CRUISE REPORT

RRS DISCOVERY CRUISE 193

30 JUNE - 1 AUGUST 1990

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Plymouth Marine Laboratory
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CONTENTS

List of Tables

List of Figures

1. PERSONNEL

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BLOOMER, Nick J.	"
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DOWIE, W.	SG1A
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2. SCIENTIFIC OBJECTIVES

To examine the internal tides generated on the Armorican slope, slope currents off North West Spain and the movement and productivity of the surface waters in the North East Atlantic. The cruise was, in part, collaborative with the GASTOM 90 experiment.

Specific Activities

1. To deploy 7 long term moorings on the Spanish Slopes.
2. To deploy 1 deep mooring on East Thulean Rise.
3. To deploy 2 short term moorings on the Armorican shelf and 2 deep complex moorings in the Bay of Biscay.
4. To deploy STABLE and 2 bottom mounted ADCP's near the critical point for internal tides on the Armorican slopes.
5. To deploy a number of drogued Argos drifting buoys, some in mesoscale eddies.
6. To measure the productivity of shelf, slope and oceanic waters.
7. To investigate the propagation of internal tides and mixing using ADCP, SeaSoar, Echo Sounders and ship's radar.

3. NARRATIVE

RRS Discovery sailed from Barry, South Wales at 1059/30 after a short delay because of a problem with the the lock gates (all times are GMT and the date is the day of June, 1990. Day numbers are shown on the Track Plot, Figure 1. 30th June is day 181. 1st August is day 213). Computer logging of all navigation, GPS, MX1107 satellite navigator and Decca to three Sun 3/60 computers was begun immediately, as was relative navigation using the EM log as soon as it was deployed. Logging of the Acoustic Doppler Current Profiler was also started. At 1740/30 the Precision Echo Sounder fish was deployed and continuous sampling and logging of surface parameters was begun.

At 0600/1 we passed the Wolf Rock and at 0800/1 we started a zig-zag course with 90° turns every 20 minutes for 4 hours across the Channel to facilitate calibration of the ADCP. At 1500/1 we hove to off the North coast of Brittany to rendezvous with a French naval helicopter to receive on board a French observer.

At 0620/2 we hove to at 47°13.9'N 6°12.05'W. CTDs and wire tests (station 12119) were carried out from 0639-1545/2.Between CTD dips at 0913/2 the productivity rig was deployed, the CTD program was also interrupted to allow a rendezvous with the French Navy Ship Alcyon at 1100/2 to enable us to receive some French supplied XBT's for use in the GASTOM 90 working area. On completion of wire tests the vessel steamed to the 123 (station 12120) mooring position 47°30'N 6°32'W and deployment of the rig took from 2035-2130/2 followed by a survey to establish satisfactory deployment. The next mooring position 124 (station 12121) at 47°29.3'N 6°31.9'W was reached at 2225/2 and deployment took from 2230-2310/2. After a short steam in a water depth of 380m STABLE was released at 0104/3 at 47°28.2'N 6°32.8'W. With the good weather continuing we were hove to on the first pop up ADCP station (12123) at 0428/3 and the 250 KHz rig was deployed at 0431/3. At 0532/3 we were ready at the second ADCP station (12124) on position 47°27.1'N 6°33.3'W and the 75 KHz rig was released at 0540/3 in 595m depth. On completion a search was started to recover the productivity rig deployed on the previous day. Being a bright calm day the rig was easily spotted and recovered at 0801/3.

After a short steam we reached the 122 mooring position (station 12126) at 0930/3 and commenced an acoustic search so that the mooring deployed on Discovery 181/89 could be recovered. By 1130/3 we had still not made acoustic contact with the mooring and the station was abandoned and a course set for the deep 125 mooring position.

Enroute to the deep mooring the first Argos satellite tracked buoy (No.3906) was deployed at 46°48.0'N 6°51.7'W (station 12127). The buoy was deployed from the stern at 1631/3 using the aft crane with the paraline then being payed out with the ship going slow ahead, finally the drogue and weight were slipped. We did encounter problems with this method of deployment with the drogue getting tangled and the deployment took much longer than anticipated. After deployment we kept station to check that both the buoyancy and the signal transmissions were functioning correctly and so that calibrations could be made. By 2020/3 all tests were completed and passage to mooring 125 continued.

At 2200/3 we were hove to at 46°39.0'N 6°56.4'W (station 12128) ready to deploy rig 125 in 4530m depth. During the night the wind strength increased to 5 - 6 exacerbating the difficulties of the deployment however by 0730/4 the deployment was completed. By 0930/4 the final survey of the mooring position was also completed and we started the steam to the 126 rig position launching an XBT every 30 minutes enroute.

Arrived at station 12129 1150/4 and first CTD cast was started at 1210/4 and completed 1227/4. Another XBT survey was carried out 1249-1544/4 from 12129 to 46°7.7'N 7°24.2W and back to 12129. Another CTD and wire test was carried out at 1626/4 but the CTD data link failed at 1800/4 at a depth of 4650m. The CTD was recovered and inboard at 2015/4. During examination of the CTD more XBTs were deployed. By 0323/5 the CTD was ready for launch again for another wire test, at 2700m the same fault on the CTD data link occurred but the wire tests were continued until 0616/5. Another XBT survey was carried out until 0852/5 the ship then hove to ready for deployment of the deep rig 126 in depth of 4670m. Deployment commenced at 0905/5 but at 1145/5 the winch hydraulics failed. We were able to resume at 1200/5 and deployment was completed by 1745/5, on completion of acoustic survey at 1840/5 we started the passage to the Spanish slope.

At 0823/6 CTD and wire test was started at rig 127 position 43°55.2'N 5°59.9'W (station 12130) and was completed by 0958/6. The rewiring of the 19 way connector of the CTD had appeared to successfully cure the earlier data link problems. At 1050/6 deployment of rig 127 was started and completed by 1232/6.At 1320/6 after the acoustic survey we started the steam to the rig 129 position at 1320/6. The ship was hove to at position 44°12.2'N 8°13.6'W (station 12131) at 2130/6 and deployment of rig 129 started at 2140/6. At 2320/6 it was necessary to move the ship slowly at 1 knot to regain the mooring position, deployment was completed by 0055/7.

At 0100/7 *RRS Discovery* set passage for Vigo to pick up domestic stores necessary for the rest of the cruise. The ship anchored in Vigo harbour at 1600/7, stores were taken on board and we weighed anchor at 1700/7 and made passage for rig 135 position.

Station 12132 was reached at 2115/7 and the CTD / wire test cast took from 2130-2157/7. Deployment of rig 135 (600m) taking from 2300/7-0010/8 with completion of acoustic survey by 0120/8. The PDR survey continued until gaining suitable depth of 1120m for rig 134 was located at 0330/8 (station 12133) position 42°04.1'N 9°27.8'W. The CTD / wire test took 0332-0433/8 and deployment of rig 134 from 0451-0633/8.

During the night the non toxic sea water supply had been giving problems with erratic supply and lots of aeration and gave up completely at 0635/8. We arrived at station 12134 at 0657/8 and commenced deployment of rig 133 (1600m) at 0823/8 and completed by 1005/8. The CTD cast was from 1035-1130/8 and on completion we began the 80 mile passage to rig 132 position.

At 1415/8 the ship was slowed to 8 knots to check on ADCP error. The non toxic supply was restored at 1430/8 and all surface sampling was put back on line. *RRS Discovery* hove to at 2305/8 at station 12135 and the CTD cast to 630m took from 2305-2336/8 , on completion rig 132 was deployed from 2357/8-0128/9 at position 43°26.3'N 9°26.7'W. After a short steam we hove to on station 12136 at 0235/9 and did a CTD cast from 0242-0318/9 to depth 1132m. Rig 131 took from 0510-0644/9 to deploy and on completion of acoustic range testing at 0837/9 we steamed back to the rig 129 position off La Coruña and did a CTD cast (station 12137) from 1553-1620/9 to depth 764m. On completion of CTD an XBT transect was completed from 12137 to position 45°6.0'N 8°03.2'W arriving at 2240/9. Here Argos buoy 3909 (station 12138) was deployed, this position was chosen because it appeared to be the centre of a clockwise gyre. After our earlier experience the method of deployment was changed to drogue first and buoy last. This proved to be a more satisfactory and relatively trouble free method. On completion of the buoy deployment a CTD cast was taken from 0008-0118/10 to depth 2027m at 45°07.7'N 8°02.1'W. An XBT run was then made from the eddy centre to position 45°44.8'N 7°32.7'W arriving at 0559/10. On completion of XBT run course 023° was set to rig 126 position in preparation for a SeaSoar deployment.

On arrival near the mooring site at 0935/10 the SeaSoar was deployed (station 12139). There were some problems with the faring alignment on the winch and veering the cable proved to be a somewhat slow and tedious business and so the SeaSoar was not fully deployed until 1104/10. The SeaSoar was towed at about 7.5 kts on 021° until 1730/10, then 031° until 1830/10 at 47°15.0'N 6°35.0'W when it was recovered. Once SeaSoar was inboard a search was made to locate Argos buoy 3906. We were unable to receive the transmission from the Novatech VHF beacon although we had obtained a recent position from Systeme Argos. The buoy was visually sighted at 2000/10 and grappled at 2026 and buoy inboard and drogue at the surface by 2230/10. The Hull of the Argos buoy was found to be badly damaged and the Novatech beacon was missing. The buoy was still operating and it was decided that an on board repair could be effected and the buoy re-deployed later during the cruise. It was decided to deploy Metocean Argos buoy 3907 at this station using the recovered drogue from 3906. The drogue was towed (at the surface) to deeper water (~3500m) to avoid deployment near the GASTOM slope moorings. This deployment completed by 0040/11 at position 47°04.9'N 06°39.9'W.

On arrival at 47°29.3'N 6°33.9'W (station 12140) the CTD was deployed from 0415-0432/11 to depth 290m, on completion *RRS Discovery* made rendezvous with the French Navy ship *Thetis* to disembark our French observer. The productivity rig was then deployed at 47°29.6'N 6°34.5W at 0615/11 in 297m water depth. On completion, operations began to recover and service the 75KHz bottom ADCP rig. The rig was located and the acoustic release operated at 0800/11, it was successfully grappled and inboard by 0904/11. An acoustic search of the area also confirmed STABLE was still in its deployed position.

At 1015/11 the ship was hove to adjacent to mooring rig 124 ready to deploy a Dhan buoy prior to the first CTD yo-yo over a tidal cycle. The Dahn buoy was finally deployed in the correct position (station 12140) at 1128/11 and the first CTD cast started at 1230/11. The tidal yo-yo continued until 0327/12 at which time the CTD was recovered inboard having completed 59 dips. After recovery of the Dhan buoy the productivity rig was re-located and successfully recovered at 0645/11 at position 47°29.3'N 6°42.2'W. The ship was moved to 47°26.8'N 6°33.5'W (station 12141) and the 75 KHz ADCP was re-deployed at 0830/11.

At 47°30.8'N 6°31.2'W SeaSoar was deployed at 1226/12 in water depth 220m and was towed on bearing 205° down the slope. At 1301/12 SeaSoar caught some of the remains of the Dahn buoy rigging, it was recovered undamaged and the line cleared and SeaSoar re-deployed at 1400/12. The transect continued to position 45°01.2'N 8°05.7'W and SeaSoar was recovered at 1225/13.

At 1230/13 *RRS Discovery* set course for the last known position of Argos Buoy 3909 and at 1300/13 it was sighted 1 nm ahead of the ship. The ship was moved to the estimated centre of the gyre at 45°03.6'N 8°02.4'W and a short CTD cast (station 12142) done from 1600-1700/13. The ship was then brought alongside the Argos buoy. There was concern about the functioning of this buoy because the data transmissions being received indicated that the rate of battery discharge was much higher than would have been expected. It was decided to recover the buoy to investigate the problem. With the aid of the ship's Zodiac the buoy was recovered without the drogue which was left in the water. At 1848/13 Argos buoy No.3918 was deployed in place of 3909 which was opened to examine the electronic package.

At 1929/13 on passage to the next buoy deployment and CTD an XBT survey was started with deployments every half hour. At 2355/13 we were on station 12144 at position 45°32.8'N 7°15.2'W ready for the deployment of Metocean Argos buoy 3919. With experience now showing the buoy was fully deployed by 0035/14, the fastest deployment yet. As soon as the buoy was clear and correct functioning ascertained, a CTD cast to 2000m was carried out and completed by 0215/14. This was followed by another half hourly XBT deployment run finishing at 0628/14 on position 45°58.0'N 6°31.9'W. At 0645/14 SeaSoar was in the water and fully paid out by 0720/14. The SeaSoar transect continued on a South Westerly course until 2101/14 when it stopped 'flying' correctly, it was recovered at 2145/14. On inspection of SeaSoar it was found that some plastic sheeting had got caught around the propeller. There being no damage, SeaSoar was re-deployed at 2344/14 and the transect continued until recovery at 0530/15 at 44°25.8'N 9°06.6'W. On completion *RRS Discovery* steamed at 12 kts for the Biscay Seamount, XBT profiles were completed on passage.

On arrival on station 12145 at 1349/15 Metocean Argos buoy 3916 was made ready and deployed by 1409/15. This was followed by a CTD on the same station and on completion at 1730/15 the 27 hour steam to the East Thulean Rise commenced. During the early part of the passage XBT profiles were taken half hourly until position 47°0.9N 13°22.7W was reached at 0703/16. The East Thulean Rise station 12146 was reached at 1748/17 and a CTD was taken from 1800-1930/17 followed by the deployment of SeaSoar at 2007/17. SeaSoar was towed on a North Westerly transect from 2030/17 until 0354/18.

At station 12147 51°30.9'N 22°04.8'W the CTD was deployed from 0438-0627/18. At 0724/18 the productivity rig was deployed on the same station, this was followed by another CTD cast at 0923/18 at station 12148 51°31.9'N 22°18.0'W. The next CTD at this station was combined with a pressure test the PML prototype submersible NO_2 sensor which was simply shackled to the CTD frame. The ship was moved to station 12149 and a CTD cast taken from 1230-1325/18. Another two CTD casts were taken at station 12150, 51°38.1'N 22°48.7'W and these were combined with another calibration test for the S4 current meter, test were completed by 1630/18.

XBT profiles were taken en route to station 12151 where another CTD cast was taken from 1811-1901/18. This was repeated to station 12152 with another CTD on arrival at 2030/18 followed by an XBT profile run to

22°58.6'N 22°58.6'W. SeaSoar was deployed at 0218/19 and towed on a North Easterly transect to 51°31.4'N 21°59.1'W finishing at 0725/19. On completion a course was set to locate and recover the productivity rig. After nearly 4 hours the rig had still not been located and the search was temporarily aborted to allow mooring rig 130 (station 12153) to be deployed.The mooring was deployed by 1714/19 in depth 3145m and the search for the productivity rig continued. At 2030/19 the rig was located and it was recovered by 2045/19 having drifted 30 miles from its deployment position and so far outside the DF range of its radio beacon that we only recovered it due to our estimation of it's probable direction of drift from the knowledge we had acquired about the currents in the area.

