 11 inch polo float incorporated into the tether line below the hull to provide extra buoyancy. The tether line termination was modified at PML to provide a stronger epoxy resin potted end for connection to the drogue line. This modification had proved to be very effective in extending the deployment time capability (see Section 5.8). This buoy was drogued and deployed on day 353 near buoy 1811 in position 25°17.33'N 33°07.19'W.

5.2 Deployment of Moonraker Buoy 3919

Buoy 3919 is a Metocean buoy which had been previously deployed, recovered and has now been refurbished at PML. A Balmoral elastomer collar was also fitted to provide additional buoyancy and protection. This buoy was fitted with sensors for barometric pressure, battery voltage monitoring, sea and air temperature and an 18 month battery pack. Buoy 3919 was drogued and deployed on day 355 in position 25°23.08'N 33°02.97'N. An ALACE float was also deployed in this position (Section 5.6).

5.3 Deployment of Turo Buoy 3898

Buoy 3898 was supplied by Turo Technology Ltd, Tasmania and was a Turo T-702 Series Data Buoy. This buoy was new to us but incorporated a number of improvements we had suggested were necessary to earlier Tasmanian buoys. Namely they had an improved reserve buoyancy of 145kg, extended battery life (24 months) and an improved moulded boot end to the connection between the hull and the drogue line, very similar in fact to the successful PML modification made to earlier buoys. This buoy was fitted with sensors for drogue loss indication, battery voltage, sea temperature and a two year battery pack. This buoy was drogued using as part of the drogue arrangement, the drogue recovered from buoy 3346 (see Section 5.8). It was deployed on day 358 on the Great Meteor Tablemount (GMT) in position 30°00.23'N 28°27.49'W.

5.4 Deployment of IDB Buoy 20816

20816 was a new buoy from IDB incorporating improvements to both buoyancy and battery life. The battery pack fitted has a design life expectancy of 24 months and the sensor suite was as before with sensors for sea temperature and battery voltage monitoring. Buoy 20816 was drogued and deployed in the sub-tropical front on day 362 in position 34°10.27'N 20°19.04'W.

5.5 Deployment of Metocean Buoys 5030 & 5031

Buoys 5030 and 5031 were of the Toga style ocean drifter supplied by Metocean Data Systems of Canada. These buoys are much larger than the other drifters used and therefore have an improved buoyancy reserve, this was further enhanced by fitting these buoys with Balmoral elastomer floatation collars and the removal of the lead ballast weight normally supplied with these buoys. The use of these buoys gives much more flexibility in the choice of drogue arrangement but cost considerably more than the smaller drifters. Both these buoys were fitted with a 24 month battery pack and sensors for barometric pressure, battery voltage monitoring, sea surface and air temperature. Both these buoys were deployed near the shelf edge West of Lisbon (Figure 3.3) close to the RAFOS and ALACE deployments. Buoy 5030 was drogued and deployed on day 007 in position 38°25.48'N 09°57.35'W. 5031 was drogued and deployed on day 008 at 38°22.05'N 09°58.75'W.

TABLE 5.1 ARGOS BUOY DEPLOYMENTS

Buoy ID	Hex ID	Date Dep.	Year Day	Time	Latitude N	Longitude W	Buoy Type
1811	34601	19-12-93	353	1630	25°17.32'	33°07.19'	IDB
3915	3D2E4	19-12-93	353	1753	25°17.33'	33°15.93'	Moonraker
3919	3D3FB	21-12-93	355	1508	25°23.08'	33°02.97'	Metocean
3898	3CE8F	24-12-93	358	2217	30°00.23'	28°27.49	Turo
20816	45408	28-12-93	362	0453	34°10.27'	20°19.04'	IDB
5030	4E9A9	07-01-94	007	2210	38°25.48'	09°57.35'	Metocean
5031	4E9FA	08-01-94	008	2112	38°22.05'	09°58.75'	Metocean

5.6 Deployment of ALACE Floats

4 Autonomous Lagrangian Circulation Explorer (ALACE) floats were purchased from the Webb Research Corporation, Falmouth, Massachusetts for deployment during CD83 (Table 5.3). ALACE is a subsurface float which cycles vertically from a depth where it is neutrally buoyant to the surface where it is located by, and relays data to, System Argos satellites. ALACEs are intended to permit the exploration of large-scale low-frequency currents and provide repeated vertical profiles of ocean variables. The ALACE floats can periodically change their buoyancy by pumping hydraulic fluid from an internal resevoir to an external bladder, thereby increasing float volume and buoyancy. The floats are designed to have a maximum depth capability of 2000m and an endurance of up to 5 years. The battery life is dependent on the number of cycles programmed into the unit. Table 5.2 lists the characteristics programmed by the factory into the PML ALACE floats.

TABLE 5.2. ALACE FLOAT CHARACTERISTICS

Float No.	Argos ID	Ballasted Operating Depth dBar	Hours at Surface	Hours Submerged
293	21076	725	15.46	744
294	21077	1100	13.61	1224
295	21078	350	16.24	744
296	21079	350	16.24	744

The floats were switched on by means of a magnetic switch, the pre-deployment checkout then starts and after a few minutes the external bladder can be seen to start to inflate. All floats start their first descent (i.e. the bladder deflates) 7.76 hours after first switch on. We attempted to organise the program so that deployment occurred a few minutes prior to descent so that we could watch the float sink. We did not always manage to achieve this. Launching the floats was an easy procedure with the float simply being carefully lowered over the stern of the ship on cloth tape which was slipped through a hole provided in the stability disk. Care had to be taken so that the float antenna was not damaged on the side of the ship and that air was not trapped in the base of the float.

TABLE 5.3. ALACE FLOAT DEPLOYMENTS

Float ID	Argos ID	Date Dep.	Year Day	Time	Latitude N	Longitude W	Float Type
296	21079	21-12-93	355	1652	25°23.01'	33°03.19	ALACE

293	21076	08-01-94	008	2114	38°22.00'	09°58.74	ALACE
294	21077	08-01-94	008	2117	38°21.94'	09°58.75'	ALACE
295	21078	08-01-94	008	2237	46°00.00'	08°38.85'	ALACE

5.7 RAFOS Float Deployments

6 Seascan RAFOS floats were embarked on CD83 to be deployed in suitable eddies on behalf of the Woods Hole Oceanographic Institution. Unfortunately the launching rig and two of the floats were found to be damaged on receipt. The RVS technical staff were able to effect a good repair on the launching rig but it was not possible to rectify the faults on the two floats at sea. The other four floats were deployed as shown in Table 5.4.

The RAFOS floats are ballasted at the factory to float at a pre-determined depth, the floats then drift at the set depth logging data as programmed for the entire planned deployment period (2 years). The on board clock then activates a circuit which burns through a wire which secures the ballast weight. When the weight is released the float rises to the sea surface and transmits it's data to the System Argos satellite continuously until the batteries fail.

Care had to be taken in launching these floats since they are housed in a glass tube and so the launching rig was essential to avoid contact with the ships side.

TABLE 5.4 RAFOS FLOAT DEPLOYMENTS

Float ID	101	113	131	133	136	137
Argos ID		02561	02560		02557	02558
Date Dep.		07-01-94	07-01-94		07-01-94	07-01-94
Year Day		007	007		007	007
Time Mission Started	Tube cracked	1408	2103	Clock in error	1825	1945
Time Dep.	Not Used	1650	2216	Not Used	1832	2013
Latitude N		38°27.08'	38°25.54'		38°24.30'	38°21.51'
Longitude W		09°42.07'	09°57.44'		09°55.36'	10°08.07'
dBar		800	1200		1000	1000

5.8 Recovery of Moonraker Buoy 3346

Buoy 3346 was deployed on day 67 1992 during the *RRS Charles Darwin* cruise CD66 in position 29°59.4' N 28°27.5'W on the edge of the GMT. The buoy's original specification gave an expectation of 15 months battery life but the buoy was still transmitting after 656 days. It was decided however to recover the buoy to examine the condition of the buoy and drogue components. We have not had such an opportunity previously to examine a drogue which had been at sea for such a long period. Normally buoys recovered from foreign shores or by third parties are missing the drogue components.

Using the latest Argos satellite position we steamed towards the buoy's last known position, we were then able to home in on the buoy using the portable Gonio Argos Direction Finder. The buoy was sighted at 1745 on day 356 and the surface float noosed at 1803 in position 26°10.44'N 33°36.07'W. Unfortunately the nylon line attaching the buoy to the drogue fouled on the ships rudder. Eventually at 1958 we were able to free the line and recover both the buoy and the complete drogue. We were pleasantly surprised at the condition of both the buoy and the drogue components. There was some fouling found on the buoy itself but not much and the biologists on board were able to make quite a collection of specimens from the top end of the drogue itself. Early excitement amongst the biologists on the discovery of an unusual sponge was quickly dispelled when they learned that this had come from the supplementary buoyancy ring we had fitted to the buoy on deployment. The chandlery and hardware showed no sign of wear whatsoever and we decided that the drogue was in a good enough condition to be be re-deployed with another buoy. (see Section 5.3)

5.9 Post Deployment

At the time of publication all the deployed buoys have continued to operate and transmit satisfactorily. We have authorised for buoy 5030 to operate on the Global Telecommunication System (G.T.S.) to provide data for the World Meteorological Organisation.

The first ALACE (296) float which was due to transmit on it's first surface cycle on 21 January 1994 failed to do so. It also failed to transmit on the 21 February and so we must presume that this unit has failed. ALACE floats 293, 294 and 295 have transmitted data as programmed.

Bob Barrett PML
Ron Easton PML
Ian Waddington IOSDL

6. MOORING OPERATIONS

The mooring operations were divided into two phases;

1. Recovery of three Great Meteor Tablemount moorings, deployed from Charles Darwin Cruise 66 March - April 1992.

2. Deployment of moorings in support of OMEX and PML scientific investigations design deployment period 2 years.

6.1 Great Meteor Tablemount Moorings.

The moorings were designed for a one year deployment and recovery was expected to have taken place in March - April 1993. However due to ship scheduling the recovery was delayed almost eight months. The designs should have given adequate performance for this extended period as materials used are proven.

Mooring 136.
29°45.55'N 28°41.69'W Deployed Day 68 1992.

Acoustic Release Oceano RT361, Current meters 9416, 9576. Buoyancy 25 off 17" glass spheres.
24 December 1993.
Mooring interrogated on approach using PES fish and single element.
Initial contact established at 3092 metres at 1415 h.
Release code transmitted and execute confirmed at 1420 h.
Vessel hove to with acoustic interrogation at 1438 h.
No obvious signs of surfacing, transmit release code 3 times each time execute confirmed.
Courses then steamed to accurately establish position and depth of release. Confirmation of release operation obtained throughout exercise.

Established that the release was on the sea floor and not buoyed up at 100m if mooring intact. 2595m closest approach, water depth 2555m.

Conclusion.
Total buoyancy failure/loss causing mooring to collapse or parting of the line above the acoustic release.
(This exercise of steaming courses should be unnecessary in future, as with an RT661 with pinger mode a bottom echo could have been established at an early stage confirming height of RT off bottom).

Mooring 138.
30°00.25'N 28°27.32'W Deployed Day 71 1992.
Acoustic Release Oceano RT361, Current meters 186, 886. Buoyancy 32" steel sphere.
24 December 1993.
Mooring interrogated on approach using PES fish and single element. Initial contact very poor and erratic, execute confirmations obtained with ENABLE and RELEASE codes.
The vessel was hove to and the overside transducer used with and without weight and at various depths with inconclusive ranges and doubtful operation confirmation.
The vessels propellor and bow prop were stopped and the transducer lowered at various positions around the vessel all with increasingly bad and missing ranges and confirmations.
Over 50 attempts were made throughout the exercise to release the mooring each indicating execute confirmation. The buoy was not seen at the surface and the initial exercise abandoned.
25 December 1993.
The mooring could not be located acoustically from a box search of 1/2 mile and it is thought the release batteries had finally collapsed.

Conclusion.
The acoustic release batteries were most probably exhausted and the mooring could not be relocated for a dragging operation.

Mooring 137.
30°11.75'N 28°18.174'W Deployed Day 69 1992
25 December 1993.
Initial acoustic contact established at 0841 with an indicated slant range of 2783m. Release code transmitted and confirmation of execute received. No indication of mooring rising to surface and the release code was retransmitted several times.
As with mooring 136 courses were steamed to establish depth and position of acoustics and again it was apparent that the RT361 unit was on the sea floor with the closest approach at 2531m with a water depth of 2506m.

Conclusion.
Total buoyancy failure/loss causing mooring to collapse or parting of the line above the acoustic release.
(This exercise of steaming courses should be unnecessary in future, as with an RT661 with pinger mode a bottom echo could have been established at an early stage confirming height of RT off bottom).

In summing up, the three unfortunate losses might have been indicated at an earlier date with the inclusion of ARGOS PTT Mooring monitors. This would possibly have enabled a rescue attempt and would have prepared this cruise to be better aware of the problems on site.

Another factor which may have some bearing on the losses was the presence on the Table Mount of a large deep sea trawler, observed steaming lines across and off the mount whilst the Darwin was in the vicinity.

6.2 Deployment of Moorings

All the moorings were deployed buoy first from the after deck using the Double Barrel Capstan winch (DBC), port side EFFER crane and after gantry.
The mooring wire was wound onto the DBC storage winch through the DBC barrels to tension the line on. Each shackle joint was wrapped with heavy duty canvas to protect the jacket wire.
Polyester lines were deployed from the manufacturers drums by hand tension through the DBC.
The deck layout and method was as previously used on CD66. (PML Cruise Report CD66/92)
The steel spheres were deployed using the starboard Rexroth winch on the gantry. The recovery line had a lifting eye tied in to lift the sphere over the stern of adequate length such that with the sphere in the water the line was slack, allowing the winch wire to be disconnected and the sphere to float clear as the mooring was streamed away astern.

Instruments were inserted into the mooring line at line shackle joints by 'Stopping off' the outboard shackle to a fixed deck chain using a stainless steel Boss hook S6.

The thermistor chains were taped to the mooring wire using PVC adhesive tape at 1 to 1.5m intervals, each thermistor bead being taped at each end. A team of 'tapers' was formed as the wire and thermistor cable were deployed along the deck from the sheave swung 6m inboard. This allowed 6m of chain to be secured at one stop. The end of the string was taped over completely with 'Bulldog' self-amalgamating tape to protect the jacket wire and to provide enhanced security.

Anchors were freefall to the sea bed and were cut away on topographic depth. Each mooring descent was observed using the RT661 acoustic release set in 10 kHz pinger mode and observed on the SIMRAD EA500 set in Passive mode. This gave an indication of descent rate, bottoming out of the mooring and height above bottom of the RT661 could be observed. The RT661 was turned off shortly after bottoming out, confirmation of the OFF state was obtained and confirmed by the pinger not turning back on after 2 minutes.

Current meters
Three types of current meter were deployed on the moorings ;

Aanderaa RCM 5 and 8 : PML, RVS, IFREMER
EG & G VACM 610C : IOSDL
SUBER VACM : IFREMER

The Aanderaa current meters were all tested onboard to check correct functioning and recording. Type 5 units were observed to wind on recording tape, but the recorded tape was not checked as no tape reader was onboard. Type 8 units were checked for correct writing to DSU and data examined using the P3059 data reading program, all DSU units were checked for correct internal clock time and data erased before deployment.

The sensors and ranges of the IFREMER meters had all been preset and calibrated before air shipment to Las Palmas and no adjustments were required. The vane units required assembly which also included fitting of the spindle assemblies to the Gimbal housings. The tail fins for the vanes were missing and all spares onboard were used to fit these out correctly.

The sensors and ranges of the PML and RVS meters were all set and calibrated at RVS and no adjustments were required.

The EG & G 610C units were shipped by container to Las Palmas and were set up before the vessel sailed, as these units can be most conveniently tested in port with no ship motion. All sensors were checked for correct operation and the clocks set and observations of recording made. The units were cased up and secured on deck until required for mooring.

SUBER VACM
The unit was supplied prepared and was not opened up onboard.
The only requirement was to switch on using the external mechanical switch. It was not possible to check correct operation as the pressure case was sealed and pressurised. An inspection of the external sensors was made to ensure free rotation.

L.F. Acoustic Transponder Beacon RT661 B1S
The L.F unit is the device used for acoustic release of the anchor to permit recovery of the instrumentation.

The MORS RT661 B1S units were specified by IOSDL and are produced as a transponder release with a 10 kHz pinger function incorporated to provide a precision 2 second 4.06 mS pinger capable of being monitored by the onboard SIMRAD EA500 echosounder fitted to NERC vessels and to be compatible with the portable CR200 receiver and waterfall display.

The electonics are powered by 3 banks of 6 x R20 SAFT LSH20 Lithium batteries giving a standby capability of 48 months with the Release motor being powered by 1 6F22 Alkaline battery capable of 15000 release operations.

Each unit was tested to deployment depth on the RVS CTD frame and tests made of all functions. A release link, tied to the CTD frame was released to test the mechanical function of the B1S Release Hook in each case. Tests were carried out using pairs of RT661s strapped in opposite corners of the frame using heavy duty PVC tape and safety lines.

The threads around the upper and lower pressure caps were additionally coated with TECTYL 506 to protect against possible crevice corrosion.

The side load bar upper shackle connection was insulated using PVC bushes to isolate the dissimilar ferralium and galvanised steel mooring components.

An RVS special product release link was used in each case, this link being manufactured from Stainless steel with a polypropylene insulating bush for mooring shackle insertion.

Electronic Specifications
Transmit width.................. 10 ms
Transmit level .... 192 db
Transmit delay 20.1ms
Transmit inhibition .... 8.53 s

FR1 = 9.0 kHz FT1 = 8.5 kHz
FR2 = 8.5 kHz FT2 = 9.0 kHz

Bit 1 = 03	FR3 = 9.5 kHz
Bit0 = 05	FR4 = 10.5 kHz
Reply	FT4 = 10 kHz
All other functions	= 12 kHz

RT661-B1S Basic Function codes for TT300

Serial No.	**Window** Mode B	**ON Pinger** Mode B	ModeE	**Release** ModeB	**OFF** ModeB
183	42D1	4211	4252	4251	4221
184	40B1	4011	4052	4051	4021
185	20D1	2011	2052	2051	2021
186	62D1	6211	6252	6251	6221
187	40C1	4021	4052	4051	4021
188	40D1	4011	4052	4051	4021
189	20E1	2011	2052	2051	2021
190	42E1	4211	4252	4251	4221

When the pinger is activated reception is on MODE E, after transmission of the Pinger command, if on MODE B, it is necessary when switched over to MODE E to retransmit the pinger signal to clear the deck unit for MODE E.
The pinger signal is displayed in "Time" every 4 seconds although the RT661 transmits on a 2 second period.

Re-transmission of the WINDOW command will stop the pinger for 60 seconds plus a further 60 seconds whilst the window is open. The pinger will restart automatically on window closure or after a command is operated. Thus it is possible to run the pinger and after WINDOW plus RELEASE the pinger will restart on receipt of an EXECUTED signal being received on the TT300, to indicate rise of mooring on an analog display such as the SIMRAD or Waterfall display.
WINDOW also acts to give a transponder slant range on the sea unit correctly receiving it.
Comment: The WINDOW requirement for every operation can be frustrating as the wait time of 60 seconds for transponder ranging slows down the operation.

Wire testing Acoustic Releases
The acoustic release units were all tested on CTD dips by attaching the units within the CTD frame. Each unit was preset with a release link inserted and then lowered to depth for functional checks and release operation. All the units tested out correctly and reception of the signal onboard was by Single element on the PES fish and displayed on the SIMRAD EA500.

PML MORS RT661 units

RELEASE OPERATION.
Transmit Window Code on PML deck unit - MODE B selected.Observe RECEIVED and range in metres-Wait 60 seconds.
Transmit Release code on Mode B. Observe RECEIVED and range in metres.
Observe EXECUTED confirmed.

PINGER OPERATION.
Transmit Window Code - Mode B. Observe RECEIVED and range in metres- Wait 60 seconds. Transmit Pinger Code-Select Mode E.
Retransmit Pinger Code-Mode E.
Observe received signal on deck unit-in TIME and on SIMRAD as Analog pulse.
SIMRAD set on 2 second sweep - observe received pinger signal and precision.

OFF.
Transmit Window - Mode B. Wait 60 seconds.
Transmit OFF-Mode B-Observe received and pinger OFF.
Pinger observed OFF on SIMRAD.

All the MORS units have been coated at the threads of fittings with TECTYL to inhibit crevice corrosion, care being taken not to coat any moving parts.

ARGOS Subsurface Beacons.

The moorings were designed with satellite relocation beacons as aids to detect premature surfacing. Five beacons were provided of the new IOSDL Mk 1 type (OMEX), two beacons of the ARGOS CIS SMM500 type (RVS) and one ORCA type (IFREMER).

Each beacon was tested on deck using the Informatique Electronique Securite Maritime GONIO 400 and comparative strengths observed.

The beacons were powered up approximately two days before deployment and signal levels monitored. Fitting to the subsurface buoys was usually one to four hours before deployment.

Beacon types and allocation.
IOSDL Mk 1.
The IOSDL Mk 1 beacons were delivered aboard requiring final testing and battery fitting. Each beacon is derived from a CEIS- TM UHF 88 ARGOS PTT set at 2 watt output and 4 byte. This is mounted into a custom built assembly with a 1/4 wave antenna. The assembly incorporates a pressure switch which activates the beacon at the surface. These units are the first production units but incorporate materials proven against corrosion and pressure at IOSDL. Pressure tested to 1000 metres.
Expected battery duration when transmitting is in excess of 100 days.

The IOSDL steel buoyancy spheres were specifically constructed to incorporate a mounting for these beacons which are mechanically clamped within the mounting.

Beacon Id	**Mooring**
21440	146
21441	147
21442	Not deployed
21443	150
21444	151

SMM 500

Two beacons were provided by RVS of the standard Titanium housing type. Powered by Lithium SAFT cells.
The subsurface buoy mountings were designed for the IOSDL beacons and the SMM units were not supplied with adaptors. The beacons were adapted by increasing the diameter to 98mm using Butyl rubber sheet, suitable for clamping within the IOSDL mounting.

Beacon Id	**Mooring**
5648	153
5650	154

ORCA

One beacon provided by IFREMER in standard Anodised and coated housing. As with the SMM beacon the unit required adaption to fit the IOSDL mounting.

Beacon Id	**Mooring**
8802	149

Mooring Line stretching.

The moorings were to be deployed buoy first using new 9mm polyester braided line. To establish the stretch of the new line sample lengths were stretched overside using 650 kg chain weight to simulate the in line loading of the moorings. 2 lengths 9mm polyester braid of 450m were wound onto the double barrel winch on top of the jacket wire for mooring 153, 31-12-1993.

Whilst attempting stretch tests the RVS double barrel capstan drum showed that it was incorrectly set up and the drum angle required adjusting to prevent the turns bunching up on payout. This adjustment was achieved with some difficulty as the adjusting ram hydraulic pump was seized and the piston had to be freed off. With the pump working it was found that the pressure relief valve was set too low and could not be screwed in due to the threads being painted up. This was cleaned and the pump achieved pressure at the ram. The slewing barrel would not move due to corrosion and paint ,this was freed up using the ships crane to apply lift to the top barrel whilst the "seal" was broken by sharp blows with a hammer to the seating.

With the slewing now working the barrels were adjusted by alternately raising and lowering 40m of line overside with 350 kg of chain attached. The barrels were adjusted such that the line spread evenly across the drums and did not require the roller gates to hold its position. The two lengths of line were deployed overside and measured outboard at 500m. When hauling to measure the stretch it was found that the counter would not increment on hauling. This was stripped down and thoroughly cleaned as the interior of the housing was severely corroded and the counter numerals were not correctly engaging with the drive pawl. The counter was temporarily repaired and the line hauled and measured. The counter later failed whilst deploying mooring 149.

Length 1	450m	500m out	515m in
2	450m	501m out	516m in
	Stretch taken as 66m		14.6%

Mooring 153 Deployment, Thursday 30th December, 1993 Day 364

Position 36°45.02'N 12°23.89'W
Water depth 4339 corrected metres
Deployed Buoy first with anchor freefall.

