Cruise Report

RRS JAMES COOK CRUISE 011

Ecosystem of the Mid-Atlantic Ridge at the Sub-Polar Front and Charlie Gibbs Fracture Zone.

13 July – 18 August 2007

Principal Scientist

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The Ship's Company[1] off Arran at the end of the voyage

Left to Right: Robert Clarke, Antonio Gatti, David Shale, Colin Griffiths, Ian Rouse, Terry Edwards, Tom Letessier, Darren Young, Birkir Bardarson, Claudia Alt, Ben Wigham, Monty Priede, Martin Cox, Jessica Craig, Gavin Tilstone, Paul Lucas, Victor Martinez, Jeff Mashburn, Nikki King, Andrew Dale, Mick Mackey, Dean Hope, Ian Cross, Martin Harrison, Peter Robinson, Tonya Rogacheva, Jane Read, Alan Hughes, Will Reid, Andrew Oliphant.

[1] Not all are present

SCIENTIFIC PERSONNEL

PRIEDE , Imants (Monty) G. (Principal Scientist)	U. Aberdeen	UK
KING Nicola J.	U. Aberdeen	UK
CRAIG Jessica	U. Aberdeen	UK
ALT Claudia	U. Aberdeen	UK
HAWKINS James (From Bantry Bay)	U. Aberdeen	UK
MIKKELSEN Espen R.	IMR Bergen	Norway
HUGHES Alan.	NOC Southampton	UK
OLIPHANT Andrew	NOC Southampton	UK
READ Jane F.	NOC Southampton	UK
BOORMAN Benjamin	NOC Southampton	UK
ROGACHEVA Antonina	P.P. Shirshov Institute, Moscow Russia	
BRIERLEY Andrew (To Bantry Bay)	U St. Andrews	UK
BARDARSON Birkir	U St. Andrews	UK
COX Martin J.	U St. Andrews	UK
LETESSIER Tom B.	U St. Andrews	UK
MASHBURN Jeffrey D.	U. Durham	UK
GRIFFITHS Colin	SAMS Oban	UK
DALE Andrew	SAMS Oban	UK
TILSTONE Gavin	PML Plymouth	UK
MARTINEZ Victor	PML Plymouth	UK
WIGHAM Benjamin	Newcastle U.	UK
CROSS Ian A.	Newcastle U.	UK
REID William	Newcastle U.	UK
SHALE David M.		UK
MACKEY Michael J.	U.C. Cork	Ireland
WILSON Christian (To Bantry Bay)	Ocean DTM	UK
WHITTLE Stephen Paul	NMFS Sea Systems	UK
ROBERTS Rhys	NMFS Sea Systems	UK
DUNCAN Paul A.	NMFS Sea Systems	UK
ROUSE Ian P.	NMFS Sea Systems	UK
EDWARDS Terence	NMFS Sea Systems	UK
YOUNG Darren	NMFS Sea Systems	UK

SHIP'S PERSONNEL

GATTI Antonio	Master
GAULD, Philip D.	Chief Officer
CLARKE, Robert	2nd Officer
STEVENS Ralph A.	3rd Officer
HOLT J. Martin	Chief Engineer
HAGAN John A.	2nd Engineer
COLLARD Glyn	3rd Engineer
PARKER Philip G.	Elec Tech Officer
MYERS Michael	Ships Systems Manager
WYTHE Vivian M.	Deck Engineer
LUCAS Paul	Purser
LEWIS Thomas	CPO Deck
HARRISON Martin A.	CPO Scientific
SPENCER Robert	PO (Deck)
DAY Stephen P.	Seaman
DOLLERY Perry	Seaman
CANTLIE Ian M.	Seaman
COONEY Charles H.	Seaman
SMYTH John Gerard	Engine Room PO
NAGLE Stephen	Head Chef
SUTTON Lloyd	Chef
ROBINSON Peter W.	Steward
HOPE Dean A.	Catering Assistant

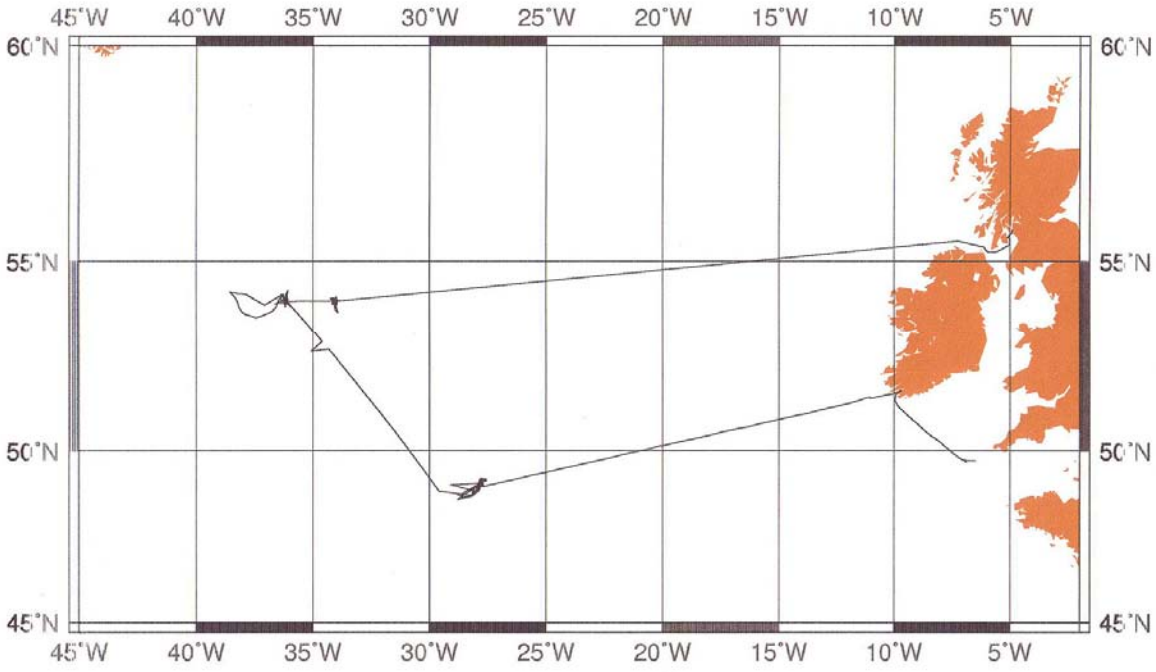

Figure 1: JC011 Cruise track. Sailed from Southampton 13 July and arrived at Fairlie 18August.

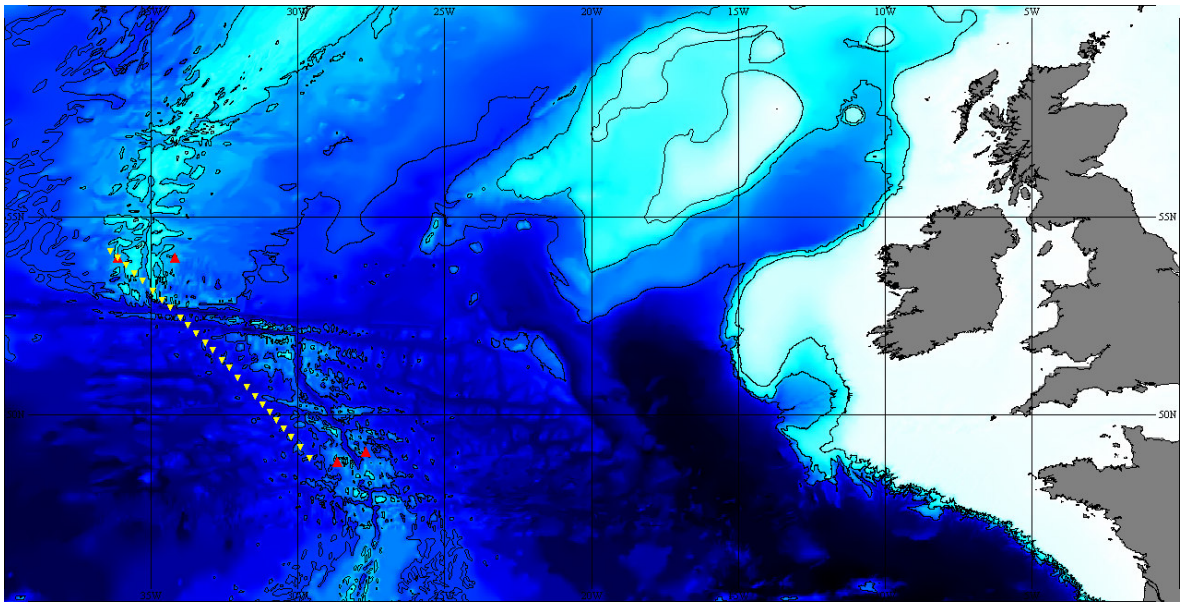

Figure 2: Chart showing the four superstations, SE, SW, NE and NW (red triangles) and the line of CTD stations along the track of the TOPEX POSEIDON satellite altimeter track (Yellow symbols).

ITINERARY

Depart: Empress Dock, Southampton, England	Friday 13 July 2007
Sonar Calibration: Bantry Bay Ireland	Sunday 15 July 2007
Sonar Calibration: Brodick Bay, Arran, Scotland	Friday 17 August 2007
Arrive: Fairlie Pier, by Largs, Firth of Clyde, Scotland	Saturday 18 August 2007

OBJECTIVES

This was the first cruise undertaken to the Mid-Atlantic Ridge as part of the NERC-funded consortium project (NE/C512961/1) entitled **ECOMAR - Ecosystem of the Mid-Atlantic Ridge at the Sub-Polar Front and Charlie Gibbs Fracture Zone. ECOMAR - Ecosystem of the Mid-Atlantic Ridge at the Sub-Polar Front and Charlie Gibbs Fracture Zone.** http://www.oceanlab.abdn.ac.uk/ecomar/index.php

ECOMAR forms part of the Census of Marine Life MAR-ECO project which is an international study of life in the northern mid-Atlantic Ocean with scientists from 16 nations participating in research of the waters around the mid-Atlantic Ridge from Iceland to the Azores (http://www.mar-eco.no).

ECOMAR is focussed on patterns and processes in an area approximately half way between Iceland and the Azores in the vicinity of the Charlie-Gibbs Fracture Zone. The fracture zone represents a major discontinuity in the structure of the ridge but is also the latitude at which the north Atlantic current crosses the ridge from west to east delineating the position of the sub-polar front with cooler productive waters to the north and warmer more oligotrophic to the south. A voyage of the *RV GO Sars* in 2004 had indicated important differences in fauna across this boundary. The aim of *RRS James Cook* cruise 011 was to establish a detailed study of the environment in this transition zone.

The specific objectives were to:

1. Make detailed bathymetric surveys with a view to establishing four long term super stations at 2500m depth at 49°N and 54°N with a two stations west of the ridge axis and two stations east of the ridge axis i.e. SW, NW, SE and NE.
2. Study the characteristic water masses in this area and their movements by means of CTD casts including a series casts along a transect between the SW and NW station along the track of the TOPEX POSEIDON satellite traversing the axis of the north Atlantic current.
3. By remote sensing to determine the locations of fronts in the study area.
4. Measure processes of primary production in the study area by remote sensing and ship-borne measurements in relation to fronts and the current regime defined by 2 and 3.
5. Measure and characterise pelagic biomass in the vicinity of the four super stations by means of multi-frequency echo-sounding and mid-water trawling.
6. Deploy moorings equipped with sediment traps at other instrumentation at each of the four super stations.
7. Measure abundance of bioluminescent organisms in the water column using a high sensitivity video and impact screen mounted on the CTD.
8. Observe benthic bioluminescence using a lander equipped with an ISIT camera.
9. Sample the benthic fish and invertebrate fauna at each of the four super stations using an otter trawl.
10. Observe and record sounds of benthic fauna attracted to baits at each of the four super stations using a lander.

11. Deploy a long term observatory (DOBO) in the Charlie-Gibbs Fracture Zone.
12. Obtain megacorer samples of sediment and its fauna at each of the 4 superstations.
13. Capture motile benthic epifauna by means of free fall traps at each of the four superstations.
14. The survey the sea floor and visible fauna by means of the SHRIMP video and photo-imaging system.

LIST OF GEARS USED

Acoustic Lander – A lander equipped with an active multi-frequency echo-sounder for measuring targets in the water column. (From IMR Bergen)

ADCP – Acoustic Doppler Current profiler. - There was one mounted on the keel of the vessel and other units on the CTD and landers.

Amphipod trap - A free fall baited trap with acoustic releases and buoyancy

ARU – Autonomous recording Unit built by Connell University, logs cetacean sounds and was deployed as part of the DOBO rig.

CTD - Conventional conductivity, temperature depth rosette sampler with 24 bottles, ADCP and other sensors.

CTD + ISIT – The CTD rosette with an ISIT camera and impact screen mounted on the side for simultaneous recording of abundance of bioluminescent organisms

CTD + SIT - The CTD rosette with an SIT camera (Less sensitive than ISIT) and impact screen mounted on the side for simultaneous recording of abundance of bioluminescent organisms

CTD TP – Identifies CTD stations on the TOPEX POSEIDON transect west of the ridge.

CTD YoYo – The CTD rosette deployed for repeated cycles without the bottles.

DOBO – Deep Ocean Benthic Observatory

EK60 - Kongsberg multi-frequency echosounder for measuring targets in the water column.

ISIT - Lander equipped with an sensitive ISIT video camera

Megacorer - A multi-corer for sediment sampling

Optics Rig – A frame equipped with optical measurement devices lowered on a cable often simultaneous with the CTD.

OTSB – Otter Trawl Semi-Balloon

PAL – Photographic Acoustic lander

RMT – Rectangular Mid-Water Trawl

SHRIMP - Seabed High Resolution Imaging Platform

SVP – Sound Velocity Profiler.

Swath Bathymetry- surveys done using the Kongsberg EM120 swath system coupled to an OLEX display

Whale Hydrophone – A towed hydrophone for recording cetacean sounds deployed when the vessel was on under way between stations.

CRUISE NARRATIVE

All times BST

Friday, 13 July Southampton NOC Empress Dock Southampton

The *RRS James Cook* was lying alongside ready to sail. All personnel and equipment on board.

1200h Departed NOC. Stiff breeze blowing from the SW anticipated a rough crossing to Bantry Bay where it was planned to undertake calibration of the Kongsberg EK 60 sonar for measuring pelagic biomass.

1300h Passed Calshot Spit
1320h Pilot left the ship

1500h In the channel good sunny weather making 12.5 knots

1630h First meeting of the Scientific Party was convened in the conference room.

2030h Weather getting worse with rain. Against a head wind and tide the ship makes 9 knots. EM210 multibeam signal was breaking up but the OLEX system was working.

Saturday, 13 July

0530h South of Lizard point, making progress in fine weather, again 9 knots against the tide.

1000h South of Bishop Rock Lighthouse

1125h Reduced speed to 4 knots to lower the starboard keel for assessment of the EK 60.

1154h Testing of the EK60 and the EM 120 continued, increased speed to 10 knots.
With the keel down the EM120 signal looked OK but the EK60 was breaking up 30% of the time as the ship pitched steaming into the swell.

1200h 49°43.5'N 06°54.6'W
Commenced steering a box at 10 knots to test sonars at different orientations to the swell coming from the west. Altered course to 180° due south.

1215h Altered course to 90°, due east.

1230h Altered course to 00°. Due north. It was found that the EK60 performed well in all orientations to the seas at 10 knots. The EM120 swath system did not work well against the swell but in all other directions across or running with the sea data were good with no drop outs.

1244h Reduced speed to 5 knots to recover the starboard keel.

1250h Resumed passage to Bantry bay having completed tests.
1300h Meeting held in the Conference room to discuss the procedures for calibration of the EK60 on arrival in Bantry Bay.

Sunday, 15 July

0300h Passed Fastnet Rock
0415h Off Sheep's head at the entrance to Bantry Bay.

0604h 51°39.65'N 09°41.52'W Holding on DP and commenced lowering the CTD for sound velocity corrections of the EK60.

0621h CTD in board. Work commenced on deploying the calibration tungsten ball beneath the ship while holding on DP.

0820h The winches and lines were deployed and the ball was hanging beneath the ship but the line was catching on the port side. The lines were hauled back out to start again.

0930h The ball was back in position under the keel.

1010h The operators detected the ball on the EK60 display.

1015h The starboard keel was lowered to the operational depth and calibration work commenced.

1245h The EK60 18 kHz transducer was completely characterised.

1530h Work on the 200kHz and 120kHz transducers was completed and the calibration procedure was progressing well.

1550h The pilot boat from Castletown - Bearhaven arrived alongside to offload spares and James Hawkins, a student from Aberdeen who was joining the ship.

1555h The pilot boat departed with Andrew Brierley and Christian Wilson who had been on board to oversee setting up of the EK60 and EM120/Olex systems respectively.

1610h On the EK60 problems were being encountered with excessive density of targets in the water obscuring the signal return from the tungsten ball. The ship was swung through 360° on DP in an attempt to disperse the organisms. This was not successful

1800h It was apparent that there seems to be a fault in 70kHz transducer resulting in a very elliptical athwartship polar diagram. Calibration of this frequency was abandoned. It was agreed to wait for night-fall in the hope that the zooplankton would disperse.

1948h Local sunset, sky overcast with cloud , calm conditions

2210h No sign of dispersal of the zooplankton so further calibration of the 38 kHz transducer was also abandoned. In summary results were:

18 kHz transducer calibration good.
200kHz transducer calibration good
120kHz transducer calibration good.
70 kHz transducer, targets could only be detected along an athwartship line across the transducer, no signal in the forward and aft sectors. Clearly damaged or wired incorrectly.

38kHz transducer could not be calibrated owing to high density of natural targets in the water.

2230h Starboard keel raised.
2240h Ball retrieved on board
2250h Lines all in board

2255h Resumed passage westwards to the SE Superstation.

Monday, 16 July.

0230h Rain showers with lighting

0330h Reduced speed to commence deployment of whale hydrophone.

0340h **Station JC011/001 Whale Hydrophone. Surface 51°25.8'N 11°01.5'W**
Hydrophone deployed towed from port stern boom.

0400h Increased speed to normal transit speed, *ca.* 11 knots.
Throughout the day ship was moved smoothly westwards in slight seas and good weather.
There were problems with the EM120 swath bathymetry output.

1307h No swath data as the ship approached the Porcupine Bank, the system was rebooted.

1549h The swath data again broke up and the system was rebooted. Henceforth continuous good data were obtained.

1805h Station JC011/001 Whale Hydrophone recovered 50°51.2'N 15°02.6'W
End of first run, 156 Miles.

1820h **Station JC011/002 CTD + Release Test to 3000m 50°51.2'N 15°02.7'W**
Acoustic releases were attached to the CTD frame for testing.
1922h PML Optic Rig launched from Starboard stern crane for a test to ca, 100m
1953h CTD reached 3000m, commenced sending command to the releases.
2000h PML Optic Rig recovered.
2030h Release tests complete, commenced hauling the CTD.
2125h CTD recovered
2134h CTD secured In board.

2145h Whale hydrophone streamed and ship set course for the SE Station.

2200h **Station JC011/003 Whale Hydrophone surface 50°45.8'N 15°39.4'W**
Recording commenced during the passage.

Tuesday, 17 July 2007

0215h Clocks retarded one hour to GMT/UTC

HENCEFORTH ALL TIMES ARE GMT.

0400h Wind NNW 20 knots

0850h Vessel slowed down to 4 knots to commence hydrophone recovery.

0855h Station JC011/003 Whale Hydrophone recovered 50°22.9'N 18°17.4'W
End of second run 103 miles.

0900h The vessel was on DP in preparation for deployment of the CTD however there was an incident when the winch moved unexpectedly and damaged the cable termination that then needed to be reworked.

0925h **Station JC011/004 Whale Hydrophone surface 50°22.9'N 18°17.4'W**
The system was redeployed, wind 330° force 3. The ship resumed passage.
The swath system continued to give good readings.

1554h Station JC011/004 Whale Hydrophone recovered 50°07.6'N 20°02.7'W
End of third run 69 miles.

1610h **Station JC011/005 CTD + Release Test to 3700m 50°07.8'N 20°03.9'W**
CTD with the second set of releases on test.

1645h PML Optic rig deployed.
1735h Optic rig recovered but was found to have malfunctioned.

1850h Tests on releases completed, commenced hauling the CTD

1858h PML Optic rig redeployed
1943h Optic rig recovered.

2015h CTD recovered in board.
2020h CTD secured in board and the vessel resumed course to the SE station, the hydrophone was redeployed

2026h **Station JC011/006 Whale Hydrophone surface 50°07.8'N 20°03.9'W**

Wednesday, 18 July

0700h Sunny smooth conditions as the ship continued in transit
0900h Daily meeting with captain
1000h Tour of the scientific equipment by the science party.
1200h A spectacular display of dolphins round the ship during lunch time entertained the diners.

1600h Science meeting in the Conference room. The vessel continued westwards throughout the day.

Thursday, 19 July

0045h Station JC011/006 Whale Hydrophone recovered 49°00.2'N 27°40.6'W

303 miles run.

0050h *RRS James Cook* on station at the SE super station waiting to commence work.

0120h **Station JC011/007 CTD and SVP 2860m 49°00.0'N 27°40.8'W**
CTD launched with the sound velocity profiler.

0353h CTD on deck. The sound velocity data were downloaded into the Kongsberg systems.

0400h **Station JC011/008 EM 120/OLEX Swath survey 49°00.00'N 27°40.80'W**
Commenced a first survey of the study area, with a transect at right angles to the ridge axis in this region.

0432h Starboard drop keel lowered for EK60 trials simultaneous with the swath bathymetry

0442h Speed increased to full survey speed of 10 knots.

0442h First survey waypoint 49°02.2'N 27°46.4'W

0539h Start of the line across t 48°44.2607'N 28°10.3415'We ridge 49°04.9'N 27°50.7'W
1028h Completed line across the ridge 48°46.0'N 28°38.0'W
1238h Traversed Summit of Seamount 48°43.6'N 28°10.9'W on the return leg eastwards.
1525h End of swath Survey vessel stopped at CTD position.

1536h S**tation JC011/009 CTD &Optics rig to 200m 49°04.84'N 27°50.78'W**
CTD entered the water.
1537h Optics rig deployed.
1620h CTD in board
1639h Optics rig inboard, Vessel moved to the mooring deployment site.

1750h **Station JC011/010/SE Mooring 2500m 49°01.92'N 27°40.82'W**
Deployment commenced.
1917h Ballast released.
1948h Having verified that the mooring was anchored on the bottom and vertical the vessel moved to the lander deployment sites.

2030h **Station JC011/011 PALander 2512m 49°02.02'N 27°42.15'W**
Commenced deployment.
2042h Lander deployed ballast released.
~2049 Flag went down.

2120h **Station JC011/012 ISIT Lander 2450m 49°01.45'N 27°43.59'W**
Commenced deployment of lander.
2126h Lander released but it failed to sink, so the vessel moved aft under DP to pick it up again.
2205h Pellet buoy back on board and recovery proceeded.
2220h ISIT back on board, excess flotation was removed and redeployment began
2248h Flag sunk below the surface; ISIT lander finally deployed after the delay.

2322h **Station JC011/013 Amphipod Trap 2627m 49°01.163'N 27°42.292'W**
Commenced deployment
2328h Amphipod trap deployed

2338h Set course for Shrimp position.

Friday, 20 July

0054h **Station JC011/014 Shrimp 2000-2613m 49° 05.376'N 27° 54.286'W**
Shrimp deployed at a start position on a ridge west of the proposed trawling plain.
0130h Deployed starboard USBL boom.
0227h Commenced Shrimp track
0525h Shrimp camera failed, stopped recording.
0635h USBL boom inboard.
0643h Shrimp in board. 49°05.40'N 27°52.01'W
0735h All secure and the vessel headed for the ISIT location.

0855h *RRS James Cook* was hove to 0.5 Nmiles south of the ISIT (Sta. 12) position.
0916h Release command sent.
1013h ISIT on the surface Station JC011/012 ISIT.
1045h Grappled
1057h ISIT lander on deck.

1105h The vessel proceeded to the Amphipod trap location (Sta. 13).
1130h On station attempting to contact the trap release.
1153h There was no confirmation that the release had triggered.
1230h Amphipod trap on the surface: Station JC011/013.
1245h Grappled
1254h Trap on deck, recovery complete, very little captured.

1412h *RRS James Cook* has moved on to the SE CTD site.

1418h **Station JC011/015 CTD & Optics rig to 200m 49°04.54'N 27°50.80'W**
Optics rig deployed.
1425h CTD deployed
1458h The CTD and Optics rig had been recovered and work at this station was completed.

1545h **Station JC011/016 CTD 2747m 49°04.83'N 27°50.79'W**
A full depth CTD at the same site as the optical studies.
1808h CTD inboard.

1930h *RRS James Cook* on station for PAL (Sta. 11) recovery.
Release command sent.
Very long delay without any sign of PAL

2110h PES fish deployed to prepare for trawling.

2240h Acoustic ranging on PAL using the release command unti detected it at 600m the ship moved ahead at 0.5 knots. It became apparent that Pal was on or near the surface directly ahead of the vessel.
2330h The pellet buoy was sighted, no other part of the mooring was visible; the buoyancy necessary had been underestimated.

Saturday, 21 July

0000h Pellet grappled and line secured.
0012h PALander on deck.

0030h *RRS James Cook* proceeded to the trawl site towards the North West with a view to towing to the southwest. A start point 9 miles downwind of the target landing site was chosen.

0210h **Station JC011/017 OTSB 2700m 49°14.68'N 27°42.31'W**
Started deploying the trawl.
0240h Trawl transferred to the main warp commenced towing at 2 knots on course 210°.
0315h Increased speed to 4 knots.
0340h The wind backed the vessel had difficulty maintaining course.
0420h Course changed to starboard by 20° to give 230° but the wind had backed to 270°
0533h 6900m of wire out, speed reduced to 2.3 knots.
0629h Speed reduced to 1 knot.
0644h Net on the bottom
0659h Increased speed to 2 knots.
0710h Increased speed t0 1.5 knots.
0723h The wire tension increased indicating the net was stuck fast.
0800h The vessel moved astern to free the net.
1000h Moving astern at 0.9 knots.
1158h 49°03.37'N 27°57.27'W The vessel was almost above the position of the net which now was pulled free.
1358h Trawl doors in board.
1405h 49°03.43'N 27°53.86'W The trawl was in board with a small catch comprising 3 fish owning to a large tear in the cod end. The trawl had got caught on rising ground at the edge of the target plateau.