By 1730/20 the ship was hove to at 51°45.8'1 21°34.8'W ready for the deployment of four Argos buoys. Metocean buoy 3917 deployment was completed by 1812/20. Metocean buoy 3906 having been repaired on board was deployed at 1913/20 at 51°44.8'N 21°33.9'W. Metocean buoy 3909 having been fitted with a replacement diode and new battery pack was deployed at 51°44.5N 21°33.6W at 1953/20. The next buoy deployment was the French Argos buoy 5821 and as part of the GASTOM 90 experiment it was released at 2039/20 at 51°44.4'N 21°33.8'W. Course was then set for our return to the centre of Biscay and en route at 1800/22 in fog we made rendezvous with the French Navy ship *Eridan* and embarked the second French observer.

Station 12155, mooring 126 position 46°16.9'N 7°14.6'W was reached at 0610/23 and after the completion of two CTD dips to 2000m the productivity rig was deployed at 0815/23. Immediately the search for rig 126 was begun, it was located at 0850/23 and released at 0920/23, the rig sub-surface buoy was spotted on the surface at 0922/23. Recovery of rig 126 was accomplished using the foredeck system. A major problem was encountered in that the spinning of the thermistor cables around the wire caused some problems with tangling, nevertheless recovery of mooring 126 was completed by 1611/23.

Station 12156, mooring 125 position was reached at 2037/23 and the rig released at 2102/23 , the buoy was not sighted until 2305/23 and it was not until 0630/24 that the rig was completely inboard. Again there were problems with twisting of the thermistor cables around the mooring wire. At 0930/24 the productivity rig was successfully recovered and *RRS Discovery* set a course for the next SeaSoar station.

Having reached 45°40.1'N 7°20.7'W SeaSoar was deployed at 1330/24 and was towed on 019° until 0001/25 when it proved difficult to control the depth of SeaSoar. On recovery it was found that part of the bottom section of the tail on Sea soar had been ripped out. A serviceable repair made from plastic and plywood enabled SeaSoar to continue in use to the end of the cruise.

At 0442/25 the ship was hove to on station 12157 near the 75 KHz ADCP site, for a CTD cast until 0506/25. The productivity rig was then deployed at 0633/25 and on completion the ADCP rig was released and inboard by 0810/25. By 0840/25 we were hove to on the STABLE station which was fully recovered by 0910/25. After only a 15 minute steam the ship was over the 250 KHz ADCP station which after release surfaced at 0953 and was recovered by 1000/25. On completion the search began for mooring rigs 124 and 123. 124 was released at 1130 and recovery completed by 1212/25, 123 was fully recovered by 1341/25. Once the moorings were inboard *RRS*

Discovery returned to the STABLE position to grab for some bottom samples for calibration of STABLE. Using a Shipek grab (station 12157) this sampling took from 1500-1946/25. At 2000/25 the productivity rig was recovered. Another CTD cast combined with a test for the PML Nitrite Sensor was done at 47°30.5'N 06°36.7'W (station 12158) from 2117-2230/25.

SeaSoar was deployed again at 47°28.7'N 6°22.6'W at 0015/26 and was towed on a South South Westerly course . At 1315/26 the SeaSoar was towed through two solitons and at 1811/26 a slow turn was made to continue the tow on a reciprocal course. SeaSoar was recovered on reaching the next station (12159) at 0031/27. The first cast was combined with a test for the Nitrite Sensor, this was then followed by tidal yo-yo from 0315-1519/27 at 45°55.9'N 7°01.5'W. Another CTD yo-yo (station 12160) was then completed from 1758-2130/27 at 46°04.1'N 6°55.3'W.

On reaching 45°29.2'N 7°43.9'W SeaSoar was deployed at 0225/28 and towed South to position 44°45.7'N 8°09.2'W and was recovered at 2008/28. At 2115/28 (station 12161) IDB Argos buoy 5030 was deployed. The same method of deployment was used for these buoys as had been used on the Metocean Toga type, although the actual drogue arrangement was different due to the differing buoyancy characteristics of these IDB buoys. On completion the SeaSoar was again deployed at 2221/28 and towed on course 090° until a change of course at 0925/29 to 215° and was recovered at 1400/29 position 44°24.7'N 6°50.5'W. The ship then steamed to the next Argos deployment position at 44°49.7'N 8°20.0'W. A CTD cast (station 12163) was completed from 2253-2358/29 and IDB buoy No. 3918 was released at 2346/29.

All scientific deployments having been completed, at 0155/30 *RRS Discovery* set a course for the Brest Approaches. At 2000/30 we made our rendezvous with the French Navy Ship *Abeille Flandre* and said goodbye to our French observerand Bernard Le Cann. On the afternoon of the July 31 as we sailed past the North Cornish coast the re-calibration of the ADCP was carried out. The vessel was finally secured at Barry at 0048 August 1.

4. CTD VERTICAL PROFILING

Prior to the first station the spare ctd, serial number 1195, was installed which had an oxygen sensor fitted. Also the light meters were removed.

The system performed reliably throughout the cruise apart from one fault* that occured after the first few casts.

The 25 cm transmissometer,TR74, was displaying a low air value, about 3.5 Volts, and had a damaged XSG4BCL connector. The connector was replaced, but subsequently the IOS 1m transmissometer was used instead for which an adaptor cable had to be made. The 1m transmissomter with its better sensitivity appeared to give good results.

Tests were performed to acquire velocity data using an S4 current meter attatched to the std frame, both hanging below it and fixed inside the frame. In both cases the data looked very noisy particularly with motion induced by the frame.

Towards the end of the cruise, at the start of a ctd, 150m, yoyo the ctd was sent down with the sample bottles closed (vents only open). This resulted in three of the bottles imploding with the loss of three reversing thermometers

* Intermittent loss of data. Fault was in the wiring to the 19 way connector at the top of the electronics cage. This had to be completely rewired.

SeaSoar (CTD)

Nine runs were successfully completed, however we had several problems on the way.

The winch system is somewhat underpowered and the spooling and fairing alignment system was always liable to rip the fairing off. Considerable effort was required from the winch driver and helpers to keep the fairing reasonably intact. For the future some rethinking and modifications are needed.

By the 16th July the hydraulic unit was leaking oil and was replaced by the spare. At the same time the wing bushes were replaced and the left hand lug on the wing axle straightened (this made the wing action much smoother).

During run 6 part of the bottom tail section was ripped out with the loss of the bottom tail fin. The RVS/IOS Engineering staff came to the rescue and rebuilt the tail section. Tail fins were made, mk1 plastic, MK2 plywood to keep the operation going. MK2 tail fin lasted to the end of the cruise.

Three points to be noted :-

The defective hydraulic unit has water in its pump unit; also, the replacement unit needed air removed from its bellows before it could be used.

The SeaSoar tailsection needs to be of a stronger construction.

During the SeaSoar operation the mechanical engineering support from Kevin Smith and Steve Whittle was crucial.

S4 Current Meters

Three out of four deployed have produced good records, serial numbers 05451262/3/4. S4 serial number 05111117, only gave three days data but the numbers did not make sense although it appeared to be cycling correctly ?

EM Log

Towards the end of the cruise starboard side transducer failed (see Marinet message to RVS). We used port side system for the rest of the cruise.

Autosal

The system worked well, even at 32°C ambient. We were slightly hampered by a problem with the softsal interface, but still got good data sets. These suggest that CTD 1195 (profiling) is about 0.015 psu low, and CTD (SeaSoar) is reading about 0.023 low. This would suggest that serious thought should be given to providing more effort for regular conductivity sensor calibration at RVS. (note temperature calibrations were ok).

B.J.M.

5. CTD AND SEASOAR CALIBRATIONS

a) Deep CTD (ser.no 01-1195)

The basic set of calibration coefficients were obtained from RVS at the start of the cruise and were stored in the file "deepctd.cal". A recent (19.4.90) calibration done at RVS was also applied to temperature (offset the cruise interim offsets of +.002°c and +.015 were added to temperature and salinity respectively. These figures were the result of comparisons with corrected digital reversing thermometers and salinity bottles and were applied to all the data so far collected with the PSTAR programme "pcalib" after all the initial processing leg,(e.g. with deepctd.cal) had taken place. A second, refined calibration was achieved after a further 10 days by comparing with data from the thermometers and salinity bottles covering a greater range of the parameters concerned. The new ("total") calibrations, applied with pcalib and replacing the single offsets above, were, for temperature, offset +.008, scaling +.99948, and for salinity, offset +.21193, scaling +.9945. These new calibrations agreed closely with those applied previously for the parameter ranges found in the early part of the cruise (temperatures 10-17°C, salinities 35.5-36.2 psu) but extended the fit down to about 4°C and 34.9 psu respectively. These new calibrations were applied to all subsequent data (but not to that collected previously, as detaled in the log sheets), and we believe should ensure accuracy to typically +/-.001°C and +/-.002 psu. In addition a pressure offset of -6.2 dbar was applied at this time. The fluorometer (Aquatracka) was scaled to represent the mV output from the photomultiplier, the transmissometer (1m, Seatech) to give representative deep water values (68-69%), and the oxygen sensor to give sensible readings, but no calibrations of these instruments were undertaken by comparisons with data. (Note that a 0.25 m path length transmissometer from RVS was used initially, but was drifting badly).

b) Shallow CTD (SeaSoar)

Again a file of basic calibration coefficients ("shalctd.cal") was obtained from RVS. An initial calibration was undertaken by towing the SeaSoar through a region of "mode" water (of uniform properties) and comparing with a CTD profile in the same area. This indicated an offset of +.001°C for temperature and +.037 psu for salinity. This was applied with the "pcalib" programme to all data so far collected in a similar way to that for the deep CTD. A second, improved, calibration was later obtained by comparing with salinity bottles, and yielded a new (total) offset of +.023 psu for salinity, which was applied to all data subsequently collected as described in the log sheets. Again, the fluorometer and oxygen sensors were treated in a similar way to that described for the deep ctd. Note that both ctd's on this cruise were under-reading for salinity (by about .015 and .023 psu as described above) and it is recommended that new calibrations for conductivity be carried out on both these instruments.

N.B. Later analysis showed that the +.037 psu offset was in fact the optimum calibration for the SeaSoar.

6. ACOUSTIC DOPPLER CURRENT PROFILER

Two configurations were set up and used on this cruise:"alnshelf", having 64 x 8m bins and bottom tracking for work in shallow water (bottom tracking to 730m achieved), giving typically 50 pings per ensemble (set to 2.5 minutes), and "alnocean", having 64 x 8m bins and no bottom tracking, for deeper water, giving typically 90 pings per ensemble. The ADCP software was version 2.34.

Data was transferred directly to the RVS computer systems and then processed with the PSTAR suite of programmes. Although this worked well for the most part, there were several gaps in the data (mostly less than 10 minutes in duration, but occasionally longer) caused by system faults. The ships heading was input directly into the ADCP from the master Sperry gyro in the gravimeter room and tests (averages over 2 minutes) showed an agreement to within +/- 0.5° (but note that the repeater gyro in the scientific plot room typically over-read by about 1.3°). Two calibrations of the ADCP were performed, in shallow water at the beginning and end of the cruise, during periods of full GPS. The first of these gave a mean scaling factor of 0.984 and a misalignment angle of 2.2° for the water track velocities. The second calibration had not been worked up at the time of writing.

Owing to recent problems with the operation of the instrument, all junction boxes between the transducers and deck unit have been removed giving a direct connection, the operating machinery is now simplified to enable deployment of the hydraulic ram, and the Asdic pod has been removed so that the transducers are open to the water. This enabled the quick (in about 2 minutes) deployment and recovery of the transducers to about 1.5m below the ship's hull, and the ADCP was run in this configuration for the duration of the cruise (apart from a short recovery at Vigo). On the present cruise there was no evidence of spurious near surface velocities aligned with the ship's track (as had been seen on cruise 181, with the transducers retracted), and this improvement was almost certainly due to steaming with the transducers extended. Tests showed that the hydraulic ram had not rotated noticeably (i.e. any rotation would have been less than 0.5°) throughout the duration of the cruise, and that the apparatus was able to be firmly locked in the same position after Vigo. Further, steaming at 12.5 kt was undertaken with the transducers deployed with no ill effects to the ADCP machinery or subsequent data quality. Consequently, it is strongly recommended that all cruises should be run with the transducers deployed.

Apart from occassional poor data when pitching into heavy swell off the Spanish coast, the only problem of note was a spurious negative vertical velocity of up to 20 cm s^{-1}, at 100-150m depth and associated with fluctuating horizontal velocities of about this order. This was correlated with and almost certainly caused by the rise of a scattering layer (zooplankton) to the surface at night, and was apparent only for four nights during the western-most section of the cruise. In addition, we also noticed that the top 2-3 bins contained negative vertical velocities throughout the duration of the cruise, and that elsewhere the vertical velocity, comparable with the error velocity, was typically +8 cm s^{-1} when steaming, but 0 cm s^{-1} when on station.

7. DATA PROCESSING, PRESENTATION AND ARCHIVING

As on previous cruises, data collection and processing was done on the three level A,B,C system devised by NERC Research Vessel Services. Data records from the various instruments and sensors were collected by level A interfaces, time stamped and immediately archived on the level B half inch magnetic tapes for primary back-up. Some processing of the data, including presentation, was done on the RVS level C system with the data being held in RVS data format. Raw and processed data were archived onto quarter inch magnetic cartridge tapes by the unix tar command. All navigation processing was completed on this system together with outputs from the thermosalinograph, meteorological sensors and surface nutrient sensors. A useful form of presentation via this route was track charts with surface values of temperature, salinity and nutrients both annotated along the track and plotted as a displacement from the track. Another useful plot was depth/time profiles for SeaSoar runs and CTD tidal yoyos with a parameter, usually temperature , colour coded on the trace.

One of the three level C Sun unix workstations was made available for further processing of data by the p-star collection of data handling programmes. Data in the RVS level C format was converted to p-star format by the datapup routine. Data transferred in this way included the Acoustic Doppler Current Profiler output (running continuously throughout the cruise), 35 CTD stations to various depths, three of which were tidal yoyos, 9 SeaSoar deployments of various durations and 213 XBT drops. Navigation was required for use in the processing and the file bestnav was transferred for this purpose.

The processing largely followed the routes taken on previous cruises (cruise 189 onwards) and much use was made of unix shell scripts to routinely process and plot the data. At the start of the cruise, the shell scripts were altered to accommodate changes in the sensors available on the CTD and SeaSoar, their calibrations and particular requirements of the present cruise. Details of the procedures followed for CTD, SeaSoar and ADCP are detailed below.

P-star binary data was archived by the use of the ddarchss routine onto quarter inch cartridge tapes. Several attempts were made early in the cruise to produce GF3 format half inch tapes of the calibrated data but failed with unknown problems with the tape drive. During the last few days of the cruise RVS staff managed to partially overcome the problem but by then most early data had been erased from the disks.

While accepting the existence of finite resources, three major bottlenecks should be reported for future consideration. One workstation for non-RVS use was inadequate, it was necessary to have three or more windows active for routine processing, plotting and archiving to maximise system use while slower human interaction took place for editing and setting up suitable plotting controls. Also during the cruise an important major feature was the use of satellite images to plan the cruise programme details on a day to day basis. While this was being done over many hours, routine processing was limited to the use of an IBM pc as a terminal, with no screen graphics available.