Item	Type	Length metres	Time Over GMT
Floats 2 x 11"	Pantherplast		
20mm 3 strand polyprop	Sturdee	15 m	
Steel 1.3m diameter	IOSDL type48 No21	1.3m	1420
Note steel sphere is labelled RVS Id 48S-21			
Fitted with ARGOS Id 5648 SMM500 type RVS.			
Chain 5/8" long link		2 m	
Pressure Balanced swivel	Elkins EE1	0.25m	
Jkt wire 8mm Od	MWRC	40m	
Chain 13mm long link		0.25m	
Current meter	SUBER No 433 IFREMER	1m	Rf 1418 1423
Chain 13mm long link		0.25m	
Jkt wire 8mm Od	MWRC	400m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 3321 RVS	0.5m	Rf 1442 1445
Jkt wire 8mm Od	MWRC	500m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 9580 RVS	0.5m	Rf 1507 1509
Polyester braid 9mm dia	Marlowbraid	516m	
Polyester braid 9mm dia	Marlowbraid	516m	
Polyester braid 9mm dia	Marlowbraid	516m	
Polyester braid 9mm dia	Marlowbraid	516m	
Chain 13mm long link		0.25m	
Acoustic Release	MORS RT661 PML No 189	1m	1554
Polyester braid 9mm dia	Marlowbraid	516m	
Polyester braid 9mm dia	Marlowbraid	516m	
Chain 13mm long link		10m	
Anchor 1000kg	Scrap chain		
On bottom at 1653 GMT	**Anchor cut away**		**1623**
Bottom separation 1000m			
Slant range 3461m	Observe switch off of pinger.		

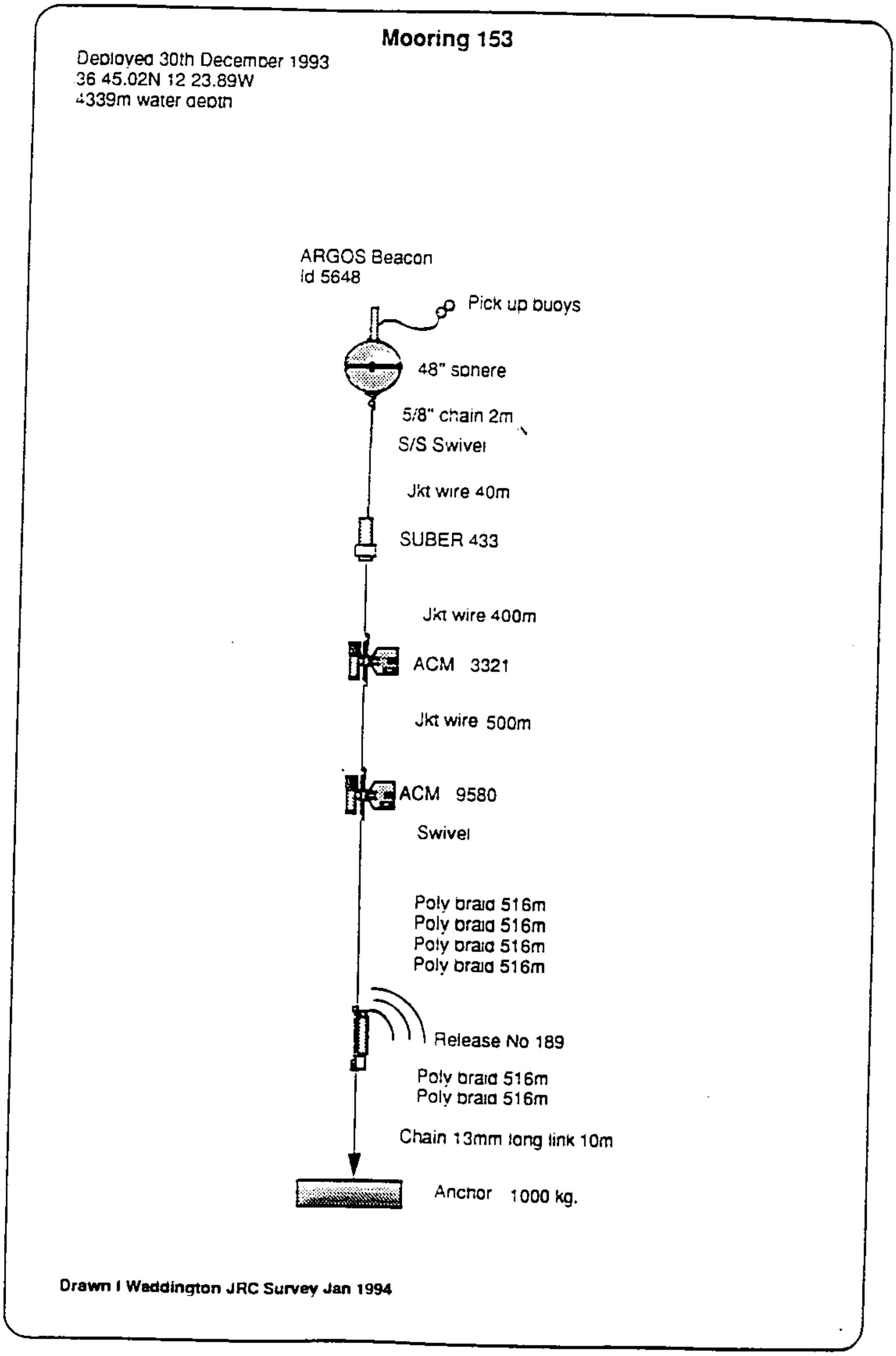


Figure 6.1. Mooring rig 153.

Mooring 153.

ACM 3321 RVS

Ch 1	Ref	Ch 2	Pressure	Ch 3	Cond
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		120 minutes	Battery SUVICON		
DSU	2990	5485		Clock set GMT	
Start sample		1600 h 18th December 1993 Day 352			

ACM 9580 RVS

Ch 1	Ref	Ch 2	Temp	Ch 3	Cond
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		60 minutes	Battery SUVICON		
DSU	2990E	5356		Clock set GMT	
Start sample		1600 h 18th December 1993 Day 352			

SUBER Current meter - 433
IFREMER
Switched on at 2000 gmt Day 363 29-12-1993

Mooring 151 Deployment, Thursday 30th December, 1993 Day 364

Position 36°30.03'N 12°28.13'W
Water depth 3520 corrected metres
Deployed Buoy first with anchor freefall.

Item	**Type**	**Length Metres**	**Time Over GMT**
Floats 2 x 11"	Pantherplast		
20mm 3 strand polyprop	Sturdee	15 m	
Steel 1.3m diameter	IOSDL type48 No22	1.3m	
Note steel sphere is labelled RVS Id 48S-22			
Fitted with ARGOS Id 21444	IOSDL Mk1 , PML		
Chain 5/8" long link		2 m	
Pressure Balanced swivel	Elkins EE1	0.25m	
Jkt wire 8mm Od	MWRC	40m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 10665 RVS	1m	Rf1957 2002+30s
Chain 13mm long link		0.25m	
Jkt wire 8mm Od	MWRC	100m	
Chain 13mm long link		0.25m	
Temperature Profiler	Aanderaa TR2 834 RVS Profiler string 2116	0.5m	2012+29s First bead at logger
Chain 13mm long link		0.25m	
Jkt wire 8mm Od	MWRC	300m	
Current meterEG & G	VACM V0429 IOSDL	0.5m	Rf 2050 2050+50s
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 10666 RVS	0.5m	RF 2124 2127+08s
Pressure Balanced swivel	Elkins EE1	0.25m	
Polyester braid 9mm dia	Marlowbraid	516m	
Polyester braid 9mm dia	Marlowbraid	516m	
Polyester braid 9mm dia	Marlowbraid	516m	
Chain 13mm long link		0.25m	
Acoustic Release	MORS RT661 PML No 186	1m	
Polyester braid 9mm dia	Marlowbraid	516m	
Polyester braid 9mm dia	Marlowbraid	190m	
Chain 13mm long link		10m	
Anchor 1000kg	Scrap Chain		Towing at 2218

On bottom at 2259 + 10s. GMT **Cut away at 2238+40s**
Bottom separation observed
Slant range 2971 m Observe switch off of pinger.

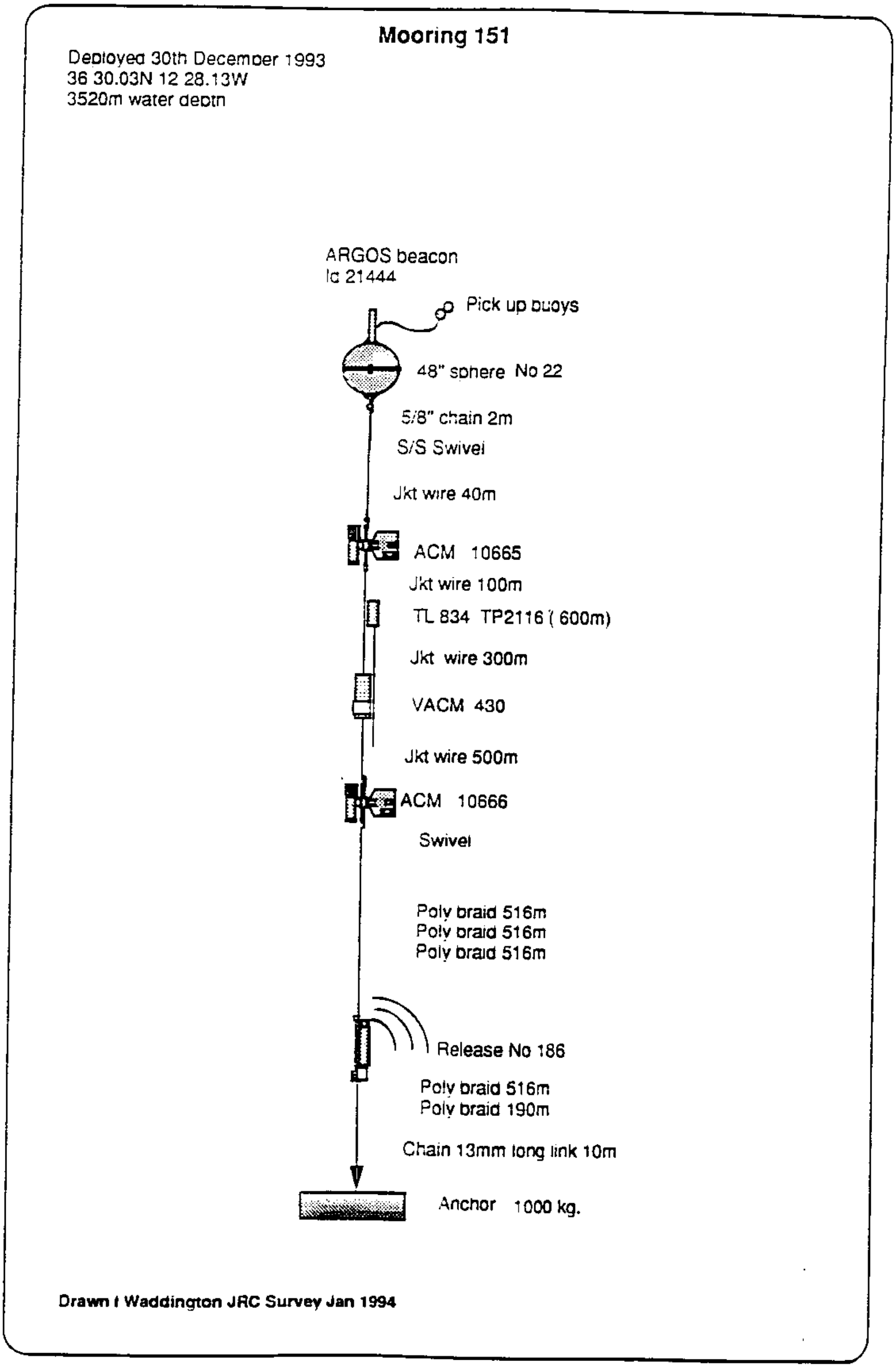


Figure 6.2. Mooring rig 151.

Mooring 151.

ACM 10665 RVS
Ch 1 Ref Ch 2 Pressure Ch 3 Cond
Ch 4 Temperature Ch 5 Compass
Ch 6 Rotor S type
Clock set 60 minutesBattery SUVICON
DSU 2990E 4840Clock set GMT
Start sample 1600 h 18th December 1993 Day 352

ACM 10666 RVS
Ch 1 Ref Ch 2 Temp Ch 3 Cond
Ch 4 Temperature Ch 5 Compass
Ch 6 Rotor S type
Clock set 60 minutesBattery SUVICON
DSU 2990E Clock set GMT
Start sample 0100 h 22nd December 1993 Day 356

TR2 834 RVS TP 2116
Ch 1 Ref Ch 2-12 Temp
Clock set 180 minutesBattery 3309
Recording tape
Clock reset at 1600 h 18th December 1993 Day 352
First data at 1900 h 18th December 1993
Plugged into string 1500 h 26th December 1993 Day 360

V0429/430
Check compass/vane alignment and stiction.Temperature variability.Set Clock 1 hour sample.Pin 22 on clock board.
Reset clocks at 1900 gmt.
First data at 2000 gmt 12th December 1993 Day 346.
Observe tape increments.

Mooring 152 Deployment, Friday 31st December, 1993 Day 365

Position 36°29.92'N 12°17.58'W
Water depth 3770 corrected metres
Deployed Buoy first with anchor freefall.

Item	Type	Length metres	Time Over GMT
Floats 2 x 11"	Pantherplast		
20mm 3 strand polyprop	Sturdee	15 m	
Steel 1.3m diameterIOSDL type48 No21		1.3m	1054
Note steel sphere is labelled RVS Id 48S-21			
Chain 5/8" long link		2 m	
Pressure Balanced swivel	Elkins EE1	0.25m	
Jkt wire 8mm Od	MWRC	40m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 2068 UBO	1m	Rf 1053 1059
Chain 13mm long link		0.25m	
Jkt wire 8mm Od	MWRC	400m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 3115 UBO	0.5m	Rf1108+19s 1111+36s
Jkt wire 8mm Od	MWRC	500m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 4436 UBO	0.5m	Rf 1119 1126+04s
Polyester braid 9mm dia	Marlowbraid	516m	
Polyester braid 9mm dia	Marlowbraid	516m	
Polyester braid 9mm dia	Marlowbraid	516m	
Chain 13mm long link		0.25m	
Acoustic Release	MORS RT661 PML No 188	1m	1200+50s
Polyester braid 9mm dia	Marlowbraid	516m	
Polyester braid 9mm dia	Marlowbraid	516m	
Chain 13mm long link		10m	
Anchor 1000kg	Scrap chain		
On bottom at 1250 gmt	**Anchor cut away**		**1226+13s**
Bottom separation 975m			
Slant range 3461m	Observe switch off of pinger.		

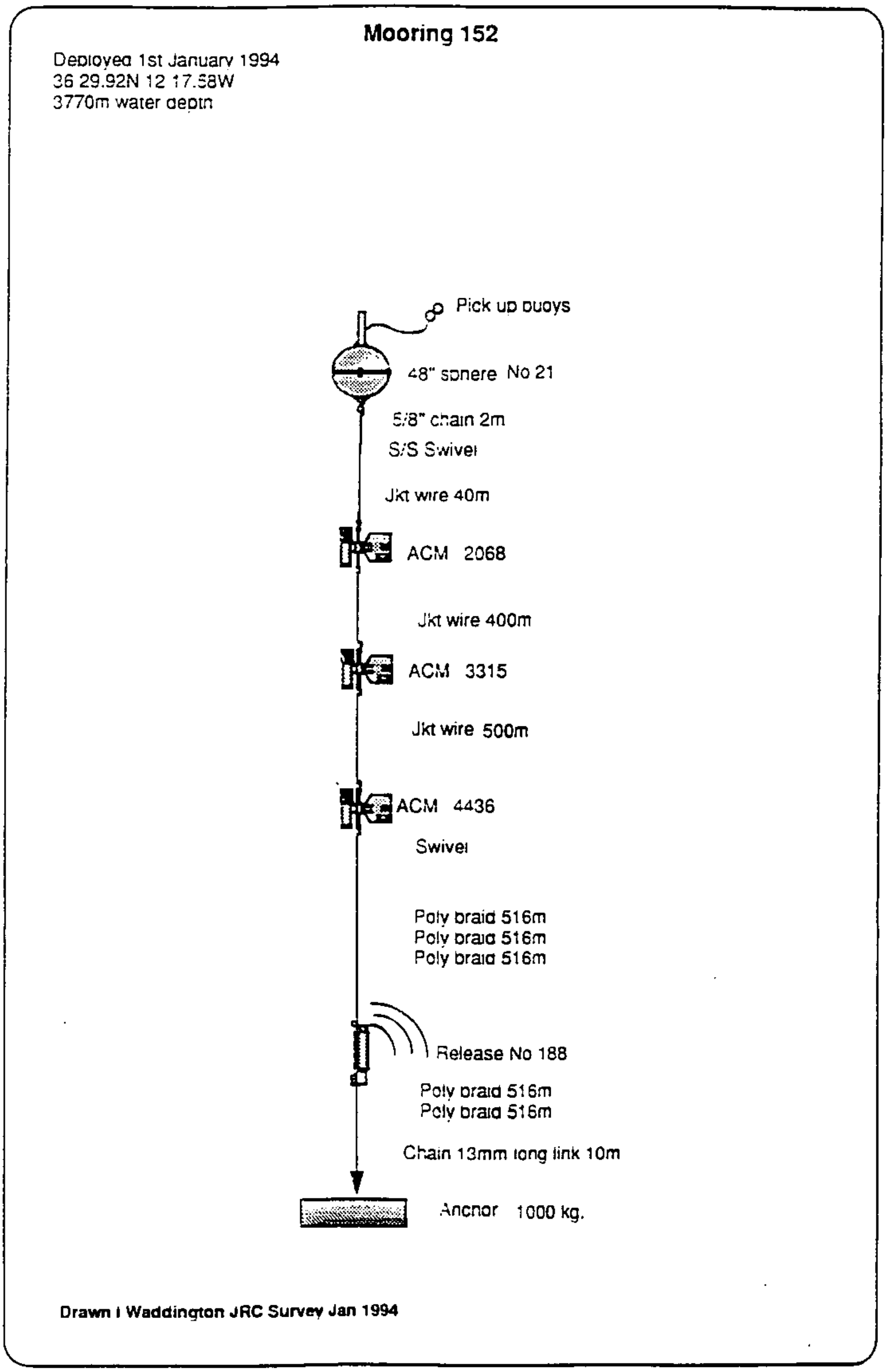


Figure 6.3. Mooring rig 152.

Mooring 152.

ACM 4436		Titanium spindle		Titanium top cap	
Ch 1	Ref	Ch 2-2 +21 C		Ch 3	+6 +13 C
Ch 4	Pressure	0-8000 psi	53043-1		
Ch 5	Compass				
Ch 6	Rotor	Old type	set 16 rpc		
Clock set		120 minutes	Battery	9.85 V	
Start sample		0200 h 17th December 1993 Day 351			
First data		0400 h 17th December			

ACM 3115		Titanium spindle		RCM-5 top cap	
Ch 1	Ref	Ch 2-2 +21 C		Ch 3	+6 +13 C
Ch 4	Pressure	0-3000 psi	51795-40		
Ch 5	Compass				
Ch 6	Rotor	Old type	set 16 rpc		
Clock set		180 minutes	Battery	9.86 V	
Start sample		0100 h 17th December 1993 Day 351			
First data		0400 h 17th December			

ACM 2068		Stainless spindle		RCM-5 top cap	
Ch 1	Ref	Ch 2-2 +21 C		Ch 3	+6 +13 C
Ch 4	Pressure	0-3000 psi	51795-21		
Ch 5	Compass				
Ch 6	Rotor	Old type	set 16 rpc		
Clock set		180 minutes	Battery	9.83 V	
Start sample		0100 h 17th December 1993 Day 351			
First data		0400 h 17th December			

Mooring 149 Deployment, Saturday 1st January, 1994 Day 001

Position 36°49.10'N 09°30.28'W
Water depth 1506 corrected metres
Deployed Buoy first with anchor freefall.

Item	Type	Length metres	Time Over GMT
Floats 2 x 11"	Pantherplast		
20mm 3 strand polyprop	Sturdee	15 m	
Steel 1.3m diameter	IOSDL type48 No25	1.3m	1634
Note steel sphere is labelled RVS Id 48S-25			
ARGOS Beacon	ORCA Id 8802 UBO		
Chain 5/8" long link		2 m	
Pressure Balanced swivel	Elkins EE1	0.25m	
Jkt wire 8mm Od	MWRC	300m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 4435 UBO	1m	Rf 1637 1639+30s
Chain 13mm long link		0.25m	
Jkt wire 8mm Od	MWRC	500m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 4437 UBO	0.5m	Rf 1651+55s 1653+12s
Jkt wire 8mm Od	MWRC	200m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 5480 UBO	0.5m	Rf 1734 1734+55s
Jkt wire 8mm Od		8m	
Chain 13mm long link		0.25m	
Acoustic Release	MORS RT661 PML No 187	1m	1737
Jkt wire 8mm Od		30m	
Chain 13mm long link		10m	
Anchor 1000kg	Scrap chain		

On bottom at 1916+20s GMT
Bottom separation 40 m
Slant range 1490 m Observe switch off of pinger 1920 h.

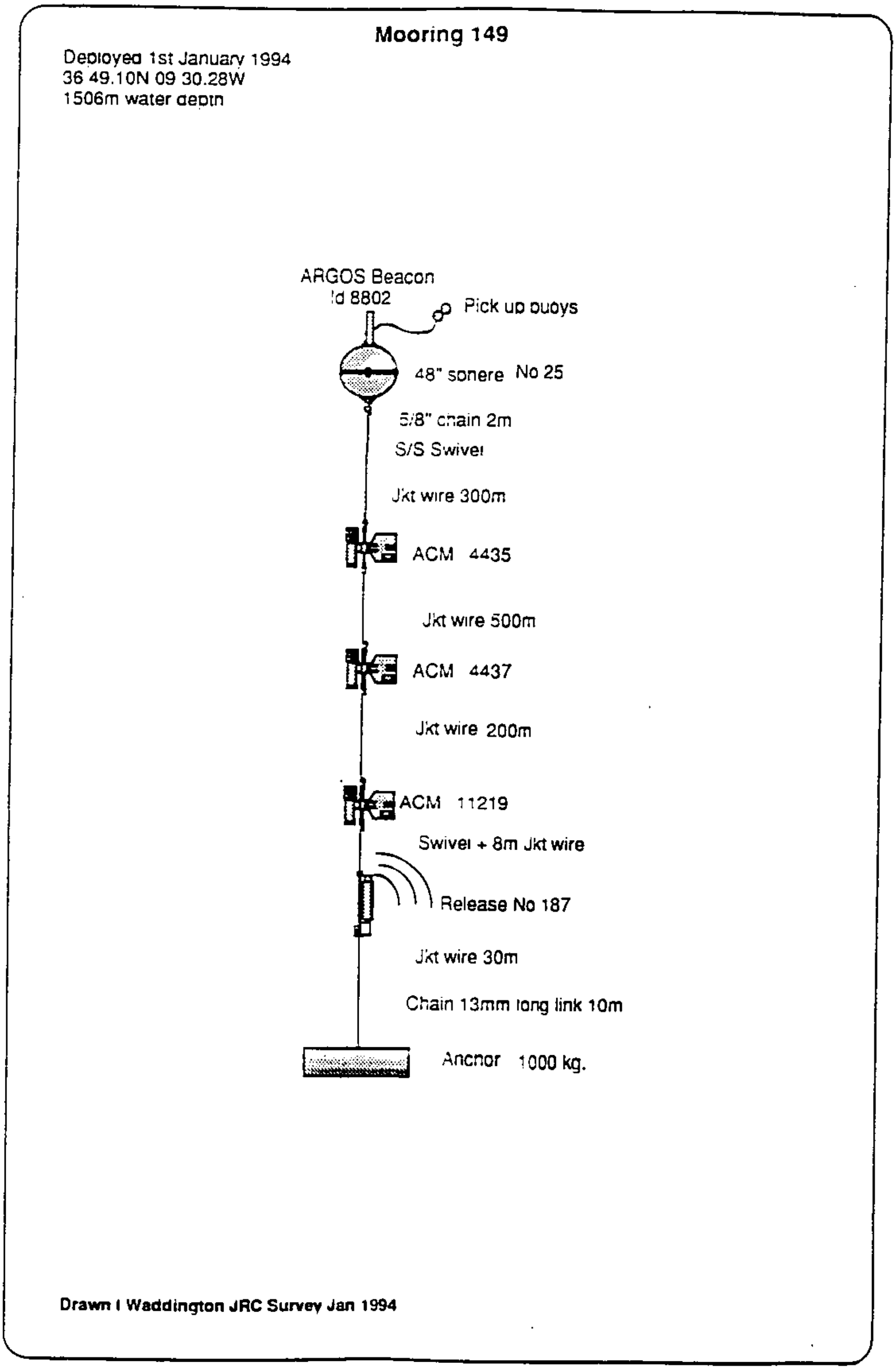


Figure 6.4. Mooring rig 149.