1436h The vessel moved to a proposed start of an EK60 survey across the axis of the ridge and median valley with a course SW towards the 700m seamount.

1533h The vessel was rolling and pitching so no good data were being collected from the EK60 (pelagic biomass) or EM120 (swath bathymetry) . Surveys were abandoned and the ship made course for the seamount and the intended deployment site for the Bergen acoustic lander. Wind was 25knots 300°

1933h **Station JC011/018 Acoustic Lander 1000m 48°44.195'N 28°10.253'W**
Commenced deployment
1957h Acoustic Lander deployed adjacent to the summit of a seamount on the western edge of median valley of the Mid Atlantic Ridge.

2120h **Station JC011/019 ISIT Lander 796m 48°43.586'N 28°09.859'W**
Commenced deployment of the ISIT lander on the same sea mount.
2127h ISIT lander deployed.

2135h *RRS James Cook* moved off to the SW station to begin an EK60 survey

Sunday, 22 July

0020h **Station JC011/020 EK60 survey 48°41.821'N 28°39.365'W**
Survey line began at the SW station on a course 263°T with wind of 20-25knots from the NE and sea state 2-3 westerley. Quality of data was good.

0535h End of Sta. 20 survey line 49°04.4'N 17°46.6'W, 37.7 nautical miles run across the axis of the ridge.

0630h *RRS James Cook* arrived on the megacorer station. Warning lights on the bridge indicated the problem with the azimuth thruster. After some checking the problem resolved itself and work could begin

0736h **Station JC011/021 Megacorer 2734m 49°05.40'N 27°50.22'W**
The megacorer was launched to sample part of the Shrimp survey line in the sedimentary basin at the SE end station.
0900h Commenced hauling
1015h Megacorer back in board with 5 good cores in very soft sediment with copious phytodetritus fluff on top.
The *RRS James Cook* westwards to the lander locations to deploy the PALander for a second time.

1143h **Station JC011/022 PALander 2546m 49°01.995'N 27°42.113'W**
Commenced deploying the lander. Just before final release it was noticed that 2 floats had come loose. The boss clip had shaken loose during deployment in quite rough seas. The mooring was therefore hauled partially back in and an additional pair of floats attached at the lower swivel.
1206h Flag sank, lander deployed.

1215h *RRS James Cook* then set out westwards to the sea mount where it was intended to retrieve ISIT and do a CTD and Optics station on the summit near the Acoustic lander station. After that owing to windy conditions ca. 30 knots it was planned to do CTDs along a transect across the ridge axis.

1543h On station sending release commands to ISIT

1612h ISIT on the surface.
1636h Pellet buoy grappled.
1657h Lander in board Station JC011/019 completed.

1804h **Station JC011/023A CTD 690m 48°43.207'N 28°10.21'W**
Began deployment of the CTD near the summit of the seamount.
1833h The CTD signal was lost at 450m. The system was retrieved back on board. It was discovered there was a slight defect in the cable termination.

2000h A meeting of scientists was convened to review the status of work at the southern stations. Since the weather was moderating it was decided to return to the trawling site in the east and postpone the CTDs until later.

2320h **Station JC011/023B OTSB 2720m 48°54.590'N 27°50.00'W**
Started deploying the trawl.

Monday, 23 July

0008h Increased speed to 4 knots.
0254h Reduced speed to 1 knot land the net.
0306h Trawl was on the sea floor.
0355h Increases speed to 2.5 knots
0416h Began hauling.
0716h Trawl in board a good clean catch of fish including small *Coryphaenoides armatus* and invertebrates 49°15.85'N 27°50.00'W.

0730h **Station JC011/024 EK60 survey 48°54.590'N 27°50.00'W**
A grid survey over the SE station, good data being collected with the keel down and vessel speed of 6 knots. All other sonars switched off.

1310h 49°08.2N 27°45.1W survey completed, the vessel turned towards the next station.

1445h **Station JC011/025 CTD + Optic rig. 1704m 49°02.20'N 27°55.62'W**
CTD deployed above the summit of the eastern margin of the axial valley.

1525h Optical rig deployed at the stern.
1637h CTD in board

1712h **Station JC011/026 ISIT Lander 1701m 49°02.22'N 27°55.58'W**
The ISIT lander was deployed on the location of the CTD on the summit of the ridge crest. The vessel moved off to the central SE site.

1820h **Station JC011/027 Megacorer 2763m 49°05.42'N 27°50.24'W**
The Megacorer was deployed at the central coring site of the SE station.
2000h Full depth started hauling.
2106h Megacorer on deck.

2118h All secure ready to move off however by this time the wind force was increasing and the weather was clearly unsuitable for trawling. It was decided to pursue the deep CTDs in the axial valley on the ridge in this region.

Tuesday, 24 July

0000h **Station JC011/028 CTD 3810m 48°56.414'N 28°03.934'W**
The CTD was deployed on the eastern side of the axial valley. The wind was force 7 during this time.

0130h The CTD reached maximum depth, commenced hauling.
0325h The CTD was on board, wind increased to force 8 from the SW with 3m swell. *RRS James Cook* moved to the next station.

0501h **Station JC011/029 CTD 4100m 48°54.58'N 28°05.33'W**
Station in the centre of the mid axial valley.

0815h CTD in board.

0840h *RRS James Cook* was on passage to the third CTD station in the median valley in sunny weather with 35 knots of wind from the south west. There was hope that the next CTD might coincide with the MODIS satellite overpass around mid-day.

0920h Ship hove to over the station but at 48°50.091'N 28°08.368'W was 4 miles south of the correct position and outside the surveyed area. There had been an error in transcription of the co-ordinates from OLEX. The CTD was aborted and the ship set off for the correct position.

1058h **Station JC011/030 CTD 3878m 48°54.091° 28°08.368'W**
1128h One of the salinity sensors failed on the way down. Stopped to consider, veering continued.
1125h Stopped at full depth, no altimeter reading.
1245h Efforts to deploy an optical rig were cancelled owing to pitching motion of the ship. Wind continued above 30knots from the west.
1423h CTD in board. Wind 35 knots gusting over 40 knots. Science was suspended owing to inclement conditions. Sunny with sparse clouds The ship remained on DP head to wind.

1715h Azimuth thruster retracted.

2050h Visibility had decreased with overcast skies strong winds continuing Force 7-8 with occasional waves coming over the bows of the *RRS James Cook.*

Wednesday, 25 July

0000h 48°57.5'N 28°37.6'N Midnight position, still hove to, wind force 7-8
0130h Wind 25-40knots westerly.

0800h *RRS James Cook* had ridden out the gale overnight head to wind progressing slowly westwards. The wind was now moderating slightly so it was decided to return to the working area while undertaking an EK60 survey downwind when signal quality could be expected to be good.

0835h **Station JC011/031 EK60 survey 49°02.5'N 29°06.1'W**
Commenced survey line down wind at 7-8 knots.

1515h 49°05.4'N 27°51.5'W Ended EK60 survey line back near the SE station.

1545h **Station JC011/032 Megacorer 2773m 49°05.42'N 28°50.24'W**
Megacorer deployed.

1713h The megacorer reached the sea floor and hauling commenced

1829h The megacorer was in board with 6 full cores, however 5 were disturbed but one was good. The *RRS James Cook* moved westwards to the ISIT lander site on the eastern margin ridge.

1955h Station 26 ISIT lander recovery. The release signal was sent from the deck unit.
2037h Lander on the surface
2055h Pellet buoy grappled and line secured.

2109h ISIT lander was recovered on deck.

It had been intended to either fish with the OTSB or deploy the Shrimp camera system. The wind was still above 20 knots and swell too high to consider these. The westerly wind precluded bottom trawling in predominantly north-south topography. Therefore a further EK60 survey was planned for the night.

2258h **Station JC011/033 EK60 survey 49°12.01'N 27°49.93'W**
A grid survey commenced throughout the night over the SE station .

Thursday, 26 July

0440h 49°09.00'N 27°41.91'W Station JC011/033 ended with the ship turning away from the survey grid to arrive at the lander recovery site at daylight.

0538h *RRS James Cook* arrived at the PALander site.

0545h PALander Sta. JC011/022 was released.

0645h PALander on the surface.

0719h PALander inboard completing work at the SE station. The vessel set course for the western fringe of the axial valley.

1121h **Station JC011/034 CTD +Optics 49°53.260'N 28°20.206'W**
1200h Optics rig deployed at the stern.
1255h Optics rig inboard.
1330h CTD inboard. The weather was quite calm by this time and very good conditions for work. The ship continued westwards to the southwest moorng site.

1530h **Station JC011/035 SW Mooring 2500m 48°46.80'N 28°38.43'W**
Commenced deployment of the mooring in calm conditions.
1641h Mooring deployed and ballast released.
1718h Mooring on the bottom the vessel progressed one mile south to a CTD position.

1745h **Station JC011/036 CTD 2550m 48°45.80'N 28°38.41'W**
CTD at the SW station completing the proposed transect at the southern stations.
2001h CTD in board

2010h **Station JC011/037 EK60 Survey 48°45.80'N 28°39.02'W**
Commenced EK60 over the SW station at 8 knots.
2025h Reduced speed to 7 knots
2104h Increased speed to 8 knots.

2206h **Station JC011/038 RMT 350-195m 48°44.667'N 28°34.974'W**
Commenced streaming the double RMT rig. EK60 was left on to identify targets.

Friday, 27 July 2007

0047h The RMT net was recovered and the vessel stopped. 48°41.30'N 28°41.15'W A good catch.

0105h **Station JC011/039 RMT 800m 48°41.30'N 28°41.15'W**
The net was deployed for a second time in the night fishing deeper.

0345h RMT net recovered with a second good catch 48°37.40'N 28°46. 4'W
In continuing calm conditions *RRS James Cook* moved back east to the seamount where the acoustic lander (Station 18) had been deployed.

0718h **Station JC011/040 CTD + Optics 837m 48°43.21'N 28°10.21'W**
On the summit of a sea mount.

0753h Optics rig deployed from the stern
0830h Optics rig inboard.
0833h CTD in board.

0845h The vessel now undertook a run over the location of the acoustic lander with the EK60 running to collect data that would be complementary to data from the acoustic lander data.

0945h EK60 run complete and the vessel was now standing by for recovery of the Acoustic lander (Station 18).

1018h The release command had been sent and the lander apparently began ascending. However the ascent stopped at ca. 200m above bottom. This was finally interpreted as ascent of the release plus its two buoyancy spheres to the limit of the length of mooring which was now anchored to the sea floor by the body of the acoustic lander which must have suffered a buoyancy failure.

1027h The vessel moved directly over the deployment position and range was checked on the IXEA deck unit. Position was then checked by boxing; ranging from 4 positions 500m east, south, west and north of the deployment location in succession.

The exact location was determined as: 48°44.2607'N 28°10.3415'W

There was no possibility of recovering the lander so the vessel moved off westwards towards the first station of the TOPEX-POSEIDON CTD transect.

1221h **Station JC011/041 Whale Hydrophone 48°45.00'N 28°17.00'W**
The vessel slowed down to deploy the whale listening hydrophone and then resumed passage in good conditions with moderate swell and 10 knots of wind from the west. The EM120 was switched on for bathymetry but data were of poor quality.
1746h On station for the CTD, the hydrophone was recovered end of station 41. 48°51.5'W 29°35.3'W

1755h The starboard drop keel was deployed to allow logging EK60 data but noise from the ADCP was on the traces and could not be eliminated by attempts to synchronise the pulses.

1803h **Station JC011/042 CTD 3510m 48°51.54'N 29°35.33'W**
The first CTD cast of the transect designed to coincide with the orbit path of the Topex-Poseidon satellite to measure flow over the ridge. EK 60 monitoring with the starboard keel down continued between the stations.

1920h Maximum wire out, started hauling. A nice clear calm evening.
2020h Spooling problems developed on the winch. A serious concern and hauling continued slowly observing the winch drum all the time.

Saturday, 28 July

0110h With 500m of wire yet to come in the problems appeared to have been overcome. It seemed there was not a problem with the winch itself but that the wire had acquired a twist in one section.

0140h The CTD was inboard.

The spacing between stations was revised to miss out one station in an effort to catch up on lost time. The vessel moved NW to this more distant station, the weather changed to cloudy and intense rainfall and visibility less than 0.5 miles by 0400h

0447h **Station JC011/043 CTD 3260m 49°09.73'N 29°55.25'W**
The second CTD of the Topex-Poseidon transect deployed in gloomy drizzly weather.
0730h CTD inboard a good fast operation of the winch.

1013h **Station JC011/044 CTD + Optics 3220m 49°26.29'N 30°13.65'W**
Topex Poseidon transect CTD No 3 with the PML optical module deployed form the stern. The weather by this time was quite sunny but nevertheless overcast, humid and fog not far away.

1532h **Station JC011/045 CTD + ISIT 3626m 49°39.22'N 30°28.21'W**
Topex Poseidon transect CTD No 4 with the Oceanlab Aberdeen, ISIT camera mounted on it. The weather was again foggy with drizzle and wind about force 3.

1813h The CTD was retrieved inboard and the ISIT camera front window was found to have broken. The camera was destroyed. Subsequent replay showed that a complete profile had been recorded down to the end of recording at ca. 3600m so it is assumed that the window failed at maximum depth.

2020h **Station JC011/046 CTD 3575m 49°51.68'N 30°42.44'W**
Topex Poseidon transect CTD No 5. A straight forward CTD in continuing drizzly weather.
2314h Near the bottom, started hauling
2327h CTD in board, moved to the next station.

Sunday, 29 July

0147h **Station JC011/047 CTD 3133m 50°04.11'N 30°56.80'W**
Topex Poseidon transect CTD 6

0432h CTD inboard

0647h **Station JC011/048 CTD + Optics 3567m 50°16.450'N 30°11.295'W**
Topex Poseidon transect CTD 7
Foggy weather, 400m visibility, poor light conditions for optics work.
0842h Optics rig out board
0927h CTD inboard
0933h Optics rig in board.

0940h **Station JC011/049 Whale Hydrophone 50°16.450'N 30°11.295'W**
The hydrophone was deployed as the vessel moved off at 2 knots. Speed then I increased to full cruising speed with the keel down for EK60 monitoring.

1123h Hydrophone recovered.

1145h **Station JC011/050 CTD 3279m 50°28.862'N 31°25.91'W**
Topex Poseidon transect CTD 8

1433h CTD in board, EK60 monitoring commenced on departure from the station.

1525h Much improved visibility with a little sunshine showing through the clouds.

1657h **Station JC011/051 CTD + SIT 3330m 50°43.64'N 31°43.66'W**
Topex Poseidon transect CTD 9. The SIT camera from SHRIMP was fitted to the CTD for bioluminescence profiling in lieu of the lost ISIT camera.

1836 Conditions had turned foggy again

1937h CTD in board and the vessel moved off with EK 60 active..
2157h Vessel on station for next CTD

2158h **Station JC011/052 CTD +SIT 3693m 50°58.36'N 32°01.61'W**
Topex Poseidon transect CTD 10

Monday, 30 July

0109h CTD in board

0320h Vessel on station for next CTD

0344h **Station JC011/053 CTD + SIT 2939m 51°13.03'N 32°19.73'W**
Topex Poseidon transect CTD 11

0602h CTD in board
0609h Departed for the next station.

0814h **Station JC011/054 CTD+ SIT + Optics 2848m 51°25.21'N 32°35.02'W**
Topex Poseidon transect CTD 12

0938h Optics rig deployed

1033h Optics rig recovered.
1047h CTD in board .

1300h Ship on station ready to commence deployment

1318h **Station JC011/055 CTD+SIT+Optics 3540m 51°39.77'N 32°53.54'W**
Topex Poseidon transect CTD 13.
1525h Deployed optics rig and started hauling on the CTD
1555h Recovered the Optics Rig
1628h CTD in board

1832h **Station JC011/056 CTD+SIT 3528m 51°51.88'N 32°09.15'W**
Topex Poseidon transect CTD 14.
2103h CTD recovered. The working conditions were good and calm with difficulties. EK 60 monitoring continued between stations but accepting interference from the ADCP.

2322h **Station JC011/057 CTD+SIT 3620m 52°06.33'N 33°28.07'W**
Topex Poseidon transect CTD 15.

Tuesday, 31 July

0228h CTD recovered, set out for the next station with the EK60 running.

0425h **Station JC011/058 CTD+SIT 3911m 52°18.35'N 33°44.01'W**
Topex Poseidon transect CTD 16 in the southern valley of the CGFZ.
0715h CTD in board.

0919h **Station JC011/059 CTD+SIT+Optics 3073m 52°30.29'N 34°00.12'W**
Topex Poseidon transect CTD 17.
1027h Optics rig deployed.
1116h Optics rig recovered. Good calm conditions but still overcast skies.
1144h CTD recovered.

1350h *RRS James Cook* was on station ready for a CTD cast into the northern valley of CGFZ. There was a delay in starting the CTD ADCP recording system.
1414h Deployed the Cornell University underwater listening device from the starboard aft crane normally used by the PML optics group. Checked the floatation before deployment with DOBO. The system was found to float OK with less than half the upper sphere out of the water.

1418h **Station JC011/060 CTD+SIT+Optics 3059m 52°44.59'N 34°19.64'W**
Topex Poseidon transect CTD 18
The CTD problems were overcome and it was deployed.
1554h Deployed the optics rig.
1646h The optics rig was brought in board.
1657h The drop keel was retracted in preparation for fast steaming.
1708h The CTD was in board.
1719h All secure on deck and the azimuth thruster was retracted. *RRS James Cook* then took a detour from the Topex Poseidon transect to deploy the DOBO lander.

1900h *RRS James Cook* was steaming towards the DOBO deployment position, ideal calm conditions with good visibility. High quality swath data was being collected at 10.5 knots.

2017h Arrived at the DOBO location.

2035h **Station JC011/061 DOBO 3690m 52°41.35'N 34°04.17'W**
DOBO was deployed in the north valley of the CGFZ at the Saunders (1994) mooring location. The Cornell University cetacean listening device was fitted into the mooring line above the Dahn buoy.
RRS James Cook returned directly to the next CTD station on the Topex Poseidon transect.

2308h **Station JC011/062 CTD+SIT 2252m 52°56.454'N 34°36.070'W**
Topex Poseidon transect CTD 19

Wednesday, 01 August

The wind gradually began to increase from the south to 18-20 knots by the time the CTD was recovered. 0112h CTD in board.

0318h **Station JC011/063 CTD+SIT 2775m 52°10.64'N 34°56.02'W**
Topex Poseidon transect CTD 20, north of the CGFZ.
The wind by this time was 25-30 knots (160°); a 1.5m swell had developed and the barometer was falling rapidly.

0529h The CTD was in board.

0802h **Station JC011/064 CTD+SIT+Optics 2252m 52°24.74'N 35°16.13'W**
Topex Poseidon transect CTD 21.

0938h The optics rig was deployed
1020h CTD in board.
1026h Optics rig in board. A misty day with 18 knots of wind. The forecast was for a very low depression to come through during the next 84h with very strong winds in excess of Force 8. This was raising concern regarding commencement of work in the NW station.

1238h **Station JC011/065 CTD+SIT+Optics 1894m 53°36.459'N 35°33.201'W**
Topex Poseidon transect CTD 22.

1245h Optics rig deployed.
1430h Optics rig and CTD recovered inboard.

1628h **Station JC011/066 CTD+SIT 1614m 53°48.15'N 35°50.42'W**
Topex Poseidon transect CTD 23

1753h CTD in board

1756h Steamed towards the NW mooring position with the swath bathymetry active. Explored the area and decided on a mooring position as near as possible to 2500m depth.

2119h The ship was lined up 3 nautical miles from the proposed mooring position, commenced deployment.

1223h **Station JC011/067 NW Mooring 2500m 53°59.334'N 36°09.361'W**
Deployed on a slope at the SE edge of a flat plain. The wind had by this time increased to 26 knots from 200°.

Thursday, 2 August

0010h Acoustic telemetry confirmed that the mooring was secure on the sea floor, the vessel proceeded south to commence a swath survey of the NW area:

0040h **Station JC011/068 Swath/EK60 Survey 53°56.87'N 36°13.30'W**
Commenced swath survey, with simultaneous EK60 monitoring towards the west.

0125h The weather was too rough, 20-30 knots with 2-3 metre seas to get good data on this heading, so the vessel turned towards the north . Continued on course 357°T gathering good data.

0300h Arrived near the CTD station, switched off the OLEX system and continued with EK60 only on a loop to the south and back north to the CTD station (TP transect no 25)

0648h *RRS James Cook* arrived in the vicinity of the CTD station but the weather by this time was too bad to continue. Scientific work was suspended.

1600h Wind was 35-50knots 260° with 6-8m seas, the *RRS James Cook* was hove to.
The depression was derived from storm Chantal and winds reached over 55 knots during the course of the day.

Friday, 3 August

0130h Winds moderated to force 6-8, visibility cleared but the vessel rolled throughout the night, not many slept well on board.

0700h Wind 35knots 280°T,

1700h It was decided that weather had moderated sufficiently to prepare to start work again. By this time the vessel was 80 miles west of the working area.

1836h After the galley had cleared away the dinner *RRS James Cook* turned towards the east and the working area.

2050h Very heavy rolling forced a change in course delaying arrival at the 1st station.

Saturday, 4 August

0335h **Station JC011/069 CTD + ISIT 2094m 54°09.008'N 36°21.636'W**
Topex Poseidon transect CTD 25, north-west of the ECOMAR NW superstation.
0536h CTD in board, *RRS James Cook* continued passage back to the NW superstation area.

0725h **Station JC011/070 CTD + ISIT + Optics 2094m 54°59.741'N 36°07.672'W**
Topex Poseidon transect CTD 24, the NW super station. This station completed the Topex-Poseidon transect.
0835h Optic rig deployed.
0915h Optic rig recovered.
0953h CTD in board.

1016h **Station JC011/071 Megacorer 2566m 54°01.000'N 36°08.400'W**
Near the centre of NW super station
1312h Megacorer in board.

1358h The weather was calm and it had been decided to deploy the long term camera lander, "Bathysnap" however to allow space for bottom trawling further swath survey was necessary to extend the available working area. The drop keel was lowered to allow simultaneous EK60 monitoring.

1418h Commenced short EM120/OLEX survey in 3m seas good data.
1507h Completed survey and lander deployment sites were chosen in an area away from planned trawling activity.

1534h **Station JC011/072 Bathysnap 2536m 53°57.864'N 36°11.486'W**
Bathysnap deployed SW of the NW superstation; to be retrieved in 2008, Images at 8 h intervals.

1626h **Station JC011/073 PALander 2573m 53°56.85'N 36°11.59'W**
Deployed on flat plain south of the Bathysnap in calm easy conditions..

1634h *RRS James Cook* proceeded back northwards to the Shrimp transect.

1757h **Station JC011/074 SHRIMP 2266m 54°01.17'N 36°05.84'W**
Shrimp deployed above a ridge with a westward transect planned down onto a flat plain where the megacorer samples were taken.
SHRIMP above the bottom viewing the sea floor, commenced traversing the ship westwards at 0.5 knots.
1944h Increased speed to 07 knots. Numerous fish and other signs of benthic life were apparent.

2020h Shrimp lights failed, a temporary halt to operations.
2051h Started again.
2154h End of transect, 2605m commenced recovery of Shrimp.
2259h Shrimp recovered in board
2314h All secured in board the vessel travelled to the trawl start position. The wind had decreased sufficiently to allow a direct tow south to north parallel with the bottom topography. Wind 315° 12 knots, seas 1-1.5m

Sunday, 5 August

0048h **Station JC011/075 OTSB 2605-2632m 53°51.1'N 36°11.6'W**
Commenced deployment of the trawl.

0400h Ceased veering.
0448h Net presumed on the bottom, towed at 1.5 knots.

0531h Commenced hauling.
0848h 54°11.14'N 36°05.66'W Net on deck with a good catch of fish and invertebrates.

0925h **Station JC011/076 CTD + Optics to 60m 53°11.140'N 36°05.657'W**
A shallow cast for primary production studies at where the OTSB was recovered. Skies were sunny and clear but by the time of the cast it was clouded over again.

0939h CTD recovered
1018h Optic rig recovered.

1030h **Station JC011/077 EK60 acoustic survey 54°01.830'N 36°07.099'W**
A grid survey design running north-south at 6.5 knots produced good clean data.
1506h End of survey 54°04.77'N 36°09.64'W

1540h **Station JC011/078 Megacorer 54°01.00'N 36°08.36'W**
A repeat of the previous day's cast.
1828h Megacorer was inboard with only one good core out of eight. The vessel departed for the PALander site.

1929h The PALander was released and began its ascent.

1951h **Station JC011/079 Amphipod Trap 2564m 53°56.44'N 36°11.56'W**
The trap was deployed while the PALander was ascending.

2022h PALander JC011/73 on the surface
2058h PALander recovered on deck.

2222h **Station JC011/080 SHRIMP 2050-2377m 54°03.80'N 36°15.17'W**
SHRIMP and USBL boom were deployed

2337h The commenced at 0.5 knots down a sediment covered slope.

Monday, 6 August

0209h Transect complete, began hauling.

0306h SHRIMP recovered back on board, the vessel departed for the trawl site.

0512h **Station JC011/081 OTSB 2600m 54°15.82'N 36°04.12'W**
The trawl was deployed at the north of the study area for a tow towards the south; the reverse of the track of the previous trawl (JC011/075).
0548h Veering stopped owing to overheating of the winch.
0620h A further stoppage to allow the winch to cool.

0905h The net was thought to be on the bottom as judged from the tension monitor. The SCANMAR net monitor system had ceased transmitting data when the winch had paid out ca. 1000m of wire.

0938h The vessel stopped, with the net snagged on the bottom. The vessel was then backed up under DP

1300h The vessel was stopped 54°06.5'N 36°07.30W above the position of the net. Attempts were made to pull to the west, to the east and back along the track to the north. The net was jammed with 5 tonnes of tension insufficient to haul it free.

1506h It was finally decided to pull the trawl free by hauling and overriding the winch safety limits.

1510h The wire broke free at 9.8 tonnes tension, and hauling continued.

1656h All the wire was inboard with just the swivels and two G clips on the end, the warps, doors , SCANMAR transducers and net were all lost.