Another major bottle-neck was the nicolet plotter. Each 12 hour ADCP or 4 hour SeaSoar section needed 9 or more routine contour or profile plots even before editing, gridding and final presentation. Careful scheduling of plotter use was necessary to ensure maximum throughput. Had any major fault occurred the data processing would have been severely set back. It was continuously necessary to juggle with the disk space available for p-star. Some larger appended files had to be deleted and remade or recovered from tape only a day or two after they had been originally produced. At the start of the cruise copies of files to be archived were made in a separate directory, but this was a luxury that had soon to be abandoned, making the archive process more complicated and prone to error. Two copies of each archive tape were maintained to avoid data loss due to human or mechanical errors.

It is a pleasure to acknowledge the competent and helpful work of the RVS computer staff David Beasley and Paul Duncan on this cruise and to thank Steven Alderson of IOSDL for pre cruise tuition on the use of the p-star system of data programmes.

D.K.G.

8. SATELLITE IMAGES

Available infra red and visible images from the NOAA satellite were selected at the NERC IA Unit in Plymouth, transmitted to Barry and then to *RRS Discovery* via the Marinet system. The compacted images, received on a PC, were transferred to the ALV package on the Sun network. This package allows the pixel colour range to be interactively modified to enhance features of interest such as fronts and eddy structures. Colour hard copy was obtained on the thermal transfer plotter.

Although an apparently expensive procedure, the reception of these images proved a great bonus in the real time planning of the cruise, saving a lot of ship time in surveying a region of interest for example to determine the optimum position for deployment of drifting buoys.

Problems and possible improvements

In order that the images can be used in dynamic cruise planning, they should be available on the ship in hours rather than days, the delay being a particular problem at weekends. Perhaps a reduced resolution set of all available images would allow some selection on board, the obviously useful ones being sent at full resolution. The buoy release near 52°N would have been chosen differently had an image that was requested repeatedly been sent; a great opportunity lost.

It would be useful if the alv package allowed other data to be displayed on the image. Of obvious use would be bathymetry and ships track, perhaps with TSG or ADCP data.

9. SURFACE CHLOROPHYLL AND NUTRIENTS

On arrival it was found that the IOS flurometer had been removed. The only replacements available were back at PML consequently the old Chelsea fluorometer and an in-house made flurometer were collected prior to sailing. There were disadvantages to both instruments. The Chelsea instrument has a log output and had been set up for estuarine and inshore measurements and had not been used for some years. Initially then the low chlorophyll fluorescence was not registering until the locked back-off potentiometer was freed and the base-line adjusted. Because of the log output with this system care must be taken that the pen recorder agrees with the fluorometer output. The disadvantage of the home made fluorometer is the low flash-rate which gives a very noisy output. Neither system had been recently calibrated and samples were filtered throughout the trip for a post-cruise calibration. Once these problems had been solved the Chelsea, in particular being inherently more precise, worked satisfactorily. Without a calibration it is impossible to give accurate figures for chlorophyll concentration but it is estimated that the surface chlorophyll was less than 1μg l^{-1} for all of the cruise except at the East Thulian Rise where the concentration rose to 2-3 μg l^{-1}.

The Technican Autoanalyzer was already set up on board *RRS Discovery* from previous cruises. On cruise 193 only nitrate and nitrate concentrations were to be measured. The nitrate channel operated well throughout the cruise but, a week into the trip when running standards, it was noticed that, unusually, the nitrite channel had developed a sluggish response and had become noisy at higher concentrations. The cause of this was a breakdown in the bubble pattern and, although this channel was re-plumbed with new tabing and a new blubber, the fault could not be corrected. This will not invalidate the data; the concentration of nitrite in the surface sea-water was always too low to be affected by the noise and the four minute increase in maximum colour formation can be allowed for in the data reduction. Except in frontal regions the nitrite concentration was only approximately 0.03 μM and never exceeded 2 μM. For the last 2/3 days of the cruise the base-lines of both nutrients showed continuous drift. It was suspected that the lamp outputs were varying after such a long period of continual use.

M.B.J.

10. IRRADIANCE, LIGHT ABSORPTION AND PRIMARY PRODUCTIVITY

Of the seven opportunities to deploy the scalar irradiance array and primary productivity two were rejected. The first due to weather, a force 6 blowing and increasing forecast, together with the fact that deployment could not start until midday which would possibly light shock the phytoplankton. The second site was rejected on the grounds that it was in the middle of the south bound shipping lane around Cape Finisterre and it was considered too risky to leave the rig unattended for 24 hours whilst the ship went into Vigo in such a busy area.

A successful 24 hr deployment was made on 2/7/90 (47° 30.12N 06° 12.04W) and was successful for primary production but the logger failed and no light records were obtained. This intermittent fault has not yet been isolated but is thought to be either a transmission error or 'bounce' in one of the magnetic reed switches. The next deployment was on the 18/7/90 (51° 30.31N 22° 03.87W) on the East Thulean Rise. No sign of the rig was found at dawn on the following day and the equipment was finally located and recovered after 12 hrs searching in position 51° 00.6N 21° 49.08W having travelled over 31 n m in 36 hours. Twelve of the thirteen light sensors had worked successfully for the whole period but the deepest (60m) had failed due to the amplification circuit board shorting probably due to condensation rather than a leak. It is unlikely that the primary production results will be valid for a 48 hr deployment. The logger also failed on the fourth deployment (46° 16.67N 7° 14.83W) due to the failure of 9 of the 27 "C" cells in the battery pack. These were new Duracell batteries and as the other 18 showed very little voltage drop it would appear that the failure was due to faulty manufacture. The final deployment on 25/7/90 (42° 26.19.2N 06° 33.057W) was a successful experiment from dawn to dusk, however the filtering of the C^{14} samples on the following day was delayed by the expediencies of SeaSoar driving therefore the apparent respiration rates will be enhanced.

Water samples were taken on seven days from 9 depths (2, 5, 7, 10, 15, 20, 30, 40 and 60 m, the same depths as the primary productivity experiments) to study the spectral values of the absorption coefficients of the various absorbing parameters. As expected the absorption by dissolved organic matter was low at all stations. More surprisingly the ratio of absorption by detrital material to the absorption by phytoplankton pigments was similar to that found in coastal waters though, naturally the absolute values for both components was considerably less. Water samples were also filtered for subsequent spectrophotometric / H.P.L.C. analysis of the extracted pigments.

M.B.J.

11. ELECTRONICS REPORT

This report is in two sections. The first deals with the testing of the Argos buoy test and location system developed at PML (Citadel Hill) by Mr J W Wood. The second section deals with the A.R.E. contract submersible prototype nitrite (NO2) sensor developed at PML (West Hoe) by Mr N Bloomer.

Section One

A local ARGOS data retrieval system has been developed which uses a BBC model B microcomputer in conjunction with TOYOCOM transmitter test set. This system was develpoed primarily for the local test and calibration check of Argos drifting buoys before and after deployment. The time lag associated with aquisition of data from Systeme Argos causes serious operational problems at sea when buoys may be deployed at short notice. The local data retrieval system develpoed at PML overcomes this problem and prevents the total loss of deploying faulty equipment.

The PML system is also equipped with signal strength monitoring and was used for buoy location with a rotatable directional aerial. During the cruise the hardware was tested and control software compiled.

Three main BASIC control programs were produced as follows :

1. TOYREAD-2

The HEX ID for the ARGOS buoy is entered via the keyboard. The program calculates the decimal ID and displays this on the VDU as a cross check. When a signal is received which carries a matching ID the program produces a printout of ID no., signal strength on an arbitrary scale, time since last reception, and data from all 8 data frames.

This program is used immediately before and after deployment of a buoy to check that valid data is being produced before its final release. Due to the range of different sensors fitted to the buoys the data is left as raw decimal and no scaling is carried out.

2. BUOYSEEK

This is a manual buoy seeking program using the aerial rotator. Again the HEX ID no. for a specific buoy is entered via the keyboard. On receipt of a signal a printout is produced of buoy ID no., signal strength on a arbitrary scale, aerial bearng, and time since last signal update. The operator is then given the opportunity to rotate the aerial. If this option is not taken within 20 seconds then the program 'times out' and reverts to seeking a signal at the existing aerial bearing. The system can therefore be left unattended.

3. AUTOSEEK-2

This is the first attempt at a fully automatic version of "BUOYSEEK". Similar to "BUOYSEEK" but the computer makes the decisions about aerial bearing based on change in signal strength at each signal update. The results are plotted as a vector display on the VDU. Printer hard copy is also produced.

General remarks :

1.These three programs now seem to be free of bugs and there were no problems with the 1 MHz BUS interface hardware which all worked according to design. A set of BASIC procedures were produced for each primary function of the system and these are used in all of the control programs. The procedures are fully discussed in the WORDSTAR document BBCPROCS.TXT held on record at PML (Citadel Hill).

2.Aerial rotator failure

It was not possible to carry out a long-term field test of "BUOYSEEK" or "AUTOSEEK-2" due to premature failure of the aerial rotator gearbox. The quality of this leaves a great deal to be desired. This cruise was its first deployment outdoors-previous operaton had only been in the lab although it was clear that the gearbox wearing rapidly (it uses a mix of brass and steel gears) prior to the cruise. At this stage of the project development there was insufficient time remaining to consider a better quality rotator as complete redesign of the motor drive circuitry would have been required.

A housing produced by Citadel Hill workshop, although intended to alleviate the gearbox problem by virtue of an additional bearing further up the mast, did not help. This was undoubtedly due to a misalignment between this new gearbox and the rotator gearbox.

Despite the job request for the rotator housing being handed to the workshop in April with desired completion date mid-May the work was not completed until four days before cruise departure at the end of June. Therefore there had been no time for test and positive modification of the housing.

The delay in the workshop appears to be due to the large amount of building work and room changing taking place at the time with furniture removal taking priority over cruise preparation. There seems to be some problem with interpretation of the priorities established by senior management here.

3.Battery failure and subsequent repair of Metocean buoy 3909/3D163 :

This buoy was first deployed on 9/7/90 after being fitted with a new battery pack. On returning to the buoy on 13/7/90 it was found that the battery voltage had been to less than 14 volts (15.2 volts originally). This rapid fall was unusual and it was decided to retrieve the buoy for further investigation. The Argos transmissions from the buoy were otherwise normal, and no change in signal strength or repetition rate was apparent.

It was discovered that there was a bad connection in the battery pack as supplied by the manufacturers. this had clearly fractured completely during deployment resulting in the buoy operating with less than 15% of its normal battery capacity. A repair was made and the buoy was restored to full working order. It was deployed on 19/7/90.

It should be noted that during this period no data had been forthcoming from ARGOS due to ship/shore communication problems. All the diagnostic checks were amde using the new BBC based system.

4. Failure and subsequent repair of IDB buoy 5033/4EA7D

This buoy had been fully serviced before leaving PML after being cast ashore near Dartmouth, South Devon. The fibreglass housing had been repaired by IDB and a new battery pack fitted at PML. On 18th July a routine check of buoy activity revealed that this buoy was not transmitting.

The buoy was stripped down and it was found that the main supply switching transmitter had failed. This was replaced and the buoy was restored to full working order. it is possible that high temperature in the buoy housing caused premature failure of the transistor - the buoy had been operating on deck in full sun.

5. System improvements

Although the Toyocom receiver was responding to buoy transmissions at a range of 5 to 6 miles the signal strength was below the measurement threshold until the range was less than about 1 mile. More gain is required in the measurement circuit.

To improve the range of the system a mast mounted UHF preamplifier could be considered. This would need to be switchable to avoid overload of the Toyocom receiver at close range.

It is felt that the existing Yagi aerial is a little too directional and requires rather precise orientation for maximum signal strength. A small angular movement, such as a slight shift in the ships bearing, leads to a large and possibly misleading change in signal strength. An aerial with fewer director elements may well give better overall performance. It would also have the added advantage of being lighter and cause less mast rotator wear.

To overcome the mechanical problems with the aerial mast rotator a switched aerial array could be considered. This would consist of three directional aerials mounted 120 degrees apart. These would be switched sequentially, signal strength measured from each aerial, and the three values obtained added vectorially to produce the resultant bearing of maximum signal strength.
The WS Ocean Systems HFR-3 direction finding system uses a technique similar to that proposed above but with four simple whip aerials mounted

at 90 degrees apart. This system gives very misleading results due to the reflections and parasitic re-radiation from the ships superstructure and was found to be near useless in practise.

6.NOVATECH VHF BEACONS

The NOVATECH VHF beacons attached to some of the buoys and rigs are quite effective and the hand-held locator (the magic broomstick) is reliable and is easy to use. The use of the VHF gives a greater range across open water than the UHF ARGOS signal which can suffer severe attenuation in poor weather conditions.

The principal advantage of this system is its portability. The operator can usually find a position on deck which is not shielded by ship's superstructure and a good directional fix can be obtained.

The life expectancy of these beacons is rather limited due to battery capacity and they were only used for short deployments. Care must be taken to ensure that an aerial matched to the crystal frequency is fitted. A miss-match here can limit the range of the beacon - a range of 12 miles has been reported in good conditions with a properly matched aerial.

One beaccon was lost completely on the first deployment of buoy 3906/3D089. The single bolt attachment of the beacon to the buoy was felt to be inadequate - it appears that the beacon fell off. A two point fixing would be easy to devise and give greater security.

Section 2

A.R.E. Contract prototype submersible NO2 sensor.

Due to the late delivery of component parts it was not possible to assemble or test the pressure housing of the sensor prior to the start of the cruise.

After initial preparation and assembly of the components parts of the pressure housing, the sensor cylinder was tested to a maximum depth of 150 metres at increments of 5, 10, 50, 100, and 150 metres. on successful completion of this stage the sensor electronics were wired and the loom connections completed. The system was then benched tested. Two forms of noise were found to be present, that of electrical pump noise, and noise due to hydraulic problems in the cell. Rewiring of the pump earth return and filter circuitry has proved effective in the case of the electrical noise. However the hydraulic problems are only partially resolved and a new cell will probably need to be constructed. The reference side of the cell appears to have either some particulate matter in it or a minor leak as it causes a small but definite signal when fluid is passed through it. Also it appears that with the fine tubing used, the transition from this to the relatively large volume of the cell, it was difficult to get smooth and consistant peak heights. With a length of relatively large bore tubing placed before the cell the situation was improved to a point where the cell was usable on the bench with a resolution of approximately 0.01uM N-NO2. This was achieved with the chart recorder set to 100mV FSD and damping circuitry in the photometer output but this arrangment will not be suitable for use with the standard Chelsea Instrument logger. However three dips were completed to 60 metres but they proved inconclusive due to the first one being complete before the variation in peak height was understood, the second due to a variation in baseline, and the third suffering from a blockage causing a total loss of sensitivity and large baseline shift.

Despite the problems encountered in its felt that progress has bween made and that given time these problems can be conclusively resolved.