Mooring 149.

ACM 5480		Stainless spindle		Titanium top cap	
Ch 1	Ref	Ch 2-2 +21 C		Ch 3	+6 +13 C
Ch 4	Pressure	0-8000 psi	51255-1		
Ch 5	Compass				
Ch 6	Rotor	Old type	set 16 rpc		
Clock set		180 minutes	Battery	9.72 V	
Start sample		1300 h 17th December 1993 Day 351			
First data		1600 h 17th December			

ACM 4437		Titanium spindle		Stainless top cap	
Ch 1	Ref	Ch 2-2 +21 C		Ch 3	+6 +13 C
Ch 4	Pressure	0-8000 psi	51400-17		
Ch 5	Compass				
Ch 6	Rotor	Old type	set 16 rpc		
Clock set		180 minutes	Battery	9.89 V	
Start sample		1300 h 17th December 1993 Day 351			
First data		1600 h 17th December			

ACM 4435		Titanium spindle		Titanium top cap	
Ch 1	Ref	Ch 2-2 +21 C		Ch 3	+6 +13 C
Ch 4	Pressure	0-3000 psi	51997-13		
Ch 5	Compass				
Ch 6	Rotor	Old type	set 16 rpc		
Clock set		120 minutes	Battery	9.82 V	
Start sample		1400 h 17th December 1993 Day 351			
First data		1600 h 17th December			

Mooring 146 Deployment, Tuesday 4th January, 1994 Day 004

Position 38°12.97'N 09°7.31'W Setubal Lisbon Canyons
Water depth 2000 corrected metres
Deployed Buoy first with anchor freefall.

Item	Type	Length metres	Time Over GMT
Floats 2 x 11"	Pantherplast		
20mm 3 strand polyprop	Sturdee	15 m	
Steel 1.3m diameter	IOSDL type48 No20	1.3m	1032
Note steel sphere is labelled RVS Id 48S-20			
ARGOS Beacon	IOSDL Mk1 Id 21440 PML		
Chain 5/8" long link		2 m	
Pressure Balanced swivel	Elkins EE1	0.25m	
Jkt wire 8mm Od	MWRC	20m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 9415 RVS	1m	Rf 1034 1035
Chain 13mm long link		0.25m	
Jkt wire 8mm Od	MWRC	200m	
Chain 13mm long link		0.25m	
Temperature profiler	Aanderaa 1024 IOSDL	0.5m	1054
Profiler string 600m (extending across VACM)	Aanderaa 2117 PML	600m	
Jkt wire 8mm Od		300m	
Chain 13mm long link		0.25m	
Current meter	EG&G VACMV0627 PML	2m	Rf 1126+40 1139+07
Jkt wire 8mm Od		500m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 11217 PML	1m	Rf 1210+30 1212+20
Jkt wire 8mm Od		500m	
Jkt wire 8mm Od		50m	
Chain 13mm long link		0.25m	
Pressure Balanced swivel	Elkins EE1	0.25m	
Chain 13mm long link		0.25m	
Acoustic Release	MORS RT661 PML No 187	1m	1238+54
Chain 13mm long link		0.25m	
Polyester braid 9mm dia	Marlowbraid	229m	
Chain 13mm long link		10m	
Anchor 1000kg	Scrap chain		
On bottom at 1401 GMT			**Cut away at 1349+58s**

Bottom seperation 230 m
Observe switch off of pinger 1406 h.

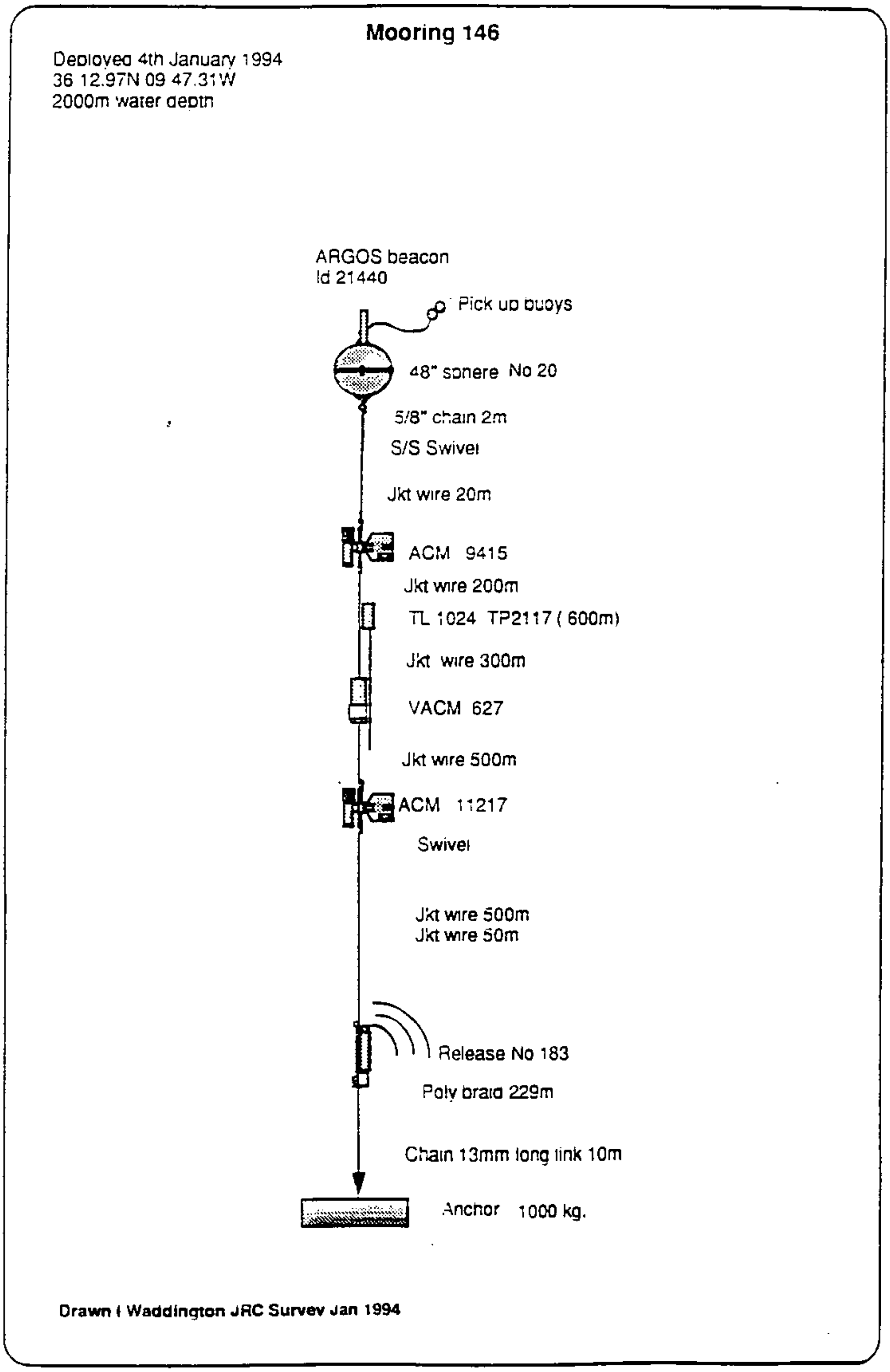


Figure 6.5. Mooring rig 146.

Mooring 146

ACM 9415 RVS Acoustic Transducer disabled

Ch 1	Ref	Ch 2	Pressure	Ch 3	Cond
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		120 minutes	Battery SUVICON		
DSU	2990 5488	Clock set GMT			
Start sample		0400 h 22nd December 1993 Day 356			

ACM 11217 PML

Ch 1	Ref	Ch 2	Temp	Ch 3	Cond
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		60 minutes	Battery SUVICON		
DSU	2990E 6767	Clock set GMT			
Start sample		0400 h 22nd December 1993 Day 356			

TR2 1024 IOSDL Electrical leadout removed **TP 2117**

Ch 1	Ref	Ch 2-12	Temp
Clock set		180 minutes	Battery 821 - New battery fitted
Recording tape			
First data at			0400 h 22nd December 1993 Day 356
Plugged into string		1500 h 26th December 1993 Day 360	

V0627

Check compass/vane alignment and stiction.Temperature variability. Set Clock 1 hour sample. Pin 22 on clock board.
Reset clocks at 1900 gmt.
First data at 2000 gmt 12th December 1993 Day 346.
Observe tape increments.

Mooring 147 Deployment, Tuesday 4th January, 1994 Day 004

Position 38°24.5'N 09°45.85'W
Water depth 2000 corrected metres
Deployed Buoy first with anchor freefall.

Item	Type	Length metres	Time Over GMT
Floats 2 x 11"	Pantherplast		
20mm 3 strand polyprop	Sturdee	15 m	
Steel 1.3m diameter	IOSDL type48 No30	1.3m	1634
Note steel sphere is labelled RVS Id 48S-30			
ARGOS Beacon	IOSDL Mk 1 21441 PML		
Chain 5/8" long link		2 m	
Pressure Balanced swivel	Elkins EE1	0.25m	
Jkt wire 8mm Od	MWRC	20m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 11213 PML	1m	Rf 1738 1741+30s
Chain 13mm long link		0.25m	
Jkt wire 8mm Od	MWRC	500m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 11218 PML	0.5m	Rf 1759+21s 1802
Jkt wire 8mm Od	MWRC	500m	
Chain 13mm long link		0.25m	
Current meter	Aanderaa No 11219 PML	0.5m	Rf 1814+40s 1821+31s
Chain 13mm long link		0.25m	
Pressure Balanced swivel	Elkins EE1	0.25m	
Chain 13mm long link		0.25m	
Acoustic Release	MORS RT661 PML No 187	1m	1821+32s
Chain 13mm long link		0.25m	
Jkt wire 8mm Od		500m	
Jkt wire 8mm Od		200m	
Polyester braid 9mm dia	Marlowbraid	91.7m	
Chain 13mm long link		10m	
Anchor 1000kg	Scrap chain		

On bottom at 1922+20s GMT **Anchor away at 1910+40s**
Bottom seperation 800 m
Slant range 1387 m Observe switch off of pinger 1926 h

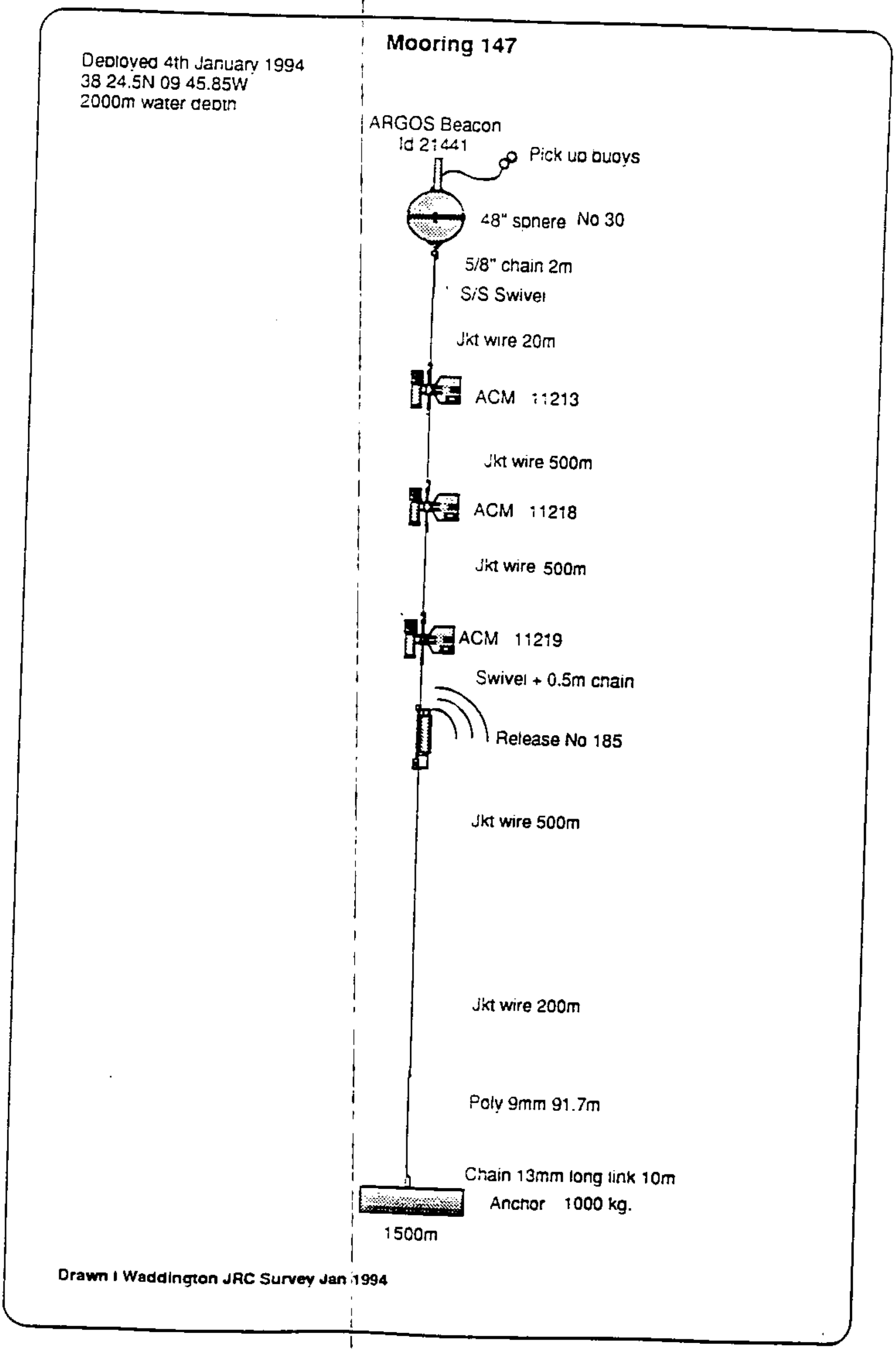


Figure 6.6. Mooring rig 147.

Mooring 147.

ACM 11219 PML

Ch 1	Ref	Ch 2	Temp	Ch 3	Cond
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		60 minutes	Battery SUVICON		
DSU	2990E 6769	Clock set GMT			
Start sample		1500 h 19th December 1993 Day 353			

ACM 11213 PML

Ch 1	Ref	Ch 2	Pressure	Ch 3	Cond
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		60 minutes	Battery SUVICON		
DSU	2990E 6763	Clock set GMT			
Start sample		1500 h 19th December 1993 Day 353			

ACM 11218 PML

Ch 1	Ref	Ch 2	Temp	Ch 3	Cond
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		60 minutes	Battery SUVICON		
DSU	2990E 6768	Clock set GMT			
Start sample		1500 h 19th December 1993 Day 353			

Current meters were also set up and logging started for moorings 150 and 154 to be deployed on the Goban Spur.These current meters were sealed and readied for deployment to remain onboard for Cruise 84 .

Mooring 150. 21st December

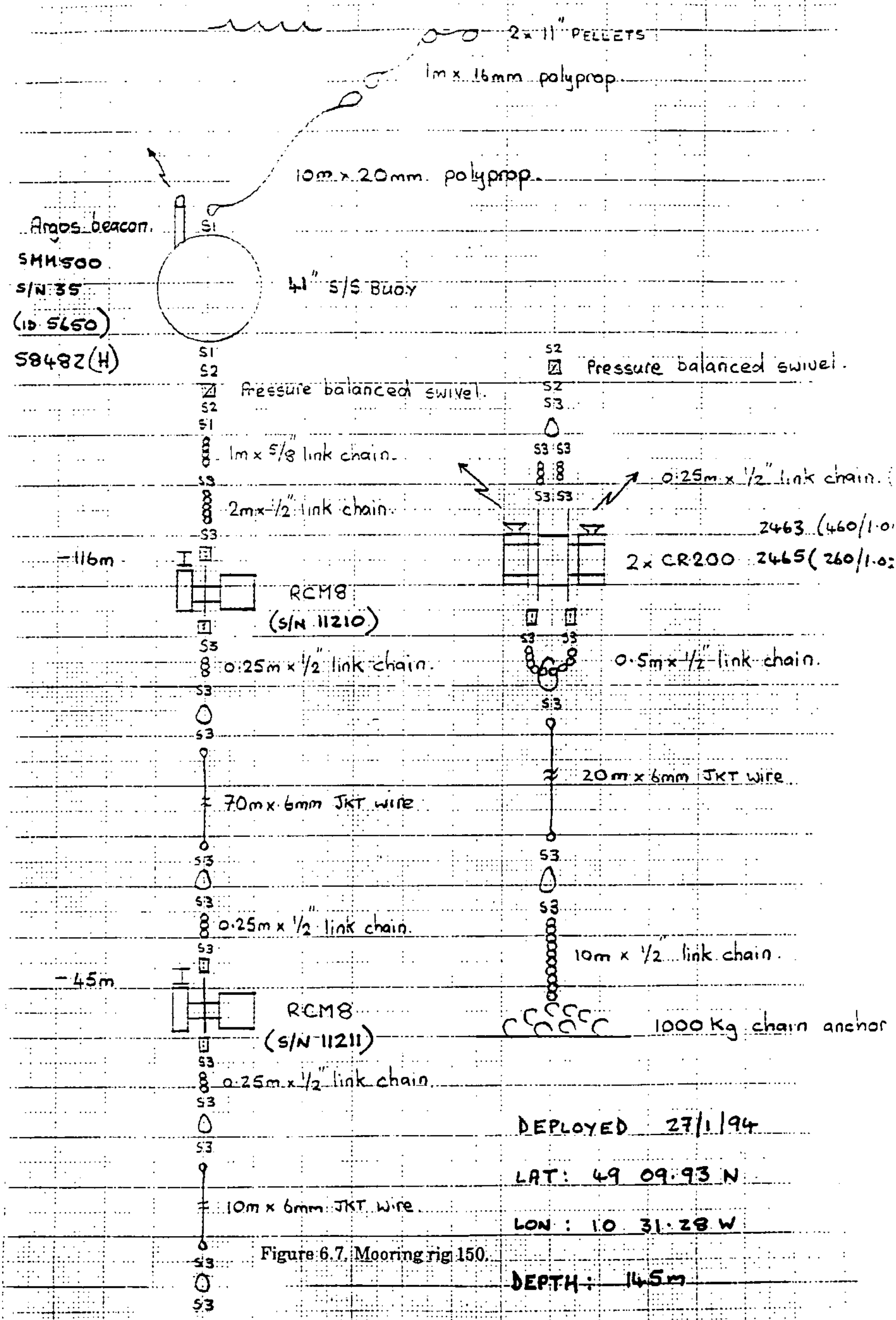
ACM 11211 PML

Ch 1	Ref	Ch 2	Temp	Ch 3	Cond
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		60 minutes	Battery SUVICON		
DSU	2990E 6761	Clock set GMT			
Start sample		0400 h 21st December 1993 Day 355			

ACM 11210 PML

Ch 1	Ref	Ch 2	Pressure	Ch 3	Cond
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		60 minutes	Battery SUVICON		
DSU	2990E 6760	Clock set GMT			
Start sample		0400 h 21st December 1993 Day 353			

CD 83/84 MOORING # 150 DEPTH : 145m LAT : 49.167N LON : 10.5



DEPLOYED 27/1/94

LAT: 49 09.93 N

LON : 10 31.28 W

DEPTH : 145m

Figure 6.7. Mooring rig 150.

Mooring 154. 19th December

ACM 11212 PML

Ch 1	Ref	Ch 2	Pressure	Ch 3	Cond
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		60 minutes	Battery SUVICON		
DSU	2990E 6762	Clock set GMT			
Start sample		0400 h 19th December 1993 Day 353			

ACM 11215 PML

Ch 1	Ref	Ch 2	Temp	Ch 3	Cond
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		60 minutes	Battery SUVICON		
DSU	2990E 6765	Clock set GMT			
Start sample		0400 h 19th December 1993 Day 353			

ACM 11214 PML

Ch 1	Ref	Ch 2	Temp	Ch 3	0
Ch 4	Temperature	Ch 5	Compass		
Ch 6	Rotor	S type			
Clock set		60 minutes	Battery SUVICON		
DSU	2990E 6764	Clock set GMT			
Start sample		0400 h 19th December 1993 Day 353			

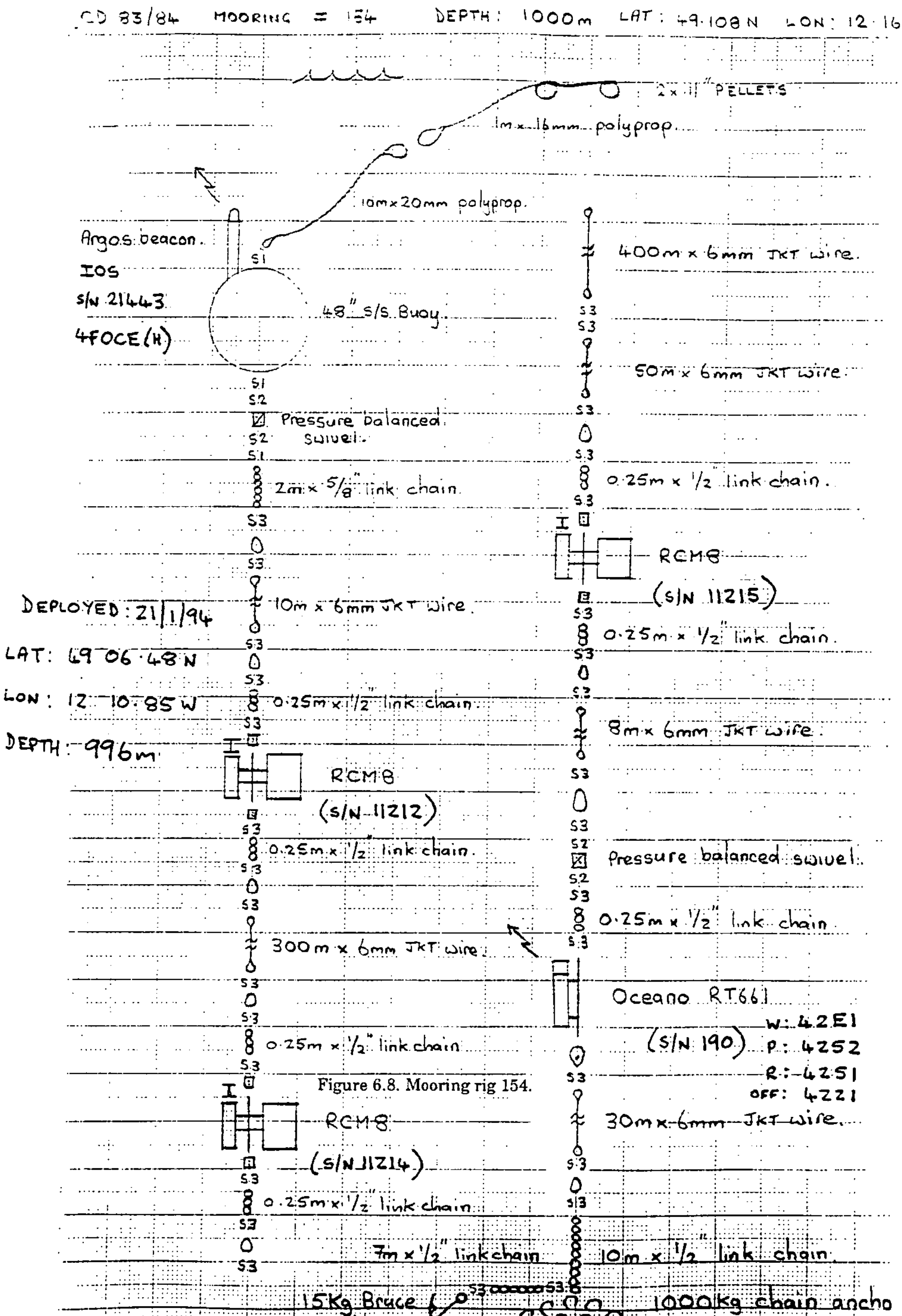


Figure 6.8. Mooring rig 154.