1708h **Station JC011/082 CTD and Optics to 60m 54°09.85'N 36°05.96'W**
The Optical rig was deployed
1723h The CTD was deployed
1746h Optics rig inboard
1755h CTD inboard
1952h *RRS James Cook* arrived over the amphipod trap for recovery but weather was worsening it was eventually judged that conditions would be too severe by the time it surfaced to recover it safely. It was decided to quickly deploy the PALander before the weather got worse.
2035h Commenced deploying the PAL lander.
2040h As the lander was lifted ballast strop parted, therefore the while the mooring and floats were being towed after the lander was tied down to the deck and again and the strop was remade. However by this time the wind was gusting over 35 knots, seas were increasing and a pair of CRP floats came of the mooring. The wind was too strong to allow hauling in of the mooring so an extra length of line was shackled in and an extra pair of floats attached.

2108h **Station JC011/083 PALander 2567m 53°56.861'N 36°11.471'W**
The lander was finally deployed after much delay.

2115h Science was suspended owing to heavy weather

2200h *RRS James Cook* was hove to heading 130° into 45knots of wind.

Tuesday, 7 August

0320h The megacorer site in the centre of the study area was approached but it was decided that the weather was still to rough to work.
0740h The weather had abated sufficiently to start work.

0811h **Station JC011/084 Megacorer 2570m 54°01.00'N 36°08.40'W**
The corer was deployed

1130h The corer was recovered with 5 good cores. The vessel then proceeded to the area for the recovery of the amphipod trap that had not been possible the previous evening.

1245h **Station JC011/085 CTD and Optics to 65m 53°56.50'N 36°11.40'W**
Gear deployed above the amphipod trap recovery site.
1320h CTD and Optics in board and the hydrophone was deployed for release of the amphipod trap JC011/079.

1400h Trap on the surface.
1425h Amphipod trap recovered with a good catch including a large *Eurythenes gryllus* and potentially news species of Ostracod.

1445h Vessel on station to recover the PALander JC011/83, release commands were sent.
1550h Lander surfaced.
1616h PALander recovered in board. At this stage it was hoped to do some RMT but the weather was still to rough to deploy the delicate RMT 8+1 rig and there was no spare equipment if anything should go wrong. It was decided to devote the rest of the time available at this station to EK60 surveys.

1632h **Station JC011/086 EK60 Survey 53°56.76'N 36°12.36'W**
RRS James Cook steered westwards to exit the benthic study area for disposal of the 3000m of damaged trawl wire from Station JC011/81.
1816h Arrived at the wire disposal position: 53°56.69'N 36°30.43'W A
1930h Completed cutting of the wire and resumed the EK60 survey. 53°55.75'N 36°37.68'W

Wednesday, 8 August

0133h End of the EK60 survey at the NW super station.

0200h **Station JC011/087 Swath, EK60 & Whale Hydrophone**
53°58.60'N 36°15.40'W
RRS James Cook began the passage from the NW to the NE Superstation at 54°N. During this passage the EM120 swath bathymetry (OLEX monitoring), EK60 and Whale hydrophone were all active except when on station for CTDs

0507h **Station JC011/088 CTD 1648m 53°59.40'N 36°46.70'W**
CTD at night on the summit of the western crest of the ridge.
0643h The CTD was recovered in board and the vessel moved off eastwards

0823h **Station JC011/089 CTD and Optics 2814m 54°09.85'N 36°05.96'W**
CTD into the bottom of the centre of the median valley accompanied by an optical cast as the CTD came to the surface.
0936h Optical rig deployed.
1012h Optical rig recovered.
1056h CTD recovered and the vessel moved off.
1225h **Station JC011/090 CTD 1333m 54°00.00'N 34°57.00'W**
CTD deployed over the summit of the eastern ridge.

1401h CTD back inboard.

1707h **Station JC011/091 CTD 2290m 54°00.00'N 34°17.99'W**

CTD on the eastern flank of the MAR.

1904h CTD in board.

2105h Station JC011/87 swath survey across the ridge was stopped at 54°00.00'N 33°51.11'W and preparations were made to undertake a series of RMT pelagic trawls. The weather was calm and it was decided to immediately take the opportunity for trawling.

2133h **Station JC011/092 RMT 8+1, 200-150m 54°00.12'N 33°50.18'W**
Trawling conducted by Martin Cox with supervision from Ben Boorman, slightly oblique upward tow through a layer detected on the EK60.

2322h End of tow 54°01.24'N 33°48.80'W Good calm conditions and a nice catch

2336h **Station JC011/093 RMT 8+1, 550-450m 54°00.12'N 33°50.18'W**
While the second cast was shot the moonlight was shining through the clouds and the weather was calming down.

2359h An enthusiastic team was sorting through the first catch including, myctophids, krill, salps and jelly fish

Thursday, 9 August

0200h Tow through an deeper layer ended 53°59.70'N 33°48.40'W

0216h **Station JC011/094 RMT 8+1, 350-250m 53°59.70'N 33°48.40'W**

0400h Net inboard 54°01.00'N 33°54.40'W

0425h **Station JC011/095 RMT 8+1, 75-30 54°01.05'N 33°54.52'W**

0520h Net in board at the end of the last tow, a shallow subsurface sample 54°01.61'N 33°57.12'W. The end of a successful night of fishing and Martin Cox had gained sufficient experience to fish the RMT without supervision.

The vessel continued on a course towards the mooring position collecting swath data underway.

0700h Beautiful red sunrise

0755h *RRS James Cook* arrived on the mooring position and preparations began.

0903h 53°58.06'N 34°06.60'W streaming of the mooring commenced 3 miles from the target deployment position.

1115h **Station JC011/096 NE Mooring 2500m 54°00.00'N 34°10.52'W**
Ballast released at the deployment of the NE mooring was completed in ideal calm conditions.

1145h The mooring position and depth was checked using acoustic telemetry to the release. All was found to be in order and the vessel moved north to deploy landers nearby.

1251h **Station JC011/097 PALander 2500m 54°05.26'N 34°09.24'W**
The lander was deployed north of the mooring at the edge of a sedimentary plain at 2500m.

1313h **Station JC011/098 Amphipod trap 2500m 54°04.08'N 34°09.43'W**
The trap was deployed near the PALander.

1420h **Station JC011/099 CTD + Optics 350-250m 54°00.00'N 33°57.97'W**
Daylight shallow cast of the CTD and the optical rig was done before moving to deploy the SHRIMP in this area.
1522h Deployed optics rig
1633h CTD and optics rig all in board.

1653h The port drop keel was lowered by 1m to improve the ADCP signal but it was decided that this might disturb the geometry of the sensors.

1709h After a discussion it was decided to raise the port drop to keel to the original position and keep it fixed for the rest of the voyage.

1726h While attempting to launch SHRIMP the conducting cable jumped off a sheave on the gantry and was damaged. This had to be cut and re-terminated; a task that would take at least 6 hours. Therefore other work was scheduled.

1815h The vessel went on a swath survey track before moving towards the megacoring site, this revealed a flat plain that was subsequently used for OTSB bottom trawling.

2030h **Station JC011/100 2500m 54°06.33'N 33°58.27'W**
Megacorer at the centre of the little plain where the mooring had been deployed.
2220h Spooling problems on the winch was delaying the work.
2400h Corer back in board with 8 excellent quality core tubes, the weather was flat calm with just light airs, and the ship moved off to the start of the proposed bottom trawl.

Friday, 10 August

0137h **Station JC011/101 OTSB 2405-2435m 54°06.33'N 33°58.27'W**
Began deploying the trawl to the east of the chosen mooring site towing from north to south in good calm conditions.
0500h Net on the bottom with 6300m of wire out.
0650h Net off the bottom.
0908h 53°47.47'N 34°02.89'W net in board with a good clean catch including starfishes, holothurians, and a variety of fishes.

It was no possible to continue with RMT work while Ben Boorman went off duty. Work started from near where the OTSB finished working head into quite light winds.
1015h **Station JC011/102 RMT 8+1, 520-430m 53°46.75'N 34°03.02'W**
Tow targeted at a layer visible on the EK60 sonar.

1249h 53°43.80'N 33°58.60'W net inboard with a good catch containing myctophid fishes.

1311h **Station JC011/103 RMT 8+1, 150-50m 53°43.80'N 33°58.60'W**
A second targeted tow.
1450h 53°41.40'N 33°55.40'W The net in board this time with many copepods.
By this time the vessel was some distance from the intended work site.

1500h **Station JC011/104 EM120 Swath & Whale Hydrophone,**

53°41.90'N 33°55.40'W
A swath survey filling in areas not previously surveyed to the south together with recording from the whale hydrophone.

1649h End of station as the vessel approached the proposed SHRIMP site.

1654h **Station JC011/105 SHRIMP 2439-2503m 53°54.71'N 34.01.87'W**
The SHRIMP was launched to survey a gentle slope crossing the trawl track. .

1818h SHRIMP on the bottom began the transect at 0.7 knots. All the ground was covered with thick sediment and there were no signs of rocky outcrops. The trawl track was clearly visible in the videos with *Peniagone marecoi* already crawling across the swept area.

2138h Track completed at 53°53.70'N 33°59.40'W waited until SHRIMP swung forward under the vessel.

2130h Commenced hauling.

2215h Delays owing to spooling problems on the winch.

2350h SHRIMP recovered in board. *RRS James Cook* departed to the same trawl start position as used the previous night.

Saturday, 11 August

0133h **Station JC011/106 OTSB 2410-2445m 54°05.68'N 33°58.54'W**
The trawl was deployed on the same track as JC011/101.

0500h Trawl on the bottom.

0846h Net recovered in board. 53°46.94'N 33°03.02'W An excellent catch of fish and invertebrates not as big as the first catch at this station.

0905h **Station JC011/107 Whale Hydrophone 53°47.32'N 34°03.09'W**
The hydrophone was deployed while the ship steamed back to the central working area.

1125h 54°04.18'N 34°09.23'W, End of the tow at the amphipod trap recovery site.
The acoustic release was activated

1215h Station JC011/098 Amphipod trap surfaced.

1230h Trap recovered with a good catch of amphipods in the lower trap. The vessel proceeded to the PALander station.

1310h **Station JC011/108 CTD + Optics to 60m 54°05.40'N 34°09.20'W**
CTD and the optics rig were deployed while PAL recovery procedures were started.

1327h PALander released.

1342h CTD and Optics in board.

1423h PALander Station JC011/97 on the surface.

1442h The PALander was in board and the vessel proceeded to the megacorer station.

1530h **Station JC011/109 Megacorer 2495m 54°00.65'N 34°10.42'W**
Corer deployed in the designated site near the NE mooring.

It was a sunny afternoon; a forecast gale did not materialise but there was a fresh winds. Fulmars were feeding the ship on scraps from the morning's catch.

1805h The megacorer was in board with 8 good cores. *RRS James Cook* then moved to the start of SHRIMP transect to the east of the sedimentary basin.

1907h **Station JC011/110 SHRIMP 2258-2493m 54°01.13'N 34°08.99'W**
SHRIMP was deployed on the top of a ridge adjacent to the sedimentary plain.

2015h SHRIMP on the bottom commenced a transect towards the west down a very steep rocky slope.

2245h 54°00.43'N 34°11.06'W end of the transect on the plain having passed by the megacorer site.

Sunday, 12 August

0018h SHRIMP recovered in board. The vessel proceeded back to the trawl start position.

0147h **Station JC011/111 OTSB 2404-2430m 54°05.68'N 33°58.54'W**
Commenced deployment of the OTSB.

0516h Net on the bottom.
0641h Net off the bottom.

0700h Nice sunny morning calm.

0846h The net was recovered with a good catch of fish and invertebrates on last trawl of the cruise.

0940h **Station JC011/112 EK60+ whale Hydrophone 54°05.68'N 33°58.54'W**
The vessel embarked on a grid survey of the NE station for 6 hours. The whale hydrophone was also towed at the same time.

1338h **Station JC011/113 CTD + Optics to 60m 54°03.01'N 34°05.98'W**
The EK60 survey was halted to allow optics casts coinciding with and overpass of the MODIS satellite on a sunny day with a clear view from space. Unfortunately the sky clouded over at the time of overpass.

1415h CTD in board
1432h Optics rig in board
1445h Resumed the EK60 survey Station JC011/112
The weather was good and people were sunbathing during the day

1613h 53°55.56'N 34°06.81'W End of the survey station JC011/112. The vessel proceeded to the Amphipod trap location.

1725h **Station JC011/114 Amphipod trap 2453m 54°02.31'N 34°09.60'W**
The trap was deployed near the megacorer position.

1754h **Station JC011/115 PALander 2482m 54°03.37'N 34°09.47'W**

This lander was deployed for the last time on this cruise and the vessel then proceeded to the megacorer site.

1833h **Station JC011/116 Megacorer 2495m 54°00.65'N 34°10.42'W**
2142h The corer was recovered with 7 good cores and one tube failed to trigger at this excellent coring site.

2215h **Station JC011/117 CTD YoYo 2470m 54°00.65'N 34°10.42'W**
The vessel then remained on DP during 9 CTD YoYo casts in which the rosette was launched without any bottles for 9 casts between the surface and 2470m without being brought back on deck.

YoYo started in nice weather but gales were forecast in the North of Scotland.

Monday, 13 August

1423h 9 casts complete, the CTD was brought in board The vessel then moved to the amphipod trap recovery site where optics casts were carried out.

1505h **Station JC011/118 CTD + Optics to 55m 54°02.30'N 34°09.78'W**
1530h CTD in board, in the mean time the amphipod trap had been released.
1534h Optics rig in board.

1540h The Amphipod trap was on the surface.
1558h The trap was recovered to complete station JC011/114 with another good catch of amphipods.

1620h The PALander was released
1735h The PAlander was in board completing station JC011/115.

1745h **Station JC011/119 EK60 survey 54°04.55'N 34°07.97'W**
A second grid survey was undertaken of the NE station.
The weather was becoming rougher again and the quality of data on some of the legs of the survey was declining.

The deadline for the end of science was approaching. It had been intended that the ship would dock in Aberdeen at the end of the voyage but northerly gales were forecast over the North of Scotland at a time when we were due to be calibrating the EK60 in the north facing Loch Eribol. Also there had been continuing water production problems on the ship and it was imperative that we leave for port soon.

2242h End of Station JC011/119, EK 60 monitoring ceased and this was the end of science at the NE station. Proposed CTD casts further east on the 54°N parallel were cancelled since this would have taken us well beyond the 2400h deadline for end of science

The azimuth thruster and drop keels were retracted for full speed passage to Fairlie on the Clyde.

2242h **Station JC011/119 Whale Hydrophone 55°55.13'N 34°10.05'W**
The hydrophone was deployed for the passage home

Tuesday, 14 August

1200h 54°14.2'N 29°44.0'W A sunny day with the vessel pitching in moderately rough seas.

2200h Nice night with stars visible

Wednesday, 15 August

1200h 54°41.6'N 21°41.0'W Making good passage but visibility decreased to less than 0.5 nMile in rain and drizzle.

2000h Quiz night in the bar-lounge

Thursday, 16 August

1200h 55°09.5'N 13°22.9'W making good progress.

1930h RPC in the bar.

Friday, 17 August

0300h Clocks changed to BST

Henceforth all times are British Summer Time.

0700h In sight of land off Scotland and Northern Ireland.

0919h Take the whale hydrophone inboard at the end of Station JC011/120 and 940 miles run. 55°22.02'N 06°15.80'W.

1200h The *RRS James Cook* was in passing west of Ailsa Craig on the way to Arran for the EK 60 calibration. Flat seas with a moderate breeze and sunshine.

1300h David Shale took a picture of the scientific party of the foredeck as the ship approached the Island of Arran. Preparations were in progress for the EK 60 calibration exercise.

1445h *RRS James Cook* had settled on station within Brodick Bay and deployment of the EK60 calibration ball commenced.

1645h The ball was successfully suspended beneath the starboard drop keel and calibration of the first transducer was in progress. In the mean time the ship's boat was launched giving the opportunity to circle the ship to take photographs, capture of specimens of jelly fish and a run ashore to collect newspapers.

Saturday, 18 August

0200h Calibration work was complete. This included checking and correcting the wiring of the 70 kHz transducer and recalibration. All transducers were successfully calibrated.

0900h *RRS James Cook* docked Fairlie Pier near Largs on the Clyde and demobilisation commenced. The wind by this time was very strong gale force from the north with driving rain making work difficult, but vindicating the decision not to attempt calibration off the North coast of Scotland and to demobilise at Fairlie.

DESCRIPTIONS OF WORK

Bathymetric Surveys

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Prior to the *GO Sars* voyage in 2004 the MARECO project funded a compilation of the best available bathymetry of the Mid-Atlantic Ridge between Iceland and the Azores which was done my Bramley Murton of NOC Southampton. This remains the most detailed chart available but is dependent on archive data of varying quality. In 2004 significant discrepancies were discovered and over most of the area the resolution is insufficient for trawling or planning of deployment of sampling gears.

A first priority in this cruise was therefore to carry out bathymetric surveys to:

1. Identify locations for the main moorings of the super stations at 2500m depth.
2. Find suitable ground for bottom trawling and other benthic sampling close to 2500m at each of the superstations.
3. Map the topographical context around each super-station mooring location.
4. Map in detail a transect across the ridge between the eastern and western stations at ca. 49°N and 54°N

The Kongsberg EM120 swath bathymetry system was used in conjunction with OLEX 3D chart system software[2] installed on an IBM Thinkpad laptop PC running the LINUX operating system. The laptop was linked via an Ethernet port to the NMEA output from the Kongsberg EM120. The OLEX system provided a chart display on which waypoints could be plotted and this was used for voyage planning and recording throughout the cruise. OLEX depth data from the *GO Sars* 2004 voyage to this area had been loaded on the computer with the aim of building on that previous data set.

Following departure from Southampton time was spent resolving the function of the EM120 and setting up the OLEX software. Trials were carried out and in the Celtic sea the first data began to be collected. There were obvious drop-outs in the data presumably owing to air bubbles under the transducer as the ship pitched going head to seas.

On arrival at the southern working area it was decided to orient the two stations so that a transect between them was approximately at right angles to the axis of the ridge. Two transects were surveyed (Figure 2) a northerly one directly between the two mooring sites and a second more to the south passing over a seamount with a summit at ca 700m.

A major limitation on the work was mutual interference between sonar systems on the ship; there was no means of synchronising pulses of the EK60, EM120, ADCP and other systems in use. This meant that no bathymetry was recorded during the Topex Poseidon transect or during EK60 surveys. Apart from this issue the swath bathymetry performed well and surveys

[2] www.olex.no

were possible at 8-10 knots providing care was taken to choose a course avoiding excessive pitching motion.

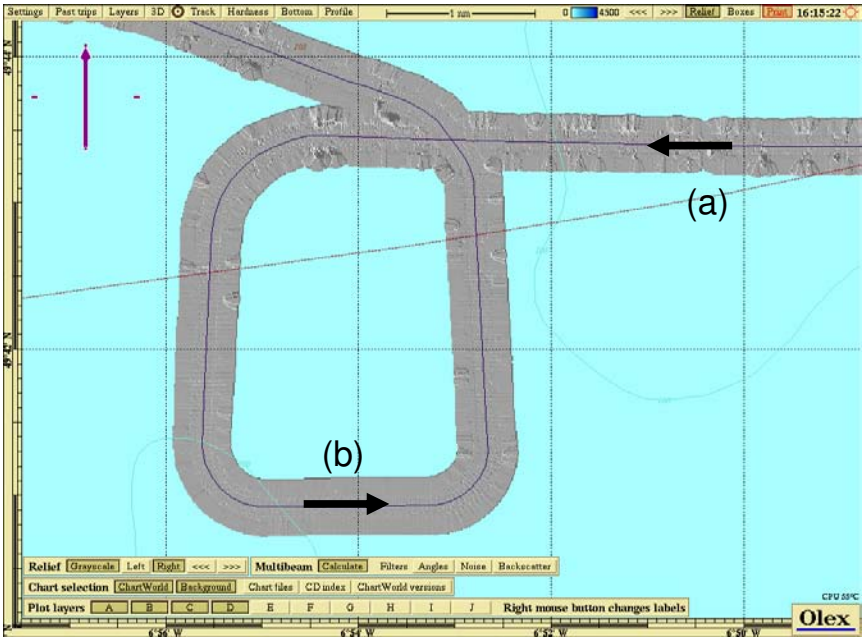


Figure 3: OLEX display of swath data in the Celtic Sea showing changes in data quality on different headings with a slight swell from the west. Note the drop outs on a westerly course (a) compared with a clean signal on an easterly course (b)

Screen dumps from the OLEX system are reproduced here as a provisional presentation of the area covered and its topography. These will be post-processed to generate charts in GIS systems. The data however are retained on the OLEX system and can be used and added to in future. At each station the survey was the first work carried out and defined the locations of the moorings and all benthic sampling.

The topography on either of the axis of the MAR was characterised by a series of small ridges with flat sedimentary plains in between orientated in lines parallel to the mid axial valley.

Figure 4: The southern super stations. The narrow swath track in the NE is previous data from the *GO Sars* in 2004. Two transects were surveyed a straight one to the north and a more southerly one passing over the summit of a sea mount.

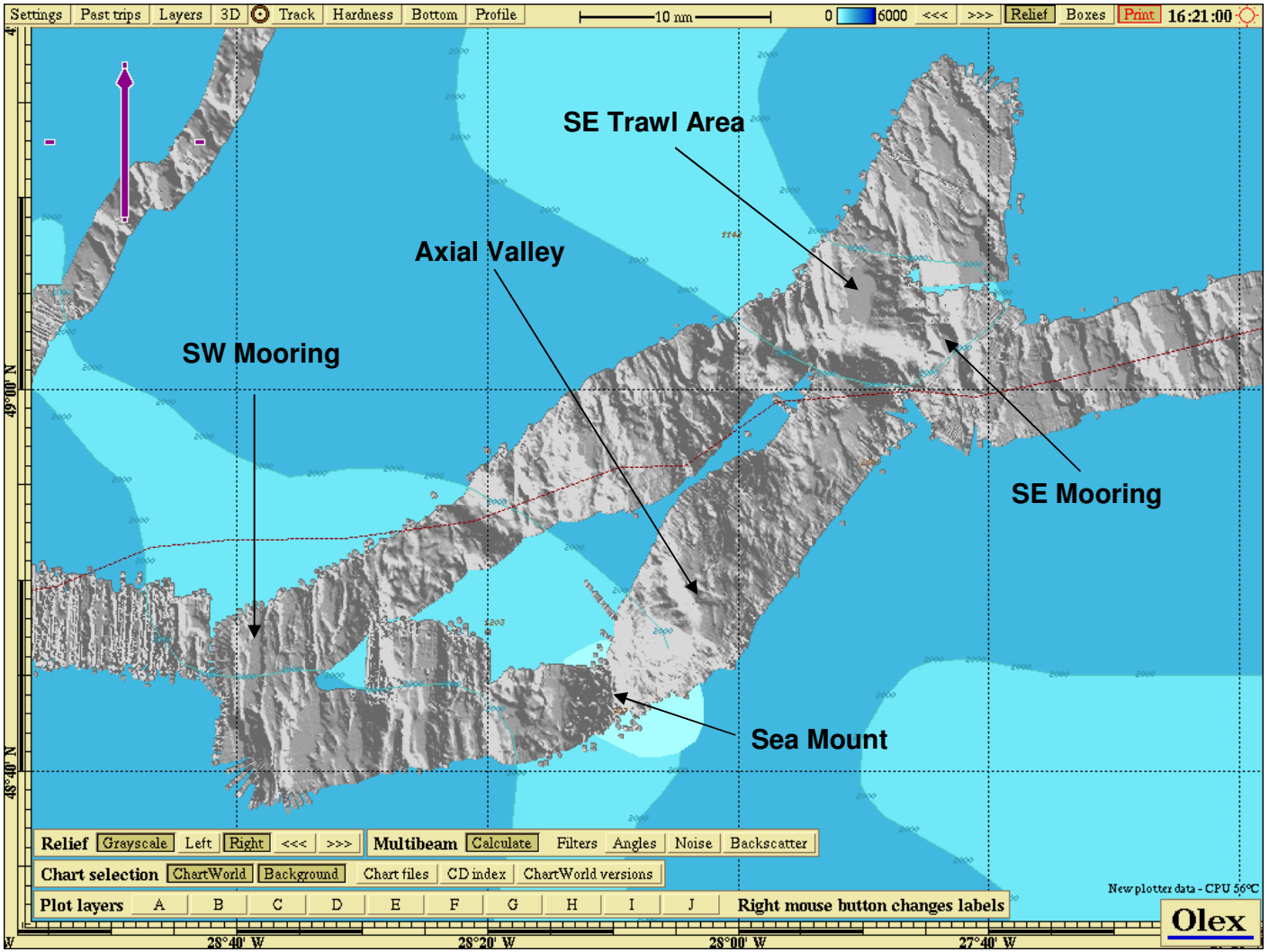


Figure 5: The southern super stations showing the profile of the northerly transect with the bottom of the axial valley at over 4000m depth

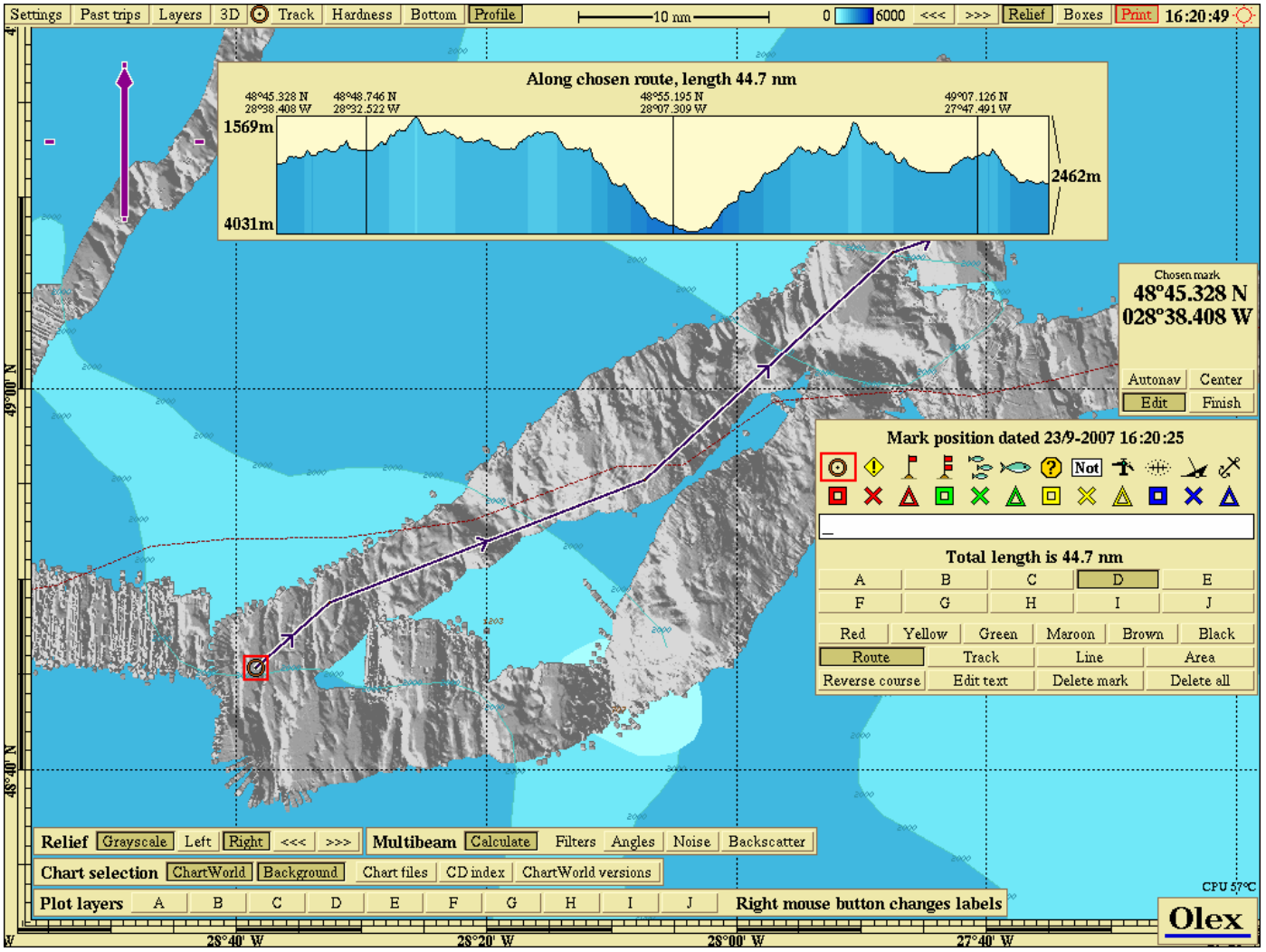


Figure 6: The southern super stations showing the profile of the southerly transect passing near the summit of the sea mount.