J.W.W
N.J.B

12. MOORINGS

Mooring operations carried out on the cruise were of two types;

1. Duration of the cruise.
2. One year duration.

1. DURATION OF THE CRUISE. Moorings 123, 124, 125, and 126.

Operations

Moorings 123 and 124 were designed at IOSDL as subsurface 200m and 300 rigs incorporating instrumentation from IOSDL, MAFF and RVS with wires and fittings from IOSDL and buoyancy from POL. All the components were brought together on the cruise and deployment and recovery proved successful from the foredeck system.

Moorings 126 and 125 also designed at IOSDL are of the "Complex" design successfully deployed on previous cruises. Mooring 126 was designed at IOSDL with instrumentation allocated from IOSDL, POL and MAFF. Lines and buoyancy from IOSDL and RVS. Acoustic releases from RVS.

Mooring 125 was designed at IOSDL in skeleton form, being finalised onboard to optimise the available equipment. Instrumentation used was supplied by IOSDL, MAFF and RVS. Lines from IOSDL and RVS. Buoyancy and acoustic release from RVS.

Deployment of 125 and 126 was anchor first from the foredeck system, unlike previous "Complex" deployments which were are all buoy first. The reason for this change was that in previous deployments prestretched and measured Kelvar line had been available from IOSDL, whereas for this cruise untensioned Paraline was to be the main line component. Thus to save time being measured on deployment was adopted. This proved very successful and deploymetn operations although of long duration were completed without any major problem. One point to be investigated for future moorings of this type is the attachment of the Thermistor cables to the smooth Polyproplene jacket on the wires, the previous practise of plastic cables ties providing insecure and the use of PVC insulation tape had to be resorted to.

Recovery of 125 and 126 was accomplished on the foredeck system. A major problem encountered was the spinning of the Thermistor cables around the wire causing many turns to be passed around the long mooring wires. A future rig of this type should incorporate shorter wires which can be stopped off to remove the turns in the Thermistor cables.

The foredeck DBC worked well on these operations with two reelers, IOSDL and RVS, being used. However the reelers have limited capacity and torque and an enlarged system would greatly improve the spooling and handking of the lines. a rereeling system to remove the lines to lightweight drums is desirable as this operation at present has to be performed by hand, a time consuming and manpower intensive operation.

My thanks go to Clive Washington whose patience and persistence in the procurement of the many items used in the moorings and his skill in desk operations made this operation so successful. Also to Ron Easton for his professional assistance throughout the deck operation.

Instrumentation

A brief summary of instrumentation deployed is shown below, comprehensive details of type and location are given in the Mooring sheet and Current meter timing sheet. The summary below indicates the successful cooperation between laboratories to produce such an array of instruments brought together to support this deployment. Only the most minor of adjustments was required to any of the instruments supplied and preliminary raw data dumps made on-board indicates good data return. Calibrations are to be made on all instumentation through autumn and winter 1990.

<u>Mooring 123.</u>

ACM 421 IOSDL.
ACM 7643 IOSDL.
S4 05451262 RVS.

<u>Mooring 124</u>

ACM 7765 IOSDL.
ACM 8511 MAFF plus Transmissometer RVS
S4 05451263 RVS.

<u>Mooring 125</u>

ACM 9481 MAFF.
ACM 9124 MAFF.
ACM 9680 POL.
ACM 9650 POL.
ACM 9107 MAFF.
ACM 9106 MAFF.
ACM 9569 RVS.
S4 05451264 RVS.
TL 806 IOSDL.TC 1723 IOSDL.
TL 925 RVS. TC 1393 RVS.
TL 926 RVS. TC 1680 RVS.
TL #1 MAFF. TC 1620 MAFF.
TL 879 IOSDL.TC 1722 IOSDL.

ACM 1259 IOSDL.
ACM 7943 IOSDL.
ACM 9483 MAFF.
ACM 6372 IOSDL.
ACM 420 IOSDL.
VACM 627 IOSDL.
VACM 666 IOSDL.
S4 05111117 RVS
TL 772 IOSDL.TC 1790 RVS.
TL 825 POL. TC 200m POL.
TL 561 POL. TC 400m POL.

2.ONE YEAR DURATION MOORINGS

A total of eight long term moorings were deployed.
Moorings 127, 129, 130, 131, 133, 134, and 135.

Designed at IOSDL long term techniques with all equipment being supplied by RVS. The preparation of the mooring hardware was carried out at RVS and also onboard Discovery Cruise 189 using materials specified by IOSDL.

The mooring deployments were all anchor first from the foredeck system and went very smoothly.

Ranging trials were conducted on Oceano acoustic releases and appear very encouraging.

A further trial of the coating of an IOSDL steel sphere is underway on mooring 130 to investigate two year duration moorings.

Instrumentation

Recording current meters of Aanderas manufacture are used throughout. Types RCM 8 being fitted with Lithium main battery packs developed for this deployment.

A summary of the instrumentation deployed is given below;

Mooring 133.	Mooring 134.	Mooring 135.
9422 1000 psi	6751 1000 psi 11-16	9416 1000 psi
9971 9-12	9970 9-12	9972 9-12
3258 -2-22	9612 9-12	

Mooring 131.	Mooring 132.	Mooring 130.
9423 1000 psi	9440 1000 psi	9966 1000 psi
9347 9-12	9352 11-16	9441 5-8
9973 9-12	9579 9-12	9439 3-5

My thanks to Simon Watts, RVS, for setting up the special temperature ranges and for his calibrations of the instruments at IOSDL. Also for his production of a PC based program to assist in the selection of components for special temperature ranges.

Mooring 123

Deployed.02-07-90.Day 183 Recovered.25-07-90.Day 206.

GPS. 47 31.05 N. 06 31.95 W. 2127 gmt.
47 31.4 N. 06 31.95 W. 2140+48s.Transit fix.

Water depth 200m.

Recovery line 15. 18mm 1 x 11" MWC. In water at
Steel sphere 40" POL.#xx. Cut away at 2131.
Chain 13mm 0.5m. Grappled at
Swivel 10/7 Gunnebo
Wire 8mm 10m.
ACM #421 IOSDL. Rotor release.2100+33s.In water. 2102+29s.
Rotor stop. 1351+30s.Out water.1349+20s.

Wire 8mm 59m.
S4 #05451262.RVS In water. 2053+01s.
Out water.1355+20s.

Wire 8mm 59m.
ACM #7643 IOSDL Rotor release.bf.2039. In water. 2043+50s.
Rotor stop. 1402+10s.Out water. 1400+01s.

Chain 13mm 0.5m
Oceano transponding release.#49.RVS In water. 2043+50s.
Wire 8mm 5m. Out water.1400+03s.
Anchor 400 kg.

Deployment anchor first.Foredeck DBC and A frame.

Deployment.Pingree, Easton, Waddington, Washington.

Acoustic details.

Preparation. Washington.RVS.Oceano #49.Disable EA37.Release EA38
The mooring was sighted on the surface although Disable code only had been transmitted. Requires further check on instrument data to determine release time.

Mooring 124

Deployed.02-07-90.Day 183. Recovered.25-07-90.Day 206

GPS. 47 28.8 N. 06 32.7 W 2227 gmt.
GPS. 47 28.86N. 06 32.48W 2256 gmt.
GPS 47 28.89N. 06 32.45W 2301 gmt.
47 29.3 N. 06 31.98W 2301 gmt.Transit DR 0103.
Water depth 305m.

Recovery line 15m 18mm 1 x 11" MWC.
Steel sphere 40" POL. In water at
Chain 13mm 0.5m. Cut away at 2301.
Swivel 10/7 Gunnebo
Wire 8mm 10m.
Acm #7765 IOSDL Rotor release.2248+40s.In water. 2250+34s.
Rotor stop.1200+30s Out water.1155+40s.

Wire 6mm 76m.
S4 #05451263.RVS. In water. 2241+45s.
Battery pack flooded. Out water.1203+09s.

Wire 6mm 76m.
ACM #8511 MAFF Rotor release.2230 In water. 2234+40s.
+transm.Unplug.1407+30.Rotor stop.1214+00s. Out water.1210+40s.
Chain 13mm 0.5m
Oceano transponding release.#48.RVS.Released at 1129+40s.
Wire 8mm 5m. Surface at 1130+30s.
Anchor 400 kg.

Deployment anchor first.Foredeck DBC and A frame.

Deployment.Pingree,Easton,Waddington,Washington.

Acoustic details.
Preparation.Washington.RVS.Oceano #48.

S4 preparation.Miller.

Mooring 125

Deployed. 03/04-07-90.Day 184/185.
Recovered.23-07-90.Day 204   24-07-90.Day 205.
GPS.46 38.06 N.   06 50.24 W.   0613 gmt.
GPS.46 38.07 N.   06 50.22 W.   0616 gmt.
Water depth.4542 acoustic metres.

Anchor 550 kg.   Over at.2211.03-07-90.
Wire.8mm.   10m.
Acoustic Release.Oceano 53.RVS. Over at.   2222+15s.
Out water.   0627.

Paraline.8mm.	500m.Measured	538m		539m.
	500m.	1070m.		525m.
	500m.	1601m.		525m.
	500m.	2140m.		531m.
	300m.	2459m.		313m.

ACM 9481.Rotor free. 2334+34s. In water. 2337+58s.
Maff.   Rotor stop. 0502+04s.Out water. 0458+20s.
Paraline.8mm.   200m.
ACM 9124.Rotor free. 2350+30s. In water. 2355+11s.
MAFF.   Rotor stop. 0449+00s.Out water. 0445?
Paraline.8mm.   100m.
Thermistor logger.806.IOSDL.   In water. 00147?04-07-90.
Out of water.0431.
Thermistor chain.1723.IOSDL.100m length on 100m 6mm jkt.
Thermistor times.   0018+10s.2.
0021+34s.3.
0026+04s.4.
0030+10s.5.
0035+31s.6.
0040+42s.7.
0046+30s.8.
0052+28s.9.
0059+00s.10. Out of water.0348.

Paraline.8mm.   100m.
ACM 9680.Rotor free. 0106+54s.   In water. 0130+37s.
POL.   Rotor stop. 0343.   Out water. 0337.
Swivel.Gunnebo 10/8.
17" glass x 4.Benthos on 13mm chain.
Paraline 100m.
ACM 9650.Rotor free.0141+44s.   In water. 0149+13s.
POL.   Rotor stop.0336+30s.   Out water. 0322+10s.
Thermistor logger.925.RVS.   In water. 0149+13s.
Out of water.0322+02s.
Thermistor chain.1393.76m. length on 100m 6mm jkt.
Thermistor times.   0150+00s.2.
0153+50s.3.
0157+30s.4.
0201.00s.5.
0204+30s.6.
0208+00s.7.
0212+24s.8.
0216+10s.9.
0225+01s.11.Out of water.0258+30s.

Mooring 125 cont.

Swivel.Gunnebo 10/8.
17" glass x 6.Benthos on 13mm chain.
Swivel.Gunnebo 10/8.
Steel wire 8mm 10m.
Thermistor logger.926.RVS. In water. 0258+40s.
Out of water. Tangled on ADCP spar.Relowered and recovered on shelter deck.Relowered at 0151+09s.
Thermistor chain.1680.76m length on 100m 6mm jkt.
Thermistor times. Not logged. 2.
3.
4.
5.
Too dark to see 6.
7.
8.
9.
10.
11. Out of water.0137.

Thermistor logger.MAFF>#1 In water.
Out of water.0124.
Thermistor chain.1620.100m length on 100m 6mm jkt.
Thermistor times. 2.
3.
Too dark to see 4.
5.
0339+10s. 6.
0342+30s. 7.
0346+00s. 8.
0349+50s. 9.
0353+50s. 10.
0410+50s. 11. Out of water.0042.

ACM 9107.Rotor free.0404+00s. In water.0412+00s.
MAFF. Rotor stop.0048+10s. Out water.0041.
Thermistor logger 879.IOSDL. In water.0415.
Out of water.0040+40s.
Thermistor chain.1722.IOSDL.100m length on 100m 6mm jkt.
Thermistor times. 2.
3.
Too dark to see 4.
5.
0339+10s. 6.
0342+30s. 7.
0346+00s. 8.
0349+50s. 9.
0353+50s. 10.
0410+50s. 11. Out of water.0042.

ACM 9107.Rotor free.0404+00s. In water.0412+00s.
MAFF. Rotor stop.0048+10s. Out water.0041.
Thermistor logger 879.IOSDL. In water.0415.
Out of water.0040+40s.
Thermistor chain.1722.IOSDL.100m length on 100m 6mm jkt.

Thermistor times. 0412+20s.2.
0418+10s.3.
0420+50s.4.
0424.06s.5.
0426+33s.6.
0429+40s.7.
0431+50s.8.
0434+26s.9.
0449+12s.10. Out of water.0008+10s.

Swivel.Gunnebo 10/8.
ACM 9106.Rotor free.0445+20s. In water. 0449+13s.
MAFF. Rotor stop.0018+00 Out water. 0008+10s.24-07-90.
Swivel Gunnebo 10/8.
Wire 6mm.Jkt. 100m.
Wire 8mm. 100m.
S.RVS. In water. 0517+10s. Out water. 2346+50s.
RVS#05451264.
Wire 8mm. 400m.
Swivel.S/S press bal.
Chain 1m 13mm.
Sphere ORE 48.RVS. Recovered to rail at 2322.23-07-90.
Pick up line.15m 24mm.
Pick up floats.MWC.11".2 off.

Cut away.0616 gmt.04-07-90. Released at.

Deployed by,Pingree,Easton,Waddington,Washington.

ACm and TC preparation.Waddington,Washington.
S4 preparation.Miller.
Hardware and Oceano.Washington.
Calibrations.Goy,Washington,Watts,Barrett.
During deployment the Oceano release was monitorred from the Forward Hydro lab on the dunking transducer. On cutting away contact was lost probably due to hull shielding or bow prop interface.

Recovery.Release was carried out by dunking over the stern port quarter.Good contact was established and reduction of range noted as mooring released indicating rise of buoyancy.On release light failed.Mooring relocated by acoustic ranging and steaming courses.

Mooring 126

Deployed.05-07-90.Day 186. Recovered.23-07-90.Day 204.

Transit.46 17.56 N. 07 14.85 W. DRT 0040. 1745 gmt.
GPS. 46 18.32 N. 07 15.02 W. 1849 gmt.

Water depth.4744 corr.m.

Steel sphere 1.3m dia.RVS.
0.5m chain.
Swivel.S/S press bal.
5m 8mm Plain wire.17 x 7 galv. IOS.
S4.05111117.In water.1717. Out water.0950.
102m 8mm 17 x 7 galv.Made on board.IOS.
ACM.1259.Rotor free.1654. In water.1659+40s.
IOSDL. Rotor stop. Out water.0957.

TL.772.IOSDL.
TC.772.RVS.200m length on 225m 6 mm jkt wire.

Thermistor times.	1650+44s.	10.	1003.
	1644+10s.	?.	1006+24s
	1638+30s.	7.	1010+40s.
	1633.	6.	101[illegible]
	1629.	5.	1016+[illegible].
	1624.	4.	1020+05s.
	1620.	3.	1023+46s.
	1617.	2.	1031+31s.
TL.	1613.	1.	1037+51s.
			1046+43s.
			1050+50s. TL772.

VACM.627.Rotor free 1602+43s. In water.1613+0s.
IOSDL. Rotor stop. 1057+40s. Out water.1052

TL.852.POL
TC. .POL.200m length on 225m 6mm jkt wire.