7. EXPENDABLE BATHYTHERMOGRAPHS

A total of 315 expendable bathythermographs (XBTs) were used extensively throughout the cruise to determine water column temperature profiles and to locate features of interest such as fronts and eddies. They were used more intensively to map the three dimensional structure of Mediterranean water eddies in combination with CTD stations and seasoar tows. A listing of the stations is given in Scientific appendix 15.1 XBT list.

Of the 315 XBTs used, most were of type T5 with a maximum design depth of 2000m, but also some of the shallower T7's were deployed. The controlling and recording system and many of the XBTs were provided by the MOD Hydrographic Office. The system used was the Sippican SA810 launcher and Bathy Systems 'SEAS' software. This included the facility to provide immediate temperature depth profile plots, with expanded plots of areas of interest, and listings of isotherm depths. Also included was a facility for transmitting the data in near real time via the GOES satellite system but for the duration of the cruise the transmitter was not working.

There is no direct connection to the ship computer network so the data was transferred by disk and converted to RVS data files. The actual time of launch and thus the true position and water depth were entered into the data files as the original data headers were recorded some minutes before launch. Top and bottom data transients and other erroneous values were flagged using the graphical editor programme. One feature of concern was the presence on all traces of large unreal displacement to low temperatures on entering the water, followed by an apparent exponential recovery to reasonable values in the top 100m or so of the surface mixed layer. The reason for this is unknown but the data acquisition hardware is suspected as on a previous cruise a different data acquisition system did not suffer the same defect. Another annoying feature of the software was the maximum depth of 1833m allowed for T5 probes, thus losing 10% of the depth capability.

The XBT data collected during surveys of eddies were combined with CTD data to produce contour maps of the depth of isotherm surfaces. The RVS data files were also converted to PSTAR data files both with and without the corrections. Temperature depth profile plots were produced.

Of the ten complete failures, most were due to the XBT wire being blown by following winds back onto the ship and thus shorting the connection. A simple launch tube reaching closer to the water would remedy this and also make the operation safer for the launcher operator on deck.

David Griffiths PML

8. CTD DEPLOYMENTS AND CALIBRATION

During the cruise 51 CTD stations were occupied. Most deployments were to depths of 2000 or 2500m. A listing of the stations is given in the Scientific Appendix 17.2 CTD list. The CTD used was the RVS owned E E & G Mk III model fitted with oxygen, transmission, fluorescence and nephelometer sensors. The in situ sample rate was 8 Hz with the Level A computer averaging the values to 1 per second with removal of outliers. Also generated was the temperature time gradient for use in resolving the time constant difference between temperature and conductivity sensors. The data was also logged and displayed in real time on a PC, but this backup was not required. Some processing and data presentation was done on the RVS data files on the level C, but the data for individual dips was also transferred to the PSTAR data format by the program datapup.

PSTAR data processing roughly followed the procedures from the previous cruise cd66, utilising macros for data calibration, editing and presentation both as listings at standard levels and as a set of profile plots.

The pressure and temperature sensors had calibrations applied from recent calibrations done at RVS. Pressure drift was checked throughout the cruise by reading the calibrated pressure when the CTD was at the surface, with sensors at 1.5m depth. Values of 0.5 to 2.9db were well within specification. The program ctdcal applied corrections to pressure for temperature and pressure hysteresis effects. Temperature is believed stable and reliable and no calibration with digital reversing thermometers was made.

Conductivity was initially given the manufacturers calibration, and the program ctdcal applied a correction for the effects of both pressure and temperature on the conductivity sensor. On most CTD dips, during up casts, salinity bottle samples were taken. The difference between calculated and bottle salinity is shown in Figure 8.1. As a result, final CTD calibration for salinity had the correction +0.078psu. No drift with time, or dependence on salinity or on pressure was discernible.

Oxygen was determined from bottle samples by the Winkler method as shown in Figure 8.2. The resulting final calibration was : oxygen(cal) = 0.076 + 1.146 * oxygen(CTD) ml/l.

Transmission, Fluorescence and Nephelometer were left converted from raw CTD counts to volts.

David Griffiths	PML
Simon Watts	RVS

9. ACOUSTIC DOPPLER CURRENT PROFILER

The ship-mounted ADCP was set to ping continuously throughout the cruise, and data entering RVS level C were 2.5 minute ensemble averages. For most of the cruise the water depth was greater than the maximum for bottom tracking, the exceptions being a period of about 18 hours on Great Meteor tablemount during days 358 - 359, about 2 hours on the Portuguese Shelf on day 009 and from day 012 until the end of the cruise. Apart from these exceptions, it was necessary to rely on GPS in order to establish the ship velocity relative to the ground, to enable water velocities relative to the ground to be calculated.

Calibration of the ADCP was carried out according to the zigzag method of Pollard and Read (1989), despite some doubts expressed as to its validity. The necessity for calibration was noted early on in the cruise, with the raw ADCP data recording substantial N-S velocities even along zonal sections. The zigzag calibration was conducted on day 348, and consisted of 8 legs, at bearings of 225 and 315 degrees alternately. The duration of each leg was 25 minutes, with 5 minutes allowed for the bridge to make the ship steady on course before each leg. The calibration was performed at a ship speed of 11 knots.

After editing out bad data cycles PSTAR software was used to calculate the amplitude correction factor A and offset angle ϕ. The resulting values were found to be A = 1.004 and ϕ = 4.198 degrees. These were compared with values of A = 1.012 and ϕ = 4.78 degrees obtained for cruise CD66. It was noted that other researchers working on RRS Charles Darwin had obtained values of order A = 1.003 and ϕ = .5 degrees. It was found necessary to reduce the value of A to 0.995 in order to remove spurious along-track velocities that were still present even after calibration, possibly due to ship set-up in the water or variations in ship steaming speed. The values A = 0.995, ϕ = 4.198 were used for the rest of the cruise. These values for the calibration resulted in satisfactory absolute velocities.

GPS navigation data was logged approximately every 3 seconds throughout the cruise. In order to obtain ship speeds for calculation of absolute velocities a running mean of 2.5 minutes was applied to the GPS data.

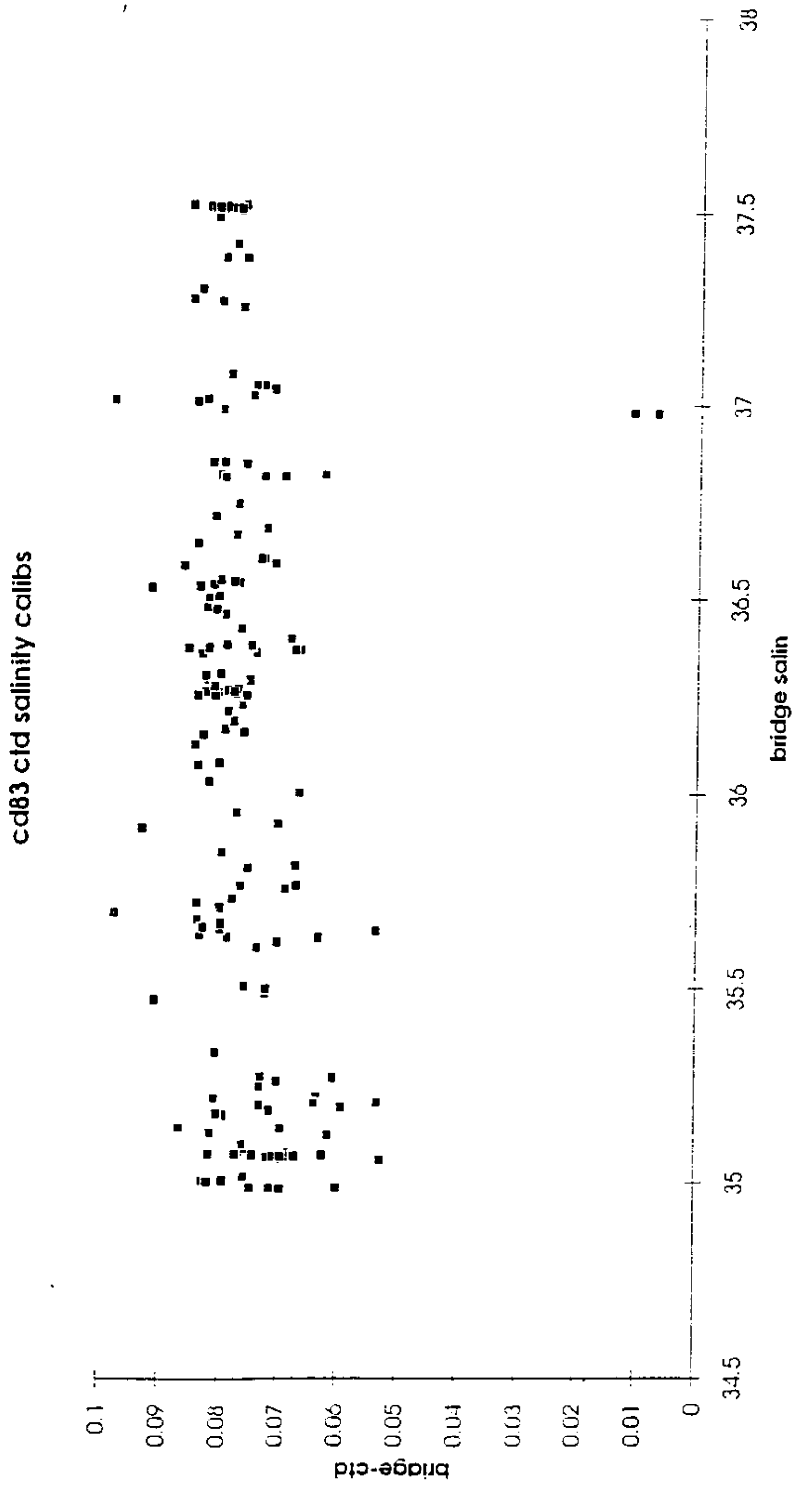


Figure 8.1. Salinity calibration.

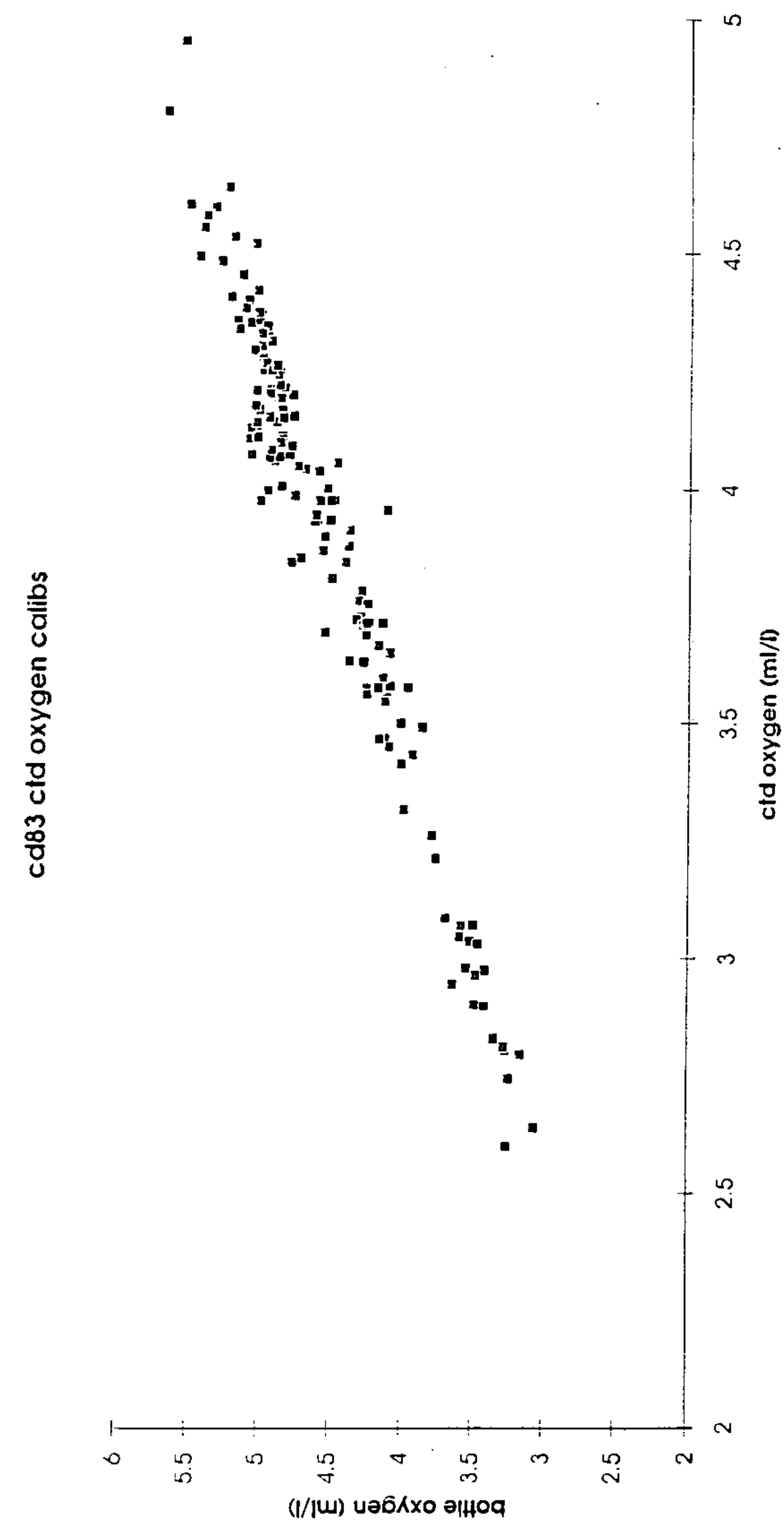


Figure 8.2. Oxygen calibration.

The ADCP data was averaged to 12.5 minute intervals and then merged with the GPS data. Analysis of the data obtained while in bottom tracking mode will provide an independent check on the accuracy of GPS-derived velocities. This has not yet been attempted.

The PC running the ADCP was observed to have a constant clock drift of approximately two minutes per day with respect to the RVS master clock. Accordingly the ADCP clock was reset every day and a correction applied to the time values of the data between clock resets.

Following an emergency power shutdown, the master clock used to reset the ADCP PC clock lost approximately two minutes with respect to GMT. This was not observed until five days had elapsed, therefore the data for that period is currently assigned the wrong time. This should be corrected in the near future.

ADCP data was processed continuously throughout the cruise, the routine output being 12-hour contour plots with time and depth of the output variables, evelrel, nvelrel, good, ampl, velerr, velvert, specwid and the two derived variables eabscal and nabscal. In addition, vector diagrams of the average velocities over bins 12-25 (~100-200m) were produced every day. As an indication of data quality, the variable %good was found to be typically > 50% for depths < 250m.

Bablu Sinha PML

10. SEASOAR DEPLOYMENT AND CALIBRATION

The seasoar was prepared at IOSDL and shipped to Las Palmas and installed by IOSDL. It was deployed for a period of 30 hours on days 354-355. Initially a problem with the data logging software resulted in very poor data quality for the seasoar down dips. This data was subsequently recovered by the RVS computer specialist on board.

Raw data was calibrated using calibration values supplied by RVS. These were a linear calibration of the pressure and a quadratic calibration of the temperature, the coefficients coming from a pre-cruise calibration by RVS personnel. Nominal calibrations converting raw counts to volts were used for the transmission, fluorescence and irradiance sensors.

Oxygen was calibrated according to the equation in the RVS manual used for the CTD stations. The temperature sensor was considered reliable and no further check was made on its calibration. There were two independent conductivity sensors on the ctd providing slightly different values. The salinity values were checked against underway measurements at the surface from the thermosalinograph. Sensor 1 was found to be high by .28 psu whilst sensor 2 was found to be low by .04 psu. The thermosalinograph reading itself was checked against CTD bottle samples at 5m and found to be reading low by .01 psu. These offsets were applied to the calibrated data at the end of the cruise. It was not possible to check the oxygen calibration as no underway measurements of surface oxygen were recorded.

Processed seasoar data was displayed as contour plots with time and depth of the variables temperature, salinity, fluorescence, transmission and oxygen respectively.

Bablu Sinha PML
Darrell Phillips RVS

11. Self Contained Acoustic Doppler Current Profiler (SCADCP)

The LADCP technique is a relatively new way of using ADCPs. It consists in using a self-contained ADCP and in lowering it in a way similar to a CTD (hence the acronym "LADCP" , for Lowered ADCP) to measure horizontal velocity profiles through the water column. This data is not available from ship mounted ADCPs, owing to their limited range.

11.1 Equipment and preparation:

The ADCP used during the cruise was the serial number 587 from RD Instruments. It is a Narrow-Band 153 kHz . For the duration of the cruise, it was fitted with CTD sensors:

- a conductivity sensor SBE 4 from SeaBird.
- a thermometer SBE 3/F from SeaBird.
- a Pressure transducer 8B7000-1 from Paroscientific.

This equipment belongs to the Centre Militaire d'Oceanographie (CMO) (EPSHOM/Brest). It is fitted with a high pressure case (pressures up to 6000db, allowing full depth casts). A special frame was designed by Jean-Pierre Girardot from LPO/UBO. It consists of a stainless steel cage where the ADCP and the CTD Sensors are installed. A vane is attached to the frame and the whole equipment is fixed to a cable and winch through a swivel and a shackle. The ADCP was fitted with Lithium batteries, obtained from RDI (1 V1, 1 V1/V2, 1 V4). The installation of the ADCP and sensors in the frame was easy, using the "rail" designed by JP Girardot. Except for early signs of corrosion, this frame behaved well.

11.2 Deployment:

A typical deployment of the L-ADCP consists of three steps:

a) Setup :

The ADCP is set up using the PC based software provided by RDI , named "SCADCP". There are two substeps:

- The "deployment planning", where the different parameters are tuned to the purposes of the user An example of such a configuration is given in the Appendix I. It must take into account different requirements, like the power and EPROM memory available, the resolution, the range, the standard deviation etc. For a full account of the settings, refer to the RDI manuals.

- Prior to deployment, this setup was downloaded from a portable PC to the ADCP, via a specific cable and connection box. This deployment sequence takes a few minutes. Then the connections are secured and lowering can proceed. One does not need to unload the ADCP from the the frame for the setup operations.

b) Deployment:

For a typical deployment, the ADCP frame was attached to the CTD cable and then lowered in a fashion very similar to the CTD itself. Due to the light weight of the ensemble, the speed of descent had to be slow (20 m/min) during the first hundreds of meters. Then the speed was 60 m/min. The speed of ascent was 60 m/min.

c) Extraction of data:

At the end of the deployment, the PC was again connected to the ADCP (still on frame) and the data downloaded from the ADCP to the PC disk, by use of "SCADCP". The whole procedure takes a few minutes at a transfer rate of 19200 bauds.

11.3 Processing

For processing the data, we used two sets of programs:

a) CODAS3 for LADCP:

This is a software package developed by E.Firing from the University of Hawaii, specifically for the LADCP. This needed the special package PERL that we did not have onboard. It was transfered from the RVS base in Barry (Andy Lord), after some trials by mail and with attached files by Marc Boeuf (CMO).

This package was successfully installed on a SparcBook1. CODAS3 also needs the commercial package MATLAB. Version 4.1 of this package was installed on the SparcBook1. We setup the CODAS3 package for our cruise, without great difficulties. LADCP dip CD01 (see Table 11.1) was processed this way. We were then on our way to the processing of the following dips. But on day 357 (23/12/93), Drive 1 of the SparcBook1, containing the MATLAB package and the data failed. A call to a Tadpole technician in France confirmed that it was a major failure.

b) CD83 processing:

We then proceeded to rewrite our own package. This involved :

A) the use of the RDI program LOGADCP to convert Binary data to ASCII files.
B) the writing of a Fortran program for:

i) reading and screening the data
ii) converting to profiles of velocities (horizontal, vertical and error), amplitudes of back scattered signals, percentage good, temperature and conductivity. The corrections due to speed of sound and navigation were not implemented during this cruise.

11.4 Descriptions of the dips

A total of 23 dips were prepared. One failed because of a leaky connector. They were concentred in two major areas:

- Near (25N,33W) a for study of a surface feature.

- Near the coast of Portugal, for the study of the flow near Cape St Vincent and near Lisbon Canyon.

Two tests were also conducted South of the Canary Islands. A description of all the dips is in Table 11.1

11.5 Early results

Appended are two figures (Figures 11.1a and b) resulting from the processing of CD01, done using CODAS3. They show the raw data (horizontal and vertical velocities for up and down casts, number of samples and shear standard deviation). The site of the dip was between Grand Canary and Tenerife. The data shows a surface current to the SW (about 20 cm/s). The up and down casts compare well.

11.6 Typical configurations of LADCP

Two basic configurations were used:

1) "deep ocean"

When the water depth exceeded the depth of the cast by more than 500m, the bottom tracking possibility was switched off.

2) "shallow ocean"

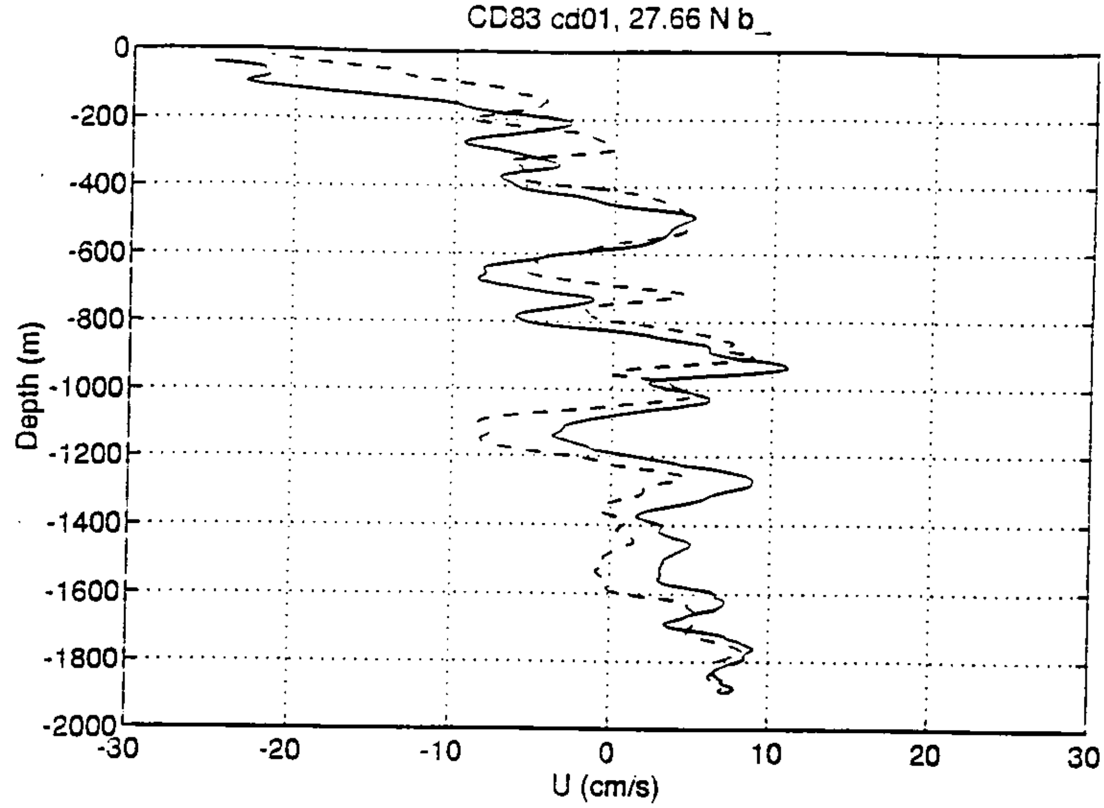
For these purposes, we decided to use the bottom tracking mode. This can track the bottom at approximately 400m.