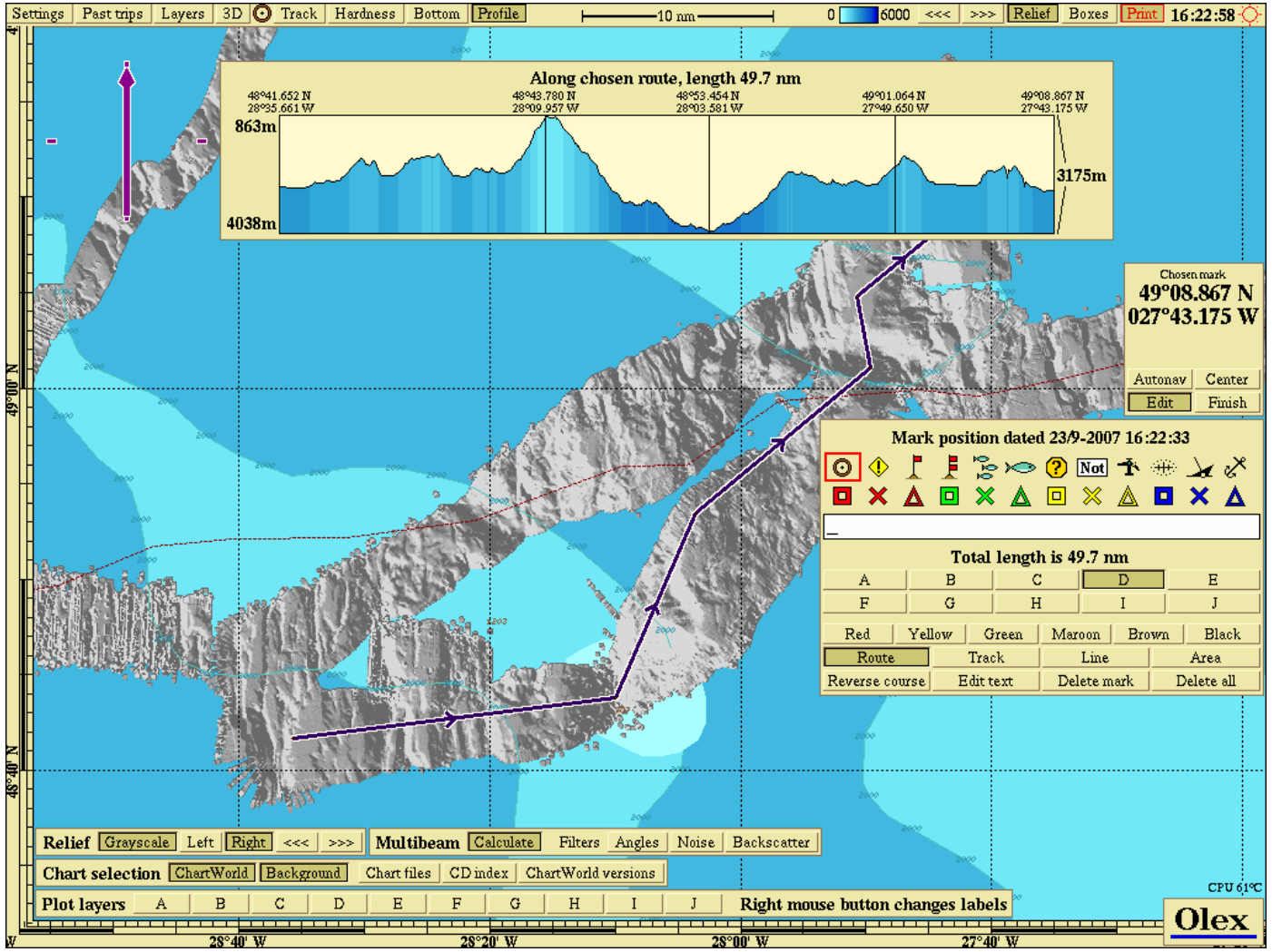


Figure 7: The South East Super Station showing waypoints and plotting during the cruise.

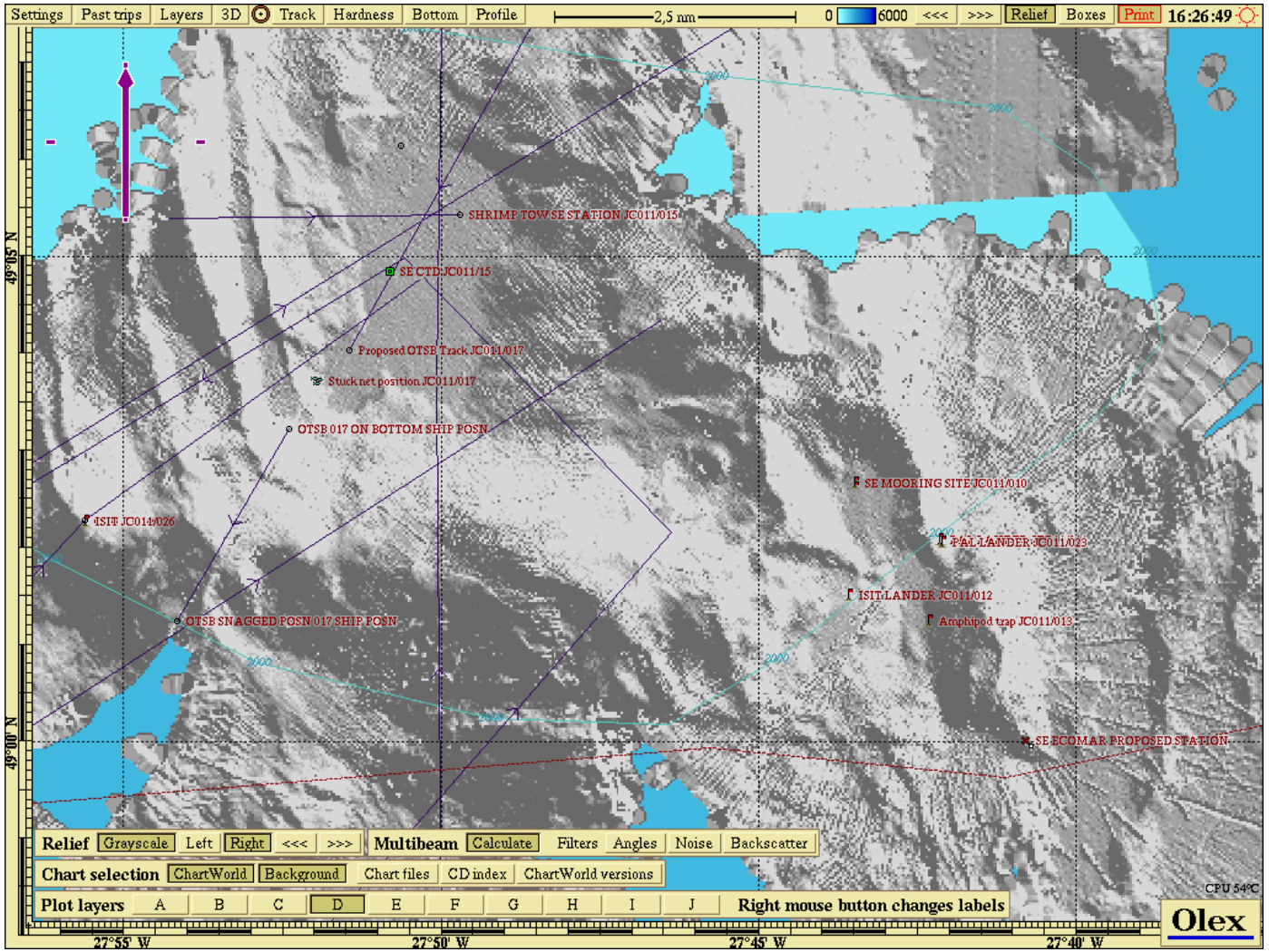


Figure 8: The South East Super Station 3D view looking north showing the mooring location and flat area selected for trawling in the distance. The vertical scale is not exaggerated

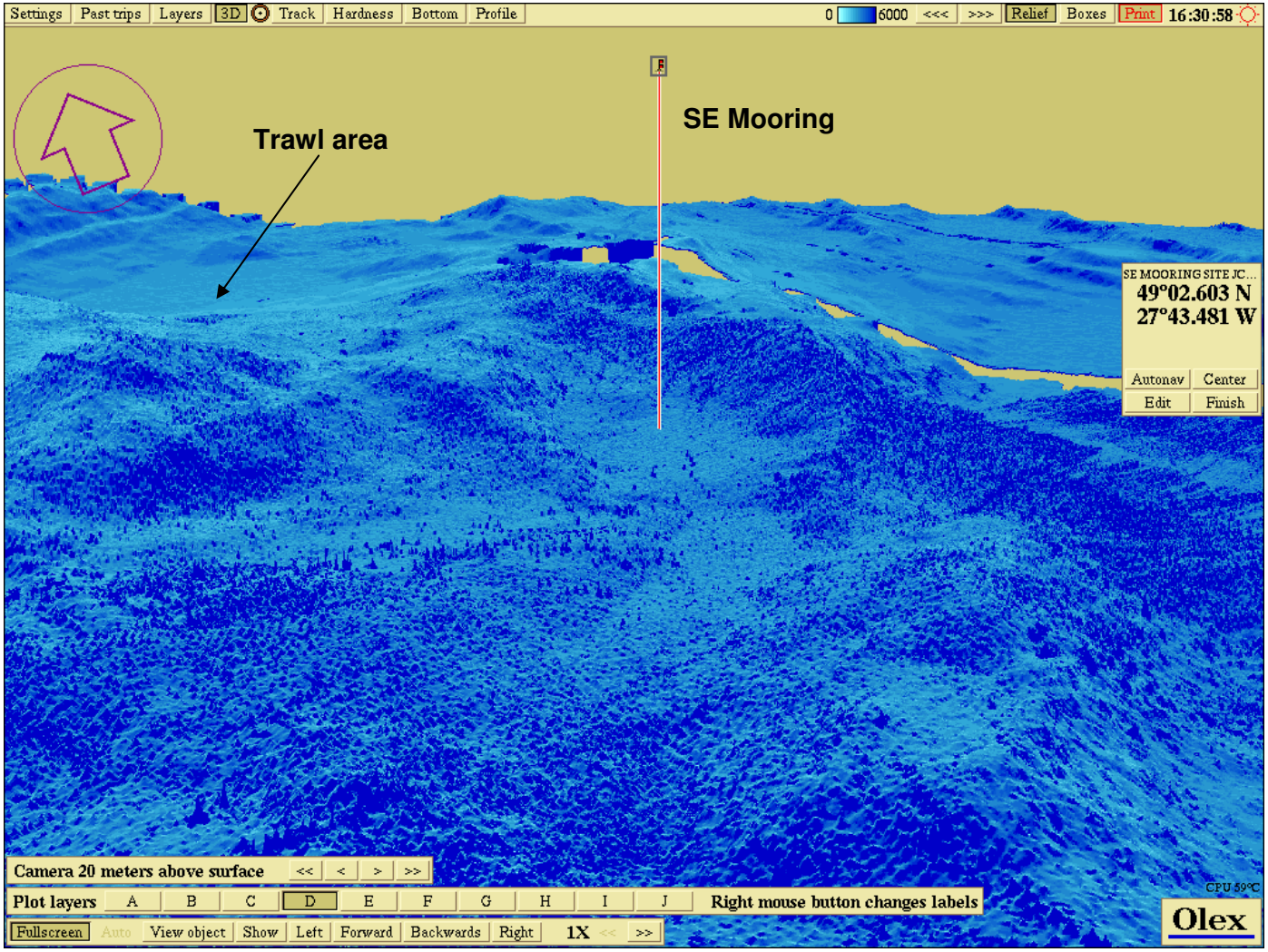


Figure 9: The South West super-station

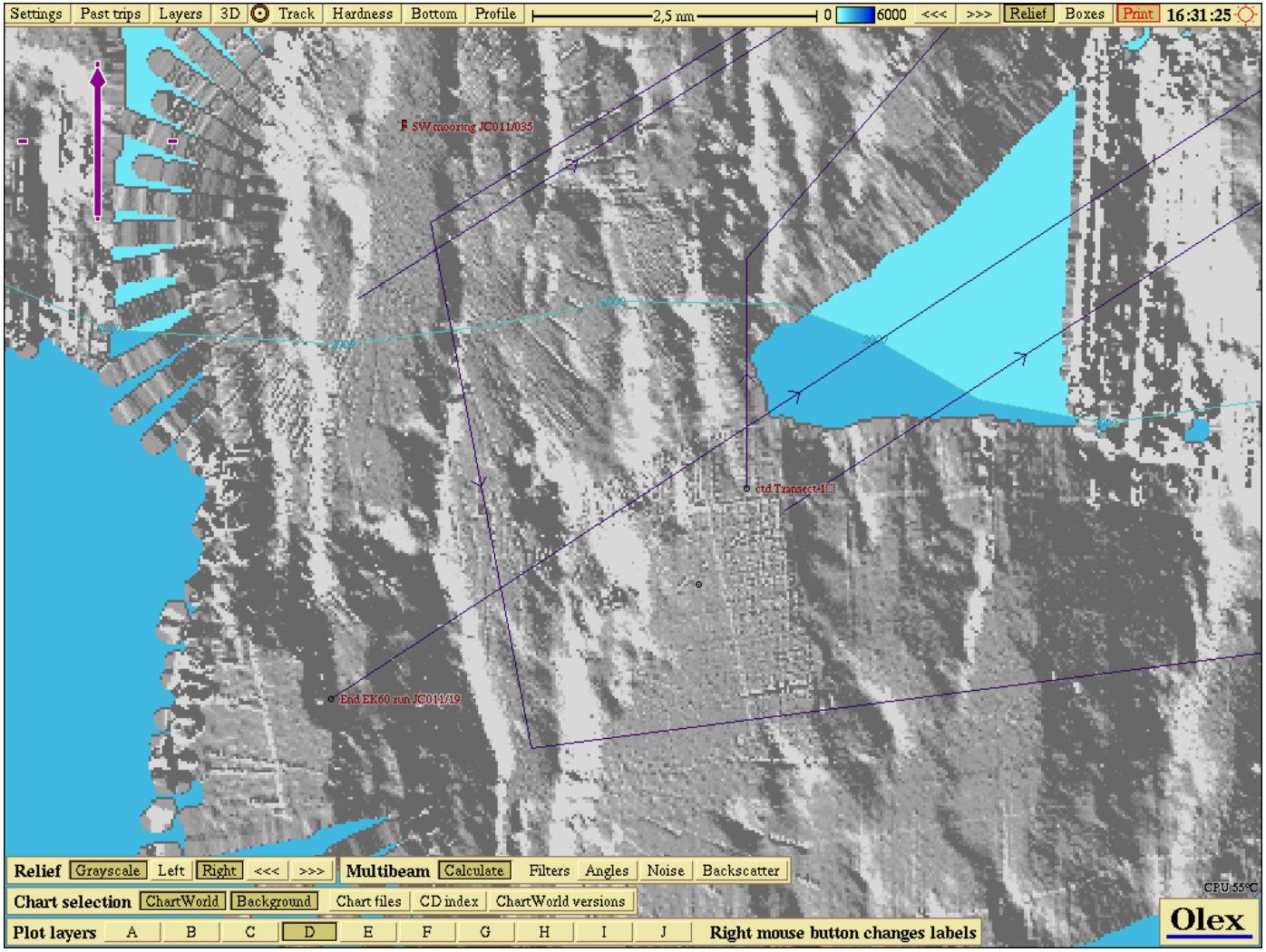


Figure 10: The South West super-station 3D view looking southh showing the mooring location. The vertical scale is not exaggerated

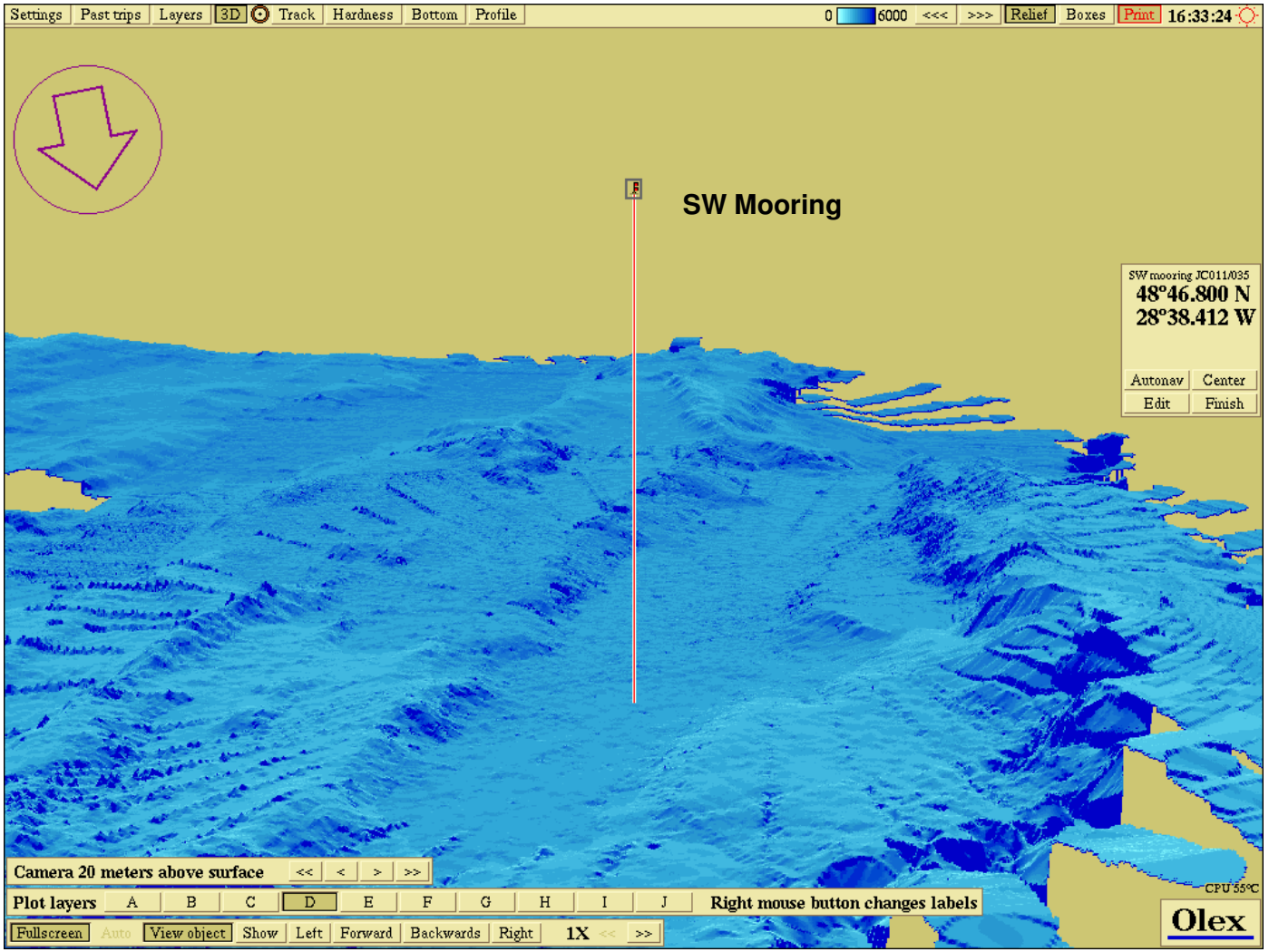


Figure 11: The northern super stations showing the area surveyed and the transect in between. The diagonal trace is the course of the *GO Sars* from 2004.

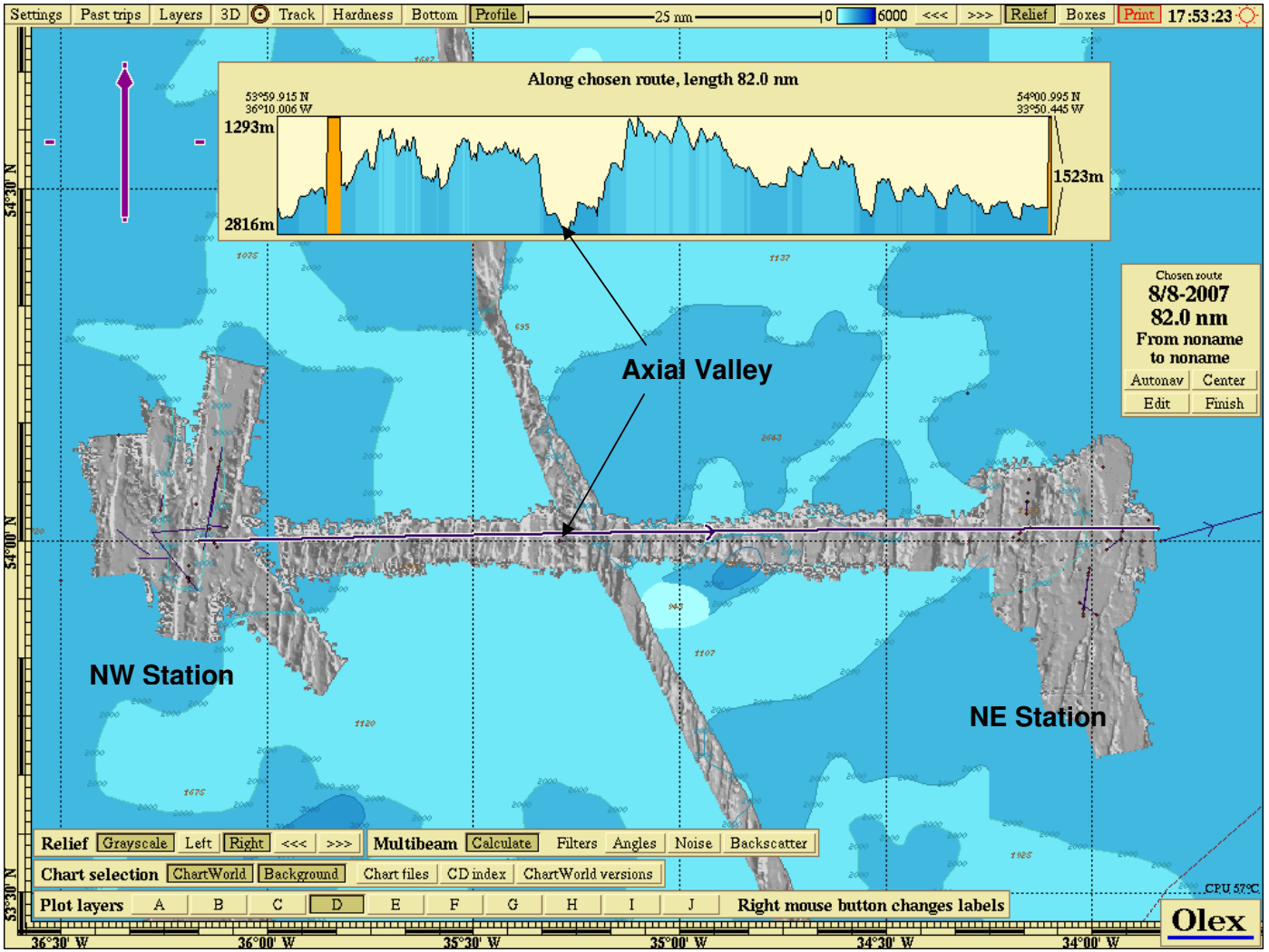


Figure 12: The NW super station.Note the ridges running north south.