Thermistor times.	1542+10s.	11.	1101+10s
	1535+30s.	10.	1104+30s.
	1531+10s.	9.	1108+49s.
	1527.	8.	1114+07s.
	1524.	7.	1118+12s.7?
	1521.	6.	1126.
	?	5.	1129+06s.
	1513.	4.	1136+50s.
	1510.	3.	1141+15s.
	1507+40	2.	1143+52s.
TL.852.	1503.	1.	

Logge bar bent on recovery at shackle bushing.
ACM.7943.Rotor free.1450+30s. In water.1502+45s.
IOSDL. Rotor stop.Rotor lost. Out water.1143+52s.
5m 8mm 17 x 7 galv.Made onboard.
Swivel Gunnebo 10/8.
6 x 17" Benthos on 13mm chain.
Swivel Gunnebo 10/8.

Mooring 126 cont.

The 400m TC.spans the VACM. Thermistor times.

225m 8mm Jacket. This wire length flooded.

1428+47s.11.1159+50s.
1421+50s.10.1205+40s.
1413+36s.9. 1210+40s.
1408+20s.8. 1228+20s.
1402+47s.7. 1233+10s.

VACM.666.Rotor free.1350. In water.1400+34s.
IOSDL. Rotor stop.1237+40s. Out water.1235.
225m 8mm Jacket.

1341+40s.6. 1250+27s.
1336+12s.5. 1257+15s.
1331+20s.4. 1318.
1327+27s.3. 1323+40s.
1320+39s.2. 1343+25s.
1312+00s.1. 1355+50s.

TL.561.POL.
TC. .POL.400M chain on 225m+VACM+225m.

ACM.9483.Rotor free.1304+10s. In water.1311.
MAFF. Rotor stop.1358. Out water.1417+30s.
5m 8mm.17 x 7 galv.Made onboard.
Swivel.Gunnebo 10/8.
4 x 17" Benthos.On 13mm chain.
Swivel.Gunnebo.10/8.
200m 8mm Paraline.
Swivel.Gunnebo.10/8.
2 x 17" Benthos.
Swivel.Gunnebo.10/8.
ACM.6372.Rotor free.1218+40s. In water.1231+55s.
IOSDL. Rotor stop.1437+20s. Out water.1432+10s.
150m 8mm Paraline.
ACM.420.Rotor free.1134+47s. In water.1208.
IOSDL. Rotor stop.1443+16s. Out water.1447.

500m 8mm Paraline.Actual total 3189m.
500m 8mm Paraline.2655m.
500m 8mm Paraline.2128m.
500m 8mm Paraline.1600m.
500m 8mm Paraline.1070m.
500m 8mm Paraline.535m.
C.R.200.2498.Parallel on titanium bar.320.298.1.08s.
C.R.200.2510. 320.278.0.98s.
10m 8mm Plain.
550kg.Clump anchor chain. Over at 0906.

Deployed by, Pingree, Easton, Waddington, Washington.
Recovered by, As above.
VACM,ACM and TC preparation. Waddington, Washington.
S4 preparation. Miller.
CR 200 wire test. Harrison.
Hardware. Washington.
Calibrations. Goy, Waddington, Watts, Barrett.

MOORING 127.

Deployed.06-07-90.Day 187.
GPS.43 54.77 N. 06 00.65 W.1124 gmt.
Transit.43 54.49 N. 06 01.11 W. DRT.0030.1232 gmt.
Water depth.765m. On bottom at 1233+50s.

2 x 11" MWC.
15m 24mm polyprop.
1 x 32" steel.RVS.
0.25m 13mm chain.
1 x 32" steel.RVS.
0.5m 13mm chain
S/S swivel
10m 8mm jkt.
ACM 6152. Rotor free.1132+50s. In water.1154+54s.
RVS.10S deep spec.RCMS.
260m 6mm jkt.
ACM 9574. Rotor free.1117+13s. In water.1123+14s.
RVS.RCM 8.
260m 6mm jkt.
ACM 9420. Rotor free.1058+30s. In water.1106+00s.
Swivel S/S press bal.
C/R.2002493. 320.280.1.16s.
10m 13mm chain.
550kg chain. In water.1052.gmt.

Deployed by, Pingree, Easton, Waddington, Washington.
Hardware preparation. Washington.
ACM preparation. Waddington, Washington.
CR 200 wire test. Harrison.
ACM calibration. Watts.

ACM NO.	Type.	CH	1.	2.		3.	4.	5.	6.	MRG.
9574	8			-2	22		11-16	com	r	127
6152	5			-2	22	1000	10-15	com	16	127
9420	8			-2	22		9-12	com	r	127

All first data 2200 gmt 05-07-90.

MOORING 129

Deployed. 06-07-90.Day 129.
Transit.44 11. 75 N. 08 16.35 W.DRT 0129.0052 gmt.
Decca. R.15.2.G.34.P.50.09.0054 gmt.
Water depth.770m. Cut away 0052 gmt.On bottom 0055 gmt.

2 x 11" MWC.
15m 24mm polyprop.
1 x 32" steel.RVS.   ID PML Pingree.
0.25m 13mm chain.
1 x 32" steel. RVS.
0.5m 13mm chain
S/S swivel.Press bal.
10m 8mm jkt.
ACM 3259.   Rotor free.2255.   In water.2306+33s.
RVS.RCM 8.
260m 6mm jkt.
ACM 9375.   Rotor free.2215+55s.   In water.2150.
RVS.RCM 8.
260m 6mm jkt.
ACM 9415   Rotor free.2145+30s.   In water.2150+30.
Swivel.S/S press bal.
C/R.200.2467.   320.359.1.02s.
10m 13mm chain.
550kg chain.

Deployed by, Pingree, Easton, Waddington, Washington.
Hardware preparation. Washington.
ACM preparation. Waddington, Washington.
CR 200wire test. Harrison.
ACM calibration. Watts.

ACM no.	Type.	CH	1.	2.	3.	4.	5.	6.	MRG.
9375	8			-2 22		11-16	com	r	129
9415	8			-2 22		11-16	com	r	129
3259	5			-2 22	1000	10-15	com	16	129

9375,9415   first data   2200 gmt 05-07-90.
NOTE: 3259 failed to take up tape. First data at 1400 gmt 06-07-90.

MOORING 130.ETR

Deployed.19-07-90.
Transit.51 28. 93 N. 22 03. 06 W. DRT 0000.1706+50 gmt.
51 28. 85 N. 22 02. 96 W. DRT 0018.1714 gmt.
Water depth.3151 acoustic metres.3143 corr.metres,Area 9.

1.3m steel sphere.IOSDL. Trials buoy.		
0.25m 13mm chain.		
Swivel S/S press bal.		
262m 6mm jkt.		
ACM 9966.	Rotor free.1638	In water.1640+38s.
RVS.		
205m 6mm jkt.		
51m 6mm jkt.		
51m 6mm jkt.		
Swivel S/S press bal.		
ACM 9441.	Rotor free.1611+45s.	In water.1616+10s.
RVS.		
51m 8mm par.		
515m 8mm par.	Actual 1072m	
515m 8mm par.		
ACM 9439.	Rotor free.1440+45s.	In water.1445+02s.
RVS.		
515m 8mm	Actual 1118m.	
515m 8mm par.		
CR 200.2450.+tilt.	320.278.0.98s.	
10m 13mm chain.		
600kg.		In water.1352.
Cut away 1706+50s.		

Deployed by, Pingree, Easton, Waddington, Washington.
Hardware preparation. Washington.
ACM preparation. Waddington, Washington.
CR 200 wire test. Harrison.
ACM calibration. Watts.
ACM First data times.1200 gmt.16-07-90.
9966 8 1000
9441 8 +5+8
9439 8 +3+5

MOORING 131

Deployed.09-07-90.Day 190.
GPS.43 29.25 N. 09 32.36 W. 0644 gmt.
Water depth.1075m.

2 x 11" MWC.
15m 22mm polyprop.
48" Steel.IOSDL 006.
0.5m 13mm chain.
Swivel.S/S press bal.
10m 8mm jkt.
ACM 9423 Rotor free.0630+30s. In water.0634+45s.
RVS.
200+235m 6mm jkt.
ACM 9347. Rotor free.0606. In water.0629+26s.
RVS.
200+235m 6mm jkt.
ACM 9973 Rotor free.0509. In water.0523+40s.
RVS.
Swivel.S/S press bal.
Oceano release#55 Disable EA58,Enable EA57, Release EA59.
10m chain.
650 kg.

Deployed by, Pingree, Easton, Waddington, Washington.
Hardware preparation. Washington.
ACM preparation. Waddington, Washington.
Oceano preparation. Washington.
ACM calibration. Watts.

Ranging trials on Oceano release. Waddington, Washington.

9423 8 1000
9347 8 +9+12
9973 8 +9+12
First datas;1700 gmt 07-07-90

MOORING 132.

Deployed.09-07-90.Day 189.
GPS.43 26.28 N. 09 26.74 W. 0127+50 dmt.
Transit.43 26. 38 N. 09 26.88 W. DRT 0014. 0128 gmt.
Water depth.590 acoustic metres.

2 x 11" MWC.
15m 22mm polyprop.
41" ORE.RVS.
0.5m 13mm chain.
Swivel S/S press bal.
10m 8mm jkt.

ACM 9440.	Rotor free.0042+10s.	In water.0043+17s.

RVS.
180m 8mm jkt.

ACM 9352.	Rotor free.0020+30s.	In water.0026+42s.

RVS.
180m 8mm jkt.

ACM 9579.	Rotor free.0001.	In water.0005+30s.

Swivel.S/S press bal.

C/R200.247.	320.398.1.02s.
10m chain.	
500 kg.	Cut away.0127+50s.
	On bottom.0129+40s.

Deployed by, Pingree, Easton, Waddington, Washington.
Hardware preparation. Washington.
ACM preparation. Waddington, Washington.
CR 200 wire test. Harrison.
ACM calibration. Watts.

9440 8 1000
9352 8 +11+16
9579 8 +9+12
First datas; 1700 gmt 07-07-90.

MOORING 133.

Deployed.08-07-90.
GPS.42 04.28 N. 09 31.52 W. 1003 gmt.
Transit.42 04.4 N. 09 31.32 W. 0037 DRT.1003 gmt.
Water depth.1585 acoustic metres.

2 x 11" MWC
15m 22mm polyprop.
48" Steel.
0.5m 13mm chain.
Swivel S/S press bal.
10m 8mm jkt.

ACM 9422.	Rotor free.0941+20s.	In water.0944+00s.
RVS.		
200+485m 6mm jkt.		
ACM 9971.	Rotor free.0855	In water.0904.
RVS.		
200+485m 6mm jkt.		
ACM 3258.	Rotor free.0823+40s.	In water.0831+31s.
Swivel S/S press bal.		
C/R 200.2495.	320.460.1.16s.	
10m chain.		
600 kg.	In water 0824.	Cut away.1003.

Deployed by, Pingree, Easton, Waddington, Washington.
Hardware preparation. Washington.
ACM preparation. Waddington, Washington.
CR 200 wire test. Harrison.
ACM calibration. Watts.

9422 8 -2+22 0-1000
9971 8 -2+22 +9+12
3258 5 -2+22 16 rpc.
First datas;1700 gmt 07-07-90.

MOORING 134.

Deployed 08-07-90.Day 189.
GPS.42 04.78 N. 09 27.64 : 0622+10s.
Water depth. 1107 acoustic metres. On bottom at 0624+50s.

2 x 11" MWC.
15m 22mm polyprop.
48" Steel.RVS.
0.5m 13mm chain.
Swivel.S/S press bal.
10m 8mm jkt.
ACM 6751. Rotor free.0558+30s. In water.0603+00s.
RVS.
200+235m. 6mm jkt.
ACM 9970. Rotor free.0524+30s. In water.0532+10s.
RVS.
200+235m. 6mm jkt.
ACM 9612 Rotor free.0453. In water.0505+30s.
RVS.
Swivel.S/S press bal.
C/R 200.2492. 320.380.1.12s.
10m chain.
650 kg. Cut away 1107.
Observed to bottom out.Sepn 11m.

Deployed by, Pingree, Easton, Waddington, Washington.
Hardware preparation. Washington.
ACM preparation, Waddington, Washington.
CR 200 wire test. Harrison.
ACM calibration. Watts.

9970	8	-2+22	9-12	
9612	8	-2+22	9-12	
6751	5	-2+22	11-16	16 rpc.

First data;1700 gmt 07-07-90.

MOORING 135.

Deployed.07/08-07-90.Day 188/189.
Transit.42 04.89 N. 09 28.8 W. DRT 0105. 0006 Day 189.
Water depth 585 acoustic metres.

2 x 11" MWC.
15m 22mm polyprop.
41" ORE.RVS.
0.5m 13mm chain.
Swivel.S/S press bal.
10m 8mm jkt.
ACM 9416. Rotor free.2325+20s. In water.2329+29s.
RVS.RCM 8.
180m 8mm jkt.
180m 8mm jkt.
ACM 9972. Rotor free.2301+10s. In water.2306+30s.
Swivel S/S press balanced.
OCEANO release.#56. Disable EA62, Enable EA61, Release EA63.
10m chain.
500kg. In water 2259. Cut away 0006/08-07-90.

Deployed by Pingree, Easton, Waddington, Washington.
Hardware preparation. Washington.
ACM preparation; Waddington, Washington.
Oceano preparation. Washington.
ACM calibration. Watts.

Ranging trials on Oceano release. Waddington, Washington.

9972	8	-2 22	9-12
9416	8	-2 22	1000

First datas;1700 gmt 07-07-90.

I.A.W.

13. DEEP S4 CURRENT METER / CTD DEPLOYMENTS

On this cruise it was planned to make simultaneous measurements of velocity and density at about 1m resolution in the vertical by attaching a deep S4 current meter to the CTD frame. The purpose of this was to calculate the Richardson numbers and so to estimate the likelihood of vertical mixing of the water column. For the first deployment, the S4 was suspended about 2m below the CTD frame, with a 25 kg weight a further 10m down. However, two problems were immediately apparant from the results. Firstly that the meter was oscillating through the water column in an almost circular motion with (apparently) about 10m radius and a 2 minute period, and secondly that spurious horizontal velocities with a 6-7 second period were observed, caused by the ship pitching gently. For the second deployment, the bottom weight was removed, and this improved the data quality.

Further improvement was achieved on the third deployment, particularly to the wave induced problem, by attaching the S4 to the CTD frame. However both problems, although much less severe than on the first deployment, were still present and indicated that the CTD frame itself was making circular orbits as described above. In view of these problems no further deployments were undertaken. Comparisons with simultaneous ADCP data indicated a possible miscalibration of the S4, which seemed to over-read possibly by a factor of 3 to 4 (which, if true, would imply CTD oscillations of only about 2-3m radius).

14. ARGOS BUOY REPORT

During *RRS Discovery* cruise 193/90 10 Argos satellite tracked drifting buoys were deployed in the Biscay Abyssal Plain and in vicinity the of East Thulean Rise. All buoys operate on the standard Argos transmit frequency of 401.650 MHz +/- 4 KHz.