TABLE 11.1 DESCRIPTION SHEET OF L-ADCP DIPS

Name	CTD dip	Latitude N		Longitude W		depth m	Date	Start dip
CD01	CTD001	27	39.5	16	30.4	3500	13/12/93	2150
CD02	CTD002	26	7.1	16	7.1	3500	14/12/93	1040
CD03	CTD013	25	21.8	33	0.3	6000	21/12/93	1155
CD04	CTD015	25	23	33	10.3	5700	21/12/93	2007
CD05	CTD016	25	23	33	17.3	5600	21/12/93	2228
CD06	CTD017	25	23	33	24.3	5400	22/12/93	446
CD07	CTD018	25	23	33	31.3	5400	22/12/93	706
CD08	CTD019	25	23	33	38.3	5300	22/12/93	1240
CD09	CTD035	36	44	8	52	680	1/1/94	2352
CD10	CTD036	36	45.9	9	13.8	810	2/1/94	523
CD11	failed							
CD12	CTD038	36	50	9	20	900	2/1/94	845
CD13	CTD039	36	38	9	23	2000	2/1/94	1852
CD14		36	32	9	28	3000	2/1/94	2149
CD15		36	42	9	18	1500	3/1/94	140
CD16	CTD040	36	55	9	30	3000	3/1/94	607
CD17	CTD041	37	25	9	25	1000	3/1/94	1853
CD18	CTD042	37	22	10	0	3700	3/1/94	2311
CD19	CTD044	38	26	9	58	4200	8/1/94	53
CD20	CTD045	38	20.5	10	5	4400	8/1/94	549
CD21	CTD046	38	16	10	13	4500	8/1/94	830
CD22	CTD047	38	10.3	10	30	4800	8/1/94	1544
CD23	CTD048	38	23	9	43	2000	9/1/94	316

Bernard LeCann UBO

(a)



(b)

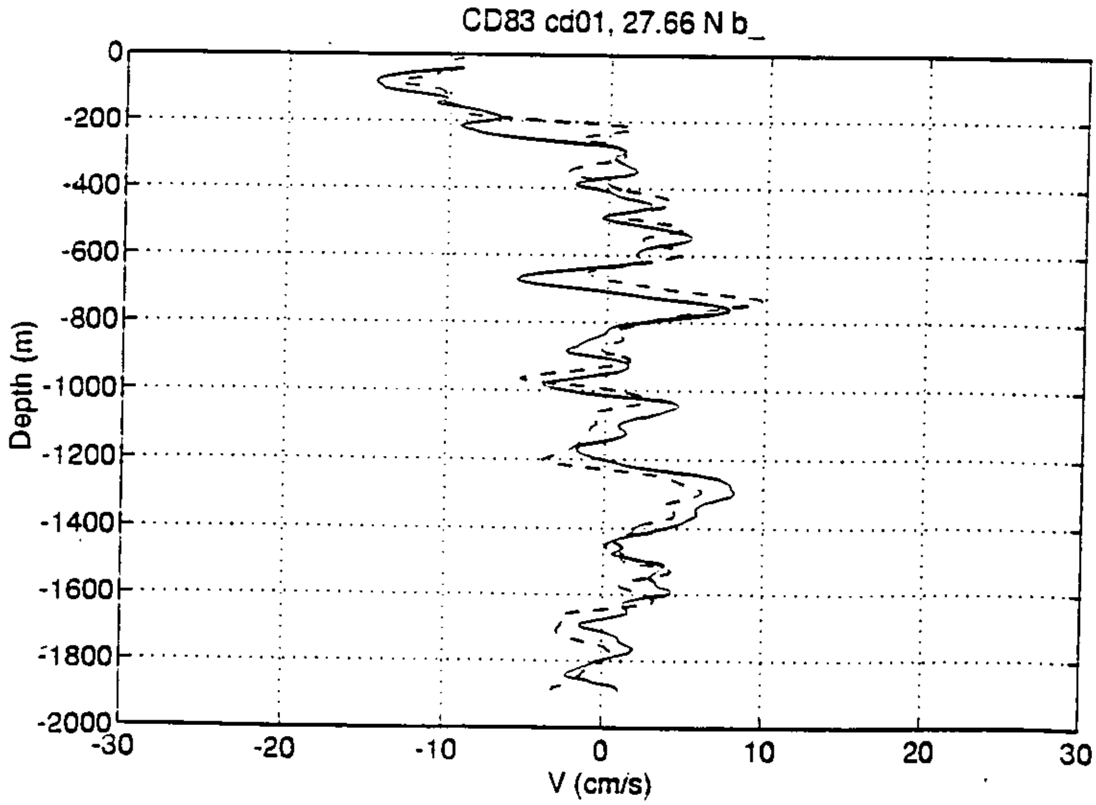


Figure 11.1. CD01: Profiles of eastward(a) and northward(b) velocities.

12. UNDULATING OCEANOGRAPHIC RECORDER

The undulating oceanographic recorder (UOR) is a self-contained, oceanographic sampler for mapping the biophysical marine environment (Aiken, 1985). It can be towed by ships to up to 13.5m/s and can record measurements for temperature, pressure, conductivity, chlorophyll, transmission and ocean colour.

Ocean colour is monitored using six pairs of light sensors, which measure down welling and up welling irradiance within the visible part of the spectrum at 412, 443(blue), 490(blue/green), 520, 555(green), 632(red) nm. Also included on the UOR is an up welling radiance sensor at 683nm, and a PAR sensor (Photo synthetically Active Radiation). The ratio of up welling to down welling is a measure of the reflective properties of the water, field measurements of which are important for the interpretation of satellite ocean colour maps.

The undulations of the UOR are controlled by a servo control system, which can be pre-set to obtain the desired undulation profile. The specifications for the Darwin 83 Cruise are summarised below in Table 12.1..

TABLE 12.1 UOR OPERATING PARAMETERS

Sensor Cylinder	Number JA2 Battery Powered
Logger Cylinder	Number JA3 Battery Powered
Sampling Rate	4 Seconds
Max. Sampling Time	16 Hrs
Tow Speed	11 knots
Tow Cable Diam	8mm
Cable Length (fully deployed)	325m
Depth Achieved	75m

For each deployment a speed of 4 knots was required, with the cable being paid out with the double barrel capstan winch, through a sheave block mounted on the after crane. Once at full speed, the load on the cable was monitored by a strain gauge to ensure that it didn't persistently exceed its maximum of 750kg. After each tow the software was available to download the data, calibrate and plot the results. Details of each tow are shown below in Scientific appendix 16.6

A total of seven tows were made during the cruise as well as two calibration profiles with the CTD. The first five were performed during the early stages of the cruises we steamed due west. The last two tows were an attempt to obtain a profile across the sub-tropical front at approximately 35 N. This was not fully completed because XBT drops were failing when the wire came into contact with the UOR tow cable. This was hindering our search for eddies and the UOR was brought back on board.

After tow 7 the UOR cable was taken off the winch to prepare for the mooring deployments. If weather had permitted, it was hoped that further tows could have taken place along the continental margins as we steamed due north towards the Bay of Biscay. Unfortunately we could not take advantage of any further steaming time.

In addition to the UOR, a vertical profiling rig was deployed on one occasion to compare the light sensors of the UOR to those of a newly purchased Profiling Reflectance Radiometer (PRR-600). The PRR-600 gives instantaneous profiles of down welling irradiance and up welling radiance. Table 12.2 outlines sensors on each instrument.

TABLE 12.2 UOR SENSORS

SENSOR	UOR Profiler	PRR-600
Ed412	*	*
Eu412	*	
Lu412	*	*
Ed443	*	*
Eu443	*	
Lu443	*	*
Ed490	*	*
Lu490	*	*
Ed510	*	*
Lu510	*	*
Ed555	*	*
Eu555	*	
Lu555	*	*
Ed632	*	
Ed665		*
Lu665		*
TEMP	*	*
DEPTH	*	*
SAL	*	
CHLOR	*	

One further profile was obtained for the UOR sensor cylinder to calibrate temperature, depth, salinity and chlorophyll, as shown in table 12.3.

TABLE 12.3 UOR CALIBRATION DIPS

PROFILE NO.	DATE	G.M.T	EVENT	LAT. (north)	LONG. (west)	DEPTH (m)	COMMENT	CALIBRATION FILE SAMPLING TIME
CD1293P1	14.12.93	12:36 12:56	IN OUT	26 06.17	16 29.91	100	Sunny, with PRR-600, from after-crane	CD9354M2.COE 1 sec
CD1293P2	26.12.93	2:57 3:20	IN OUT	30 48.86	26 27.85	200	No light sensors Calibration profile on CTD026	CD9354M2.COE 1 sec

Paul Chatwin UOP

13. DMS AND DMSP ANALYSIS

13.1 Introduction.

Over oceanic areas, atmospheric oxidation products of dimethylsulfide (DMS) play a major role in the formation of cloud condensation nuclei (CCN), whose number concentration affect the size distribution of droplets in stratiform clouds, and thus the cloud layer albedo. The concentration of DMS in seawater is the result of complex processes of production from dimethylsulfonio-propionate (DMSP) synthesized in phytoplankton cells and removal by bacteria consumption, chemical oxidation in seawater, and emission at the ocean-atmosphere interface.

During Charles Darwin cruise 83, DMS and DMSP have been analysed in seawater samples collected from Niskin bottles attached to the CTD during stations and from the non-toxic supply of the ship along two transits to study the infuence of physical, chemical and biological parameters on organosulfur compounds production.

13.2 Experimental procedure.

a- Samples.

Samples of about 300 ml of seawater were divided into 2 aliquots of 250 ml and 60 ml for analysis of DMS and DMSP respectively.

9 samples were collected and analysed for DMS and DMSP during the crossing of the subtropical front on 29/12/93 from 11:30 to 20:30 (Table 13.1).

17 samples (i.e. one every 6 hours) were collected along the track of the ship steaming back to Barry from the station 51 (38.03N - 9.54W) and analysed for DMS and DMSP (Table 13.2).

156 samples were collected from 32 of the 51 CTDs performed during the cruise and analysed for DMS and DMSP. No samples were collected during some CTDs when they were too close to the previous ones to allow the necessary immediate analysis of DMS, or when no bottle was filled in the surface layer of the ocean (0-200m).

TABLE 13.1: SAMPLES ANALYZED CROSSING THE SUBTROPICAL FRONT (29/12)

Time	Latitude	Longitude	
11:30	37 10.4	16 02.6	17.48
12:50	37 13.7	15 56.2	17.52
14:30	37 27.3	15 22.3	17.00
15:30	37 32.5	15 09.0	16.64
16:30	37 37.7	14 55.6	16.65
17:30	37 42.4	14 44.2	16.79
18:30	37 47.9	14 31.4	16.57
19:35	37 52.5	14 18.5	16.57
20:30	37 58.1	14 04.6	15.85

g:\ctdplot\ctdat
win2wrs.exe
Producing plots
using a custom
written macro under
Lotus 1-2-3

TABLE 13.2 SAMPLES ANALYSED DURING THE TRANSIT CTD 51 - LANDS END.

Date	Time	Latitude	Longitude	Depth	
09/01	09:30	38 02.6	09 53.7	3111	15.7
	16:00	39 02.2	10 04.7	221	14.8
	19:00	39 34.0	10 01.0	2150	14.6
	23:30	40 04.0	09 33.6	166	14.6
10/01	04:00	40 32.5	09 33.0	1600	14.5
	12:00	40 46.1	09 57.9	3500	14.5
	18:00	41 06.4	10 22.2	4120	14.3
11/01	00:00	41 57.3	10 35.2	2850	14.3
	06:00	43 01.7	10 01.2	3097	13.1
	12:00	44 06.5	09 33.4	4884	12.7
	18:00	45 11.9	09 02.1	4856	12.2
12/01	00:00	46 15.0	08 31.0	4777	11.8
	06:00	47 23.9	07 57.6	3474	11.8
	08:50	47 52.1	07 43.9	580	11.6
	12:00	48 19.4	07 29.8	153	11.2
	18:00	49 26.4	06 56.6	120	10.3
13/01	00:00	50 21.1	05 59.4	77	9.7

b- Analysis.

In the samples, DMS can be produced by cleavage of DMSP and destroyed by various oxidation processes. The analysis of DMS must therefore be performed as soon as possible after sampling, which forbids storage of samples.

DMS was extract of seawater samples collected from the CTDs by a helium flow of 60 ml/min for 1 hr. Tests performed aboard have demonstrated the yield of this extraction to be 79+/-4%. These conditions were adopted as the best compromise to allow the analysis of numerous samples with reasonable precision.

For analysis of samples collected during the transect to Barry, extraction was extended to 2 hours to ensure a total recovery of DMS.

DMS extracted from seawater was cryogenically trapped at -90C in a Teflon 1/8 ' U-tube filled with Tenax GC. It was then desorbed at +95C and separated from CO2 and COS into the Chromosil 310 packed column of a gas chromatograph Varian 3400. Quantitative detection was achieved by a double flame photometric detector operating in sulfur mode. During this cruise, the roll of the ship made the baseline quite noisy leading to a detection limit not better than 4 to 6 ng DMS and a precision of about 10%.

DMSP was converted to DMS by addition of 1 ml of NaOH 10M for 60 ml of seawater. The samples have to be stored for at least 12 hours in the dark for to reaction to be complete. DMSP is then analysed like DMS (1/2 hr extraction). This analysis gives the concentration of DMS + DMSP.

c- Calibration.

The complete analytical method (trapping + detection) was accurately calibrated every 3 to 4 days by 2 different means: injection of known masses of DMS in the cryogenic trap using a permeation device (previously calibrated in CFR laboratory in France) and analysis of DMS standard solution in the same way as seawater samples. These various calibrations shew no significant drift in the sensitivity (<3%) of the analytical method. Both permeation device and standard DMS solution will be calibrated again at CFR at the end of the cruise. The preliminary results presented in this report cannot therefore be considered as definitive.

13.3 Preliminary results.

a- Surface concentrations (4 to 5 m).

DMS concentration in surface seawater was generally around 1 nmol/l, which is typically the DMS concentration observed in wintertime in the open ocean of subtropical regions. No significant variation was observed crossing the subtropical front. On the contrary, a decrease of a factor of 2-3 in DMS concentrations was observed between 38 N and 50N.

The only significant increase in DMS surface concentration was observed close to Gorringe Ridge (CTD 34). The few results obtained around the continental margin (CTDs 35, 36, 38, 40) do not show any significant difference with the open ocean.

DMSP concentrations were generally around 9 times higher than DMS concentration south of 30N. This ratio increased gradually to reach a factor of 20 north of the subtropical front. The highest DMSP concentration was observed at station 34. High DMSP surface concentration were also observed at stations 35 and 40, around the continental shelf. DMSP surface concentrations decreased by a factor of about 4 between 38N and 50N.

b- Profiles (5-200m)

Generally, the profiles obtained during this cruise show quite constant DMS and DMSP concentrations above the thermocline, and a sharp decrease of both concentrations below the thermocline to below the detection limit. A gradual decrease of DMS and DMSP concentration to the thermoclyne was observed at station 34 only. The profiles obtained in the margin areas do not present significant differences compared to the profiles obtained in the open ocean at the same latitude.

13.4 Conclusion.

The goal of this study in the framework of the EC program OMEX (Ocean Margin Exchange) was to investigate the role of continental margins in DMS production. Unfortunately, few stations around margins have been performed because of the rough weather prevailing north of 40N during the period of the cruise. The few preliminary results obtained over margins seems nevertheless to indicate no exceptional production of organosulfur compounds in these areas during wintertime. Additional conclusions should be drawn from the comparison of these results with the physical, chemical and biological characteristic of the water masses sampled during this cruise.

Jean-Philippe Putaud CNRS-CEA

14. PHYTOPLANKTON SAMPLING

66 samples of net phytoplankton were taken during the cruise (see Scientific appendix 17.3). The samples were taken by tows, made as vertical as possible, by hand from the stern of the ship, using nets of 20 cm diameter at the mouth and a length of 120 cm with a mesh size of 10μm. As these nets are not appropiate for use on as big a ship as RRS Charles Darwin during bad weather, samples were also taken by filtering water from the continuous non toxic water supply in the wet lab, using small nets of 10 cm of diameter in the mouth and 50 cm long.

As the surface waters were very mixed, and no difference was observed between samples obtained by both methods of sampling, most of the samples have been collected from the non toxic water supply. From each sample, one subsample was fixed immediately with HMTA buffered formalin, and the other observed immediately with a ZEISS inverted microscope at different magnifications ranging from 25x to 400x for proper identification of unarmoured flagellates that can be distorted by fixatives.

Phytoplankton (Quantitative)

Duplicated water samples have taken at discrete depths or from the non toxic seawater supply, and fixed with neutralized formaldehyde and Lugol's solution for after cruise identification and counting (see Table 16.1).

Phytoplankton (Semi-quantitative)

To get an estimate of the concentrations of large rare species, volumes around 1 litre were filtered through membrane filters of 5μm pore size and fixed with a few ml of seawater from the same sample with HMTA buffered formalin 3 (see Scientific appendix 17.4).

Microplankton (Semi-quantitative)

In order to evaluate the relative importance of small heterotrophs, water samples of several litres have been filtered through 2.5 cm diameter discs made of Nytal net of 30μm mesh size, and fixed with few ml of seawater from the same sample with HMTA buffered formalin (see Scientific appendix 17.5).

14.1 Preliminary Results

Around 270 different taxons have been differentiated in the living samples on water mount observed during the cruise. In a sample taken between CTD06 and CTD07, the dinoflagellate *Gymnodinium breve* was observed. This species is common in waters of the Gulf of Mexico where it forms toxic blooms in Florida. In European waters it has only been observed sporadically in the west coast of the Iberian Peninsula. Another interesting species observed is *Gymnodinium catenatum*. This toxic species was observed in the samples taken between the Setubal canyon and Galicia. Coastal blooms of this species have been associated with intrusions of offshore warm water into the coast at the end of the upwelling season in the autumn.

Santiago Fraga IEO

15. BIOLOGY

The biological sampling was carried out in five areas, the sampling procedure changing from one to another.

At working area A, 4 CTD profiles (CTD #s 8, 9, 13 & 20) were sampled. Samples were taken from 4 - 5 depths, covering the euphotic zone, for size-fractionated chlorophyll (2µm & 0.45µm), total particulate carbon and nitrogen (PCN), bacteria and cyanobacteria (acridine orange stained), phytoplankton and microzooplankton (30µm) countings, microzooplankton (30µm) PCN, and size-fractionated (2µm & GF/F) primary production (C-14).

In addition, water samples from a weak chlorophyll maximum (ca 100m) were taken at CTDs nos. 9 & 13 in order to determine the phytoplankton physiological state and growth capacity. Samples were inoculated with C-14 and incubated (surface water refrigeration) at their light of origin and two increased lights (2, 10 & 40 % surface irradiance) for 12 and 24 hours, before being filtered onto GF/F. The filter's content will be fractionated into the main final products of the photosynthetic metabolism (carbohydrates, proteins, lipids and low molecular weight metabolites).

At the Great Meteor Seamount area 4 CTD stations were done on the plateau, the slope and away from the seamount. Samples were taken from 6 depths in the euphotic zone for size-fractionated chlorophyll, total PCN, bacteria and cyanobacteria, phytoplankton and microzooplankton countings, and size fractionated primary production.

The sampling at the subtropical front consisted in two CTD profiles (nos.31 & 32) at the southern zone and one CTD (no. 33) at the northern zone connected through a surface transect. Surface water samples were taken from the non toxic water supply at different intervals depending on the surface temperature gradient. Both at the surface and CTD stations (6 - 4 depths in the euphotic zone) water samples were taken for size-fractionated chlorophyll, total PCN, bacteria and cyanobacteria, phytoplankton and microzooplankton countings. Size fractionated primary production samples were only taken at CTDs 31 and 33 and at selected points in the surface transect.

At the Cape St. Vincent area water samples from both the upper and lower core of Mediterranean water outflow (at ca 600 m and 1100 m, at CTD stations nos. 35, 36, 38, 39 &40) were taken for total PCN, bacteria and cyanobacteria countings and biochemical composition of particulate matter (carbohydrates, proteins and lipids). In addition, two experiments for the measurement of community respiration rate were performed at each core. Ten 125 ml glass bottles were filled with seawater. Four bottles were immediately fixed for dissolved oxygen titration (Winkler procedure); the other six were kept in darkness in the deck incubator for 24 h, when they were fixed and titrated. Bacteria samples were taken as well at CTDs nos. 44, 45 and 46.

At the poleward flow area a surface transect (NTWS) was conducted. The slope was cut several times, the sampling being concentrated in those cuts. Samples were taken for size-fractionated chlorophyll (5µm, 2µm and 0.45µm), total PCN, calcium, bacteria and cyanobacteria, phytoplankton and microzooplankton countings. Primary production experiments couldn't be performed because the weather conditions did not allow the incubator to be kept on deck.

Scientific appendix 17.7 shows a complete list of PCN, biochemical composition, bacteria and primary production samples. For phytoplankton and microzooplankton samples see Section 14. For size-fractionated chlorophyll and mesozooplankton samples see Section 16.

15.2 Dissolved oxygen.

Dissolved oxygen concentration was determined for selected CTDs and depth throughout the cruise in order to calibrate the CTD oxygen sensor. Oxygen concentration was determined by the Winkler procedure with a potentiometric end-point detector (Metrohm 716 DMS). Scientific appendix 17.8 shows a complete list of samples titrated along the cruise.

Pablo Serret UO

16. MEASUREMENT OF SURFACE PROPERTIES

16.1 Instrumentation

During the cruise period continuous online monitoring of surface (4m) properties was carried out for temperature, salinity, chlorophyll fluorescence, transmission and inorganic nutrients (nitrate, silicate and phosphate). Seawater was fed from the Darwin's non-toxic supply with the intake at 4m. Data was logged on either chart recorders, PC's or the ship's level B computer system.

16.2 Temperature and salinity

a) RVS supplied Sea Bird thermosalinograph with sensors mounted in the ship's wet lab with water supplied from the non-toxic seawater supply via a heading/debubbling tank. It was not found possible to log the output to RVS level B, but it was logged to a PC in the main lab and then transferred to the level B by floppy disc. Since this is a standard piece of equipment which is used on most oceanographic cruises, it must be asked why it was impossible to log the data onto the ship's level B system.

b) PML supplied TSD system, deck mounted with output to a chart recorder only.

16.3 Transmission

Transmission measurements were made by two 25cm Seatech transmissometers mounted in deck boxes and fed from the ship's non toxic seawater supply. Cleaning of the transmissometer lenses was routinely carried out every two days.

16.4 Chlorophyll fluorescence

Fluorescence measurements were carried out with two Chelsea Instruments Aquatracka fluorometers mounted in deck boxes. Calibration will be carried out by comparison of the voltage outputs during the cruise with 2 hourly samples taken for discrete chlorophyll analysis by fluorometry.

16.5 Inorganic nutrients

The autoanalyser system used for this cruise was in most aspects identical to the setup used for the Darwin 66/92 cruise. Channels were run for Nitrate and Nitrite, Silicate, and Phosphate. Discrete samples were run for 5 minutes interdispersed with a 1 minute wash giving a 6 minute sampling cycle. Calibration was carried out by running 3 to 4 calibration standards with each run (see Darwin 66 and Discovery 198/92 cruise reports).

Problems were experienced with the colorimeter as sensitivity dropped during the period of the cruise. The analysis of the discrete CTD samples was carried out by careful calibration. As the calibrations were found to be nonlinear the correct regressions for each set of samples will have to be reworked at PML.

Data was logged onto chart recorders only.

16.6 Chemical and biological sampling

a) Underway sampling

Whilst underway more than 400 2-hourly samples were taken for chlorophyll estimates by filtration on either 0.45μm membranes or GF/F microfibre filters. A number of samples were taken for size fractionated chlorophyll with 2μm and 5μm nucleopore filters. Analysis was carried out by extraction into 90% Acetone and measurement of the extracts after > 15 hours on a Turner 112 fluorometer.

In addition, Samples were taken for particulate C, N by filtration of prescreened seawater (200μm) onto GF/F microfibre filters and deep frozen until analysed.

b) Mesozooplankton

At a number of sites double vertical hauls were taken with a WP2-200μm net from 150m to surface at a haul rate of 30m/min. One sample was concentrated and fixed in 4% buffered formaldehyde. The remaining sample was size fractionated using 2000, 10000, 500 and 200μm meshes. Aliquots (usually 50/250) were taken onto GF/F filteres for estimates of Mesozooplankton biomass. The remainder of the sample was filtered off onto sharkskin filters for examination of individual copepods by SAHFOS.