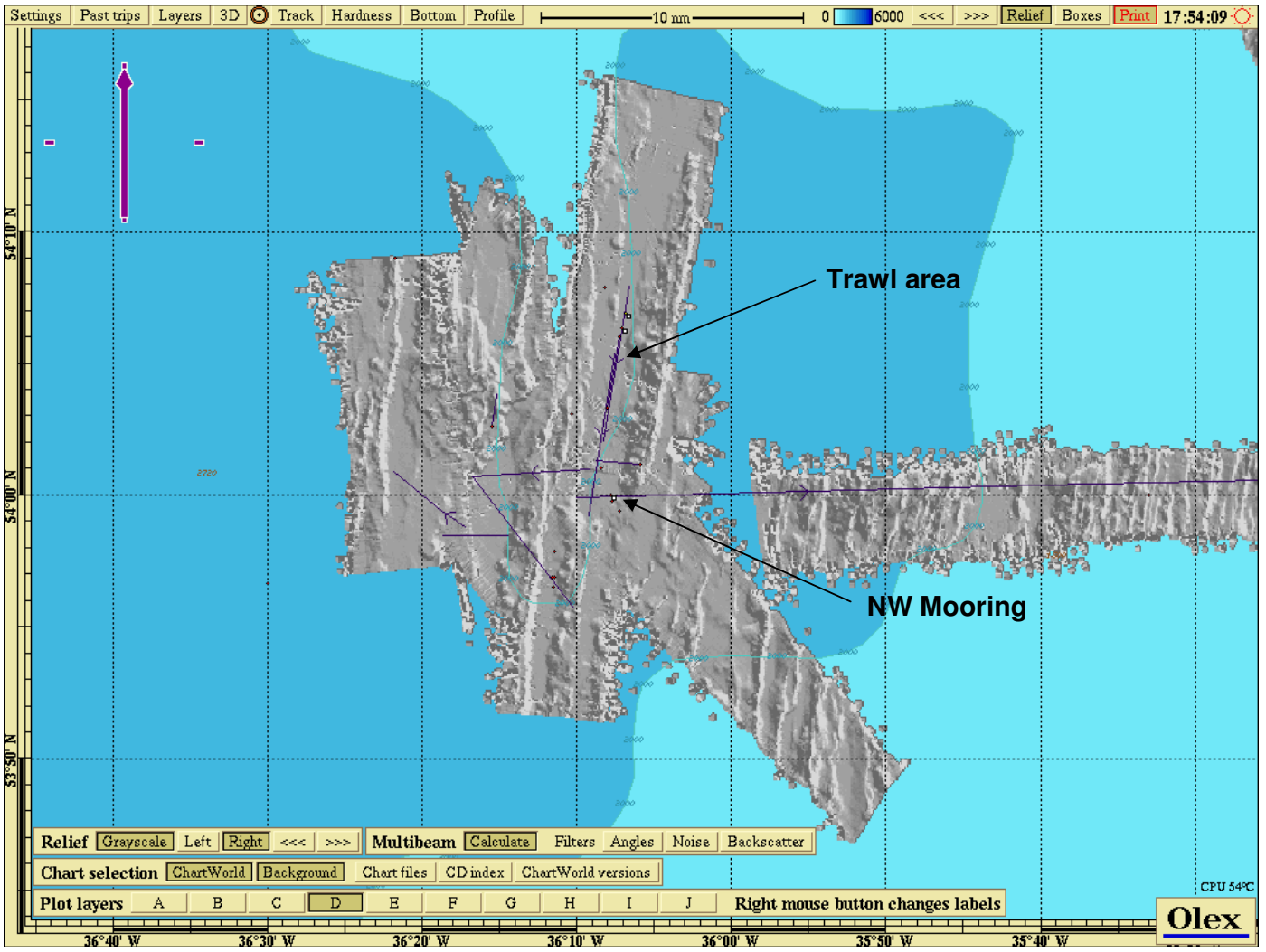


Figure 13: 3D view of the North West Super Station, looking north. Note the steep faces oriented towards the axis of the Mid Atlantic Ridge.

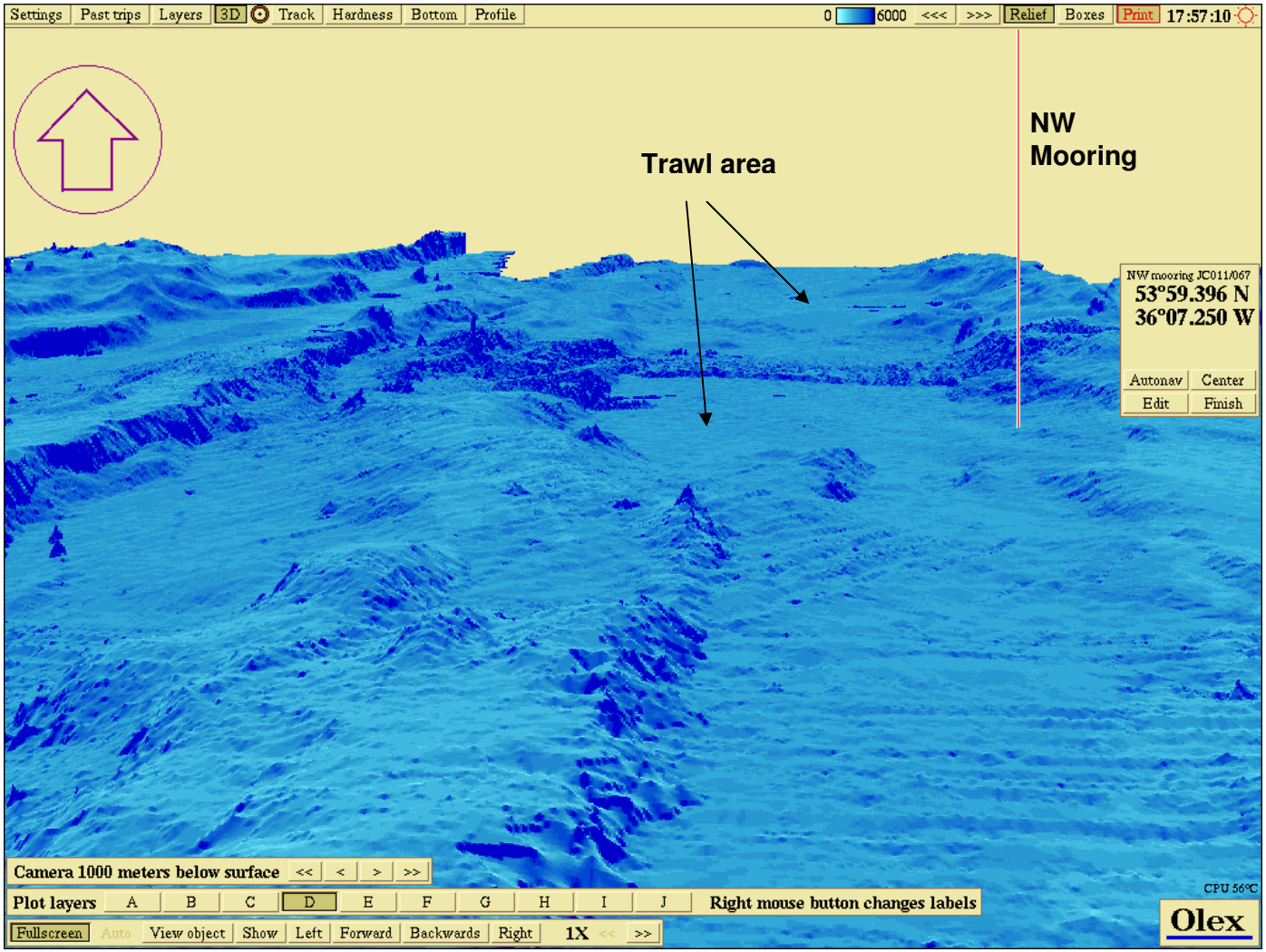


Figure 14: The North East Super Station. The relatively large flat area available provided the most successful trawling of the cruise, co-inciding with good weather conditions

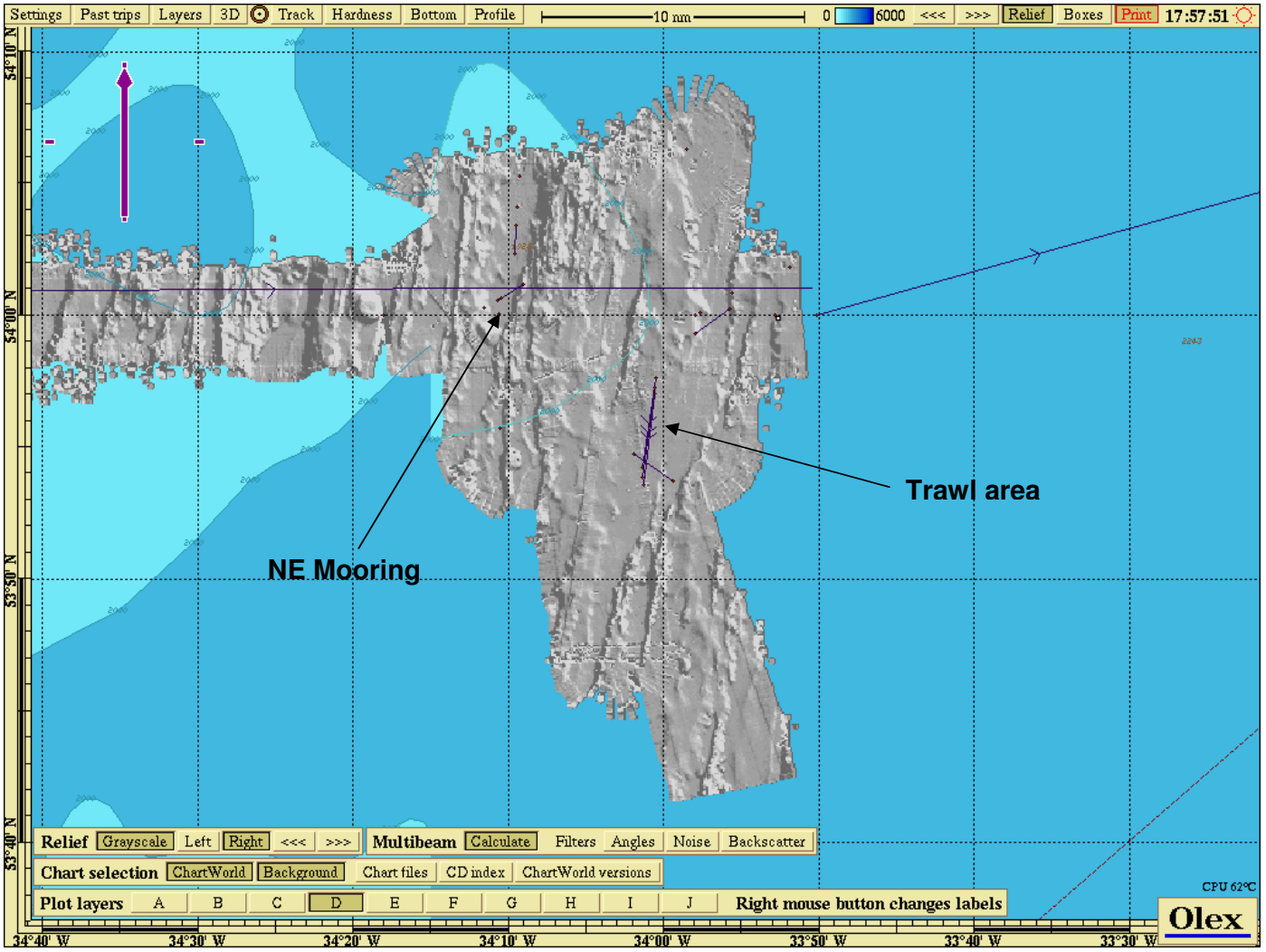
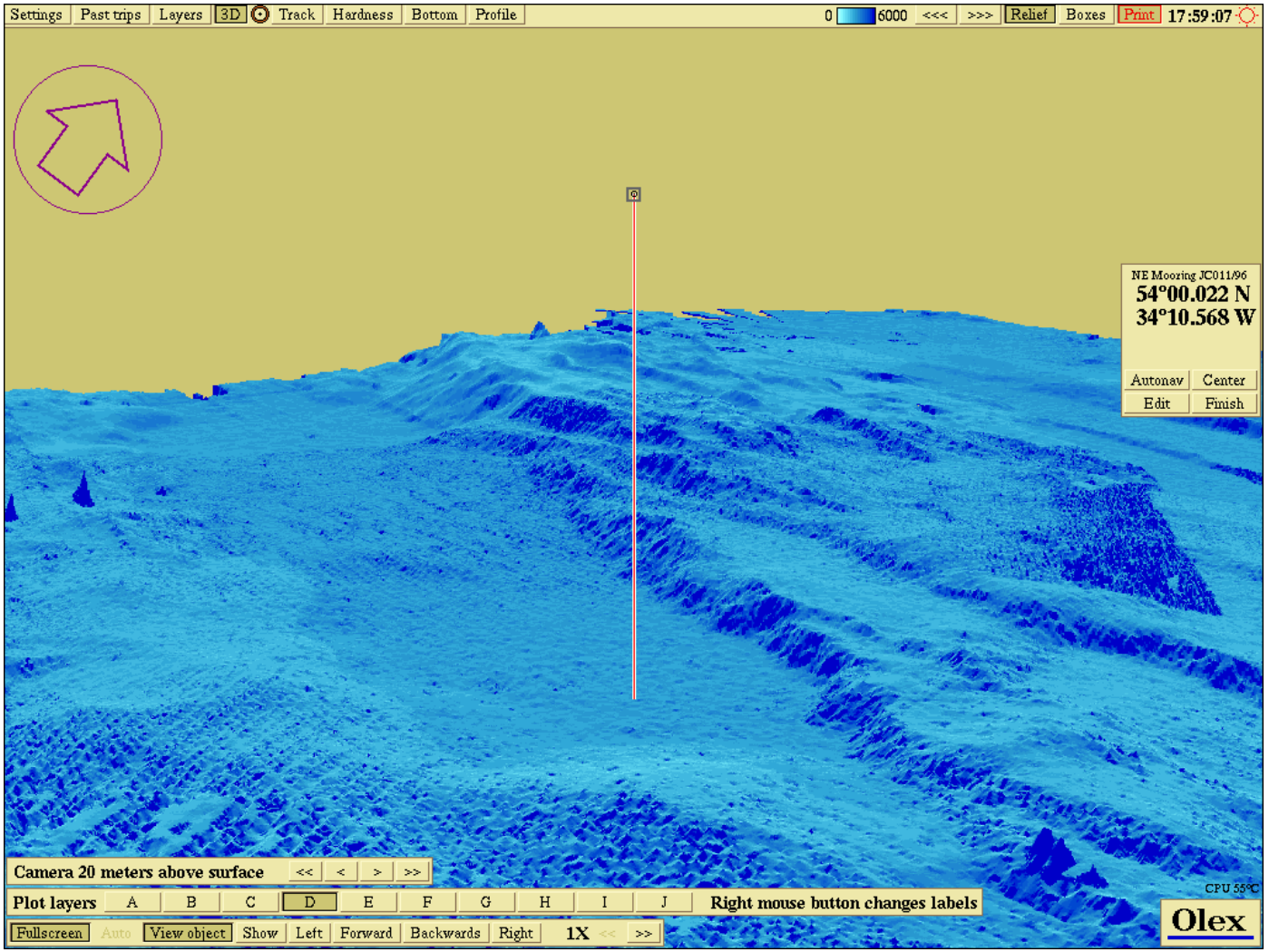


Figure 15: The North East Super Station showing the Location of the mooring at the south end of a flat plain in which all the coring and lander work was done.



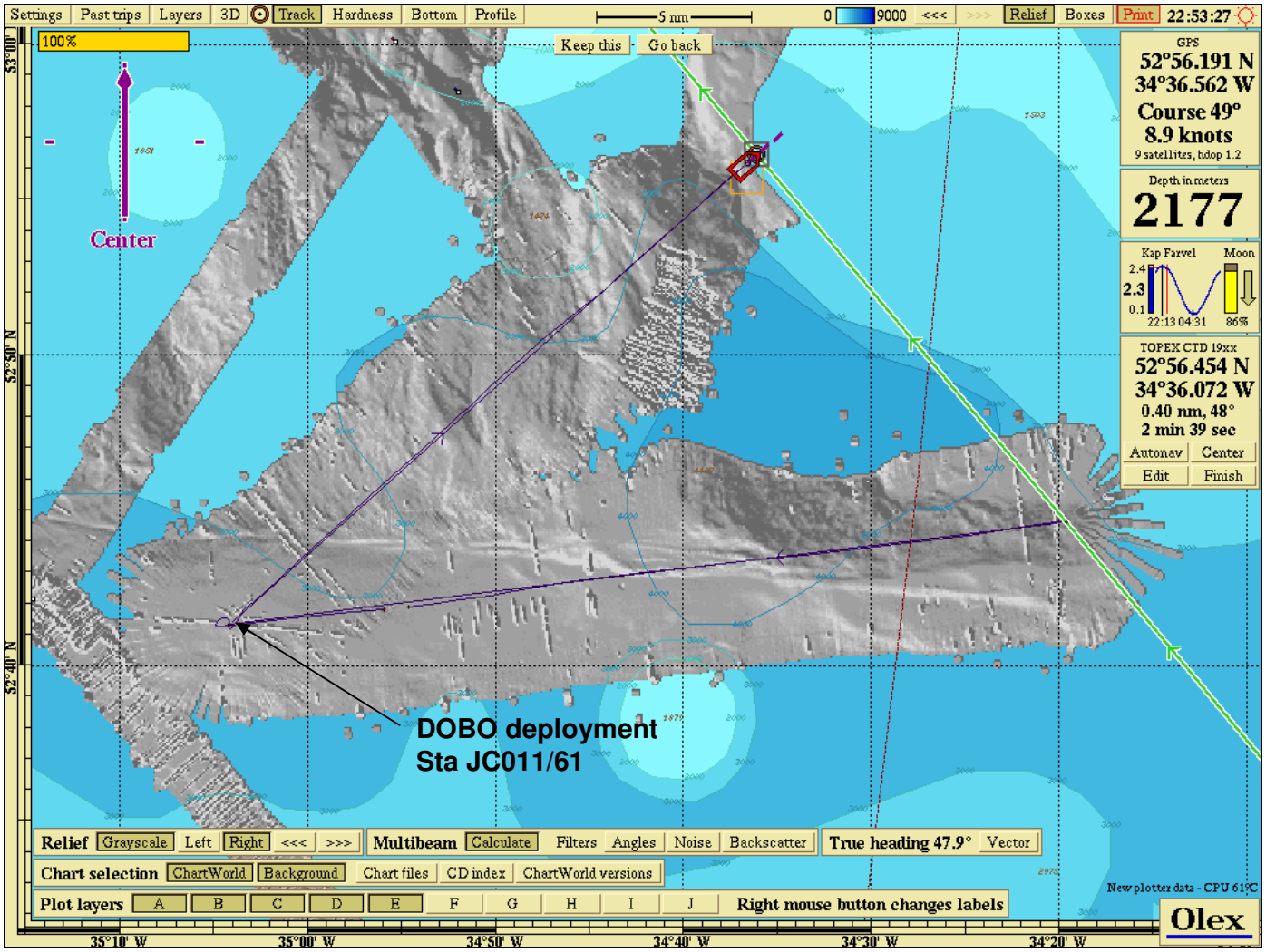


Figure 16: The floor of the Charlie Gibbs Fracture zone with deployment of DOBO, Station. JC011/061 3960m depth at the turning point in the SW. Live screen dumo during the voyage showing the location and speed the vessel. Note the *RRS James* produces good data at 8.9 knots.

The narrower tracks crossing, area are from the *GO Sars.*

of *Cook*

this

ECOMAR Cruise Report:

Remote Sensing

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Objectives
By remote sensing, appropriately calibrated with in situ incubations, PML will produce regional estimates of surface primary production over the study area.

Methods: AVHRR and MODIS Images.
AVHRR and MODIS-aqua OCm2 (1.1 x 1.1 km) Local Area Coverage (LAC) data were received by Dundee Satellite Receiving station, decoded and transferred to the Remote Sensing Group at Plymouth Marine Laboratory (PML). AVHRR level 1b data were processed using the PML processing software Panorama. MODIS level 1b passes were processed using SeaDAS v5.1. The following quality flags were implemented for the MODIS passes to eliminate erroneous data: (1) atmospheric correction failure, (2) land, (3) bad ancillary data, (4) high sun glint, (6) high satellite viewing angle (>60°), (8) negative water leaving radiance, (15) low water leaving radiance and (13) high solar zenith angle (>70°).

Primary Production images
The wavelength resolving model of Morel (Morel, 1991) was implemented following Smyth et al. (2005) and Tilstone et al. (2005). Integration was performed over all daylight hours, for wavelengths 400–700 nm and to the 0.1% light level and computed through the iterative approach of Morel and Berthon (Morel and Berthon, 1989). Composite satellite maps of primary production were generated following Smyth et al. (Smyth et al., 2005) forced with weekly satellite fields of NASA MODIS OCm2, SST and PAR (Frouin and Pinker, 1995).

Results
The satellite imagery for the duration of the ECOMAR cruise (13 July – 19 August) was hampered by cloudy conditions and there was not a single clear overpass over the study area. Research activities were guided by composite images, a summary of which is given below.

AVHRR Sea Surface Temperature (SST)
Prior to the cruise, the boundary between the sub-polar front could be clearly seen between 50.5 & 52°N separating colder (11 – 12°C), arctic overflow water north of the front from warmer (14 – 16°C) sub-tropical water to the south (Figure 17a), and between 29 & 31°W. This feature was present throughout the cruise and there was little change in the SST except west of 31°W from 5 to 14 August when the water to the east became slightly warmer (Figure 17b-f).

Ocean Colour MODIS-aqua OCm2
Prior to the cruise, Chla was high (1 mg m^{-3}) north of the sub-polar front and to the west of the mid Atlantic ridge, in patches reaching 8 mg m^{-3} (Figure 18a). South of the sub-polar front Chla was low and generally <0.1 mg m^{-3}.

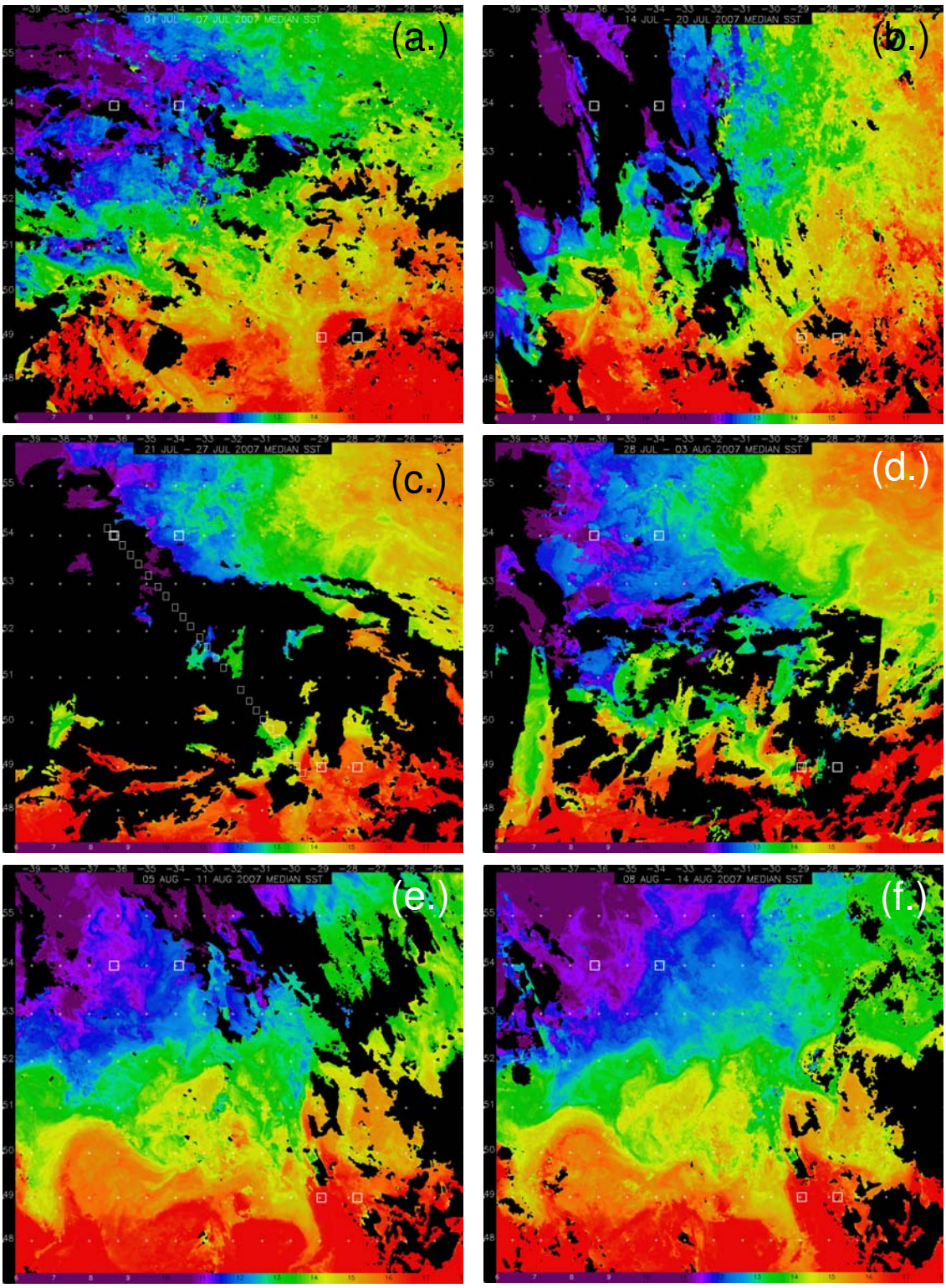

Figure 17: AVHRR SST composites for 01 – 07 July (a), 14 – 20 July (b.), 21 – 27 July (c.), 25 July – 03 August (d.), 05 – 11 August (e.), 08 – 14 August 2007 (f.). Bold squares show the position of the northerly and southerly super-stations. In (c.) lighter squares indicate CD stations along the TOPEX / POSEIDON transect.