7 buoys were of the METOCEAN Data Systems Toga style equipped with three main sensors, barometric pressure, sea surface temperature and air temperature plus battery voltage monitoring.

2 buoys were IDB fibreglass mushroom type equipped only with sensors for sea surface temperature plus battery voltage monitoring parameter.

In addition a French Toga Style buoy for the GASTOM 90 experiment was deployed on their behalf.

Prior to deployment and immediately on deployment each buoy was monitored from *RRS Discovery* using the PML BBC/Argos local data retrieval system so that the buoy sensors could be calibrated and correct functioning verified. Subsequently position fixing and data retrieval from System Argos was communicated by PML via RVS and the Marinet system to Discovery. This system proved somewhat erratic and additional position fixes were sought by us from Discovery using INMARSAT to access System Argos via the U.K. PSS network. Although some success was achieved this communications link also proved difficult for a variety of reasons.

DEPLOYMENT OF METOCEAN BUOYS 3906/3907

Buoy 3906 was deployed early in the cruise to provide some buoyancy data on the new PML design drogues. Due to the uncertainty of the change in buoyancy after immersion extra buoyancy in the form of a 30" plastic buff was attached to the buoy for the duration (1 week) of the test. In addition a NOVATECH VHF beacon was attached to facilitate subsequent retrieval.

3906 was fitted with a 4 piece 16 metre PML drogue suspended below the buoy. The drogue was weighted at the bottom end and additional buoyancy was provided by 8 x 11" polo floats suspended in line 50 metres below the buoy.

3906 was deployed on 3-7-90 at position 46°49.3'N 6°53.4'W SW of the shelf break in a water depth of 4,500 metres. After one week on 10-7-90 3906 was relocated to check on buoyancy and its hull was found to be severely damaged. On recovery of the buoy it appeared that the buff which had metal attachment points had continually hit the hull of the buoy.

During the original deployment the buoy was deployed first over the stern of *RRS Discovery* using the aft crane. 50 metres of 16mm nylon rope, polo floats and 8mm Paraline were then paid out with the ship going ahead at 0.5 to 1 knot. Finally the drogue was lowered into the water with the weight being slipped last of all. There were problems with the drogue getting tangled with its suspension line using this deployment method.

The drogues were recovered and found to be untangled, 6 x 94 litre plastic bins were added to the drogued assembly which was re-deployed. Metocean buoy 3907 was attached to the drogue line in place of 3906.

Buoy 3906 was found to be in working order and a repair to the hull was effected using pvc tape and Superethane plastic coating ready for a later deployment.

DEPLOYMENT OF METOCEAN BUOYS 3909/3918

Buoy 3909 was deployed on 9-7-90 at 45°05.7'N 08°03.3'W in the centre of the clockwise gyre designated 'Moddy' in a water depth of 4,840 metres. After the earlier experience the method of deployment was changed. The buoy was suspended from the aft rail of the ship by a slip rope. The drogue was paid out followed by the paraline with the ship going ahead 0.5 to 1 knot. When all the paraline, floats and top nylon rope were paid out the weight was allowed to come onto the buoy which was then slipped free.

3909 was fitted with a 4 piece 16 metre PML drogue to which 6 x 94 litre plastic bins were attached to provide extra drag to the drogue. The drogue was suspended 320 metres below the buoy and was weighted at the lower end with extra polo float buoyancy provided 50 metres below the surface.

RRS Discovery passed near buoy 3909 on 13-7-90 and data transmissions received from the buoy indicated that the battery voltage had dropped to 13.8 volts from an original 15.2 volts. A new battery had been fitted on deployment and so it was decided to recover the buoy to investigate (See electronics report) this rapid drop in voltage.

On recovery the drogue was left in the water and Metocean buoy 3918 was attached to replace 3909 at position 45°03.6'N 8°05.3'W.

DEPLOYMENT OF METOCEAN BUOY 3919

This buoy was deployed on 14-7-90 at position 45°31.9'N 7°15.0,W at the centre of the anti-clockwise gyre in a water depth of 4,805 metres.

DEPLOYMENT OF METOCEAN BUOY 3916

3916 was deployed on 15-7-90 in the vicinity of the Biscay Sea Mount at position 45°24.8'N 10°32.9'W in water depth 2725 metres.

DEPLOYMENT OF METOCEAN BUOYS 3917/3906/3909 AND CMM BUOY 5821

These buoys were all deployed on 20-7-90 in the vicinity of East Thulean Rise. Buoys 3906 and 3909 had been repaired and were operating satisfactorily to nominal standard sensor calibration.

3917 was deployed at 51°45.2'N 21°34.9'W in water depth 2,640 metres. A parachute was added to the bottom of the drogue to increase drag.

3906 was deployed at 51°44.8'N 21°33.7'W. The drogue assembly consisted of 3 x 16m PML drogues plus 6 x 94 litre bins.

3909 was deployed at 51°44.4'N 21°33.8'W with a 2 piece PML drogue plus 4 x 94 litre bins.

Buoy 5821 was deployed at 51°44.4'N 21°33.5'W and was drogued with a single PML 16 metre drogue.

DEPLOYMENT OF IDB BUOYS 5030 / 3915

Because these small Mushroom type fibreglass buoys have little reserve buoyancy it was necessary to provide a different drogue arrangement for these buoys and additional buoyancy.

5030 was deployed on 28-7-90 at 44°43.8'N 8°15.9'W , water depth of 4,820 metres. A single 16m PML drogue was suspended 220 metres below the buoy. 7 polo floats were rigged 20 metres below the surface with another 7 attached to the buoy at the surface.

3915 was deployed on 29-7-90 at 44°49.7'N 8°20.0'W again in a water depth of 4,850m. A novel PML design 'Stranded Rope' drogue was used suspended 80 metres below the buoy with the same polo float arrangement as used with 5030.

POST DEPLOYMENT

We authorised buoys 3916,3917,3919 and 5821 to operate on the Global Telecommunication System (G.T.S.) to provide data to the meteorological office for weather forecasting.

All buoys except 3915 have continued to transmit to date. IDB buoys do not update as frequently as the Metocean buoys. This is presumably due in part to the aerial design and also the low profile of the buoy. This is also shown by the inconsistencies in local data acquisition by the PML/BBC system on board *RRS Discovery*.

There have also been problems with access to System Argos via both Marinet and Inmarsat/PSS routes. It is difficult to ascertain where the problems with the PSS link occur, we tried many access gateways, namely Wormley, Keyworth and Plymouth. The problems could have occurred at any of the modems or with the PSS network itself. It may be that sometimes our signal strength from *RRS Discovery* was not sufficient for the remote modems to respond. The Marinet link should be the obvious (and least expensive) route but the shortcomings seem to stem mainly from the apparent lack of urgency with which messages were handled. On docking it was found out that the Argos system is readily accessible at RVS Barry and buoy positions could easily have been sent with the ship's daily Marinet.

R.L.B

15. SEDIMENT TRANSPORT AND BOUNDARY LAYER EQUIPMENT (STABLE)

POP-UP STABLE was deployed during Discovery cruise 193 for the first time. It was used to investigate a nepheloid layer which had been detected earlier, and which appeared to be streaming off the shelf-break in about 380 metres of water from the La Chapelle Bank area.

The aluminium frame was fitted with six glass spheres for buoyancy; two of the spheres contained the transponding release circuits which dropped the three lead feet on acoustic command from the ship. The whole frame, together with the instrumentation, then became buoyant, and returned to the surface.

Two orthogonal electromagnetic current meters measured all three components of turbulent flow at 4Hz: high frequency pressure-changes were logged simultaneously. Sediment resuspension associated with turbulence was measured with acoustic and optical backscatter sensors.

Tidal currents were measured with a stack of four rotors: integrated readings were logged every minute. Current direction was measured with a vane. Tidal water-depth variations were monitored using a Digiquartz pressure sensor. Bedload sediment transport which occurred in response to tidal currents was monitored using a time-lapse camera with flash and shadow-bar.

Rig attitude was measured using pitch and roll sensors, and sea-water temperature was monitored with a thermistor. The apparatuus was orientated using a diver's compass in the field of view of the camera.

The data logger recorded high frequency parameters in bursts at 4Hz, and low frequency parameters at one minute intervals. Its performance was monitored before and after deployment using a Toshiba 1200 personal computer.

POP-UP STABLE was deployed in 388 metres of water at 0105Z on 3rd July, 1990, in position 47 degrees 28.24 North, 6 degrees 32.81 West, (on the western edge of La Chapelle Bank). It was recovered at 0910Z on the 25th July.

In order to calibrate the sediment sensors on return to the laboratory, sediment samples were obtained from the deployment area using a Shipek grab. This was not easy because of rapidly-changing bathymetry and strong currents. Eight samples were obtained; they showed some variability in nature: there has to be some uncertainty about the exact grain-size distribution of the sediment at the STABLE site.

J.D.H.

16. SEA-BED ACOUSTIC DOPPLER CURRENT PROFILERS (ADCP)

Two sea-bed mounted pop-up ADCP systems were supplied by POL Bidston for deployment at the shelf edge on Discovery cruise 193 and are self recording instruments which measure the current profile in the water column above the instrument by the acoustic Doppler technique.

The objectives of the deployment were firstly to measure the current structure at the shelf edge due to internal tides and waves together with the STABLE mooring to investigate sediment transport, and secondly to further the development of the instrument for use in the self edge environment with regard to its operating range and the back-scatter signed strength.

Two stations were occupied by ADCP systems along a line traversing the shelf break and separated by about 3 miles with the STABLE mooring set between and current meter mooring 123, and 124 set to the North. At the first station 2 beam 250 KHz system was deployed at 245 m water depth having been set up to make a sample every 12 minutes with 240 pings being averaged over over 11 minutes to give 20 cells, each with a size of about 7 m. This same type of instrument was successfully used in the North Sea Programme throughout 1988 and 89 at depths up to 90 m with high concentration of signal scatterers, with the above set-up the range capability of the instrument would be tested in a lower scattering environment and greater depth. The instrument was deployed for a duration of 22 days and was still operating normally when recovered by acoustic release from the sea-bed. A preliminary look at the data was possible by reading off the last 16 hourly scans from the cache memory when on deck, this shows that good data was being recorded on to the internal mag tape for most of the profile but that the full range of the instrument was not being achieved. The performance will be analysed further when the complete data record can be processed back at P.O.L.

At the second station the 3 beam 75 KHz system was dployed at a depth of 600 m for a duration of 8 days then recovered, batteries replaced and re-deployed at a depth of 585 m for a further 13 days. This was the first trial of the 75 KHz system in the 3 beam mode and with deep pressure cases capable of 1000 m depth. The set-up with the present software only allows 16 cells in each of the 3 beams to be processed and gives a profile range of about 360 m with 12 min sampling and 140 pings averaged over 11 min. Prior to deployment the system was given a float test to verify that there was enough buoyancy to support the extra weight of the 3. 75 KHz transducers and the heavier pressure cases. After each of the last two trials the last 16 hours of sea-bed data was recovered from the cache memory and the Raw Doppler shift counts processed on-board into X, Y, and Z co-ordinates then converted into raw counts of Easterly and Northerly components of flow by incorporating the compass heading. Vector plots of four for each of the 16 cells show the strongest currents at about 50 m above the sea-bed with maximum on-shelf flow about 3 to 4 hours before high water at Plymouth. However, the magnitude of the vectors ina given cell is very variable during a tidal period although similar between adjacent cells. This result was unexpected and may become clearer when the full data record is processed back at P.O.L.

Summary of the station details :

250 Khz station:-

Position 47° 29.973N	06° 32.507W by G.P.S.
Water depth (uncorrected)	245m
Deployment on sea-bed	04-37 z 3 July 1990
Release from sea-bed	09-47 z 25 July 1990
Descent rate	0.68m sec^{-1}

75 KHz station

Trial n° 1, Position 47° 26.888N	06° 33.61W by G.P.S.
Water depth (uncorrected)	600m
Deployment on sea-bed	05-47 z 3 July 1990
Release from sea-bed	07-47 z 11 July 1990
Descent note	0.81m sec^{-1}

Trial n° 2, Position 47° 26.875N	06° 33.53W by G.P.S.
Water depth (uncorrected)	585m
Deployment on sea-bed	08-27 z 12 July 1990
release from sea-bed	07-33 z 25 July 1990

Weather conditions were good for deployment and recoveries, all instruments functioned normally, no damage during period at sea. The IOS release acoustics and deck equipment functioned normally and the navigation by G.P.S. was precise.

A.J.H.

17. XBT's

Rapid surveys of eddies were made using XBTs. The XBT's used during Discovery cruise 193 were provided by ARE, the French Hydrographic Institute EPSHOM, and IOS. The records were transferred to the RVS computer system and displayed in near real time, ie about 30 minutes. The slowest part was the transfer from the HP85 cartridge tapes to the level A, limiting resolution to about 10km at cruise speed. The data were edited by an interactive graphical editor before transfer to p-star data files. A first order TS relationship , derived from CTD dips in the area was used to compute geostrophic velocities.

18. CONCLUSIONS

This was a long but successful cruise with the scientific work benefiting from the full co-operation of the ships' officers and crew. The programme was tight, no time was lost due to bad weather, and the main scientific objectives of the cruise were fully met.

TABLE 1. XBT STATIONS

XBT NO.	DAY	JULY DATE	TIME	LATITUDE (N)	LONGITUDE (W)	TYPE
001	184	3	13:16	47° 3.40	6°48.91	5
002	185	4	09:00	46°36.15	6°50.08	5
003	185	4	09:30	46°32.60	6°53.71	5
004	185	4	09:56	46°29.44	6°57.21	5
005	185	4	10:22	46°26.33	7° 0.80	5
006	185	4	10:46	46°23.60	7° 4.19	5
007	185	4	11:15	46°20.67	7° 8.[illegible]	5
008	185	4	11:39	46°18.83	7°12.[illegible]	5
009	185	4	12:49	46°17.82	7°13.30	5
010	185	4	13:14	46°16.62	7°14.22	5
011	185	4	13:40	46°13.42	7°17.61	5
012	185	4	14:04	46°10.47	7°20.88	5
013	185	4	14:27	46° 7.74	7°24.19	5
014	185	4	14:53	46° 9.69	7°22.77	5
015	185	4	15:16	46°12.75	7°19.37	5
016	185	4	15:44	46°16.73	7°15.70	5
017	185	4	22:14	46°18.81	7°15.63	4
018	185	4	22:31	46°18.75	7°15.35	4
019	185	4	23.55	46°19.25	7°14.39	4
020	186	5	01:00	46°19.18	7°13.81	4
021	186	5	01:58	46°18.86	7°13.30	4
022	186	5	02:58	46°18.48	7°12.75	4
023	186	5	06:01	46°17.75	7°13.43	4
024	186	5	07:00	46°17.69	7°14.58	5
025	186	5	07:57	46°17.78	7°14.87	4
026	190	5	08:52	46°20.08	7°12.12	4
027	190	9	16:34	44°11.29	8°16.79	5
028	190	9	17:22	44°17.57	8°15.30	5
029	190	9	17:55	44°22.84	8°14.12	5
030	190	9	18:40	44°29.94	8°12.73	5
031	190	9	19:26	44°33.09	8°11.49	5
032	190	9	20:07	44°43.41	8°10.35	5
033	190	9	20:53	44°50.37	8° 8.71	5
034	190	9	21:35	44°56.74	8° 6.60	5
035	190	9	22:20	45° 3.62	8° 4.02	5
036	191	10	01:44	45° 9.70	8° 0.35	5
037	191	10	02:23	45°15.04	7°55.99	5
038	191	10	02:54	45°19.26	7°52.44	5
039	191	10	03:36	45°25.06	7°47.26	5
040	191	10	04:19	45°31.40	7°42.46	5
041	191	10	04:59	45°37.48	7°38.14	5
042	191	10	05:49	45°44.83	7°32.68	5
043	191	11	21:25	47°28.48	6°35.16	4
044	194	13	19:29	45° 3.40	8° 2.03	5
045	194	13	19:37	45° 4.17	8° 0.43	5
046	194	13	20:07	45° 7.25	7°54.78	5
047	194	13	20:37	45°10.33	7°49.12	5
048	194	13	21:12	45°14.09	7°42.24	5
049	194	13	21:51	45°18.51	7°34.40	5

TABLE 1. Cont.