Bob Head PML

17. SCIENTIFIC APPENDICES

17.1 XBT Station Listing

XBT	DATE	TIME	LATITUDE		LONGITUDE		DEPTH m	MAXP db
xbt001	93/12/13	14:42	28	10.68N	16	1.48W	2680	1281
xbt002	93/12/13	14:53	28	8.85N	16	3.03W	2638	1629
xbt003	93/12/13	16:31	27	53.93N	16	15.09W	2754	1832
xbt004	93/12/14	0:48	27	23.73N	16	30.02W	3552	1832
xbt005	93/12/14	2:13	27	8.20N	16	29.92W	3555	1832
xbt006	93/12/14	3:37	26	53.10N	16	29.92W	3580	1832
xbt007	93/12/14	5:05	26	37.26N	16	29.97W	3572	1832
xbt008	93/12/14	6:34	26	21.69N	16	30.00W	3557	1832
xbt009	93/12/14	18:30	26	4.46N	17	13.25W	3527	576
xbt010	93/12/14	18:41	26	4.41N	17	14.62W	3512	1832
xbt011	93/12/14	21:19	26	3.28N	17	46.74W	3522	1832
xbt012	93/12/15	0:12	26	2.05N	18	20.10W	3408	1832
xbt013	93/12/15	3:03	26	0.92N	18	53.32W	3374	1832
xbt014	93/12/15	5:48	25	59.72N	19	26.66W	3768	1832
xbt015	93/12/15	14:18	25	57.32N	20	33.32W	4373	1832
xbt016	93/12/15	17:18	25	56.16N	21	6.67W	4538	1832
xbt017	93/12/15	20:10	25	55.00N	21	40.12W	0	1832
xbt018	93/12/15	22:56	25	53.80N	22	13.25W	4820	1832
xbt019	93/12/16	1:42	25	52.60N	22	46.63W	4913	1832
xbt020	93/12/16	10:24	25	50.27N	23	53.32W	5055	1798
xbt021	93/12/16	13:07	25	49.10N	24	26.85W	5114	1676
xbt022	93/12/16	15:46	25	47.83N	25	0.01W	4876	1723
xbt023	93/12/16	18:22	25	46.66N	25	33.23W	5248	1746
xbt024	93/12/16	21:00	25	45.45N	26	6.79W	2872	233
xbt025	93/12/16	21:04	25	45.43N	26	7.35W	2616	1688
xbt026	93/12/17	4:44	25	43.08N	27	13.24W	0	1832
xbt027	93/12/17	7:30	25	41.87N	27	46.73W	5340	1832
xbt028	93/12/17	10:12	25	40.68N	28	20.04W	4736	1693
xbt029	93/12/17	12:51	25	39.46N	28	53.43W	5562	729
xbt030	93/12/17	12:57	25	39.41N	28	54.29W	5566	1832
xbt031	93/12/17	15:32	25	38.37N	29	26.76W	5325	1832
xbt032	93/12/17	23:59	25	35.96N	30	33.38W	5416	1226
xbt033	93/12/18	0:05	25	35.92N	30	34.30W	5528	1781
xbt034	93/12/18	2:34	25	34.77N	31	6.63W	5256	1832
xbt035	93/12/18	5:12	25	33.56N	31	39.95W	5584	277
xbt036	93/12/18	5:16	25	33.54N	31	40.50W	5468	233
xbt038	93/12/18	5:52	25	33.33N	31	46.92W	5681	256
xbt039	93/12/18	10:07	25	32.36N	32	13.29W	5929	1711
xbt040	93/12/18	11:26	25	31.78N	32	29.95W	5778	1605
xbt041	93/12/18	12:47	25	31.16N	32	46.66W	5732	1676
xbt042	93/12/18	14:09	25	30.62N	33	3.34W	5778	1723
xbt043	93/12/18	14:57	25	30.30N	33	12.25W	5908	1711
xbt044	93/12/18	19:27	25	29.95N	33	25.05W	5864	1735
xbt045	93/12/18	20:33	25	20.04N	33	20.02W	5803	1792
xbt046	93/12/18	21:55	25	10.01N	33	9.99W	5804	1832
xbt047	93/12/18	22:54	25	15.00N	33	4.97W	5614	1832

XBT	DATE	TIME	LATITUDE		LONGITUDE		DEPTH m	MAXP db
xbt048	93/12/18	23:25	25	20.00N	33	5.02W	5009	1832
xbt050	93/12/19	0:30	25	30.01N	33	4.98W	5286	1832
xbt051	93/12/19	0:38	25	30.92N	33	4.94W	5405	1832
xbt052	93/12/19	1:06	25	34.97N	33	4.99W	5694	1832
xbt053	93/12/19	1:38	25	39.96N	33	4.99W	5799	1832
xbt054	93/12/19	2:13	25	45.01N	33	5.01W	5435	1832
xbt055	93/12/19	3:30	25	34.96N	32	58.93W	5482	763
xbt056	93/12/19	4:05	25	29.95N	32	56.10W	5626	763
xbt057	93/12/19	4:41	25	25.05N	32	53.02W	5468	763
xbt058	93/12/19	5:25	25	19.99N	32	49.94W	5937	763
xbt059	93/12/19	5:53	25	19.98N	32	55.04W	5957	763
xbt060	93/12/19	6:20	25	19.99N	33	0.06W	5846	763
xbt062	93/12/19	17:08	25	17.51N	33	12.03W	5376	763
xbt064	93/12/19	17:39	25	17.35N	33	16.18W	5655	763
xbt065	93/12/19	19:24	25	17.28N	33	20.96W	5690	763
xbt066	93/12/19	19:52	25	17.32N	33	26.14W	5412	763
xbt067	93/12/19	20:20	25	17.32N	33	31.07W	5863	763
xbt068	93/12/19	20:46	25	17.33N	33	35.96W	5484	763
xbt069	93/12/19	21:13	25	17.32N	33	40.99W	5118	763
xbt070	93/12/20	16:02	24	48.37N	33	9.56W	5832	1832
xbt071	93/12/20	17:01	24	55.30N	33	7.96W	5902	1832
xbt072	93/12/20	18:28	25	6.14N	33	7.99W	5823	1832
xbt073	93/12/22	14:33	25	34.89N	33	33.78W	5376	1372
xbt074	93/12/22	15:31	25	45.04N	33	29.99W	5356	1275
xbt075	93/12/22	16:31	25	56.22N	33	32.57W	5558	1238
xbt076	93/12/23	0:31	26	24.43N	33	17.75W	5051	763
xbt077	93/12/23	2:29	26	37.80N	33	0.02W	5058	763
xbt078	93/12/23	4:28	26	51.23N	32	41.98W	5046	763
xbt079	93/12/23	6:26	27	4.60N	32	23.97W	5050	762
xbt080	93/12/23	8:25	27	18.07N	32	5.95W	5188	763
xbt081	93/12/23	17:18	27	44.59N	31	29.23W	5149	763
xbt082	93/12/23	19:31	27	58.31N	31	11.97W	4431	763
xbt083	93/12/23	21:39	28	11.71N	30	53.93W	4928	763
xbt084	93/12/23	23:48	28	25.10N	30	35.91W	4974	763
xbt085	93/12/24	1:55	28	38.46N	30	18.12W	4736	763
xbt086	93/12/24	7:16	29	0.88N	29	46.86W	4434	763
xbt087	93/12/24	8:41	29	9.99N	29	33.81W	4543	763
xbt088	93/12/24	10:06	29	18.78N	29	20.82W	4240	763
xbt089	93/12/24	11:30	29	27.72N	29	7.73W	3704	763
xbt090	93/12/24	12:53	29	36.54N	28	54.73W	1680	763
xbt091	93/12/24	16:09	29	47.05N	28	40.67W	1860	763
xbt094	93/12/24	17:27	29	57.47N	28	30.52W	288	362
xbt095	93/12/25	20:12	30	27.19N	27	39.76W	2906	575
xbt096	93/12/25	22:20	30	34.24N	27	15.89W	3434	763
xbt097	93/12/26	0:32	30	41.47N	26	51.44W	0	763
xbt098	93/12/26	7:57	30	55.53N	26	3.66W	5016	1438
xbt099	93/12/26	10:07	31	2.75N	25	39.38W	5096	1329
xbt100	93/12/26	12:11	31	9.75N	25	15.36W	5128	1378
xbt101	93/12/26	18:10	31	20.35N	24	39.39W	5129	1408
xbt102	93/12/26	19:09	31	23.87N	24	27.30W	5232	1348
xbt103	93/12/26	20:13	31	27.67N	24	14.16W	5122	1348
xbt104	93/12/26	21:04	31	30.78N	24	3.67W	5220	1348
xbt105	93/12/26	22:06	31	34.49N	23	51.05W	5172	1384
xbt106	93/12/26	23:04	31	37.91N	23	39.18W	5114	1299

XBT	DATE	TIME	LATITUDE		LONGITUDE		DEPTH m	MAXP db
xbt107	93/12/27	0:03	31	41.49N	23	26.94W	5101	1268
xbt109	93/12/27	5:35	31	47.49N	23	7.52W	5125	1311
xbt110	93/12/27	6:14	31	50.00N	22	59.99W	5016	1348
xbt111	93/12/27	6:53	31	52.46N	22	52.54W	5236	1290
xbt112	93/12/27	7:32	31	55.01N	22	44.92W	4977	1260
xbt113	93/12/27	8:10	31	57.55N	22	37.41W	4968	1281
xbt114	93/12/27	9:56	32	0.08N	22	30.26W	5108	1832
xbt115	93/12/27	12:10	32	10.07N	22	19.94W	4886	1284
xbt116	93/12/27	13:22	32	19.93N	22	10.17W	4878	384
xbt117	93/12/27	13:27	32	20.62N	22	9.51W	4980	381
xbt118	93/12/27	14:37	32	29.91N	22	0.05W	4930	1348
xbt119	93/12/27	15:55	32	39.97N	21	50.03W	4896	1832
xbt120	93/12/27	17:22	32	50.01N	21	39.97W	4926	520
xbt121	93/12/27	17:28	32	50.78N	21	39.15W	4928	222
xbt122	93/12/27	17:44	32	52.85N	21	36.90W	4938	1287
xbt123	93/12/27	18:36	33	0.02N	21	29.98W	3751	1287
xbt124	93/12/27	19:49	33	9.97N	21	20.02W	4988	1250
xbt125	93/12/27	21:02	33	19.97N	21	9.99W	5008	1207
xbt126	93/12/27	22:14	33	30.08N	20	59.90W	4976	1311
xbt127	93/12/27	23:23	33	40.04N	20	49.95W	2912	1305
xbt128	93/12/28	0:30	33	49.93N	20	40.06W	3312	1305
xbt129	93/12/28	1:38	33	59.98N	20	30.03W	4909	1275
xbt130	93/12/28	3:06	34	10.04N	20	19.85W	4871	1832
xbt131	93/12/28	6:03	34	19.99N	20	9.97W	4842	1244
xbt132	93/12/28	7:08	34	29.94N	20	0.01W	3405	1292
xbt133	93/12/28	8:20	34	37.46N	19	45.04W	4875	1262
xbt134	93/12/28	9:39	34	45.00N	19	30.00W	4782	343
xbt136	93/12/28	9:50	34	45.39N	19	29.34W	4556	519
xbt137	93/12/28	9:56	34	45.61N	19	28.92W	4732	537
xbt138	93/12/28	10:10	34	46.58N	19	27.23W	0	1305
xbt139	93/12/28	11:10	34	52.52N	19	14.91W	3958	422
xbt140	93/12/28	11:16	34	53.19N	19	13.73W	3790	1183
xbt141	93/12/28	12:21	34	59.94N	19	0.16W	4800	1145
xbt142	93/12/28	13:33	35	7.47N	18	45.10W	0	1201
xbt143	93/12/28	14:45	35	15.08N	18	30.07W	4454	1096
xbt144	93/12/28	16:02	35	22.98N	18	14.00W	4492	1127
xbt145	93/12/28	17:10	35	30.00N	17	59.97W	4732	714
xbt146	93/12/28	17:18	35	30.96N	17	58.52W	0	1275
xbt147	93/12/29	11:47	37	12.46N	15	59.14W	4074	780
xbt148	93/12/28	18:02	35	36.21N	17	51.80W	4690	611
xbt149	93/12/28	18:10	35	36.85N	17	51.02W	4698	1832
xbt150	93/12/28	19:11	35	32.87N	17	52.08W	4661	1832
xbt151	93/12/28	19:34	35	29.99N	17	52.65W	4662	1832
xbt152	93/12/28	20:04	35	32.41N	17	56.89W	4935	1832
xbt153	93/12/28	20:38	35	36.14N	18	1.66W	4209	1705
xbt154	93/12/28	21:07	35	38.58N	18	4.77W	4806	1832
xbt155	93/12/28	22:49	35	33.42N	18	10.10W	4841	1832
xbt156	93/12/29	0:22	35	41.02N	17	59.73W	4790	1298
xbt157	93/12/29	1:25	35	49.53N	17	48.74W	3372	1238
xbt158	93/12/29	2:26	35	57.78N	17	38.08W	4464	1268
xbt159	93/12/29	3:27	36	5.93N	17	27.50W	3502	1311
xbt160	93/12/29	4:29	36	14.29N	17	16.67W	0	1164
xbt161	93/12/29	5:29	36	22.45N	17	6.08W	3104	1213
xbt162	93/12/29	6:32	36	30.63N	16	55.43W	4688	1402

xbt163	93/12/29	7:34	36	38.66N	16	44.78W	3922	1226
XBT	**DATE**	**TIME**	**LATITUDE**		**LONGITUDE**		**DEPTH** m	**MAXP** db
xbt165	93/12/29	9:37	36	55.20N	16	23.47W	3160	1127
xbt166	93/12/29	10:35	37	3.21N	16	13.13W	0	1195
xbt167	93/12/29	11:46	37	12.34N	15	59.35W	3152	1287
xbt169	93/12/29	13:18	37	20.45N	15	38.71W	4217	1170
xbt170	93/12/29	14:41	37	27.99N	15	20.29W	3964	1139
xbt171	93/12/29	16:11	37	36.00N	14	60.00W	4316	1145
xbt172	93/12/29	17:00	37	40.05N	14	50.05W	4287	1769
xbt173	93/12/29	17:50	37	44.19N	14	40.01W	4052	1468
xbt174	93/12/29	19:20	37	51.96N	14	20.07W	4184	1605
xbt175	93/12/29	22:44	37	59.27N	13	59.58W	4215	1832
xbt176	93/12/30	0:04	37	52.50N	13	44.99W	3948	1213
xbt177	93/12/30	1:19	37	44.97N	13	30.16W	4032	1558
xbt178	93/12/30	2:21	37	34.56N	13	25.58W	4202	1510
xbt179	93/12/30	3:23	37	23.88N	13	21.06W	4174	1516
xbt180	93/12/30	4:23	37	13.46N	13	16.47W	4028	1676
xbt181	93/12/30	5:23	37	3.08N	13	12.03W	4317	1688
xbt182	93/12/30	6:28	36	56.05N	13	0.06W	4758	1540
xbt183	93/12/30	7:32	36	48.98N	12	47.96W	4673	1693
xbt184	93/12/30	8:26	36	47.03N	12	35.91W	4061	1414
xbt185	93/12/30	10:09	36	43.83N	12	22.42W	4078	1832
xbt186	93/12/30	17:48	36	37.48N	12	26.08W	3700	1832
xbt187	93/12/31	2:57	36	19.97N	12	34.73W	3374	1510
xbt188	93/12/31	3:58	36	10.01N	12	41.34W	3926	1534
xbt189	93/12/31	5:05	36	0.00N	12	48.15W	4810	1617
xbt190	93/12/31	6:12	35	59.99N	12	33.08W	4418	1652
xbt191	93/12/31	7:30	36	0.06N	12	17.99W	4383	1581
xbt192	93/12/31	8:26	36	10.00N	12	18.00W	4142	1336
xbt193	93/12/31	9:20	36	19.99N	12	18.03W	3776	1599
xbt194	93/12/31	14:25	36	20.01N	12	10.14W	3054	1432
xbt195	93/12/31	15:35	36	9.83N	11	59.87W	3552	1641
xbt196	93/12/31	16:43	36	0.03N	11	50.00W	4185	1832
xbt197	93/12/31	17:43	36	5.98N	11	40.03W	3745	1670
xbt198	93/12/31	18:38	36	11.97N	11	30.04W	2649	1705
xbt199	93/12/31	19:34	36	18.01N	11	19.99W	3462	1605
xbt200	93/12/31	20:30	36	24.05N	11	9.92W	3560	1593
xbt201	93/12/31	21:22	36	29.87N	11	0.24W	3764	1832
xbt202	93/12/31	22:58	36	14.05N	11	5.94W	4481	1711
xbt203	94/01/01	0:47	36	26.97N	11	20.04W	2369	1329
xbt204	94/01/01	3:49	36	60.00N	11	25.14W	5065	1486
xbt205	94/01/01	5:00	37	7.59N	11	12.39W	4927	1734
xbt206	94/01/01	6:13	37	15.42N	10	59.37W	4914	1763
xbt207	94/01/01	7:10	37	14.97N	10	47.93W	4366	1758
xbt208	94/01/01	8:02	37	15.00N	10	36.03W	3782	1676
xbt209	94/01/01	9:02	37	4.83N	10	31.80W	2964	1664
xbt210	94/01/01	10:20	36	49.90N	10	32.11W	3244	1610
xbt211	94/01/01	11:32	36	35.95N	10	32.02W	3753	1516
xbt212	94/01/01	12:46	36	38.92N	10	16.00W	3872	1486
xbt213	94/01/01	13:54	36	41.97N	10	0.10W	2928	1492
xbt214	94/01/01	15:05	36	44.99N	9	43.95W	3478	1564
xbt215	94/01/01	15:42	36	46.47N	9	35.70W	2416	1456
xbt217	94/01/01	20:47	36	46.98N	9	13.22W	705	763
xbt218	94/01/01	21:22	36	45.58N	9	4.93W	510	484
xbt219	94/01/02	1:37	36	42.05N	8	55.99W	715	763

xbt220	94/01/02	2:00	36	40.28N	8	59.45W	746	763
XBT	**DATE**	**TIME**	**LATITUDE**		**LONGITUDE**		**DEPTH** m	**MAXP** db
xbt222	94/01/02	2:54	36	39.99N	9	9.37W	1198	1311
xbt223	94/01/02	10:33	36	54.91N	9	15.08W	704	763
xbt224	94/01/02	11:27	37	1.16N	9	11.87W	1044	763
xbt225	94/01/02	12:04	37	5.50N	9	9.56W	882	908
xbt226	94/01/02	12:59	37	4.96N	9	19.98W	1444	1487
xbt227	94/01/02	13:47	37	5.00N	9	30.02W	1093	1148
xbt228	94/01/02	14:38	36	57.61N	9	25.05W	0	145
xbt229	94/01/02	14:41	36	57.25N	9	24.73W	0	1564
xbt230	94/01/02	21:36	36	32.02N	9	28.01W	3004	1832
xbt231	94/01/03	1:14	36	41.91N	9	18.04W	1060	1079
xbt232	94/01/03	2:55	36	44.96N	9	22.07W	958	1035
xbt233	94/01/03	3:29	36	50.06N	9	26.00W	1158	1197
xbt234	94/01/03	8:00	36	59.97N	9	29.97W	1381	1406
xbt235	94/01/03	9:00	36	54.95N	9	40.10W	1939	1728
xbt236	94/01/03	10:28	36	55.00N	10	0.03W	2586	1462
xbt237	94/01/03	11:14	36	55.00N	10	10.17W	3850	1728
xbt238	94/01/03	12:30	37	7.42N	10	10.07W	3874	1599
xbt239	94/01/03	13:45	37	5.01N	9	53.97W	3218	1570
xbt240	94/01/03	14:51	37	9.98N	9	39.94W	2096	1763
xbt241	94/01/03	15:44	37	15.99N	9	30.85W	1268	763
xbt242	94/01/03	21:07	37	24.00N	9	36.67W	1698	1719
xbt243	94/01/03	22:05	37	22.91N	9	48.80W	3426	1699
xbt244	94/01/04	4:22	37	31.95N	10	9.94W	2751	1832
xbt245	94/01/04	5:22	37	41.89N	10	10.00W	2988	1832
xbt246	94/01/04	6:21	37	51.89N	10	10.01W	3065	1758
xbt247	94/01/04	7:25	37	59.97N	10	0.05W	3140	1652
xbt248	94/01/04	8:32	38	7.26N	9	52.10W	3660	1564
xbt249	94/01/04	9:22	38	13.49N	9	45.01W	2016	1516
xbt250	94/01/04	15:30	38	20.05N	9	35.04W	2486	1623
xbt251	94/01/04	19:25	38	24.58N	9	46.00W	0	1832
xbt252	94/01/04	20:40	38	24.01N	9	59.92W	3566	1396
xbt253	94/01/04	21:47	38	11.84N	9	59.99W	3288	1546
xbt254	94/01/04	23:04	38	12.01N	10	15.15W	3512	1664
xbt255	94/01/05	0:22	38	23.94N	10	15.04W	3798	1611
xbt256	94/01/05	1:33	38	35.97N	10	15.09W	3230	1705
xbt257	94/01/05	2:40	38	35.98N	10	0.06W	1920	1552
xbt258	94/01/05	9:16	38	30.06N	10	30.10W	4702	1775
xbt259	94/01/05	11:20	38	30.01N	10	50.09W	4812	1832
xbt260	94/01/05	13:43	38	30.13N	11	9.72W	4825	1832
xbt261	94/01/05	15:19	38	20.03N	11	0.23W	4950	1528
xbt262	94/01/05	16:44	38	9.94N	10	49.85W	4899	1456
xbt263	94/01/05	18:07	37	59.97N	10	40.02W	4884	1569
xbt264	94/01/05	18:49	37	54.91N	10	34.98W	4584	1611
xbt265	94/01/05	19:30	37	49.99N	10	29.94W	3906	1444
xbt266	94/01/05	20:37	37	44.97N	10	20.02W	3430	1516
xbt267	94/01/05	21:57	37	45.03N	9	59.99W	2632	1599
xbt268	94/01/05	23:45	37	35.90N	9	54.84W	2411	1617
xbt269	94/01/07	8:31	38	20.12N	11	8.60W	4970	1360
xbt270	94/01/07	10:44	38	19.06N	10	48.87W	4916	1468
xbt271	94/01/07	12:14	38	18.98N	10	28.95W	4786	1646
xbt272	94/01/07	13:44	38	19.00N	10	8.99W	4536	1682
xbt273	94/01/07	15:13	38	19.00N	9	49.07W	3481	1474
xbt274	94/01/07	17:00	38	27.07N	9	42.22W	0	1472

xbt275	94/01/07	18:39	38	24.33N	9	55.40W	4308	1832
XBT	DATE	TIME	LATITUDE		LONGITUDE		DEPTH m	MAXP db
xbt277	94/01/07	21:18	38	25.85N	9	59.96W	4208	1658
xbt278	94/01/09	4:57	38	19.03N	9	43.04W	0	1646
xbt279	94/01/09	5:33	38	13.04N	9	40.99W	1451	1459
xbt280	94/01/09	6:13	38	7.03N	9	42.01W	2554	1611
xbt281	94/01/09	10:34	38	4.89N	9	55.15W	3891	1832
xbt282	94/01/09	11:03	38	8.48N	9	55.94W	3578	1201
xbt283	94/01/09	11:29	38	13.02N	9	57.86W	0	1317
xbt284	94/01/09	12:00	38	18.37N	10	0.31W	4208	1342
xbt285	94/01/09	12:27	38	23.01N	10	2.20W	4604	1396
xbt286	94/01/09	12:53	38	27.42N	10	4.01W	4031	1323
xbt287	94/01/09	13:21	38	32.27N	10	5.90W	0	1360
xbt288	94/01/09	13:49	38	36.93N	10	8.02W	0	1238
xbt289	94/01/09	14:27	38	43.97N	10	7.33W	1873	1287
xbt290	94/01/09	14:48	38	48.00N	10	6.65W	534	507
xbt291	94/01/09	16:02	39	2.07N	10	5.13W	219	202
xbt292	94/01/09	16:17	39	4.96N	10	4.89W	312	296
xbt293	94/01/09	17:39	39	19.95N	10	3.12W	476	187
xbt294	94/01/09	19:07	39	35.07N	10	1.30W	0	1552
xbt295	94/01/09	20:24	39	49.17N	9	59.49W	0	1354
xbt296	94/01/09	21:41	40	2.72N	9	56.55W	1568	1342
xbt297	94/01/11	9:36	43	40.23N	9	46.24W	2399	1293
xbt298	94/01/11	11:00	43	55.41N	9	38.59W	3104	1268
xbt299	94/01/11	12:22	44	10.34N	9	31.23W	4876	1311
xbt300	94/01/11	13:38	44	24.04N	9	25.48W	4576	1329
xbt301	94/01/11	14:55	44	38.00N	9	18.72W	4894	1316
xbt302	94/01/11	16:17	44	52.89N	9	11.68W	4888	1317
xbt303	94/01/11	17:36	45	6.95N	9	4.95W	4869	1207
xbt304	94/01/11	18:54	45	20.99N	8	58.24W	4854	1213
xbt305	94/01/11	20:12	45	34.95N	8	51.50W	4838	1244
xbt306	94/01/11	21:36	45	50.29N	8	44.06W	4820	1226
xbt307	94/01/11	22:35	45	59.84N	8	39.00W	4806	1832
xbt308	94/01/12	0:12	46	17.39N	8	30.13W	4774	1293
xbt309	94/01/12	1:17	46	29.96N	8	24.42W	4713	1305
xbt310	94/01/12	2:35	46	44.98N	8	17.06W	0	1293
xbt311	94/01/12	3:57	46	59.98N	8	6.53W	4107	1164
xbt312	94/01/12	5:15	47	15.03N	8	2.21W	4092	1145
xbt313	94/01/12	6:35	47	29.95N	7	54.83W	3152	1158
xbt314	94/01/12	8:42	47	48.86N	7	45.36W	0	542
xbt315	94/01/12	10:00	48	0.84N	7	39.84W	203	199