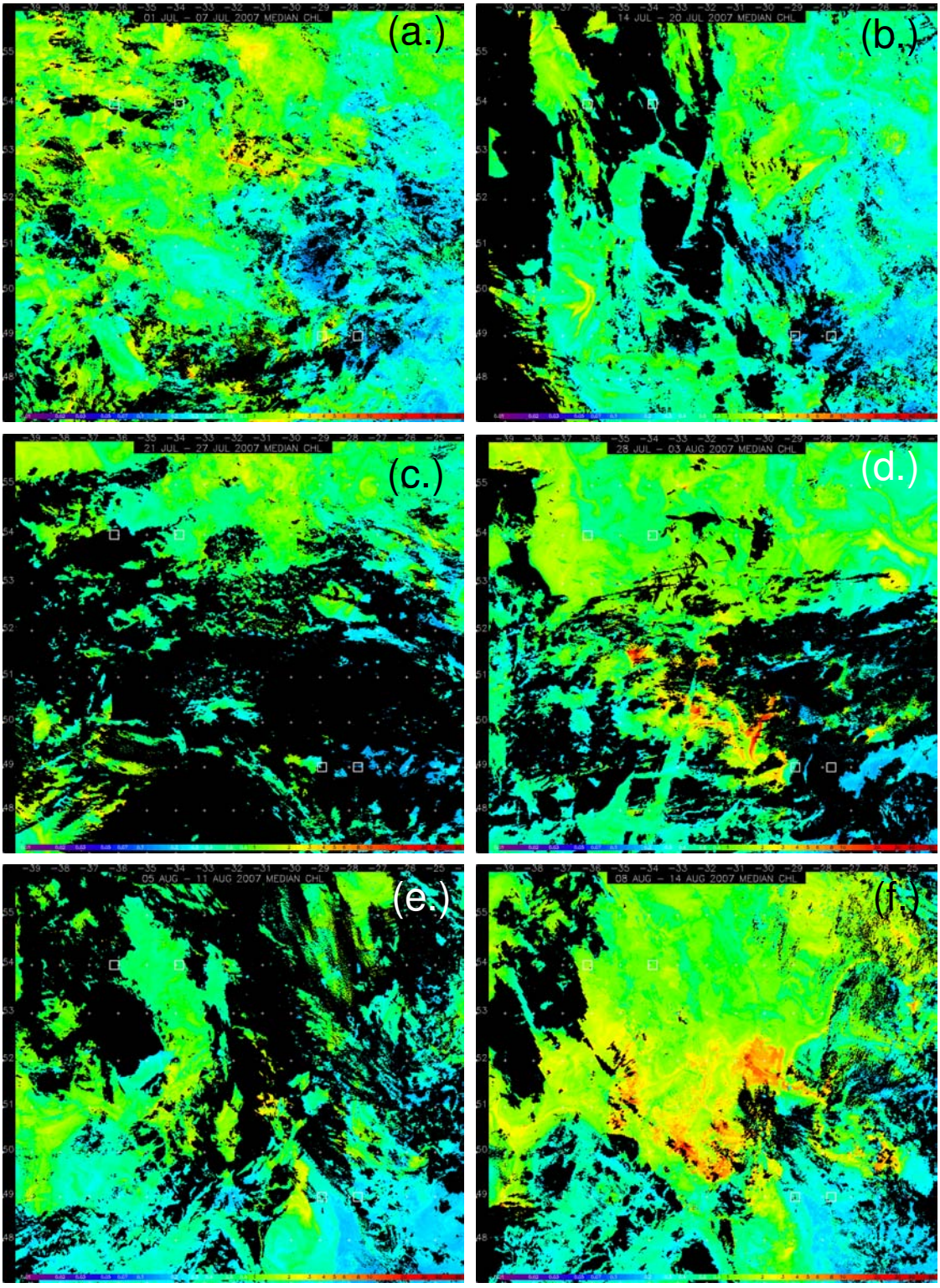

Figure 18: MODIS-aqua OCm2 composites for 01 – 07 July (a), 14 – 20 July (b.), 21 – 27 July (c.), 25 July – 03 August (d.), 05 – 11 August (e.), 08 – 14 August 2007 (f.).

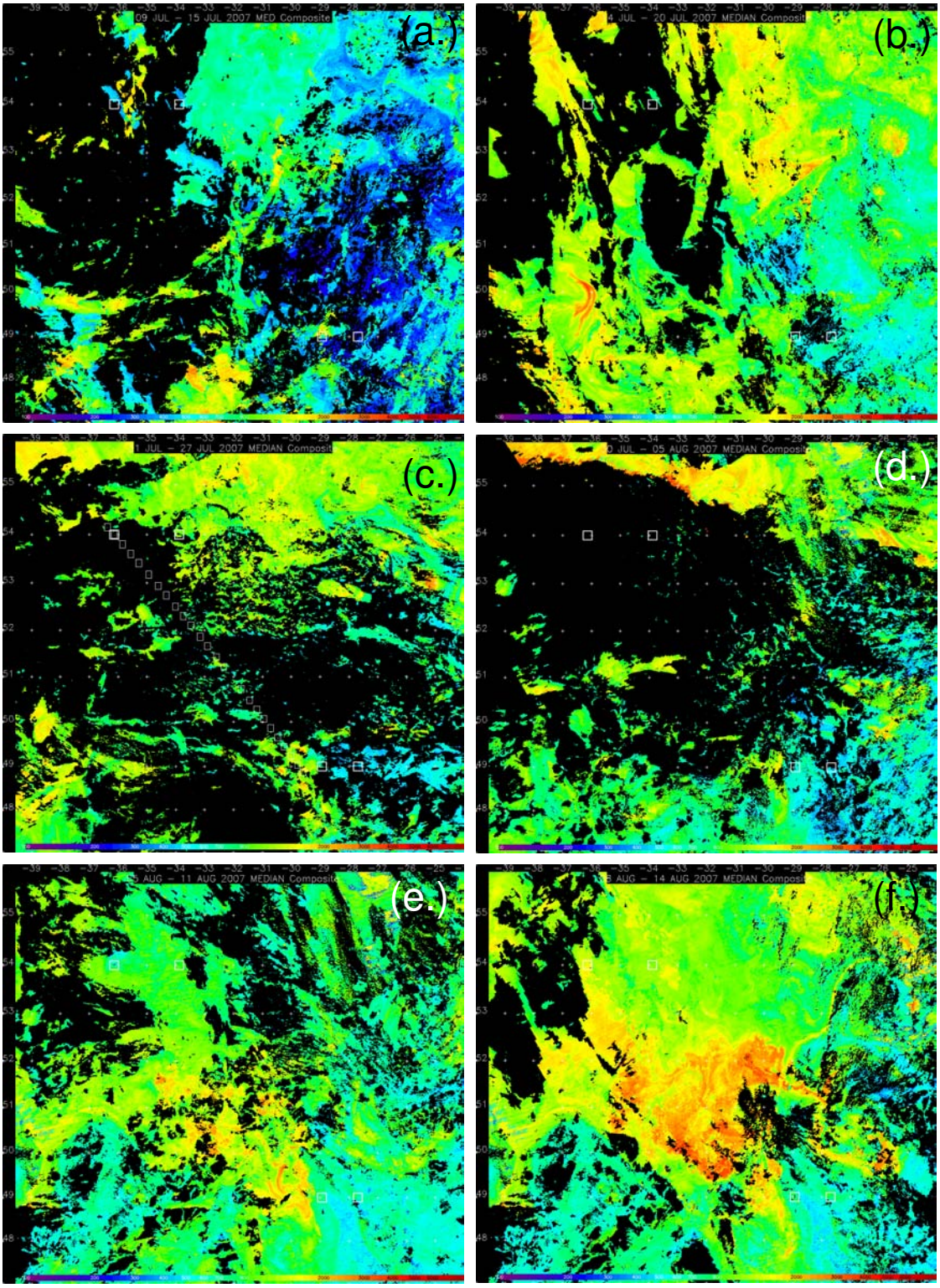

Figure 19: Primary Production composites for 01 – 07 July (a), 14 – 20 July (b.), 21 – 27 July (c.), 25 July – 03 August (d.), 05 – 11 August (e.), 08 – 14 August 2007 (f.).

Between 14 and 20 July, the high Chla to the north and west became more patchy and in places decreased to <1.0 mg m^{-3}, except at 50°N, 36.5°W where it reached 3 mg m^{-3} and was associated with a

mesoscale eddy (Figure 18b). During this period there was no clear imagery at the northerly ECOMAR stations. From the 21 to 27 July, Chla at the northerly stations was 1.0 mg m^{-3} and quite homogenous throughout the region (Figure 182c). To the south of 52°N there was no clear ocean colour imagery available during this period. From the 28 July to 3 August to the west of the sampling stations along the TOPEX / POSEIDON transect, Chla increased up to 10 mg m^{-3} and remained at 1.0 mg m^{-3} at the northerly stations and <0.1 mg m^{-3} at the southerly stations (Figure 18d). From 5 to 11 August, the images were cloudy, but clear pixels at the NW station indicated that Chla was between 0.5 and 1.0 mg and <0.5 at the SE and SW stations (Figure 18e). From 8 to 14 August we had the clearest scenes during the cruise which indicated a high band of Chla (2-10mg) across the sub polar front. Chla concentrations increased to 2 mg at the NW station and remained at <0.5 mg at the SE and SW stations (Figure 18f).

Primary Production images

Prior to the cruise from the 1 to 7 July, primary production was low at the SE station <0.1 gC m^{-2} d^{-1}, almost 2 gC m^{-2} d^{-1} at the SW station and approximately 1 gC m^{-2} d^{-1} at the NE and NW stations (Figure 19a). From 14 to 20 July, cloud cover obscured satellite coverage at the NW and NE stations, and primary production remained low at the SE station <0.5 gC m^{-2} d^{-1} (Figure 19b). From 21 – 27 July, there were again few clear satellite images due to cloud over. At the SW and SE stations PP remained <0.5 gC m^{-2} d^{-1} (Figure 19c). From 30 July – 5 August there was again poor coverage due to cloud cover (Figure 19d). The number of clear scenes improved from 5 to 14 August, when there was a slight increase in primary production at the SW and SE stations to about 1 gC m^{-2} d^{-1} and an increase at the NE and NW stations to between 1 and 2 gC m^{-2} d^{-1} (Figures 19e & f). In the composite image of 8 to 14 August, there was a definite band of higher production up to 3 gC m^{-2} d^{-1}, at the location of the sub-polar front (Figure 19f).

In Figure 20, the MODIS-aqua Chla and PML primary production values from the composite images are plotted at each of the stations sampled (For location of the stations, see Figure 20 & Table 1 of ECOMAR Cruise Report Primary Production and Marine Optics). There was no satellite imagery coverage whilst sampling at the SE station. Chla (0.2 mg m^{-3}) and primary production (0.4 gC m^{-2} d^{-1}) were low at the SW station and increased to 1.5 mg m^{-3} Chla over the sub-polar front during the TOPEX / Poseidon transect. At the NW station Chla was generally low at the mooring site 0.5 mg m^{-3} but patchy, and increased to 1.0 mg m-3 at the Lander deployment site, whereas the primary production was between 0.75 & 0.85 gC m^{-2} d^{-1}. At the NE station Chla was 0.7 mg m^{-3} and primary production varied from 0.85 to 1 gC m^{-2} d^{-1}.

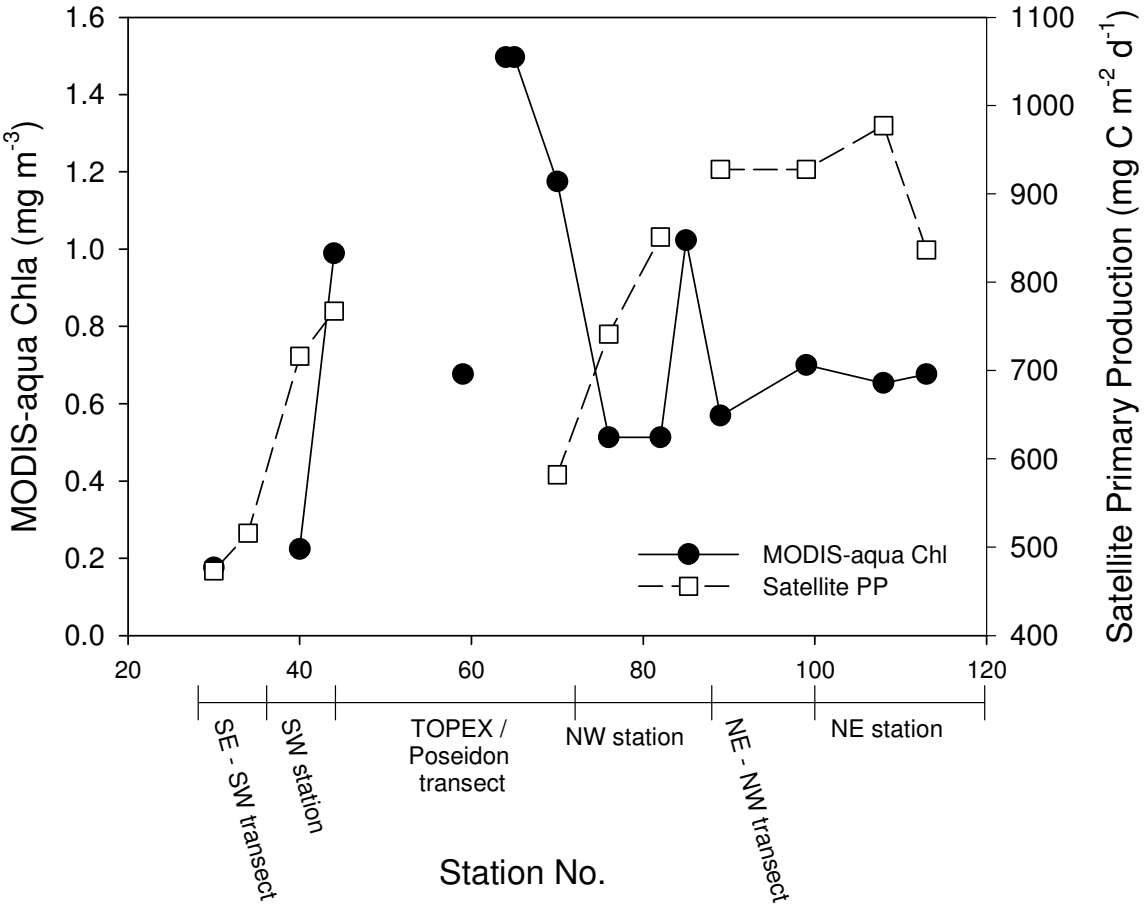

Figure 20: MODIS-aqua Chla and PML primary production extracted from clear pixels of composite images at each station during JC011. No data indicates cloud cover.

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Primary Production and Marine Optics

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Objectives
Do the mid Atlantic Ridge and Charlie Gibbs Fracture Zone create areas of high primary production and what is the likely export flux of carbon to the sea floor? Remote sensing, in situ incubations and bio-optical variables will be used to assess whether there are varying regimes of primary production between these regions and either side of the sub polar front.

Methods
Water samples were taken from 10l niskin bottles on the CTD rosette from between 6 and 3 depths in the euphoic zone from 24 stations to measure the parameters described below. Coincident optical were also performed during the upcast of the CTD. A total of 1024 measurements were made. In addition, water leaving reflectance was also measured each day at 30 second intervals.

Primary Production.
27 Photosynthesis-Irradiance experiments were conducted; 14 to measure total production and 13 to measure size fractionated production in two size classes of phytoplankton, >0.7 and >2.7µ. The experiments were conducted in photosynthetrons illuminated by 50 W, 12 V tungsten halogen lamps following the methods described in Tilstone *et al.* (2003). Each incubator houses 15 sub-samples in 60 ml polycarbonate bottles which were inoculated with between 185k Bq (5 µCi) and 370 kBq (10 µCi) of ^{14}C labelled bicarbonate.

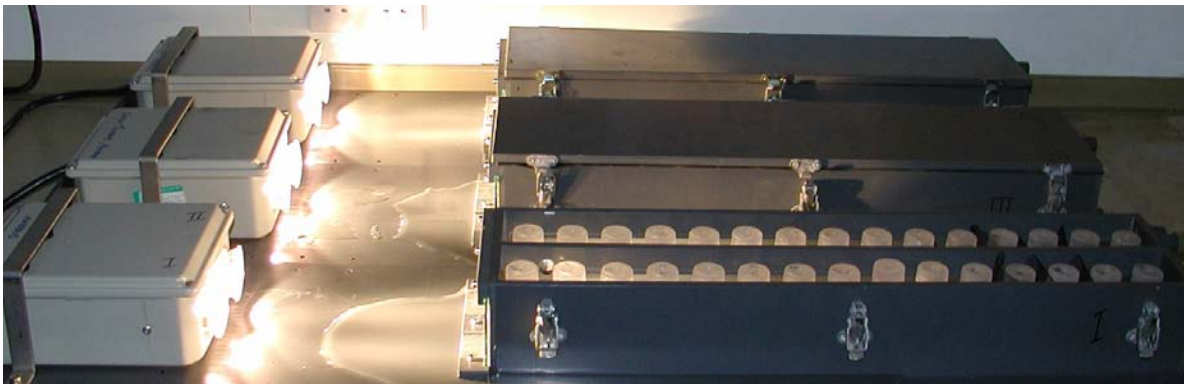

Figure 21: Photosynthesis-Irradiance photosynthetrons.

The samples were maintained at *in situ* temperature using the ships non-toxic supply or a digital temperature controller. After 1 to 2 h of incubation, the suspended material were filtered through 25 mm Whatman GF/F filters to measure the total production or sequentially filtered through GF/D (pore size ~2.7µ) and then GF/F filters (pore size ~0.7µ) to estimate the nano and pico-phytoplankton production respectively. The filters were exposed to concentrated HCl fumes for 12 h immersed in scintillation cocktail and ^{14}C disintegration time per minute (DPM) was measured on board using a WinSpectral 1414 liquid scintillation counter and the external standard and the channel ratio methods to correct for quenching. The broadband light-saturated Chla-specific rate of photosynthesis P_m^B [mg C (mg chl a)$^{-1}$ h^{-1}] and the light limited slope α^B [mg C (mg chl a)$^{-1}$ h^{-1} (µmol m^{-2} s^{-1})$^{-1}$] will be estimated by fitting the data to the model of Platt *et al.* (Platt et al., 1980). The photosynthetically

active radiation absorbed by phytoplankton [E_{PUR} (µmol m^{-3} s^{-1})] at each position in the incubator and for each sampling depth was estimated according to (Dubinsky, 1980). The maximum quantum yield of carbon fixation [ϕ_m mol C fixed (mol photons absorbed)$^{-1}$] will be determined by fitting the Chla-specific photosynthetic rates P_z^B [mg C (mg chl a)$^{-1}$ h^{-1}] to the photosynthetically available radiation absorbed by phytoplankton [E_{PUR} (µmol m^{-3} s^{-1})] following Figueiras et al., (1999). The daily integrated PP ($mgCm^{-2}d^{-1}$) will be estimated using a bio-optical model which inputs E_{PUR}, Chla and spectral photosynthetic parameters calculated from measurements of the phytoplankton absorption coefficient ($a_{ph}(\lambda)$) and integrates primary production at minute by minute intervals, down to 0.1% irradiance depth following Tilstone *et al.* (2003).

Inherent and Apparent Optical Properties.

Optical profiles

Coincident profiles of particulate and dissolved absorption and attenuation coefficients were measured with WetLabs ac-s and ac-9, particulate backscattering coefficients were measured using Hobilabs Hydroscat-6 and Wetlabs backscatter meter, Volume scattering function with WetLabs VSF-1, Conductivity-Temperature-Density with a Seabird 19, downwelling irradiance using TRIOS spectral radiometer, Photosynthetically Available Radiation using a Chelsea instruments PAR sensor and phytoplankton photo-physiology using Chelsea instruments Fast Repetition Rate Fluorometer were measured at 22 stations (Table 1). The Wetlabs ac-s and ac-9 instruments were calibrated with pure seawater every 2 days and the FRRF was calibrated with seawater filtered through a 0.2 µ filter at every station.

Discrete Samples

Water samples from six to three depths at 24 stations were filtered onto GFF filters for the analysis of phytoplankton pigments by High Performance Liquid Chromatography (HPLC) using the methods described in Barlow et al. (1997), particulate, phytoplankton and detrital absorption coefficients using the methods described in Tassan and Ferrri (1995), Total Suspended Matter (TSM) and Particulate Organic Carbon (POC) concentration following van der Linde et al (1998), particle size distribution by coulter counter and phytoplankton community composition by flow cytometry. In addition, these parameters will also be measured from 13 stations on GFD filters to give an estimate of the bio-optical properties of the nano-phytoplankton.

Water samples were also filtered through 0.2 µ filters for the analysis of absorption coefficient of coloured dissolved organic matter (CDOM) following Tilstone et al. (2004). Seawater samples were fixed in Gluteraldehyde to analyse the phytoplankton community composition by flow cytometry and the particle size distribution by coulter counter.

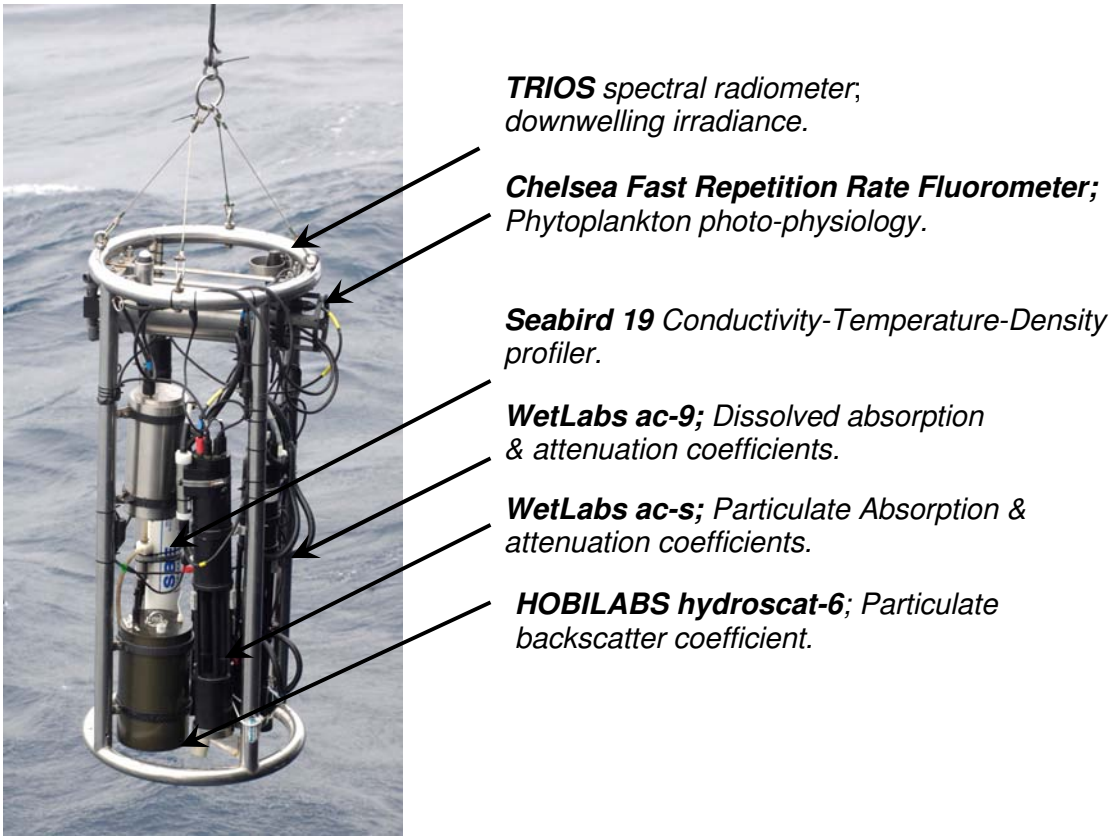

Figure 22: Plymouth Marine Laboratory optical profiler; the main instruments are indicated.

Water Leaving Reflectance

Measurements were performed with three SATLANTIC HyperSAS spectroradiometers, two measuring radiance and one measuring downwelling irradiance. The instruments were mounted on a frame as shown in Figure 22. Zenith angles of the sea- and sky viewing radiance sensors were 40°. The frame was fixed to the observation platform on RRS James Cook, facing forward to minimize ship shadow and reflection. The data were logged every 30 seconds from sunrise to sunset for the duration of the cruise except during stormy conditions when waves were >5 mts. Water-leaving reflectance will be calculated from simultaneous above-water measurements of downwelling irradiance, total upwelling radiance at a zenith angle of 40° and sky radiance.

Figure 23: Configuration of the SATLANTIC HyperSAS mounted on the observation platform of RRS James Cook.

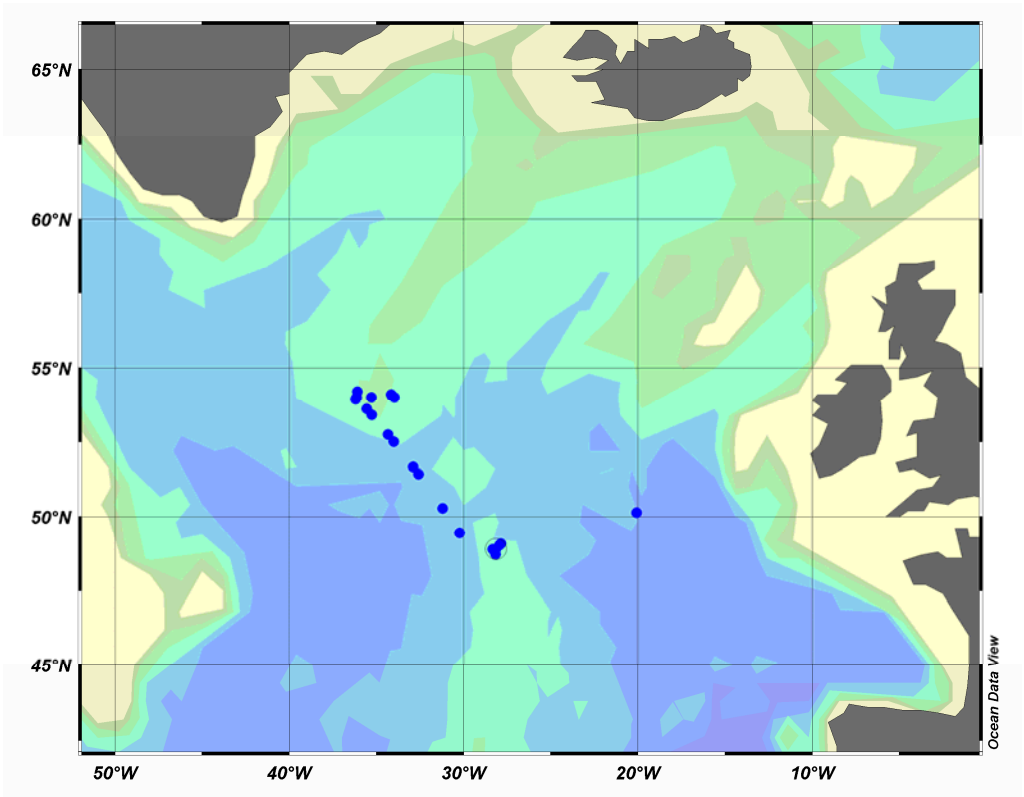

Figure 24: Sampling stations for the determination of primary production and inherent and apparent optical properties.