XBT NO.	DAY	JULY DATE	TIME	LATITUDE (N)	LONGITUDE (W)	TYPE
050	194	13	22:22	45°22.09	7°28.64	5
051	194	13	22:54	45°25.82	7°22.70	5
052	194	13	23:23	45°29.77	7°18.01	5
053	195	14	02:23	45°30.40	7°16.33	5
054	195	14	02:58	45°33.52	7° 9.77	5
055	195	14	03:29	45°37.15	7° 3.94	5
056	195	14	04:02	45°41.13	6°57.70	5
057	195	14	04:32	45°44.10	6°53.09	5
058	195	14	04:38	45°44.69	6°52.06	5
059	195	14	05:12	45°48.64	6°46.01	5
060	195	14	05:43	45°52.56	6°40.31	5
061	195	14	06:14	45°56.38	6°34.35	5
062	195	15	10:47	45° 3.07	6°56.95	7
063	196	15	11:10	45° 6.00	10° 1.61	7
064	196	15	11:24	45° 7.28	10° 4.39	7
065	196	15	11:45	45°10.56	10° 8.60	7
066	196	15	12:08	45°13.69	10°13.37	7
067	196	15	12:30	45°16.50	10°19.97	7
068	196	15	12:57	45°19.73	10°23.34	7
069	196	15	13:21	45°22.53	10°28.26	7
070	196	15	13:45	45°24.95	10°32.80	7
071	196	15	17:23	45°24.88	10°33.20	7
072	196	15	17:46	45°27.17	10°36.78	7
073	196	15	18:20	45°31.42	10°43.35	7
074	196	15	18:51	45°35.32	10°49.41	7
075	196	15	19:16	45°38.20	10°54.70	7
076	196	15	19:40	45°40.99	10°59.67	7
077	196	15	20:03	45°43.52	11° 4.58	7
078	196	15	20:35	45°46.96	11°11.47	7
079	196	15	21:16	45°51.28	11°20.36	7
080	196	15	21:56	45°55.56	11°29.22	7
081	196	15	22:31	45°59.60	11°36.80	7
082	196	15	23:02	46° 3.45	11°43.41	7
083	196	15	23:34	46° 7.15	11°50.52	7
084	196	15	00:08	46°11.36	11°57.75	7
085	197	16	00:30	46°14.11	12° 2.45	7
086	197	16	00:59	46°17.81	12° 8.42	7
087	197	16	01:27	46°21.20	12°14.10	7
088	197	16	02:03	46°25.00	12°21.83	7
089	197	16	02:28	46°27.80	12°27.00	7
090	197	16	02:28	46°27.80	12°27.00	7
091	197	16	03:00	46°31.70	12°33.34	7
092	197	16	03:33	46°35.63	12°39.83	7
093	197	16	04:01	46°38.91	12°45.52	7
094	197	16	04:35	46°42.93	12°52.52	7
095	197	16	05:01	46°46.04	12°57.94	7
096	197	16	05:31	46°49.57	13° 4.11	7
097	197	16	06:04	46°53.61	13°10.70	7
098	197	16	06:32	46°57.05	13°16.40	7
099	197	16	07:03	47° 0.88	13°22.76	7

TABLE 1. Cont.

XBT NO.	DAY	JULY DATE	TIME	LATITUDE (N)	LONGITUDE (W)	TYPE
100	199	18	11:35	51°31.77	22°19.00	7
101	199	18	11:55	51°32.94	22°24.14	7
102	199	18	13:43	51°35.27	22°31.83	7
103	199	18	14:16	51°36.74	22°40.14	7
104	199	18	16:51	51°39.93	22°50.30	7
105	199	18	17:15	51°41.58	22°55.90	7
106	199	18	17:24	51°42.40	22°58.13	7
107	199	18	17:50	51°43.61	23° 4.79	7
108	199	18	19:24	51°45.98	23°12.87	7
109	199	18	19:49	51°48.01	23°19.11	7
110	199	18	20:12	51°49.34	23°24.94	7
111	199	18	22:06	51°45.78	23°27.51	7
112	199	18	22:37	51°41.07	23°22.66	7
113	199	18	23:06	51°36.78	23:18.05	7
114	199	18	23:34	51°32.60	23°13.52	7
115	200	19	00:03	51°28.27	23° 8.94	7
116	200	19	00:33	51°23.54	23° 4.68	7
117	200	19	01:02	51°18.78	23° 1.43	7
118	200	19	01:22	51°15.45	23° 0.01	7
119	201	20	10:47	52°10.77	22°30.10	7
120	201	20	11:09	52°10.52	22°36.20	7
121	201	20	11:33	52° 7.33	22°37.81	7
122	201	20	12:07	52° 1.09	22°37.44	7
123	201	20	12:53	51°52.94	22°37.36	7
124	201	20	13:21	51°48.00	22°37.30	7
125	201	20	20:53	51°44.21	21°33.18	7
126	204	23	10:27	46°17.45	7°14.91	7
127	204	23	12:50	46°17.41	7°14.67	7
128	204	23	15:03	46°16.57	7°14.45	7
129	204	23	16:22	46°16.03	7°14.45	7
130	205	24	00:18	46°36.57	6°50.99	4
131	205	24	00:23	46°36.52	6°51.00	4
132	205	24	00:33	46°36.45	6°50.96	4
133	205	24	00:43	46°36.43	6°50.94	4
134	205	24	00:58	46°36.31	6°50.92	4
135	205	24	01:06	46°36.26	6°50.89	4
136	205	24	01:17	46°36.14	6°50.89	4
137	205	24	01:26	46°36.09	6°50.86	4
138	205	24	01:34	46°36.11	6°50.80	4
139	205	24	01:48	46°35.99	6°50.69	4
140	205	24	02:00	46°35.89	6°50.68	4
141	205	24	02:13	46°35.68	6°50.72	4
142	205	24	09:05	46°15.24	7°15.01	4
143	205	24	10:21	46° 7.57	7°17.77	4
144	205	24	10:51	46° 1.91	7°19.13	4
145	205	24	11:25	45°56.00	7°18.83	4
146	205	24	11:57	45°50.85	7°18.10	4
147	205	24	13:02	45°39.96	7°20.89	4
148	206	25	02:25	47° 4.85	6°35.89	7
149	206	25	02:53	47° 9.07	6°35.22	7

TABLE 1. Cont

XBT NO.	DAY	JULY DATE	TIME	LATITUDE (N)	LONGITUDE (W)	TYPE
150	206	25	03:15	47°13.00	6°34.62	7
151	206	25	03:35	47°16.67	6°34.62	7
152	206	25	03:55	47°20.41	6°34.25	7
153	206	25	04:17	47°24.47	6°33.22	7
154	208	27	11:06	45°56.74	7° 2.18	
155	208	27	11:29	45°56.45	7° 2.30	
156	208	27	11:46	45°56.38	7° 2.26	
157	208	27	11:53	45°56.36	7° 2.21	
158	208	27	11:59	45°56.32	7° 2.13	
159	208	27	12:03	45°56.28	7° 2.15	
160	208	27	12:08	45°56.24	7° 2.19	
161	208	27	12:17	45°56.20	7° 2.04	
162	208	27	12:22	45°56.16	7° 1.98	
163	208	27	12:27	45°56.10	7° 1.97	
164	208	27	12:32	45°55.99	7° 1.98	
165	208	27	12:37	45°55.88	7° 2.04	
166	208	27	12:42	45°55.74	7° 2.05	
167	208	27	12:49	45°55.61	7° 2.10	
168	208	27	12:58	45°55.52	7° 1.96	
169	208	27	13:06	45°55.48	7° 1.79	
170	208	27	13:11	45°55.46	7° 1.77	
171	208	27	13:16	45°55.45	7° 1.72	
172	208	27	13:23	45°55.46	7° 1.75	
173	208	27	13:29	45°55.47	7° 1.84	
174	208	27	13:36	45°55.43	7° 1.83	
175	208	27	13:43	45°55.49	7° 1.93	
176	208	27	13:49	45°55.55	7° 1.99	
177	208	27	13:55	45°55.60	7° 2.02	
178	208	27	14:01	45°55.67	7° 2.13	
179	208	27	14:08	45°55.74	7° 2.20	
180	208	27	14:14	45°55.82	7° 2.27	
181	208	27	14:22	45°55.90	7° 2.32	
182	208	27	14:34	45°56.03	7° 2.45	
183	208	27	14:40	45°56.08	7° 2.48	
184	210	29	14:46	45°56.13	7° 2.53	
185	210	29	14:52	45°56.19	7° 2.57	
186	210	29	14:59	45°56.24	7° 2.57	
187	210	29	15:06	45°56.34	7° 2.58	
188	210	29	15:12	45°56.39	7° 2.57	
189	210	29	15:28	45°56.37	7° 2.64	
190	210	29	18:04	46° 4.67	6°56.63	
191	210	29	18:15	46° 4.55	6°56.47	
192	210	29	14:28	44°25.90	6°55.22	
193	210	29	14:48	44°26.18	7° 0.18	
194	210	29	15:09	44°26.26	7° 5.29	
195	210	29	15:32	44°25.69	7°10.83	
196	210	29	16:02	44°25.10	7°18.05	
197	210	29	16:32	44°24.92	7°24.11	
198	210	29	16:38	44°24.89	7°25.41	
199	210	29	17:04	44°24.97	7°31.35	

TABLE 1. Cont.

XBT NO.	DAY	JULY DATE	TIME	LATITUDE (N)	LONGITUDE (W)	TYPE
200	210	29	17:29	44°25.14	7°36.78	
201	210	29	18:06	44°25.24	7°44.72	
202	210	29	18:32	44°25.38	7°50.39	
203	210	29	19:03	44°25.61	7°57.17	
204	210	29	19:32	44°25.11	8° 3.57	
205	210	29	20:25	44°29.22	8° 6.06	
206	210	29	20:58	44°34.68	8° 9.40	
207	210	29	21:31	44°39.96	8°12.91	
208	210	29	22:02	44°44.88	8°16.58	
209	210	29	23:28	44°49.67	8°20.97	
210	211	30	00:26	44°53.62	8°24.36	
211	211	30	00:54	44°58.23	8°27.12	
212	211	30	01:26	45° 3.47	8°30.20	
213	211	30	01:56	45° 8.42	8°32.50	

TABLE 2.

SEASOAR DEPLOYMENTS

RUN NO	DAY	START DATE	START TIME	START LATITUDE (N)	START LONGITUDE (W)	STOP DATE	STOP TIME	STOP LATITUDE (N)	STOP LONGITUDE (W)
1	191	10 JLY	10:28	46°18.94	7°13.28	10 JLY	18:39	47°15.44	6°35.30
2	193	12 JLY	12:42	47°29.91	6°33.35	13 JLY	11:45	45° 1.41	8° 5.50
3	195	14 JLY	07:09	45°56.21	6°34.15	15 JLY	05:18	44°26.74	9° 5.40
4	198	17 JLY	20:12	50°59.60	20°59.75	18 JLY	03:23	51°31.19	22° 5.60
5	200	19 JLY	01:41	51°15.61	22°57.72	19 JLY	06:43	51°31.12	22° 2.70
6	205	24 JLY	13:08	45°40.44	7°20.55	25 JLY	00:05	46°58.49	6°39.20
7	207	26 JLY	00:16	47°28.70	6°22.71	26 JLY	23.59	46° 1.95	6°58.40
8	209	28 JLY	02:31	45°28.74	7°44.24	28 JLY	19:17	44°45.67	8°11.40
9	209	28 JLY	21:59	44°45.39	8°16.91	29 JLY	13:35	44°23.97	6°49.40

TABLE 3. CTD STATIONS

Cast	July Date	Day	Start Time	End Time	Water Depth (m)	Max press (dbar)	Latitude (N)	Longitude (W)
12119-1	2	183	06:39	07:03	290	65	47°13.99'	06°12.05'
12119-2	2	183	08:16	08:52	1210	150	47°14.13'	06°12.91'
12129-1	4	185	16:23	17:50	4710	4762	46°18.06'	07°14.73'
12129-2	5	186	03:17	04:09	4685	2726	46°18.35'	07°12.62'
12130-1	6	187	08:21	09:56	980	890	43°55.21'	06°00.07'
12132-1	7	188	21:30	21:58	676	652	42°04.47'	09°24.94'
12133-1	8	189	03:36	04:34	1120	1109	42°04.15'	09°27.81'
12134-1	8	189	10:37	11:31	1645	1600	42°05.62'	09°31.39'
12135-1	8	189	23:06	23:33	640	624	43°26.54'	09°26.70'
12136-1	9	190	02:40	03:19	1110	1312	43°29.67'	09°32.80'
12137-1	9	190	15:45	16:20	725	752	44°11.13'	08°16.86'
12138-1	10	191	00:06	01:18	4835	2028	45°07.75'	08°02.06'
12140-1	11	192	04:12	04:30	290	65	47°29.62'	06°33.69'
12140-Y	11	192	12:45	03:33			47°29.32'	06°34.78'
12142-1	13	194	14:31	15:07	4835	1005	45°04.02'	08°05.95'
12143-1	13	194	15:46	16:59	4770	2001	45°03.49'	08°02.21'
12144-1	14	195	01:01	02:08	4805	2008	45°31.06'	07°16.55'
12145-1	15	196	15:33	16:43	2725	2019	45°25.17'	10°32.72'
12146-1	17	198	18:09	19:27	2850	2025	51°00.05'	20°59.28'
12147-1	18	199	04:37	05:52	3180	2020	51°30.80'	22°04.69'
12148-1	18	199	09:35	10:18	3380	1005	51°35.06'	22°18.01'
12148-2	18	199	10:41	11:17	3300	1676	51°31.83'	22°17.80'
12149-1	18	199	12:33	13:17	3500	1017	51°34.19'	22°28.47'
12150-1	18	199	15:08	15:52	3315	1013	51°38.29'	22°49.28'

TABLE 3. Cont.