17.2 CTD Station List

CTD	DATE	TIME	LATITUDE		LONGITUDE		DEPTH m	MAXP db
ctd001	93/12/13	19:02	27	39.40N	16	30.00W	3476	2026
ctd002	93/12/14	8:25	26	6.01N	16	29.89W	3490	2012
ctd003	93/12/15	9:11	25	58.50N	19	59.30W	4058	2032
ctd004	93/12/16	5:24	25	51.70N	23	19.60W	4990	2031
ctd005	93/12/17	0:03	25	44.40N	26	40.70W	5253	2029
ctd006	93/12/17	18:23	25	37.20N	29	59.90W	5598	2029
ctd007	93/12/18	6:34	25	33.70N	31	49.20W	5787	2029
ctd008	93/12/18	15:48	25	29.70N	33	19.80W	5435	2023
ctd009	93/12/19	7:06	25	20.40N	33	4.98W	5025	2537
ctd010	93/12/19	10:20	25	22.25N	33	10.07W	6067	2031
ctd011	93/12/19	13:13	25	17.02N	33	9.97W	4875	505
ctd012	93/12/19	15:31	25	17.06N	33	7.22W	4424	512
ctd013	93/12/21	9:35	25	20.66N	32	59.88W	6055	2539
ctd014	93/12/21	16:01	25	23.27N	33	3.23W	5430	505
ctd015	93/12/21	18:09	25	23.40N	33	10.33W	5974	2032
ctd016	93/12/22	0:18	25	23.55N	33	17.80W	5532	2030
ctd017	93/12/22	2:47	25	23.39N	33	24.56W	5520	2029
ctd018	93/12/22	8:27	25	23.00N	33	31.39W	5341	2027
ctd019	93/12/22	11:00	25	22.70N	33	38.40W	5575	2537
ctd020	93/12/22	20:19	26	11.19N	33	35.94W	5228	2541
ctd021	93/12/23	13:36	27	31.40N	31	48.20W	5085	2034
ctd022	93/12/24	4:15	28	51.50N	30	0.10W	4788	2027
ctd023	93/12/24	19:38	30	0.44N	28	27.46W	310	263
ctd024	93/12/25	2:45	30	11.22N	28	19.00W	2351	997
ctd025	93/12/25	16:42	30	19.90N	28	3.90W	3933	503
ctd026	93/12/26	2:57	30	48.47N	26	27.77W	4977	200
ctd027	93/12/26	3:45	30	48.47N	26	27.77W	4977	2031
ctd028	93/12/26	14:22	31	17.20N	24	51.30W	5372	200
ctd029	93/12/26	14:47	31	17.20N	24	51.30W	5372	2031
ctd030	93/12/27	1:10	31	44.99N	23	14.99W	5420	2030
ctd031	93/12/27	9:08	32	0.30N	22	30.60W	5120	506
ctd032	93/12/28	3:14	34	10.10N	20	19.70W	4870	505
ctd033	93/12/29	21:05	37	59.90N	13	59.90W	4060	506
ctd034	93/12/30	23:41	36	29.80N	12	28.80W	3505	2032
ctd035	94/01/01	22:44	36	44.20N	8	52.10W	676	678
ctd036	94/01/02	3:55	36	46.10N	9	14.20W	820	808
ctd037	94/01/02	7:17	36	50.10N	9	19.70W	801	75
ctd038	94/01/02	7:35	36	50.10N	9	19.60W	800	800
ctd039	94/01/02	16:51	36	36.60N	9	22.90W	2200	2032
ctd040	94/01/03	4:14	36	54.92N	9	30.00W	2325	2041
ctd041	94/01/03	17:02	37	25.00N	9	25.00W	1090	1102
ctd042	94/01/04	0:43	37	22.12N	10	0.06W	3630	2032
ctd043	94/01/05	4:21	38	23.00N	9	53.90W	3796	3532
ctd044	94/01/07	22:51	38	25.90N	9	57.90W	4300	2542
ctd045	94/01/08	3:44	38	20.60N	10	5.50W	4544	2048
ctd046	94/01/08	10:19	38	15.80N	10	13.90W	4500	2543
ctd047	94/01/08	13:48	38	10.10N	10	29.80W	4820	2545
ctd048	94/01/08	17:33	38	9.80N	10	30.60W	4827	204
ctd049	94/01/08	21:30	38	21.80N	9	58.90W	4400	2540
ctd050	94/01/09	1:22	38	23.30N	9	43.30W	1965	2131
ctd051	94/01/09	7:41	38	3.10N	9	53.90W	3120	2540

17.3 List of Net Phytoplankton Samples

#	Date	Time	Lat.	Long.	Loc.	Temp.	Saln.	Depth	Type
1	13-12-93	21.00	27°39'	16°30'	CTD01	19.84	36.88	100	Vert.
2	14-12-93	12.00	26°06'	16°29'	CTD02	20.03	36.86	100	Vert.
3	15-12-93	11.10	25°58'	20°00'	CTD03	20.8	37.1	100	Vert.
4	16-12-93	07.05	25°51'	23°19'	CTD04	21.5	37.3	100	Vert.
5	17-12-93	01.45	25°44'	26°40'	CTD05	22.1	37.4	100	Vert.
6	17-12-93	20.05	25°37'	30°00'	CTD06	23.08	37.52	100	Vert.
7	17-12-93	21.45	25°37'	30°05'		23.03	37.50	4	Cont.
		22.16	25°36'	30°11'		22.88	37.50		
8	18-12-93	11.53	25°31'	32°35'		22.87	37.51	4	Cont.
		13.00	25°31'	32°50'		22.79	37.50		
9	18-12-93	18.15	25°30'	30°20'	CTD08	22.95	37.54	100	Vert.
10	19-12-93	09.10	25°20'	33°04'	CTD09	22.7	37.50	100	Vert.
11	19-12-93	22.40	25°17'	33°43'		23.08	37.55	4	Cont.
		23.10	25°17'	33°43'		23.08	37.55		
12	20-12-93	00.34	25°16'	33°34'	"	22.8	37.51	4	Cont.
		01.07	25°16'	33°29'		22.83	37.49		
13	20-12-93	01.28	25°16'	33°26'	"	22.80	37.50	4	Cont.
		02.27	25°16'	33°18'		22.80	37.50		
14	20-12-93	02.50	25°16'	33°15'	"	22.73	37.51	4	Cont.
		03.20	25°16'	33°10'		22.71	37.51		
15	20-12-93	03.40	21°17'	33°17'	"	22.72	37.51	4	Cont.
		04.00	25°17'	33°02'					
16	20-12-93	04.45	25°16'	32°56'	"	22.72	37.51	4	Cont.
		05.31	25°16'	32°41'					
17	20-12-93	06.00	25°16'	32°45'	"			4	Cont.
		06.00	25°16'	32°40'		22.75	37.52		
18	20-12-93	07.31	25°17'	32°30'	"	22.76	37.49	4	Cont.
		08.05	25°15'	32°36'		22.76	37.49		
19	20-12-93	17.02	24°55'	33°07'		22.82	37.50	4	Cont.
		17.30	24°59'	33°07'		22.83	37.52		
20	20-12-93	19.54	25°17'	33°08'	"	22.72	37.51	4	Cont.
		20.16	25°20'	33°08'		22.70	37.51		
21	20-12-93	20.30	25°21'	33°08'	"	22.67	37.51	4	Cont.
		20.54	25°24'	33°08'		22.67	37.50		
22	22-12-93	22.20	26°11'	33°35'	CTD 20	22.73	37.47	100	Vert.
23	22-12-93	22.30	26°11'	33°35'		22.72	37.48	4	Cont.
		23.30	26°21'	33°21'		22.75	37.48		
24	24-12-93	13.00	29°37'	28°53'	near GMT	20.92	37.11	4	Cont.
		14.00	29°43'	28°45'		20.83	37.62		
25	24-12-93	16.30	29°49'	28°37'	slope GMT	20.61	37.02	4	Cont.
26	24-12-93	20.00	30°26'	27°41'	CTD25->26	20.31	37.04	4	Cont.
27	26-12-93	03.45	30°48'	26°27'	CTD-26	19.31	36.79	4	Cont.
28	26-12-93	14.45	31°16'	24°51'	CTD-28	19.36	36.85	4	Cont.
29	26-12-93	21.11	31°31'	24°02'	CTD29->30	19.17	36.80	4	Cont.
		21.30	31°32'	23°58'		19.41	36.86		

#	Date	Time	Lat.	Long.	Loc.	Temp.	Saln.	Depth	Type
30	7-12-93	10.25	32°00'	22°30'	CTD-31	18.76	36.72	4	Cont.
31	27-12-93	13.30	32°21'	22°09'	STF	18.62	36.69	4	Cont.
		14.00	32°26'	22°04'		18.58	36.67		
32	27-12-93	17.00	32°47'	21°42'		18.52	36.65	4	Cont.
		17.30	32°51'	21°37'		18.60	36.67		
33	28-12-93	01.00	33°57'	20°32'		18.16	36.57	4	Cont.
		01.45	34°01'	20°28'		18.19	36.56		
34	28-12-93	12.40	35°02'	18°55'		18.56	36.68	4	Cont.
		13.30	35°07'	18°45'		18.51	36.68		
35	28-12-93	16.06	35°22'	18°14'		17.97	36.57	4	Cont.
		16.30	35°26'	18°08'		18.24	36.61		
36	29-12-93	00.45	35°44'	17°55'		17.23	36.50	4	Cont.
		01.03	35°46'	17°52'		16.77	36.47		
37	29-12-93	15.40	37°33'	15°07'		16.69	36.45	4	Cont.
		16.28	37°37'	14°55'		16.63	36.43		
38	29-12-93	20.00	37°55'	14°11'		15.83	36.26	4	Cont.
		20.30	37°58'	14°04'		15.85	36.27		
39	30-12-93	12.15	36°44'	12°24'		16.43	36.45	4	Cont.
		13.56	36°43'	12°20'		16.42	36.40		
40	1-1-94	12.16	36°37'	10°22'		16.33	36.46	4	Cont.
		12.46	36°39'	10°15'		16.24	36.40		
41	1-1-94	07.15	36°48'	09°29'	Rig 149	16.00	36.38	4	Cont.
		08.12	36°48'	09°20'		16.68	36.44		
42	2-1-94	15.35	36°46'	09°23'		15.06	36.19	4	Cont.
		16.16	36°37'	09°22'		15.06	36.19		
43	3-1-94	19.10	37°23'	09°24'	CTD-41	15.96	36.37	4	Cont.
44	4-1-94	04.16	37°31'	10°09'		15.95	36.37	4	Cont.
		04.54	37°37'	10°10'		15.95	35.37		
45	4-1-94	16.06	38°20'	09°33'		14.70	36.04	4	Cont.
		16.30	38°18'	09°36'		15.11	36.14		
46	4-1-94	18.00	38°23'	09°43'	Rig 147	15.30	15.33	4	Cont.
		18.30	38°24'	09°44'		15.33	36.29		
47	4-1-94	21.11	38°18'	10°10'		15.46	36.27	4	Cont.
		21.37	38°13'	10°10'		15.39	36.25		
48	4-1-94	22.50	38°11'	10°13'		15.70	36.31	4	Cont.
		23.30	38°13'	10°16'		15.68	36.29		
49	5-1-94	05.23	38°22'	09°53'	CTD-43	15.54	36.24	4	Cont.
50	5-1-94	07.39	38°26'	10°11'		15.48	36.23	4	Cont.
		08.09	38°27'	10°17'		15.25	36.16		
51	5-1-94	09.27	38°30'	10°32'		15.20	36.14	4	Cont.
		09.49	38°30'	10°35'		15.22	36.16		
52	5-1-94	11.07	38°30'	10°52'		15.37	36.18	4	Cont.
		11.40	38°30'	10°52'		15.33	36.18		
53	5-1-94	16.10	38°14'	10°55'		15.11	36.09	4	Cont.
		16.40	38°11'	10°52'		15.39	36.26		
54	5-1-94	17.47	38°02'	10°42'		15.55	36.29	4	Cont.
		18.17	37°58'	10°38'		14.97	36.09		
55	5-1-94	19.45	37°48'	10°28'		15.45	36.24	4	Cont.
		20.15	47°46'	10°23		15.50	36.26		

#	Date	Time	Lat.	Long.	Loc.	Temp.	Saln.	Depth	Type
56	5-1-94	21.40	37°44'	10°04'		15.90	36.35	4	Cont.
		21.57	37°44'	09°59		15.78	36.34		
57	6-1-94	04.50	37°32'	10°07'		15.95	36.39	4	Cont.
		05.30	37°32'	10°09'		37.32	10.09		
58	7-1-94	13.30	38°19'	10°11'		15.28	36.26	4	Cont.
		14.20	38°19'	10°00'		15.24	36.24		
59	8-1-94	13.16	38°11'	10°25'		15.43	36.28	4	Cont.
		14.13	38°10'	10°29'	CTD-47	15.37	36.27		
60	9-1-94	16.00	39°02'	10°04'		14.70	36.08	4	Cont.
		16.30	39°08'	10°04'		14.68	36.08		
61	9-1-94	18.25	39°28'	10°02'		14.53	36.02	4	Cont.
		19.18	39°37'	10°01'		14.49	36.02		
62	9-1-94	07.00	40°39'	09°41'		14.31	35.97	4	Cont.
		07.30	40°40'	09°41'		14.34	36.98		
63	10-1-94	16.49	41°02'	10°16'		13.91	35.89	4	Cont.
		17.30	41°04'	10°19'		13.96	35.89		
64	10-1-94	21.40	41°32'	10°34'		13.94	35.90	4	Cont.
		22.05	41°36'	10°34'		14.15	35.98		
65	11-1-94	05.10	42°52'	10°08'		13.62	35.86	4	Cont.
		05.45	42°59'	10°05'		13.60	33.83		
66	11-1-94	17.30	45°06'	09°04'		12.19	35.60	4	Cont.
		19.56	45°32'	08°52'		12.09	35.55		

17.4 List of Discrete samples Concentrated by Membrane Filters

All samples were of 1000 ml filtered through 5µm pore size membrane filters, except sample 3 of 2000 ml and sample 27 in which by mistake two samples were joined in the same tube: one of 1000 ml through a 5µm pore size, and other of 2000 ml through a disk of net of 30 µm mesh size.

#	Date	Time	Lat.	Long.	Loc.	Prof
1	20-12-93	17.02	24°55'	33°07'	4	
2	20-12-93	19.54	25°17'	33°08'	"	4
3	20-12-93	20.16	25°20'	33°08'	"	4
4	21-12-93	11.30	25°20'	33°00'	CTD-13	4
5				"		40
6				"		70
7				"		100
8				"		150
9				"		175
10				"		200
11				"		250
12	22-12-93	20.30	26°11'	33°35'	CTD-20	5
13				"		25
14				"		60
15				"		130
16	24-12-93	20.30	30°00'	28°27'	CTD-23	5
17				"		25
18				"		60
19				"		80
20				"		150
21	25-12-93	03.00	30°11'	28°18'	CTD-24	5
22				"		25
23				"		60
24				"		80
25				"		120
27	25-12-93	17.00	30°20'	28°03'	CTD-25	5
28				"		25
29				"		60
30				"		80
31				"		120
32	26-12-93	04.00	30°48'	26°27'	CTD-27	5
33				"		25
34				"		60
35				"		100
36	27-12-93	09.00	32°00'	22°30'	CTD-31	5
37				"		10
38				"		25
39				"		50
40				"		80
41				"		120
42	28-12-93	03.30	34°09'	20°20'	CTD-32	5
43				"		25
44				"		50

#	Date	Time	Lat.	Long.	Loc.	Prof
45					"	100
46	28-12-93		13.30	35°07'	18°45'STF	4
47		14.00	35°10'	18°39'	STF	4
48		14.30	35°15'	18°33'	STF	4
49		15.00	35°17'	18°25'	STF	4
50		15.30	35°20'	18°19'	STF	4
51		16.00	35°02'	18°14'	STF	4
52		16.30	35°22'	18°08'	STF	4
53		17.00	35°29'	18°02'	STF	4
54		17.30	35°32'	17°56'	STF	4
55		18.00	35°36'	17°51'	STF	4
56		18.40	35°39'	17°47'	STF	4
57		19.02	35°33'	17°51'	STF	4
58		19.18	35°32'	17°53'	STF	4
59		19.24			STF	4
60		19.39			STF	4
61	29-12-93		00.43	35°44'	17°55'STF	4
62		01.05			STF	4
63		01.30			STF	4
64		04.00			STF	4
65		14.00	37°24'	15°28'	STF	4
66		19.42	37°54'	14°14'	STF	4
67	29-12-93		20.55	38°00'	14°00'CTD-33	5
68	29-12-93		20.55	38°00'	14°00'CTD-33	25
69					"	50
70					"	80
71					"	120

17.5 List of Plankton Samples of > 30µm

#	Date	Time	Lat.	Long.	Loc.	Depth	Vol (ml)
145	18-12-93	18.00	25°30	33 20	CTD-08	5	2000
148					"	25	2000
150					"	60	3300
152					"	116	3200
263	22-12-93	18.00	25°30	33 20	CTD-20	25	2000
269					"	130	1000
294	24-12-93	20.30	30°00	28 27	CTD-23	5	2000
296					"	25	1000
298					"	60	2500
300					"	80	2000
304					"	150	2000
308	25-12-93	03.00	30°11	28 18	CTD-24	5	2000
310					"	25	2000
312					"	60	1250
314					"	80	1800
316					"	120	2700
325	25-12-93	17.00	30°20	28 03	CTD-25	25	2000
327					"	60	3000
329					"	80	3000
331					"	120	4000
333					"	150	4000
1070	26-12-93	04.00	30°48	26 27	CTD-27	5	2300
340					"	25	1000
342					"	60	2600
344					"	100	2400
346					"	150	5000
358	27-12-93	09.00	32°00	22 30	CTD-31	5	3000
360					"	10	2000
362					"	25	3000
364					"	50	3000
366					"	80	4800
368					"	120	6000
377	28-12-93	03.30	34°09'	20°20'	CTD-32	5	1000
379					"	25	1000
381					"	50	2000
383					"	100	2000
394	28-12-93	14.30	35°15'	18°33'	STF	4	3000
396		15.00	35°17'	18°25'	STF	4	3000
398		15.30	35°20'	18°19'	STF	4	3000
400		16.00	35°22'	18°14'	STF	4	3000
402		16.30	35°22'	18°08'	STF	4	3000
404		17.00	35°29'	18°02'	STF	4	3000
406		17.30	35°32'	17°56'	STF	4	3000
408		18.00	35°36'	17°51'	STF	4	3000
410		18.40	35°39'	17°47'	STF	4	3000
412		19.02	35°33'	17°51'	STF	4	3000
414		19.18	35°32'	17°53'	STF	4	3000
416		19.24			STF	4	3000
418		19.39			STF	4	3000

#	Date	Time	Lat.	Long.	Loc.	Depth	Vol (ml)
422	29-12-93	00.43	35°44'	17°55'	STF	4	3000
424		01.05			STF	4	3000
426		01.30			STF	4	2350
429		04.00			STF	4	3000
436		14.00	37°24'	15°28'	STF	4	3000
440		19.42	37°54'	14°14'	STF	4	3000

17.6 UOR TOWS

TOW NO.	TIME (GMT)	EVENT	LATITUDE N	LONGITUDE W	TOW TIME (h:m)	TOW DIST (km)	DEPTH RANGE (m)	SPD (knts)	CALIBRATION FILE & SAMPLING TIME	COMMENTS
CD129301	14.12.93 13:22 15.12.93 08:42	IN OUT	26 06.89 25 58.48	16 29.99 19 59.32	17:58	353	70	11	CD9332M1.COE 4 sec O.K	Zig-zag course at beginning of tow for the ship ADCP calibration
CD129302	15.12.93 11:20 16.12.93 04:47	IN OUT	25 58.32 25 51.76	20 00.77 23 19.8	17:27	341	70	11.6	CD9332M1.COE 4 sec O.K	Tension O.K at this speed
CD129303	16.12.93 07:20 16.12.93 23:51	IN OUT	25 51.8 25 43.8	23 18.9 26 40.2	16:33	340	70	11.7	CD9332M1.COE 4 sec O.K	
CD129304	17.12.93 01:55 17.12.93 18:13	IN OUT	25 44.86 25 37.09	26 42.02 29 39.69	16:19	334	70	11.7	CD9332M1.COE 4 sec O.K	
CD129305	17.12.93 21:12 18.12.93 05:30	IN OUT	25 37.31 25 33.5	30 00.28 31 43.5	09:07	183	70	11	CD9332M1.COE 4 sec O.K	Brought in early after 3 failed XBT's
CD129306	26.12.93 14:23	IN	31 16.63	24 51.50	00:19		0-200m	20m per mi	CD9332M1.COE 1 sec O.K	Logger & sensor on CTD028 for calibration
CD129307	27.12.93 10:51 28.12.93 02:57	IN OUT	32 01.7 34 09.6	22 29.02 20 20.4	16:06	315	70	11.2	CD9332M1.COE 4 sec O.K	Tow through sub-tropical front
CD129308	28.12.93 04:59 28.12.93 22:20	IN OUT	34 10.50 35 31.35	20 18.83 18 07.51	17:20	350	70	11.5	CD9332M1.COE 4 sec O.K	End tow when looking for meddy
CD129309	02.01.94	IN	36 50.0	09 19.7	07:30		0-75m	10-15m per minute	CD9332M1.COE 1 sec O.K	Logger & sensor on CTD037 for re-calibration

17.7

Primary production incubations (C-14).