Table 1: Primary production sampling stations and measurements taken.

Station No.	Date	Time GMT	Latitude	Longitude	Discrete sample depths (m)	Measurements taken*
5	17 Jul	1610 2015	50° 07.8'N	20° 03.9'W	10, 40, 70, 90	PE, HPLC, Pabs, †ac-s, bb6, FRRF, CTD, ‡WLR (7:20 to 20:30).
9	19 Jul	1536 1620	49°04.84'N	27°50.78'W	5, 20, 40, 70, 100, 130	PE, HPLC, Pabs, POC, CDOM, PSD, FCM ac-s, bb6, FRRF, CTD, WLR (7:30 to 22:30).
15	20 Jul	1425 1458	49°04.54'N	27°50.80'W	5, 20, 50, 80, 100	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, ac-9, ac-s, bb6, FRRF, CTD, WLR (8:57 to 21:21).
25	23 Jul	1445 1637	49°02.20'W	27°55.62'W	5, 20, 40, 70	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, bb6, FRRF, CTD, WLR (08:20 to 23:23).
30	24 Jul	1058 1423	48°54.09'N	28°08.37'W	5, 30, 50, 80	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, too rough to deploy optics profiler, WLR (7:44 to 23:39).
34	26 Jul	1126 1327	48°53.26'N	28°20.21'W	5, 25, 50, 80.	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, ac-s, bb6, FRRF, CTD, WLR (7:16 to 21:22).
40	27 Jul	0720 0833	48°43.21'N	28°10.21'W	5, 30, 50, 70.	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, ac-s, bb6, FRRF, CTD, WLR (13:45 to 20:19).
44	28 July	1013 1303	49°26.29'N	30°13.65'W	5, 20, 40, 60.	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, ac-s, bb6, FRRF, CTD, WLR (06:28 to 21:30).
48	29 Jul	0647 0927	50°16.45'N	31°11.29'W	5, 30, 50, 70.	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, ac-s, bb6, CTD, WLR (06:42 to 22:03).
54	30 Jul	0814	51°25.21'N	32°35.02'W	5, 30, 60	PE, HPLC, Pabs, POC, CDOM, PSD, FCM, ac-9, ac-s, bb6, CTD, WLR (08:37 to 21:42).

		1047				
55	30 Jul	1318 1627	51°39.77’N	32°53.54’W	5, 30, 60	PE, HPLC, Pabs, POC, CDOM, PSD, FCM, ac-9, ac-s, bb6, CTD.
59	31 Jul	0919 1145	52°30.29’N	34°00.12’W	5, 25, 50	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, ac-s, bb6, FRRF, CTD, WLR (08:28 to 21:54).
60	31 Jul	1419	52°44.59’N	34°19.64’W	5, 25, 60	PE, HPLC, Pabs, POC, CDOM, PSD, FCM, ac-s, bb6, FRRF, CTD.
64	1 Aug	0802 1020	53°24.74’N	35°16.13’W	5, 30, 40, 55	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, ac-s, bb6, CTD, WLR (08:36 to 21:44).
65	1 Aug	1238 1430	53°36.46’N	35°33.20’W	5, 15, 40	PE, HPLC, Pabs, POC, CDOM, PSD, FCM, ac-9, ac-s, bb6, CTD.
70	4 Aug	0730 0953	53°59.74’N	36°07.67’W	5, 35, 55	PE, HPLC, Pabs, POC, CDOM, PSD, FCM, Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, ac-s, bb6, FRRF, CTD, WLR (00:00 to 23:24 Sensor error).
76	5 Aug	0925 1018	54°11.14’N	36°05.66’W	5, 30, 60	PE, HPLC, Pabs, POC, CDOM, PSD, FCM, Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, ac-s, bb6, FRRF, CTD, WLR (08:12 to 19:19 Sensor error; frayed cable).
82	6 Aug	1708 1755	54°09.85’N	36°05.96’W	5, 35, 60	PE, HPLC, Pabs, POC, CDOM, PSD, FCM, ac-9, ac-s, bb6, FRRF, CTD, WLR (1634 to 2:31; cable repaired).
85	7 Aug	1252 1320	53°56.49’N	36°11.41’W	5, 30, 50, 65	PE, HPLC, Pabs, POC, CDOM, PSD, FCM, ac-s, bb6, FRRF, CTD, WLR (09:24 to 18:56).
89	8 Aug	0823 1056	54°00.10’N	35°17.60’W	5, 30, 50, 60	PE, HPLC, Pabs, POC, CDOM, PSD, FCM, ac-s, bb6, CTD, WLR (08:31 to 18:35).
99	9 Aug	1426 1633	54°00.00’N	33°57.97’W	5, 25, 50, 70	PE, HPLC, Pabs, POC, CDOM, PSD, FCM, ac-9, ac-s, bb6, FRRF, CTD, WLR (08:36 to 21:53).
108	11 Aug	1310 1342	54°05.40’N	34°09.2’W	5, 30, 45, 60	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, ac-9, ac-s, bb6, FRRF, CTD, WLR (09:08 to 21:17). Possible satellite match up.
113	12 Aug	1338 1432	54°03.01’N	34°05.98’W	5, 20, 40, 60	PE, HPLC, Pabs, POC, CDOM, PSD, FCM, ac-9, ac-s, bb6, FRRF, CTD,

118	13 Aug	1505 1533	54°02.30'N	34°09.78'W	5, 25, 55	WLR (07:50 to 23:59). Possible satellite match up. PE, HPLC, Pabs, POC, CDOM, PSD, FCM, Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, CDOM, Size Frac PSD, Size Frac FCM, ac-s, bb6, FRRF, CTD, WLR (00:00 to 23:59).

* PE – photosynthesis-irradiance experiments, HPLC – phytoplankton pigments by High Performance Liquid Chromatography, Aph – particulate, phytoplankton & detrital absorption coefficients, POC – particulate organic carbon & total suspended material, CDOM – absorption coefficient of coloured dissolved organic material, PSD – particle size distribution by coulter counter, FCM – flow cytometry, Size Frac – measurements fractionated onto 0.7 & 2.7µ filters.

† ac-9, ac-s, bb6, FRRF & CTD are optical profiles with hyper- or multi-spectral measurements made with the following instruments: ac-9 - dissolved absorption & attenuation by *WETLabs ac-9, Volume Scattering function by WETLabs ECO-VSF-1* and Downwelling irradiance *TRIOS radiometer,* ac-s *Particulate absorption & attenuation by WETLabs ac-s* and Backscattering coefficient by *WETLabs backscatter meter,* bb6 - Backscattering coefficient by *HOBILABS Hydroscat-6,*
FRRF - Photo-physiology by *Fast Repetition Rate Fluorometer Chelsea-FRRF*, CTD - Conductivity-Temperature-Density by *SeaBird 19 plus.* When an instrument is not listed, it indicates instrument failure.

‡ WLR – water leaving reflectance measured with SATLANTIC HyperSAS every 30 seconds (times in brackets are logging start and end times).

Preliminary results

The SE and SW stations (Figures 25a and 5b) had a lower fluorescence than the NW station (Figures 25c and 5d), but there was little difference in fluorescence between the stations either side of the ridge. Backscatter was not related to fluorescence at the SE and SW stations possibly indicating a higher amount of detrital material than phytoplankton. Backscatter was related to fluorescence at the NW station and the presence of phytoplankton seems to affect the spectral slope of the backscatter at this station (insert in Figs 25d).

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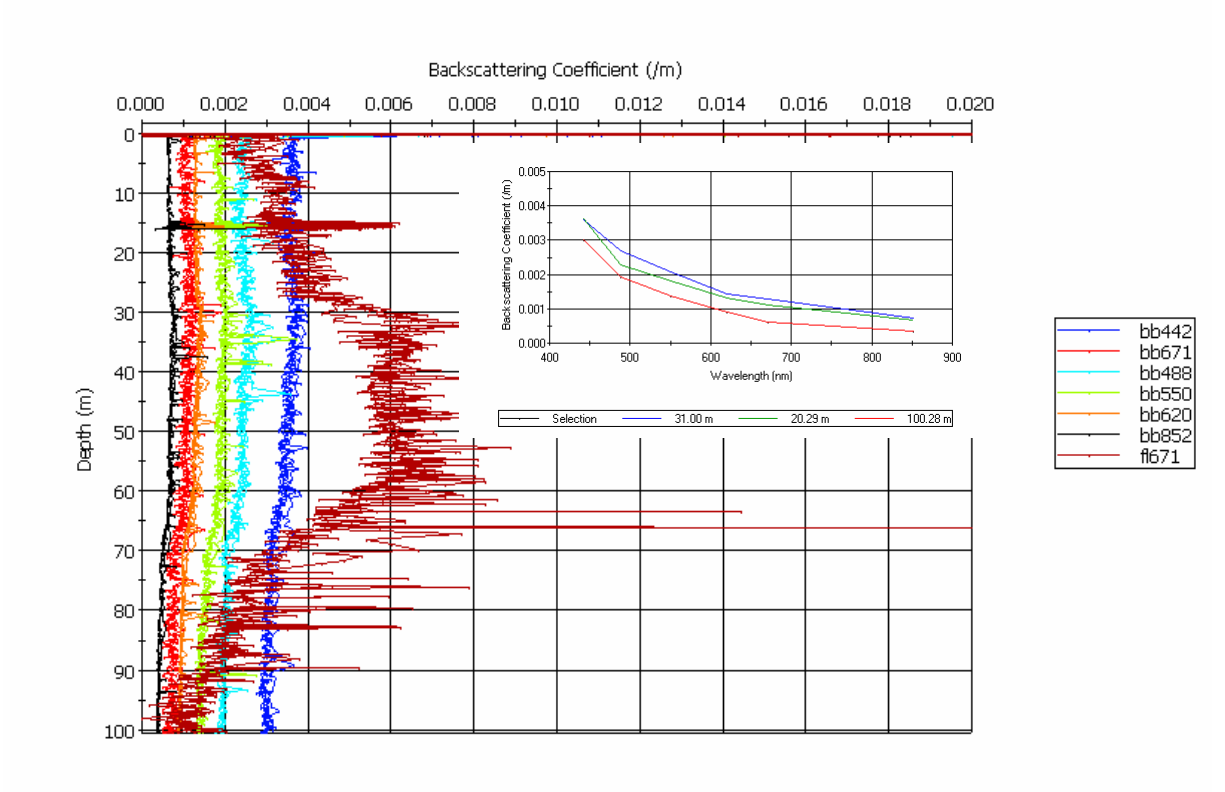
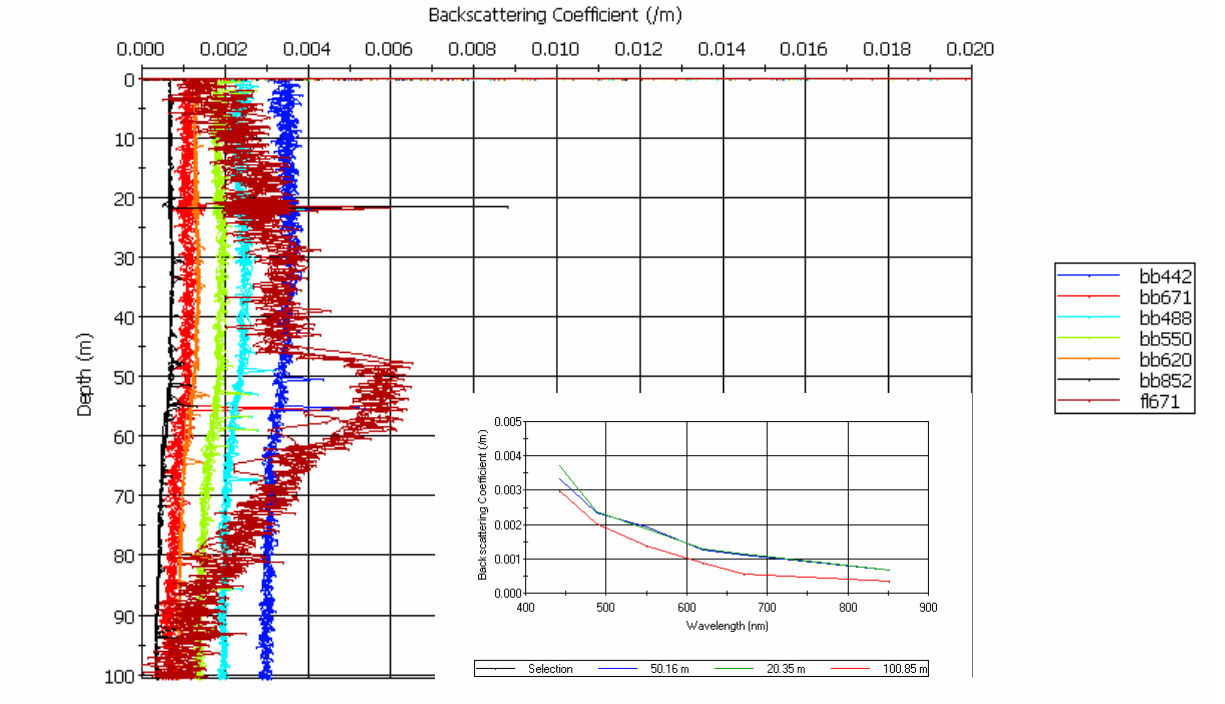
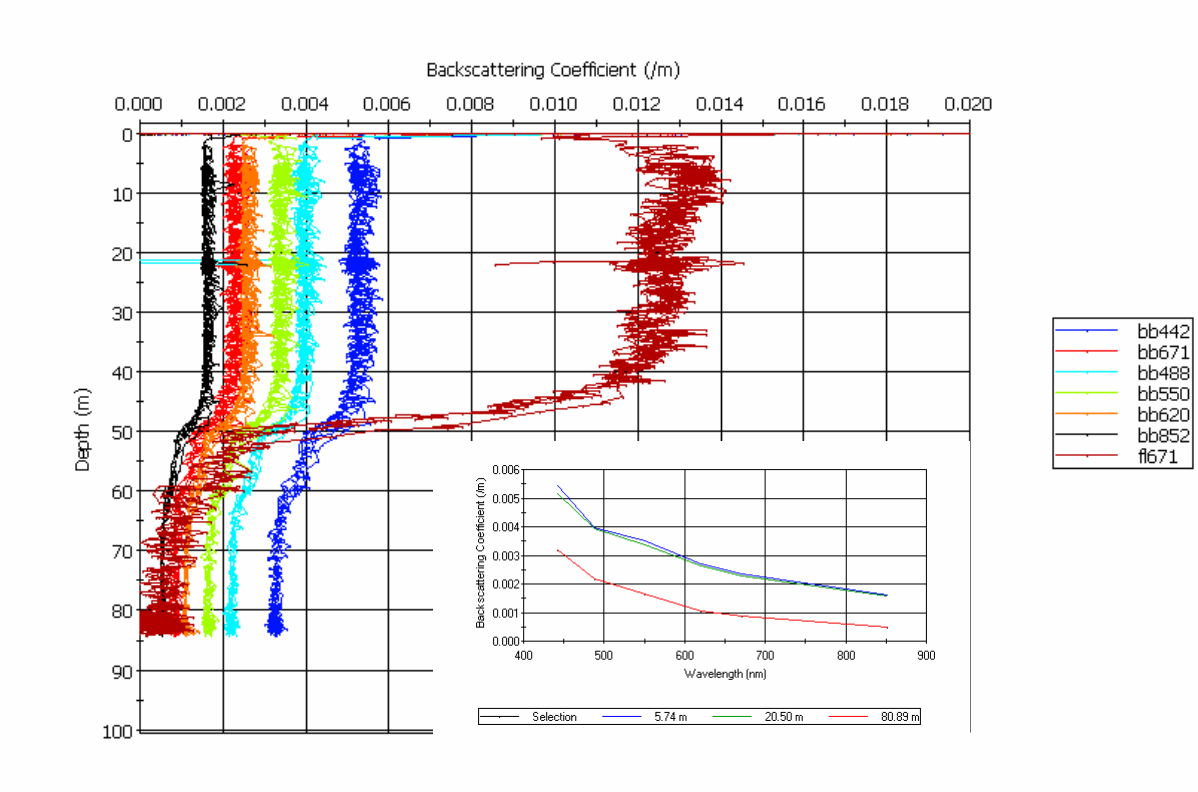


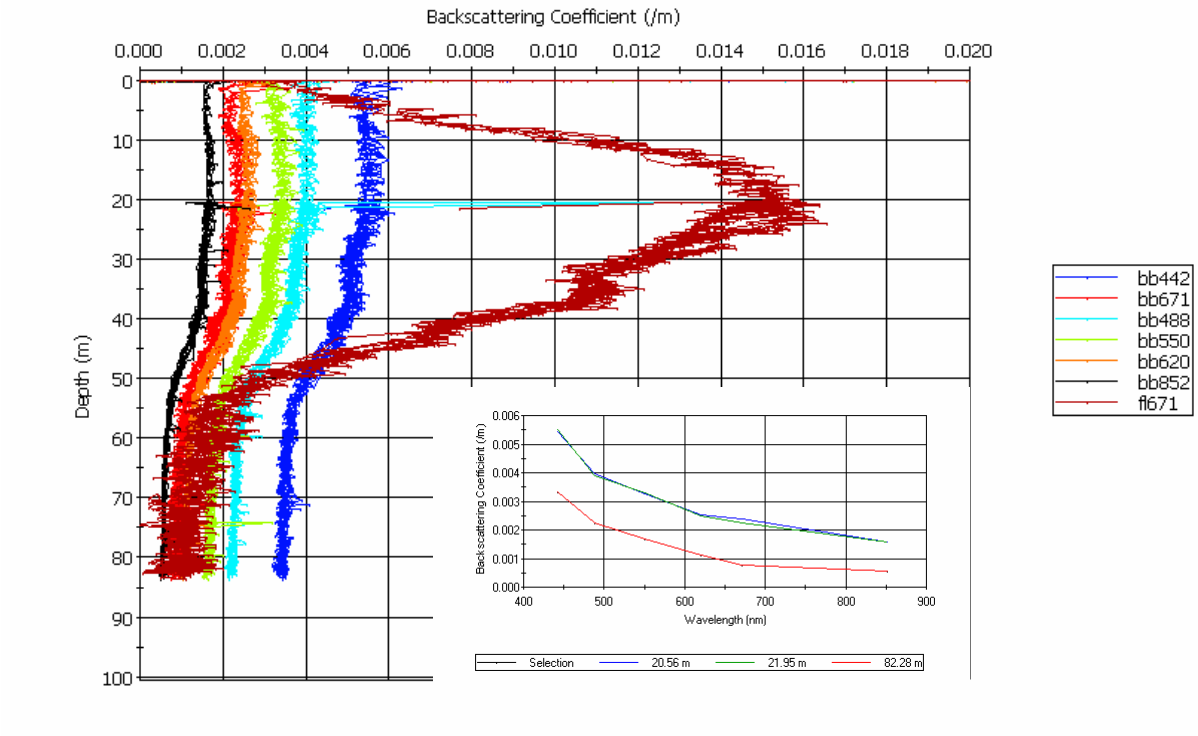
a.- Station SE (Stn 15, 20/07/07)



b.- Station SW (Stn 40, 27/07/07)



c.- Station NE (Stn 85, 07/08/07)



d.- Station NW (Stn 113, 13/08/07)

Figure 25: Backscattering coefficient and fluorescence profiles at SE, SW, NE and NW stations. Insert in each figure shows the spectral variation in backscatter coefficient.

CTD Operations

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National Marine Facilities, Sensors and Moorings Group, National Oceanography Centre, Southampton

A total of 61 CTD profiles were carried out (Table 2).

Stainless Steel CTD Frame

The stainless steel frame configuration was as follows:

- Sea-Bird 9/11 *plus* CTD System with dual TC pairs
- 24 by 10L Ocean Test Equipment External Spring Water Samplers
- Sea-Bird 43 Oxygen Sensor
- Chelsea MKIII Aquatracka Fluorometer
- Chelsea MKII Alphatracka 25cm path Transmissometer
- OED LADCP Pressure Case Battery Pack
- RD Instruments Workhorse 300 KHz Lowered ADCP (downward-looking master configuration)
- RD Instruments Workhorse 300 KHz Lowered ADCP (upward-looking slave configuration)
- Benthos Altimeter
- Wetlabs BBRTD backscatter sensor

The pressure sensor is located 30cm from the bottom of the water samplers, and 119cm from the top of the water samplers.

The same frame was used throughout the cruise. Notes on maintenance and events regarding the equipment are noted in Technical Appendix I.

All the CTD cats are listed in Table 2. except cast 1 which was a short cast in Bantry Bay to obtain sound velocity information for the EK60 calibration

Table 2: RRS James Cook cruise 011 CTD Station List

Station Number	cast	jday	date	start time	down time	end time	latitude °N	longitude °W	water depth	wire out	ht off bottom	max press	no of samples O2	N	S	Comments
11002	2	197	16vii07	1720	1837	2023	50 51.20	15 2.69	3384	3000	n/a	3045	8	0	0	wire test
11003	3	198	17vii07	1615	1730	2019	50 7.84	20 3.88	4460	3861	n/a	3862	15	0	3	wire test, PP cast
11007	4	200	19vii07	0120	0221	0353	48 60.00	27 40.80	2860	2801	9	2851	15	19	6	SE mooring
11009	5	200	19vii07	1536	1542	1620	49 4.84	27 50.79	2749	130	n/a	203	2	12	0	PP cast, SE mooring
11015	6	201	20vii07	1425	1435	1458	49 4.84	27 50.80	2748	100	n/a	155	0	5	0	PP cast, SE mooring
11016	7	201	20vii07	1545	1653	1808	49 4.84	27 50.80	2747	2735	9	2777	9	14	6	SE mooring
11023	8	203	22vii07	1800			48 43.36	28 10.07				476				aborted, cable flooded
11025	9	204	23vii07	1445	1525	1637	49 2.20	27 55.62	1704	1715	9	1717	11	12	4	PP cast, E ridge crest
11028	10	205	24vii07	0000	0126	0325	48 56.49	28 3.93	3810	3796	12	3865	8	14	5	axial rift
11029	11	205	24vii07	0501	0625	0815	48 54.52	28 5.80	4043	4033	10	4108	8	15	5	axial rift
11030	12	205	24vii07	1058	1228	1423	48 54.08	28 8.51	3878	3855	10	3925	8	15	6	PP, axial rift
11034	13	207	26vii07	1126	1210	1327	48 44.79	28 14.53	1568	1560	10	1579	14	16	5	PP, W ridge crest
11036	14	207	26vii07	1745	1841	2001	48 45.80	28 38.62	2550	2537	9	2575	8	15	6	SW mooring
11040	15	208	27vii07	0720	0752	0833	48 43.21	28 10.21	847	902	10	912	6	14	5	seamount, PP
11042	16	208	27vii07	1804	1918	0142	48 51.54	29 35.35	3515	3505	10	3566	6	14	5	start of sat track,spooling problems on upcast,
11043	17	209	28vii07	0454	0601	0728	49 9.73	29 55.25	3260	3250	10	3300	6	14	5	
11044	18	209	28vii07	1013	1120	1303	49 26.30	30 13.66	3221	3225	9.5	3279	7	16	5	PP
11045	19	209	28vii07	1523	1643	1813	49 39.22	30 28.21	3627	3620	6	3685	6	14	5	
11046	20	209	28vii07	2020	2142	2327	49 51.68	30 42.44	3709	3750	10	3818	6	18	6	
11047	21	210	29vii07	0147	0257	0432	50 4.11	30 56.80	3134	3130	-	3178	6	16	6	
11048	22	210	29vii07	0647	0800	0927	50 16.50	31 11.29	3567	3554	5	3617	6	16	7	PP
11050	23	210	29vii07	1145	1255	1434	50 28.86	31 25.91	3278	3255	-	3311	8	17	5	
11051	24	210	29vii07	1658	1810	1937	50 43.64	31 43.65	3333	3364	-	3423	7	17	5	
11052	25	210	29vii07	2158	2328	0109	50 58.36	32 1.60	3693	3710	5.1	3776	8	14	5	
11053	26	211	30vii07	0344	0445	0603	51 13.03	32 19.73	2939	2945	11	2995	6	13	5	
11054	27	211	30vii07	0814	0925	1047	51 25.21	32 35.02	2848	3104	15	3156	7	16	5	PP
11055	28	211	30vii07	1318	1450	1627	51 39.78	32 53.54	3540	3710	16.4	3775	8	16	5	PP
11056	29	211	30vii07	1835	1941	2103	51 51.88	33 9.15	3528	3510	9.5	3572	8	13	6	
11057	30	211	30vii07	2322	0034	0228	52 6.33	33 28.08	3620	3620	5	3685	8	18	6	
11058	31	212	31vii07	0425	0541	0716	52 18.33	33 44.02	3911	3899	7	3971	8	18	5	CGFZ S valley
11059	32	212	31vii07	0919	1022	1145	52 30.29	34 0.11	3073	3091	10	3143	8	16	5	PP
11060	33	212	31vii07	1419	1536	1710	52 44.59	34 19.63	3747	3690	-	3758	8	18	5	PP, CGFZ N valley
11062	34	212	31vii07	2308	2358	0112	52 56.45	34 36.07	2255	2250	10	2284	8	14	5	
11063	35	213	1viii07	0318	0415	0529	53 10.64	34 56.03	2805	2806	10	2851	8	15	5	ridge crest E
11064	36	213	1viii07	0802	0859	1010	53 24.76	35 16.15	2558	2556	8.8	2595	8	16	6	PP, axial rift
11065	37	213	1viii07	1239	1325	1430	53 36.46	35 33.20	1894	1880	7.9	1907	8	13	5	PP

11066	38	213	1viii07	1628	1708	1753	53 48.12	35 50.38	1615	1670	10.2	1694	7	12	5	ridge crest W
11069	39	216	4viii07	0340	0435	0536	54 9.06	36 21.80	2094	2082	10	2112	7	14	5	N end of sat track
11070	40	216	4viii07	0730	0832	0953	53 59.74	36 7.72	2570	2582	10.4	2624	8	17	6	PP, NW mooring
11076	41	217	5viii07	0925	0934	0948	54 11.13	36 5.66	2619	60	-	207	0	3	0	PP
11082	42	218	6viii07	1723	1732	1754	54 9.90	36 6.00	2623	60	-	155	0	3	0	PP
11085	43	219	7viii07	1252	1300	1320	53 56.49	36 11.40	2655	65	-	156	0	4	0	PP
11088	44	220	8viii07	0514	0553	0643	53 59.98	35 32.96	1648?	1703	10	1728	7	10	5	N ridge crest west
11089	45	220	8viii07	0824	0927	1051	53 59.99	35 17.60	2734	2788	9	2834	7	16	6	PP , N axial rift
11090	46	220	8viii07	1229	1311	1401	54 0.00	34 57.01	1333	1477	17.3	1497	7	11	5	N ridge crest east
11091	47	220	8viii07	1708	1758	1904	53 59.99	34 18.00	2290	2390	10.1	2428	8	14	5	
11099	48	221	9viii07	1426	1519	1633	54 0.00	33 57.97	2445	2440	10	2478	8	14	4	PP
11108	49	223	11viii07	1315	1325	1345	54 5.37	34 9.21	2505	60	-	155	0	4	0	PP
11113	50	224	12viii07	1343	1351	1412	54 3.01	34 5.99	2405	60	-	155	0	4	0	PP
11117	51-60	224	12viii07	2216		1424	54 0.65	34 10.42	2494	2470	14	2470	0	0	0	10 cast yoyo ctd
11118	61	225	13viii07	1505	1514	1533	54 2.85	34 9.77	2460	55	-	154	0	3	0	PP

Dissolved oxygen analysis and nutrient data collection on James Cook cruise 11

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Dissolved oxygen sampling and analysis

During the cruise a total of 330 samples from 44 CTD stations were collected for dissolved oxygen analysis. Samples were always drawn first from the Niskin bottles. Samples were selected by reference to the CTD profiles to identify depths where there were maxima and minima in oxygen concentration, or where oxygen gradients were weak or absent.