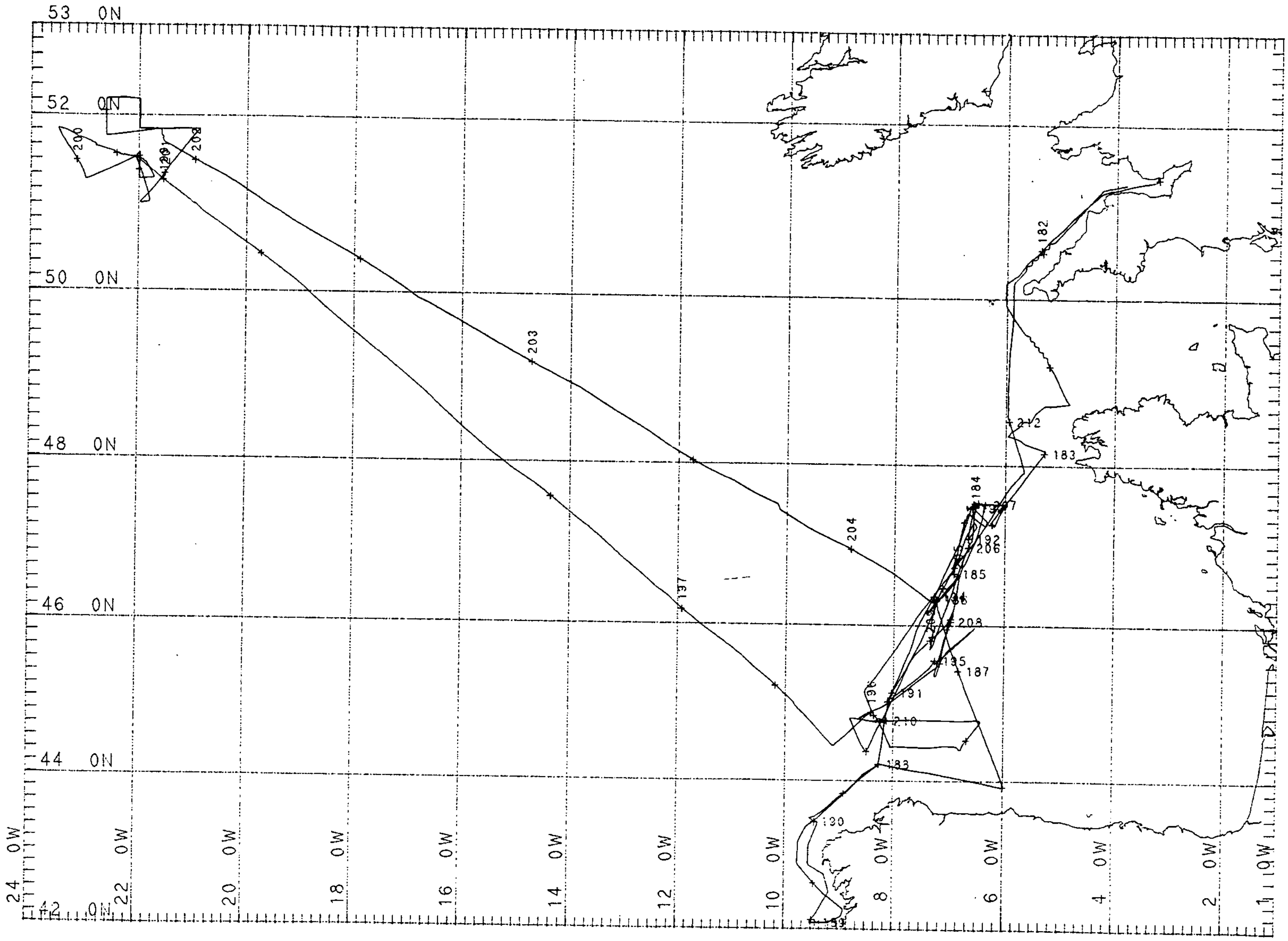
Cast	July Date	Day	Start Time	End Time	Water Depth (m)	Max press (dbar)	Latitude (N)	Longitude (W)
12150-2	18	199	16:09	16:28	3217	98	51°38.89'	22°48.29'
12151-1	18	199	18:14	18:55	3080	1004	51°44.01'	23°09.27'
12152-1	18	199	20:49	21:27	3305	1003	51°50.03'	23°30.42'
12155-1	23	204	06:11	06:34	4710	2002	46°16.95'	07°14.62'
121552	23	204	06:52	08:05	4710	2029	46°16.74'	07°15.09'
12157-1	25	206	04:43	05:04	690	58	47°26.67'	06°33.14'
12158-1	25	206	21:28	22:22	267	57	47°30.52'	06°36.76'
12159-1	27	208	01:53	02:42	4767	57	47°57.00'	07°02.41'
12159-Y	27	208	03:13	15:24	4767	1520	45°57.13'	07°02.25'
12160-Y	27	208	18:11	21:32	4740	200	46°04.59'	06°56.51'
12163-1	29	210	22:50	23:26	4700	1005	44°49.29'	08°20.77'

TABLE 4. MOORING POSITIONS

Mooring No	Date Deployed/Recovered		Equipment	Height off Bottom (m)	GPS
123	02-07-90	25-07-90	acm4 421	128	47°31.05'N 06°31.95'W
			s4 05451262	68	
			acm4 7643	8	
124	02-07-90	25-07-90	acm4 7765	162	47°28.80'N 06°32.70'W
			s4 05451263	85	
			acm4 8511	8	
125	04-07-90	23-07-90	s4 05451264	3790	46°38.06'N 06°50.24'W
			acm8 9569	3960	
			acm7 9106	3489	
			tc/tl 1722/879	3388-3488	
			acm7 9107	3388	
			tc/tl 1620/TR8	3287-3387	
			tc/tl 1680/926	3186-3286	
			tc/tl 1393/925	3075-3175	
			acm8 9650	3075	
			acm8 9680	2973	
			tc/tl 1723/806	2772-2872	
			acm7 9124	2672	
			acm7 9481	2471	
126	05-07-90	23-07-90	s4 05111117	4575	46°17.56'N 07°14.85'W
			acm 1259	4473	
			tc/tl 1790/772	4247-4447	
			vacm 627	4245	
			tc/tl 200m/852	4020-4220	
			acm 7943	4020	
			tc/tl 400m/561	3560-3960	
			vacm 666	3785	
			acm7 9487	3560	
			acm 6372	3352	
			acm 420	3201	
127	06-07-90		acm5 6152	535	43°54.77'N 06°00.65'W
			acm8 9574	274	
			acm8 9420	13	
129	06-07-90		acm5 3259	535	44°11.75'N 08°16.35'W
			acm8 9375	274	
			acm8 9415	13	
130	19-07-90		acm8 9966	2433	51°28.93'N 22°03.06'W
			acm8 9441	2125	
			acm8 9439	1043	
131	09-07-90		acm8 9423	885	43°29.25'N 09°32.36'W
			acm8 9347	449	
			acm8 9973	13	

TABLE 4. Cont.

Mooring No	Date Deployed/Recovered	Equipment	Height off Bottom (m)	GPS
132	09-07-90	acm8 9440	375	43°26.28'N 09°26.74'W
		acm8 9352	194	
		acm8 9579	13	
133	08-07-90	acm8 9422	1385	42°04.28'N 09°31.52'W
		acm8 9971	699	
		acm5 3258	13	
134	08-07-90	acm5 6751	885	42°04.78'N 09°27.64'W
		acm8 9970	449	
		acm8 9612	13	
135	07-07-90	acm8 9416	374	42°04.89'N 09°28.80'W
		acm8 9972	13	



MERCATOR PROJECTION

SCALE 1 TO 8563374 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

GRID NO. 1

— Track plotted from bestnav

Fig. 1

Discovery 193 whole cruise track

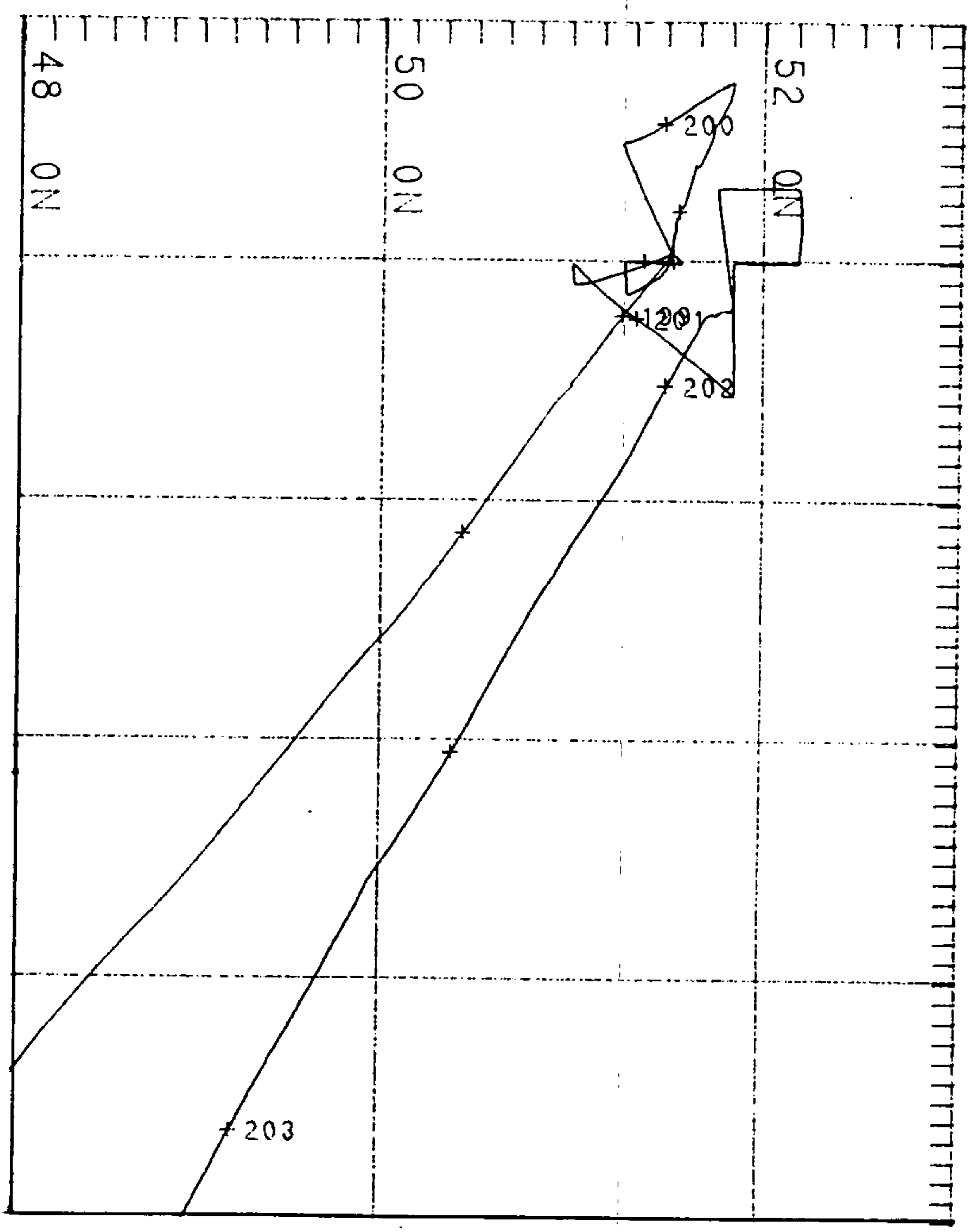
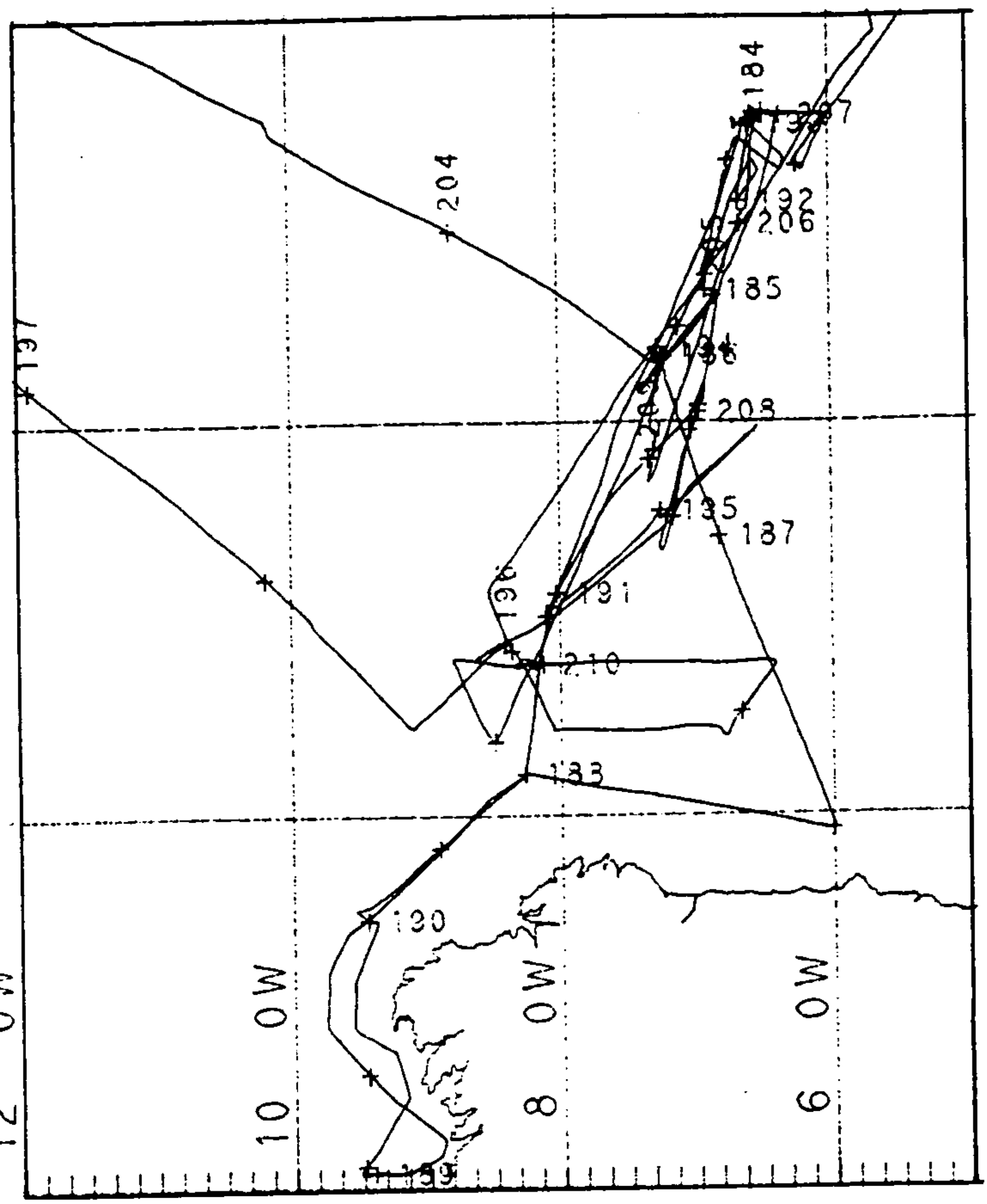


Fig.2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8 0W
6 0W
184
192
206
185
208
135
187
204
191
210
183
130

Fig. 3