Date	Time	Sampling Lat.	Long.	CTD No	Depth	Incubation conditions %Io	Time	No. of samples 2µm	GF/F
17/12	09:30	25 40.7	28 17.1	NTW	4 m	100	9 h	2	2
17/12	09:30	25 40.7	28 17.1	NTW	4 m	100	24 h	0	3
18/12	18:00	25 30.9	32 20.8	CTD-8	5 m	100	9 h	3	3
					25 m	40	9 h	3	3
					60 m	8	9 h	3	3
					120 m	2	9 h	3	3
19/12	07:00	25 19.8	33 05.8	CTD-9	5 m	100	9 h	3	3
					50 m	8	9 h	3	3
					100 m	2	9 h	3	3
					100 m	2	24 h	0	3
					100 m	40	24 h	0	3
21/12	09:30	25 20.6	32 59.8	CTD-13	5 m	100	7 h	0	3
					5 m	100	24 h	0	3
					100 m	2	7 h	0	3
					100 m	2	24 h	0	3
					100 m	8	7 h	0	3
					100 m	8	24 h	0	3
					100 m	40	7 h	0	3
					100 m	40	24 h	0	3
24/12	20:34	26 11.4	33 35.8	CTD-20	5 m	100	10 h	3	3
					60 m	8	10 h	3	3
					130 m	2		3	3
24/12	20:00	30 00.8	28 27.7	CTD-23	5 m	100	10 h	3	3
					25 m	40	10 h	3	3
					60 m	8	10 h	3	3
					80 m	2	10 h	3	3
25/12	02:45	30 11.5	28 18.7	CTD-24	5 m	100	10 h	3	3
					25 m	40	10 h	3	3
					60 m	8	10 h	3	3
					80 m	2	10 h	3	3
25/12	17:00	30 19.9	28 03.9	CTD-25	5 m	100	10 h	3	3
					25 m	40	10 h	3	3
					60 m	8	10 h	3	3
					80 m	2	10 h	3	3
26/12	02:57	30 48.4	26 27.6	CTD-26	5 m	100	10 h	3	3
					25 m	40	10 h	3	3
					60 m	8	10 h	3	3
					80 m	2	10 h	3	3
27/12	09:00	32 00.3	22 30.6	CTD-31	5 m	100	8 h	3	3
					10 m	60	8 h	3	3
					25 m	20	8 h	3	3
					50 m	8	8 h	3	3
					80 m	2	8 h	3	3
28/12	10:30	34 48.7	19 22.6	NTW	4 m	100	24 h	0	3
28/12	14:30	35 15.9	18 33.4	NTW	4 m	100	7 h	3	3
28/12	16:00	35 22.9	18 14.1	NTW	4 m	100	8 30h	3	3
28/12	17:00	35 29.3	18 02.1	NTW	4 m	100	8 30h	3	3

Date	Time	Sampling Lat.	Long.	CTD No	Depth	Incubation conditions %Io	Time	No. of samples 2µm	GF/F
28/12	17:30	35 32.7	17 52.4	NTW	4 m	100	8 30h	3	3
28/12	19:02	35 34.4	17 51.2	NTW	4 m	100	8 30h	3	3
29/12	00:43	35 44	17 55	NTW	4 m	100	8 30h	3	3
29/12	01:05	35 47	17 52	NTW	4 m	100	8 30h	3	3
29/12	01:30	35 50.6	17 47.1	NTW	4 m	100	8 30h	3	3
29/12	04:00	36 10.7	17 21.4	NTW	4 m	100	8 30h	3	3
29/12	19:55	37 55	14 12	NTW	4 m	100	8 30h	3	3
29/12	21:00	37 59.9	13 59.9	CTD-33	5	100	9 h	3	3
					25	20	9 h	3	3
					50	8	9 h	3	3
					80	2	9 h	3	3

CD 83. Bacteria samples.

Date	Time	Lat.	Long.	CTD No	Depth	Sample No.
18/12	18:00	25 30.9	32 20.8	CTD-8	5 m	144
					25 m	147
					60 m	150
					116 m	153
					200 m	156
19/12	07:00	25 19.8	33 05.8	CTD-9	5 m	165
					50 m	168
					100 m	171
					150 m	174
19/12	22:15	25 17.6	33 41.4	NTW	4 m	195
20/12	00:25	25 16.6	33 35.6	NTW	4 m	197
	01:52	25 16.6	33 23.3	NTW	4 m	199
	03:45	25 17.2	33 07.3	NTW	4 m	201
	05:08	25 16.6	33 52.7	NTW	4 m	202
	06:39	25 16.7	32 40.0	NTW	4 m	203
24/12	20:34	26 11.4	33 35.8	CTD-20	5 m	260
					25 m	263
					60 m	266
					130 m	269
24/12	20:00	30 00.8	28 27.7	CTD-23	5 m	294
					25 m	296
					60 m	298
					80 m	300
					150 m	304
25/12	02:45	30 11.5	28 18.7	CTD-24	5 m	308
					25 m	310
					60 m	312
					80 m	314
					120 m	316
					150 m	318
25/12	17:00	30 19.9	28 03.9	CTD-25	5 m	323
					25 m	325
					60 m	327
					80 m	329

Date	Time	Lat.	Long.	CTD No	Depth	Sample No.
					120 m	331
					150 m	333
27/12	09:00	32 00.3	22 30.6	CTD-31	10 m	360
					25 m	362
					50 m	364
					80 m	366
					120 m	368
27/12	15:00	32 33.2	21 56.4	NTW	4 m	1
27/12	15:30	32 37.6	21 52.3	NTW	4 m	2
27/12	16:00	32 40.2	21 49.5	NTW	4 m	3
27/12	16:30	32 43.4	21 46.2	NTW	4 m	4
27/12	17:00	32 47.3	21 42.3	NTW	4 m	5
27/12	17:30	32 51.4	21 37.8	NTW	4 m	6
27/12	18:00	32 55.3	21 33.9	NTW	4 m	7
27/12	18:30	32 59.1	21 30.9	NTW	4 m	8
27/12	19:00	33 03.2	21 27.1	NTW	4 m	9
27/12	19:30	33 07.4	21 22.4	NTW	4 m	10
27/12	21:06	33 20.1	21 10.0	NTW	4 m	11
27/12	21:30	33 23.7	21 03.4	NTW	4 m	12
27/12	22:00	33 28.5	21 01.5	NTW	4 m	13
27/12	22:30	33 32.8	20 57.4	NTW	4 m	14
27/12	23:00	33 37.3	20 52.6	NTW	4 m	15
27/12	23:30	33 41.3	20 48.8	NTW	4 m	16
27/12	00:00	33 46.1	20 43.7	NTW	4 m	17
28/12	00:30	33 50.4	20 39.3	NTW	4 m	18
28/12	01:00	33 55	20 34	NTW	4 m	19
28/12	01:30	33 59.1	20 30.4	NTW	4 m	20
28/12	02:00	34 04.1	20 26.1	NTW	4 m	21
28/12	02:30	34 07.9	20 22.1	NTW	4 m	22
28/12	03:30	34 09.8	20 20.4	CTD-32	5 m	377
					25 m	379
					50 m	381
					100 m	383
28/12	06:00	34 19.7	20 10.2	NTW	4 m	23
28/12	06:30	34 24.6	20 05.4	NTW	4 m	24
28/12	07:30	34 32.3	19 55.6	NTW	4 m	25
28/12	08:00	34 35.3	19 49.1	NTW	4 m	26
28/12	08:30	33 38.6	19 42.7	NTW	4 m	27
28/12	09:00	33 40.3	19 36.4	NTW	4 m	28
28/12	09:30	34 45.2	19 30	NTW	4 m	29
28/12	10:00	34 45.9	19 28.3	NTW	4 m	30
28/12	10:30	34 48.7	19 22.6	NTW	4 m	31
28/12	11:00	34 51.5	19 16.6	NTW	4 m	32
28/12	11:30	34 55.4	19 09.0	NTW	4 m	33
28/12	12:00	34 57.8	19 03.9	NTW	4 m	34
28/12	12:30	35 00.6	18 57.9	NTW	4 m	35
28/12	13:00	35 03.7	18 51.5	NTW	4 m	36
28/12	13:30	35 07.5	18 45.2	NTW	4 m	37
28/12	14:00	35 10.4	18 39.3	NTW	4 m	38
28/12	14:30	35 16.0	18 33.4	NTW	4 m	394
28/12	15:00	35 17.1	18 25.8	NTW	4 m	396
28/12	15:30	35 20.3	18 19.4	NTW	4 m	398

Date	Time	Lat.	Long.	CTD No	Depth	Sample No.
28/12	16:00	35 22.9	18 14.1	NTW	4 m	400
28/12	16:30	35 26.0	18 08.2	NTW	4 m	402
28/12	17:00	35 29.3	18 02.1	NTW	4 m	404
28/12	17:30	35 32.7	17 56.4	NTW	4 m	406
28/12	18:00	35 36.4	17 51.6	NTW	4 m	408
28/12	18:40	35 39	17 47	NTW	4 m	410
28/12	19:02	35 33.4	17 51.2	NTW	4 m	412
28/12	19:18	35 32.2	17 53.2	NTW	4 m	414
28/12	19:24	35 31	17 52	NTW	4 m	416
28/12	19:39	35 30	17 53	NTW	4 m	418
29/12	00:43	35 44	17 55	NTW	4 m	422
29/12	01:05	35 47	17 52	NTW	4 m	424
29/12	01:30	35 50.6	17 47.1	NTW	4 m	426
29/12	04:00	36 10.7	17 21.4	NTW	4 m	429
29/12	19:42	37 54.2	14 14.0	NTW	4 m	440
29/12	19:55	37 55.2	14 11.8	NTW	4 m	442
29/12	20:55	37 59.9	13 59.9	CTD-33	5 m	445
					25 m	447
					80 m	451
					120 m	453
1/1	22:00	36 43.9	08 55.1	CTD-35	644 m	496
2/1	04:50	36 46.0	09 13.6	CTD-36	625 m	498
2/1	07:35	36 50.0	09 10.7	CTD-38	5 m	512
					50 m	511
					100 m	510
					200 m	509
					300 m	508
					350 m	507
					400 m	506
					450 m	505
					525 m	504
					600 m	503
					625 m	502
					700 m	501
2/1	18:00	36 36.7	09 22.8	CTD-39	600 m	516
					1100 m	517
					1200 m	518
					1300 m	519
					1400 m	520
3/1	05:00	36 55.0	09 30.3	CTD-40	500 m	526
					600 m	527
					800 m	528
					1000 m	529
					1500 m	530
7/1	22:50	38 25.8	09 57.4	CTD-44	400 m	576
					800 m	577
					1150 m	578
					1600 m	579
8/1	05:35	38 20.9	10 05.4	CTD-45	600 m	587
					1200 m	588
8/1	10:20	38 15.8	10 13.9	CTD-46	400 m	589
					800 m	590

Date	Time	Lat.	Long.	CTD No	Depth	Sample No.
					1250 m	591
					2500 m	592
9/1	14:00	38 39.9	10 08.3	NTWS	4 m	599
9/1	17:00	39 13.8	10 03.5	NTWS	4 m	605
9/1	18:30	39 28.8	10 02.2	NTWS	4 m	608
9/1	20:30	40 05.4	09 48.5	NTWS	4 m	614
9/1	23:22	40 03.8	09 34.4	NTWS	4 m	611
9/1	23:59	40 06.1	09 26.7	NTWS	4 m	617
10/1	01:50	40 25.3	09 24.0	NTWS	4 m	620
10/1	03:11	40 30.3	09 28.9	NTWS	4 m	623
10/1	03:25	40 31.1	09 30.5	NTWS	4 m	626
10/1	12:00	40 46.2	09 58.1	NTWS	4 m	629
10/1	17:01	41 02.7	10 17.2	NTWS	4 m	632

CD 83. PCN samples.

Date	Time	Lat.	Long.	CTD No	Depth	Sample No.	Vol (ml)
14/12				CTD-2	5 m	1	250
					50 m	2	250
					100 m	3	250
					200 m	4	250
17/12	14:00	25 38.7	29 07.1	NTWS	4 m	104	250
17/12	18:00	25 37.1	29 59.1	NTWS	4 m	106	250
17/12	22:00	25 36.9	30 08.1	NTWS	4 m	119	250
18/12	02:00	25 34.8	30 59.2	NTWS	4 m	121	250
18/12	06:00	25 35.5	31 48.8	NTWS	4 m	123	250
18/12	08:00	25 33.3	31 49.1	CTD-7	5 m	125	250
					50 m	126	250
					100 m	127	250
					150 m	128	250
					250 m	129	250
					400 m	130	250
					500 m	131	250
					900 m	132	250
					1000 m	133	250
					1200 m	134	250
					1500 m	135	250
					2000 m	136	250
18/12	10:00	25 32.4	32 12.4	NTWS	4 m	140	250
18/12	14:00	25 30.7	33 01.9	NTWS	4 m	142	250
				CTD-8	5 m	144	500
					25 m	147	500
					60 m	150	500
					116 m	153	500
18/12	22:10	25 08.8	33 08.1	NTWS	4 m	160	250
19/12	02:00	25 43.7	33 05.2	NTWS	4 m	162	250
19/12	06:00	25 20.1	~~35~~ 32 56.7	NTWS	4 m	164	250
				CTD-9	5 m	165	250

Date	Time	Lat.	Long.	CTD No	Depth	Sample No.	Vol (ml)
					50 m	168	500
					100 m	171	500
					150 m	174	500
19/12		25 17.0	33 10.3	CTD-11	5 m	186	250
					50 m	187	250
					80 m	188	250
					100 m	189	250
					120 m	190	250
					150 m	191	250
19/12	22:00	25 17.1	33 43.0	NTWS	4 m	194	250
19/12	22:15	25 17.6	33 41.4	NTWS	4 m	195	250
20/12	00:25	25 16.6	33 35.6	NTWS	4 m	197	250
20/12	02:04	25 16.6	33 20.9	NTWS	4 m	200	250
20/12	03:45	25 17.2	33 07.3	NTWS	4 m	201	250
20/12	05:08	25 16.6	32 52.7	NTWS	4 m	202	250
20/12	06:34	25 16.7	32 40.0	NTWS	4 m	203	250
20/12	10:00	25 11.6	32 52.8	NTWS	4 m	205	250
20/12	14:02	24 54.5	33 04.7	NTWS	4 m	206	250
20/12	18:00	25 03.0	33 07.8	NTWS	4 m	208	250
20/12	22:00	25 36.6	33 08.2	NTWS	4 m	210	250
21/12	02:00	25 46.9	33 00.1	NTWS	4 m	212	250
21/12	06:00	25 17.1	32 59.8	NTWS	4 m	214	250
21/12	10:00	25 20.6	33 00.8	NTWS	4 m	216	250
21/12	09:30	25 20.6	32 59.8	CTD-13	4 m	230	250
					40 m	218	250
					70 m	219	250
					100 m	220	250
					150 m	221	250
					175 m	222	250
					200 m	223	250
					250 m	224	250
21/12	16 :00	25 23.0	33 03.4	CTD-14	5 m	232	250
					150 m	233	250
					175 m	234	250
					200 m	235	250
21/12	18:00	25 22.9	33 10.5	CTD-15	5 m	236	250
					150 m	237	250
					175 m	238	250
					200 m	239	250
21/12	22:00	25 22.2	~~30 16.4~~ 33 10.38	NTWS	4 m	240	250
22/12	01:15	25 23.0	33 17.3	CTD-16	5 m	242	250
					150 m	243	250
					175 m	244	250
22/12	04:21	25 23.1	33 24.7	CTD-17	5 m	245	250
					50 m	246	250
					150 m	247	250
22/12	10:00	25 23.5	33 31.4	NTWS	4 m	252	250
22/12	08:30	25 22.9	33 31.3	CTD-18	5 m	249	250
					50 m	250	250

Date	Time	Lat.	Long.	CTD No	Depth	Sample No.	Vol (ml)
					150 m	251	250
22/12	11:00	25 23.2	33 38.3	CTD-19	5 m	254	250
					50 m	255	250
					100 m	256	250
22/12	16:00	25 51.4	33 31.5	NTWS	4 m	257	250
22/12	18:00	26 10.4	33 36.1	NTWS	4 m	258	250
22/12	20:34	26 11.5	33 35.8	CTD-20	5 m	260	500
					25 m	263	500
				(>30µm)	25 m	263	2000
					60 m	266	500
					130 m	269	500
				(>30µm)	130 m	269	1000
23/12	02:00	26 34.6	33 04.0	NTWS	4 m	272	250
23/12	10:20	27 31.0	31 48.6	NTWS	4 m	276	250
23/12	18:00	27 48.8	31 24.1	NTWS	4 m	279	250
23/12	22:20	28 16.3	30 47.8	NTWS	4 m	281	250
24/12	02:00	28 39.1	30 17.0	NTWS	4 m	283	250
24/12	04:00	28 51.6	30 00.0	CTD-22	5 m	285	250
					50 m	286	250
					150 m	287	250
24/12	~~20:07~~ 08:00	29 ~~19.9~~ 5.8	29 ~~19.4~~ 40.2	NTWS	4 m	289	250
24/12	14:00	29 43.3	28 45.1	NTWS	4 m	291	250
24/12	18:00	30 00.2	28 27.8	NTWS	4 m	293	250
24 /12	20:30	30 00.8	28 27.7	CTD-23	5 m	294	500
				(>30µm)	5 m	295	10000
					25 m	296	500
				(>30µm)	25 m	297	10000
					60 m	298	500
				(>30µm)	60 m	299	10000
					80 m	300	500
				(>30µm)	80 m	301	10000
					120 m	302	500
					150 m	304	500
				(>30µm)	150 m	305	10000
25/12	02:20	30 10.2	28 19.5	NTWS	4 m	307	250
25/12	02:45	30 11.5	28 18.7	CTD-24	5 m	308	500
					4 m	309	10000
					25 m	310	500
					25 m	311	10000
					60 m	312	500
					60 m	313	10000
					80 m	314	500
					80 m	lost	
					120 m	316	500
					120 m	317	10000
					150 m	318	500

Date	Time	Lat.	Long.	CTD No	Depth	Sample No.	Vol (ml)
25/12	10:00	30 11.7	28 18.1	NTWS	4 m	321	250
25/12	14:00	30 04.5	28 21.3	NTWS	4 m	322	250
25/12	17:00	30 19.9	28 03.9	CTD-25	5 m	323	500
					25 m	325	500
				(>30µm)	25 m	326	10000
					60 m	327	500
				(>30µm)	60 m	328	10000
					80 m	329	500
				(>30µm)	80 m	330	10000
					120 m	331	500
				(>30µm)	120 m	332	10000
					150 m	333	500
				(>30µm)	150 m	334	10000
26/12	02:00	30 46.8	26 34.8	NTWS	4 m	336	250
26/12	10:00	31 03.3	25 37.6	NTWS	4 m	348	250
26/12	03:45	30 48.4	26 27.7	CTD-27	5 m	1070	500
				(>30µm)	5 m	339	10000
					25 m	340	500
				(>30µm)	25 m	341	10000
					60 m	342	500
					60 m	lost	
					100 m	344	500
				(>30µm)	100 m	345	10000
					150 m	346	500
26/12	14:05	31 15.8	24 53.6	NTWS	4 m	350	250
27/12	02:00	31 44.9	23 15.0	NTWS	4 m	354	250
27/12	06:30	31 51.3	22 56.6	NTWS	4 m	356	250
27/12	09:18	32 00	23 30	CTD-31	5 m	358	500
				(>30µm)	5 m	359	10000
					10 m	360	500
				(>30µm)	10 m	361	10000
					25 m	362	500
				(>30µm)	25 m	363	10000
					50 m	364	500
				(>30µm)	50 m	365	10000
					80 m	366	500
				(>30µm)	80 m	367	10000
					120 m	368	500
				(>30µm)	150 m	369	10000
27/12	14:00	32 26.3	22 04.1	NTWS	4 m	370	250
27/12	16:00	32 40.2	21 49.5	NTWS	4 m	371	250
27/12	18:00	32 55.3	21 33.9	NTWS	4 m	372	250
27/12	20:00	33 11.3	21 18.7	NTWS	4 m	373	250
27/12	22:00	33 28.5	21 01.5	NTWS	4 m	374	250
28/12	00:00	33 46.1	20 43.7	NTWS	4 m	375	250
28/12	02:00	34 04.1	20 26.1	NTWS	4 m	376	250

17.8

Dissolved Oxygen Concentration.

Date	Time	Lat	Long	CTD No	Depth	mlO2/l
15/12	09:11	25 58.4	19 59.3	CTD 3	5	Lost
					20	4.99
					40	4.99
					60	5.02
					100	5.03
					400	4.16
					500	3.86
					900	3.16
					1000	3.41
					1200	4.01
					1500	4.57
					2000	5.08
16/12	06:00	25 51.8	23 19.7	CTD 4	5	0.00
					20	5.07
					40	5.11
					60	5.13
					100	5.19
					400	4.47
					500	4.39
					900	3.51
					1000	3.75
					1200	4.25
					1500	4.75
					2000	5.20
17/12	00:30	25 44.3	26 40.6	CTD 5	5	5.04
					50	5.00
					100	5.02
					250	4.30
					400	4.37
					500	4.28
					700	3.26
					900	3.34
					1000	3.58
					1200	4.12
					1500	4.59
					2000	5.40
17/12	18:40	25 37.2	29 59.9	CTD 6	5	5.07
					50	4.99
					100	5.02
					150	4.88
					250	4.50
					400	4.08
					500	3.79
					900	3.41
					1000	3.59
					1200	4.09
					1500	4.88

					2000	5.50

Date	Time	Lat	Long	CTD No	Depth	mlO2/l
18/12	06:30	25 33.6	31 49.2	CTD 7	5	5.06
					50	5.06
					100	5.16
					150	4.84
					250	4.55
					400	4.36
					500	4.16
					900	3.48
					1000	3.69
					1200	4.25
					1500	4.89
					2000	5.43
18/12	16:32	28 30.8	33 20.4	CTD 8	5	4.83
					25	4.84
					60	4.77
					120	4.88
					200	4.58
					400	4.13
					500	4.09
					800	3.06
					1000	3.46
					1200	4.11
					1500	4.68
					2000	5.32
19/12	07:00	25 19.8	33 05.8	CTD 9	5	4.94
					50	4.93
					100	4.98
					150	4.88
					200	4.86
					300	4.50
					400	4.26
					600	4.00
					900	3.24
					1000	3.54
					1200	4.13
					2000	5.38
19/12	10:00	25 22.[illegible]	33 10.0	CTD 10	5	4.93
					50	4.86
					100	4.99
					150	4.97
					200	4.85
					300	4.54
					400	4.27
					600	3.98
					850	3.26
					1000	3.63
					2000	5.27

Date	Time	Lat	Long	CTD No	Depth	mlO2/l
19/12	14:00	25 17.1	33 10.5	CTD 11	5	4.96
					50	4.94
					80	4.94
					100	5.15
					120	5.01
					150	5.00
					180	4.84
					200	4.84
					250	4.71
					300	4.49
					400	4.25
					500	4.12
21/12	09:30	25 20.6	32 59.8	CTD 13	40	5.01
					70	5.04
					100	5.23
					150	4.92
					175	4.88
					200	4.84
					250	4.83
					300	4.53
					400	4.29
					600	3.92
					850	3.27
					2500	5.66
21/12	18:00	25 22.9	33 10.5	CTD 15	50	4.95
					150	4.92
					175	4.86
					200	4.87
					250	4.85
					300	4.61
22/12	02:35	25 22.97	33 24.7	CTD 17	50	5.02
					150	4.79
					200	4.84
					300	4.46
					500	4.11
					1500	4.77
22/12	08:28	25 23.0	33 31.4	CTD 18	151	4.77
					202	4.60
					300	4.32
					500	4.16
					1500	4.76
22/12	11:00	25 22.7	33 38.3	CTD 19	50	4.92
					100	4.93
					175	4.73
					250	4.37
					400	4.17
					1000	3.47

Date	Time	Lat	Long	CTD No	Depth	mlO2/l
22/12	21:00	26 11.6	33 35.9	CTD 20	5	4.85
					25	4.88
					60	4.93
					130	4.99
					200	4.54
					420	24.19
					300	4.24
					400	4.23
					1540	4.27
					3075	3.49
					6125	3.96
					12190	5.54
30/12	23:30	36 27.0	12 28.9	CTD 34	5	5.75
					25	5.66
					50	5.61
					80	5.44
					120	4.98
					150	4.95
					1000	4.33
					2000	5.60
2/1	07:35	36 50.0	09 10.7	CTD-38	5	5.47
					200	4.73
					525	4.26
					600	4.52
					700	4.53
2/1	18:00	36 36.7	09 22.8	CTD-39	5	5.36
					600	4.09
					700	3.89
					1000	4.17
					1200	4.27
					1400	4.53
					2000	5.50
4/1	00:40	37 21.4	09 59.5	CTD-42	5	5.42
					100	5.44
					400	4.66
					800	4.44
					1200	4.28
					2000	5.52
7/1	22:50	38 25.8	09 57.4	CTD-44	400	4.654
					700	4.533
					1400	4.395
					2500	5.681
8/1	10:20	38 15.8	10 13.9	CTD-46	400	4.625
					600	4.348
					1100	4.202
					2500	5.658

8/1	13:45	38 10.1	10 29.8	CTD-47	400 600 1000 2500	4.773 4.385 4.163 5.663
8/1	21:26	38 21.9	9 58.7	CTD-49	400 500 1300 2500	4.579 4.442 4.296 5.654
9/1	01:23	38 23.0	09 43.5	CTD-50	400 800 1200 2123	4.879 4.354 4.257 5.495
9/1	07:40	38 27.4	09 54.7	CTD-51	400 700 1200 2500	4.666 4.311 4.222 5.626