Water was drawn from the Niskin bottles through tubing into 100 ml calibrated clear glass bottles. Bubble free water was allowed to overflow the bottle to approximately twice the bottle volume. Samples were fixed immediately. Temperature of the sample was measured prior to fixing. Dissolved oxygen was fixed by adding 1ml each of first manganous chloride and then alkaline iodide solution (sodium hydroxide – sodium iodide). The reagents were dispensed with variable quantity bottle top pipettes. Samples were shaken vigorously before being allowed to settle. Time before titration varied from about 1 hour to as much as 12 hours. Samples were shaken again about half an hour before titration.

Before titration, samples were acidified using 1 ml of 12M sulphuric acid to dissolve the precipitate. Oxygen concentrations were determined using a semi-automated Winkler titration system. The titration endpoint was measured by a Metrohm 716 DMS titrino with magnetic stirrer using amperometric end point detection. The volume of sodium thiosulphate dispensed was entered into an excel spreadsheet to calculate the concentration of dissolved oxygen.

Sodium thiosulphate solution was prepared at the beginning of the cruise by dissolving 25g sodium thiosulphate in 1 litre of Millipore water. Sodium thiosulphate was standardised on a daily basis, whenever there were oxygen samples to titrate (figure 26). Standardisation was done with a commercially prepared 0.01N potassium iodate solution (Ocean Scientific International Laboratories). The average of two or three standard titre volumes were used to calculate dissolved oxygen concentrations. Reagent blanks were removed by using the same flask prior to sodium thiosulphate standardisation.

At least one duplicate sample was drawn on each CTD station, and in some cases several were taken. Mean duplicate difference was 0.05 with standard deviation of 1.24 over 58 duplicates (figure 27). Duplicates varied over the cruise, with differences up to 2.9. The reason for such large discrepancies was unclear and seemed random.

Two problems were encountered during the cruise. The first was when minute air bubbles were found in the samples during stations 48-50. These bubbles were introduced with the alkaline iodide reagent. Cleaning the reagent dispenser solved the problem and a new batch of reagent was introduced for station 53.

The second problem developed through the second half of the cruise, when determination of the end point seemed unreliable. During titration of samples from station 64 it was noticed that several of the bottles retained a slight yellowish hue. This could be further titrated with an addition of 0.01 – 0.02 sodium thiosulphate. One possible cause for this was re-oxidation of the sample after titration. Since the titration of this cast was done at the same time as the sampling of the next cast, it is

possible that re-oxidation took place. However the same problem occurred on several subsequent casts, particularly with blank and standard titrations. These were clearly not due to oxidation, since the procedure was being watched carefully. Cleaning the electrode carefully with dry blue paper seemed to resolve the problem, but occurrences increased in frequency as the cruise progressed.

A new batch of sulphuric acid was introduced on station 69, whereas the same volume of manganous chloride lasted until station 91. The bottle top dispensers need checking when returned to NOC, to ensure that they were delivering accurate volumes of reagent.

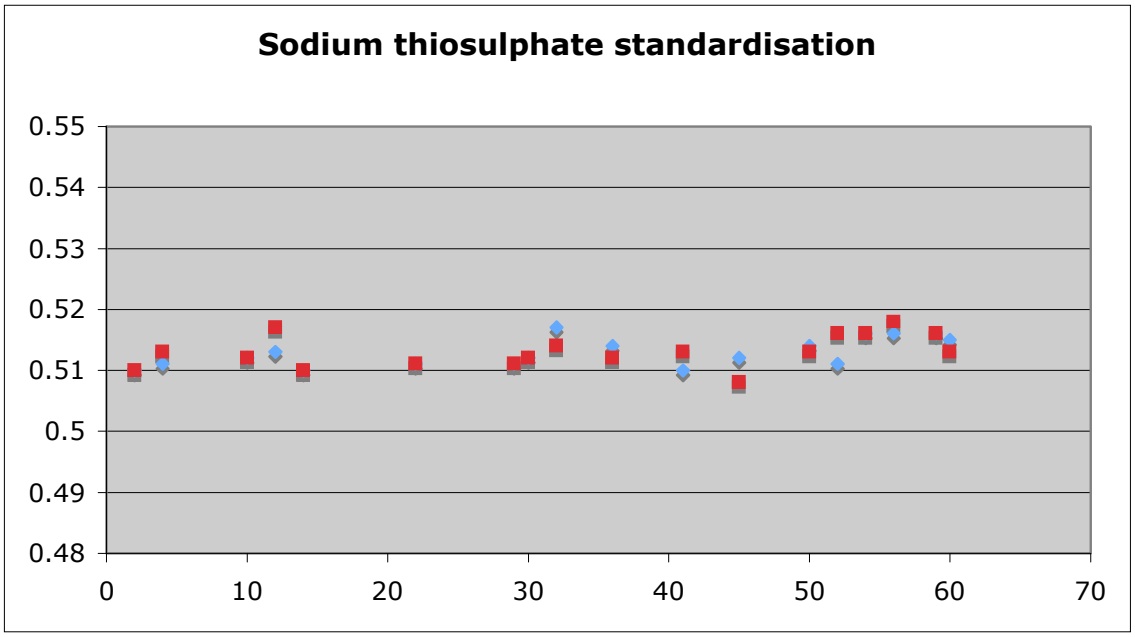

Figure 26: Standardisation of sodium thiosulphate

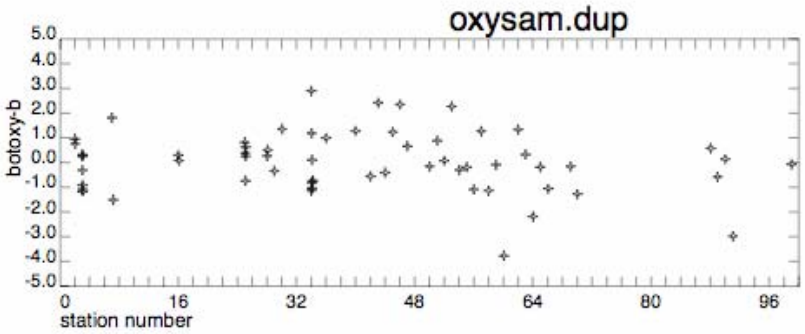

Figure 27: Differences between duplicate oxygen samples

CTD oxygen sensor calibration

Oxygen sample data were compared with the CTD oxygen sensor measurements. Samples were matched to the downcast oxygen value at the pressure at which the bottle was fired on the upcast. This was to avoid any hysteresis between down and up casts. A simple linear fit was found (figure 28) with the calibration to correct the CTD oxygen sensor of:

O2 = 0.7127 x CTDO + 5.7361 N = 264 r2 = 0.9826

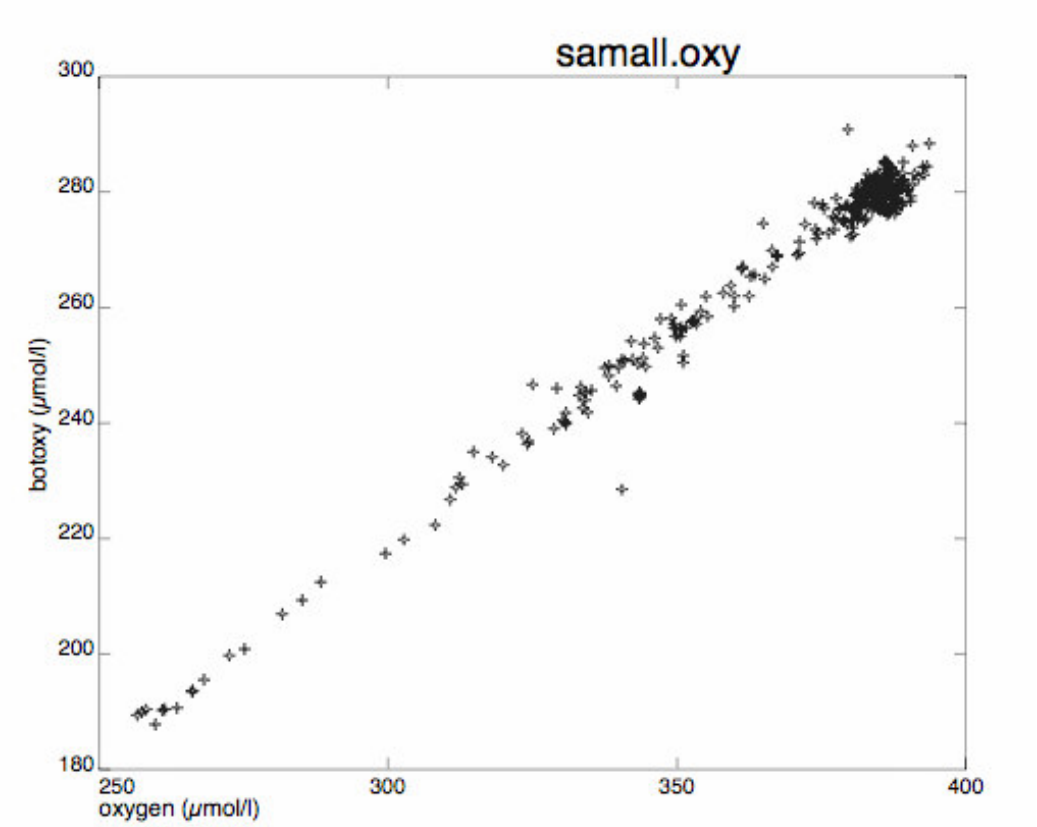

Figure 28: Sample dissolved oxygen vs CTD oxygen

Nutrient data collection

622 nutrient samples were collected from 49 CTD stations. Samples were collected in Sterilin sample vials and frozen. They will be transported to NOC and analysed for nitrate+nitrite, phophate and silicate.

ECOMAR Mooring Deployments

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Andy Dale & Colin Griffiths
Scottish Association of Marine Science

Four Moorings were deployed during JC011. All moorings were deployed in ~2500m of water. They will be turned round on the next ECOMAR trip aboard.
RRS Discovery during the summer of 2008. All moorings have two sediment traps, one 100m asf and the other 1000m with a current meter below each mooring. The Northern moorings have additional currents meters and CTD sensors.

JC011 SE mooring deployment, Station 10 (Figure 29).
Date: 19th July 2007
Position: N 49º 02.59970 W 027º 43.48399
Water Depth: 2500m

Order of events. (all GMT)

Start 1749 recovery line, billings and top buoyancy 8 x glass spheres
1759 sediment trap 11262-10 (21 Way)
1804 RCM7 current meter 11050
1823 7 x glass spheres
1828 Sediment trap 11804-06 (21 Way)
1832 RCM8 Current meter 9440
1837 AR861 release 683
1915 Anchor released.

Deployment notes

Top Sediment trap deployed vertically, bottom sediment trap laid down but very little leakage.
No links put into bottom RCM / rope connections.
Deployment normal, 2 x aft cranes used for handling equipment, block on port crane. RR on DB, SW and MH on red zone, DY on reeler, TE and CG assisting.

Drop rate approx 100m/min

Diagnostic showed release vertical, code 5031

RCMs 11050 & 9440, hourly sampling, switch on @ 0730Z 14/07/2007

Schedule for both 21 way sediment traps:-

Event 1 of 22 = 08/01/2007 00:00:00
Event 2 of 22 = 09/01/2007 00:00:00
Event 3 of 22 = 10/01/2007 00:00:00
Event 4 of 22 = 11/01/2007 00:00:00
Event 5 of 22 = 12/01/2007 00:00:00
Event 6 of 22 = 01/01/2008 00:00:00
Event 7 of 22 = 02/01/2008 00:00:00
Event 8 of 22 = 03/01/2008 00:00:00
Event 9 of 22 = 03/16/2008 00:00:00
Event 10 of 22 = 04/01/2008 00:00:00
Event 11 of 22 = 04/16/2008 00:00:00
Event 12 of 22 = 05/01/2008 00:00:00
Event 13 of 22 = 05/16/2008 00:00:00
Event 14 of 22 = 06/01/2008 00:00:00
Event 15 of 22 = 06/16/2008 00:00:00
Event 16 of 22 = 07/01/2008 00:00:00
Event 17 of 22 = 07/16/2008 00:00:00
Event 18 of 22 = 08/01/2008 00:00:00
Event 19 of 22 = 08/16/2008 00:00:00
Event 20 of 22 = 09/01/2008 00:00:00
Event 21 of 22 = 09/16/2008 00:00:00
Event 22 of 22 = 10/01/2008 00:00:00

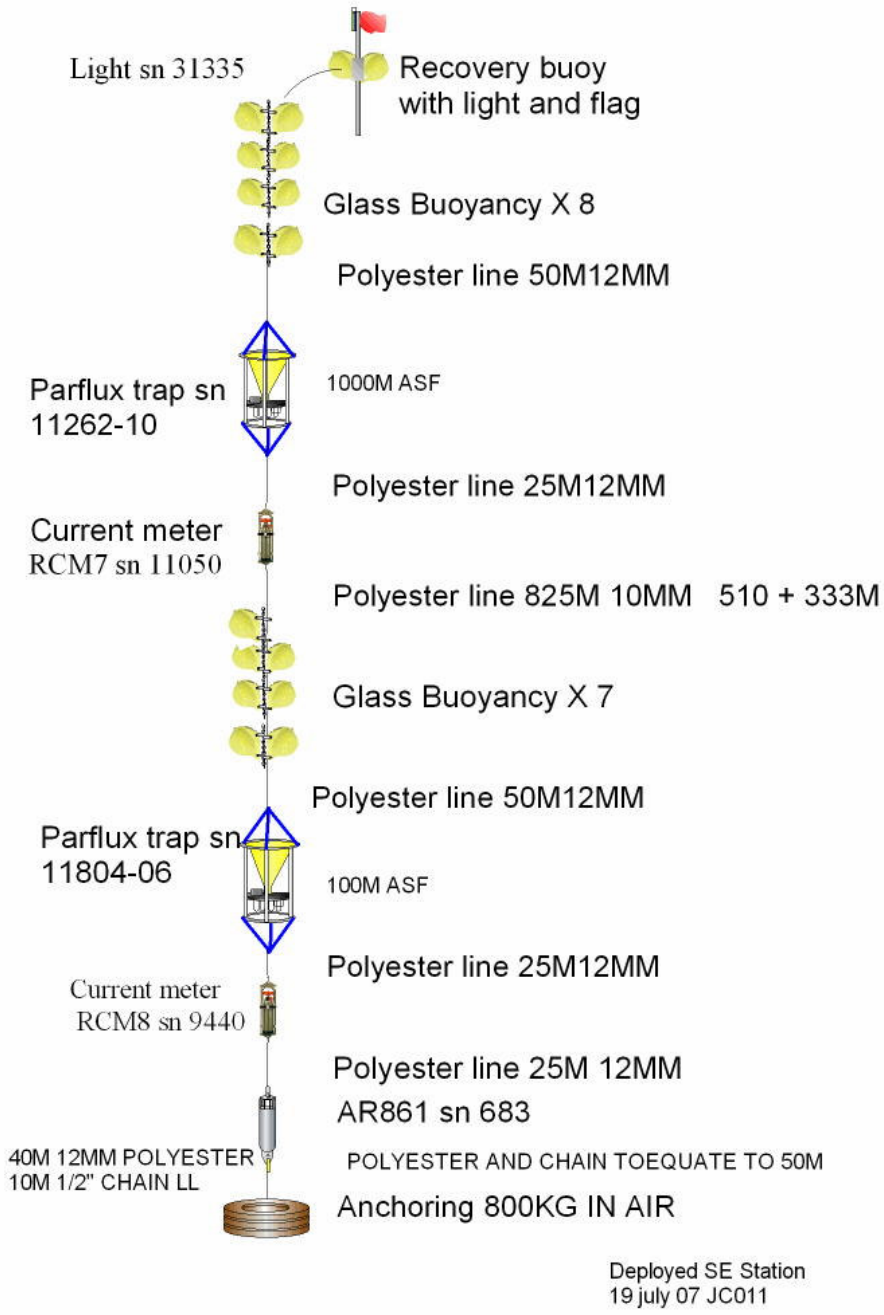

Figure 29: JC011 SE mooring deployment, Station 10.

JC011 SW mooring deployment, Station 035 (Figure 30).
Date: 26th July 2007
Position: N48º 46.800' W028º 38.412'
Depth: 3001m

Order of events

Start 1528, recovery line, billings float and top buoyancy 8 x glass
15 38 sediment trap sn 520 (13 way)
1541 RCM7 current meter sn 9069
1604 7 x glass spheres
1608 Sediment trap sn 11804-04 (21 way)
1612 RCM8 current meter 11571
1615 Release sn 315
1640 anchor released.

Deployment notes
Ship speed 0.5 knots, increased to 1 then 1.5. Run in 1.5 miles. 20 mins in hand.
Top sediment trap deployed vertically, both trap deployed horizontally, slight leakage.
Deployment normal, 2 x aft cranes used for handling equipment, block on port crane. RR on DB, SW and MH on red zone, DY on reeler, TE and CG assisting. Mooring deployed
In calm conditions with a slight swell.

Drop rate approx 100m/min.

RCM 9069 hourly sampling, switch on @ 1530Z 14/07/2007
RCM 11571 hourly sampling, switch on @ 0830Z 15/07/2007

Schedule for 13 way sediment trap:-

Event 01 of 14 = 08/01/07 00:00:00
Event 02 of 14 = 09/01/07 00:00:00
Event 03 of 14 = 10/01/07 00:00:00
Event 04 of 14 = 11/01/07 00:00:00
Event 05 of 14 = 12/01/07 00:00:00
Event 06 of 14 = 01/01/08 00:00:00
Event 07 of 14 = 02/01/08 00:00:00
Event 08 of 14 = 03/01/08 00:00:00
Event 09 of 14 = 04/01/08 00:00:00
Event 10 of 14 = 05/01/08 00:00:00
Event 11 of 14 = 06/01/08 00:00:00
Event 12 of 14 = 07/01/08 00:00:00
Event 13 of 14 = 08/01/08 00:00:00
Event 14 of 14 = 09/01/08 00:00:00

Schedule for 21way sediment trap:-

Event 1 of 22 = 08/01/2007 00:00:00
Event 2 of 22 = 09/01/2007 00:00:00
Event 3 of 22 = 10/01/2007 00:00:00

Event 4 of 22 = 11/01/2007 00:00:00
Event 5 of 22 = 12/01/2007 00:00:00
Event 6 of 22 = 01/01/2008 00:00:00
Event 7 of 22 = 02/01/2008 00:00:00
Event 8 of 22 = 03/01/2008 00:00:00
Event 9 of 22 = 03/16/2008 00:00:00
Event 10 of 22 = 04/01/2008 00:00:00
Event 11 of 22 = 04/16/2008 00:00:00
Event 12 of 22 = 05/01/2008 00:00:00
Event 13 of 22 = 05/16/2008 00:00:00
Event 14 of 22 = 06/01/2008 00:00:00
Event 15 of 22 = 06/16/2008 00:00:00
Event 16 of 22 = 07/01/2008 00:00:00
Event 17 of 22 = 07/16/2008 00:00:00
Event 18 of 22 = 08/01/2008 00:00:00
Event 19 of 22 = 08/16/2008 00:00:00
Event 20 of 22 = 09/01/2008 00:00:00
Event 21 of 22 = 09/16/2008 00:00:00
Event 22 of 22 = 10/01/2008 00:00:00

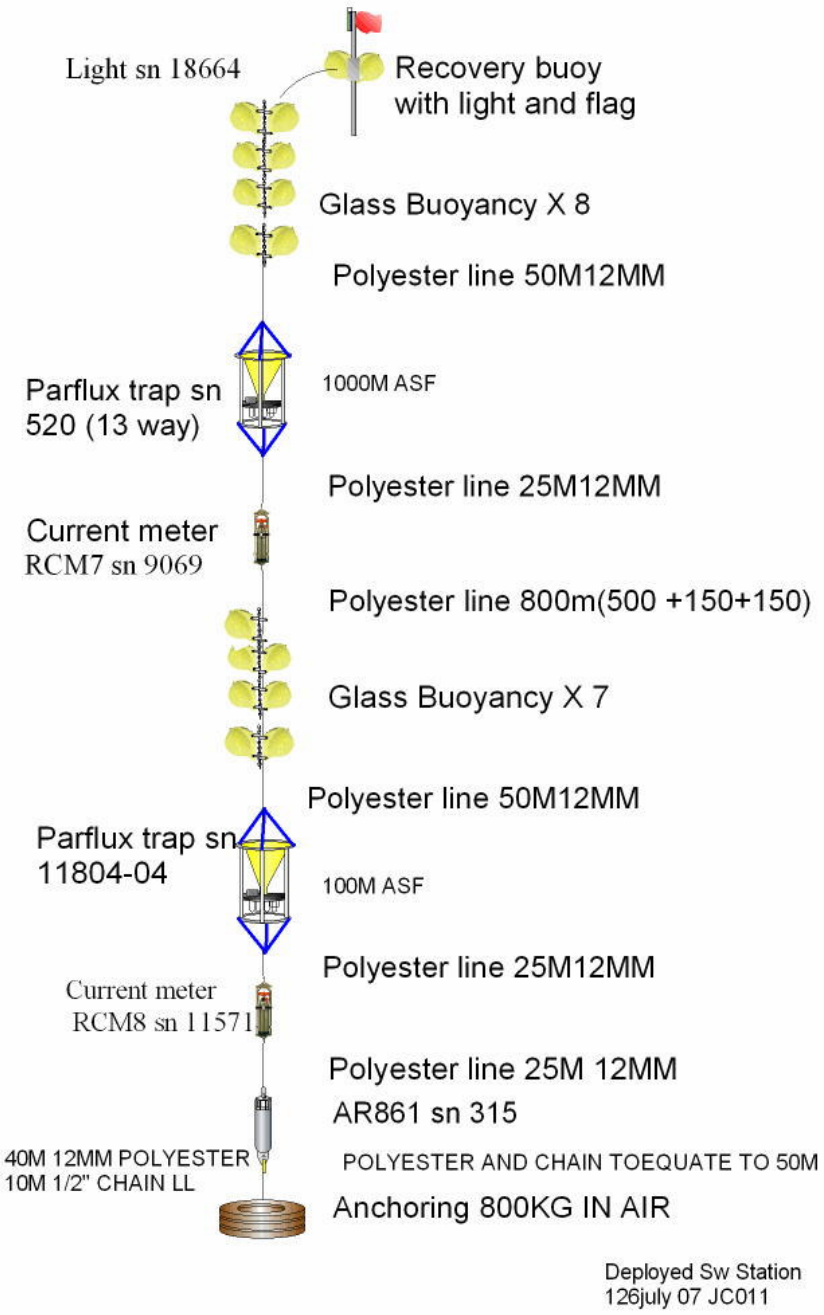

Figure 30: JC011 SW mooring deployment, Station 035.

JC011 NW Mooring Deployment, Station 67 (Figure 31).
Date: 1st August 2007
Position: 53º59.31174 N 36º07.40064 W
Depth: EA600 2504m

Order of events

Start 2120, recovery line and float
2121 RCM7 sn 11813
2136 RCM7 sn 6152
2148 RCM8 sn 11215
2159 RCM8 sn 9449
2213 Sediment trap sn 11262-09 (21 way)
2213 RCM11 sn 400
2224 RCM8 12577
2242 Sediment trap sn 11804-03 (21 way)
2242 RCM11 398
2248 RCM 8 sn 9447 and release AR861 sn 685
2322 Anchor released

Deployment notes

Landing site flat, approx 1 mile long. Run in was 2 miles. Initial ship speed was 0.5kn, increased to 1 then 1.5. Deployment normal, 2 x aft cranes used for handling equipment, block on port crane. RR on DB, SW and MH on red zone, DY on reeler, TE and CG assisting.

Descent rate approx 100m/min.

RCM7 11813 hourly sampling, switch on @ 0830Z 15/7/2007
RCM7 6152 hourly sampling, switch on @ 1530Z 14/7/2007
RCM8 11215 hourly sampling, switch on @ 1530Z 14/7/2007
RCM8 9449 hourly sampling, switch on @ 1530Z 14/7/2007
RCM11 400 hourly sampling, switch on @ 1600Z 1/8/2007
RCM8 12577 hourly sampling, switch on @ 0730Z 14/7/2007
RCM11 398 hourly sampling, switch on @ 1600Z 1/8/2007
RCM8 9447 hourly sampling, switch on @ 0730Z 14/7/2007

Sediment Trap Schedule for both traps:-

Event 1 of 22 = 08/16/2007 00:00:00
Event 2 of 22 = 09/01/2007 00:00:00
Event 3 of 22 = 10/01/2007 00:00:00
Event 4 of 22 = 11/01/2007 00:00:00
Event 5 of 22 = 12/01/2007 00:00:00
Event 6 of 22 = 01/01/2008 00:00:00
Event 7 of 22 = 02/01/2008 00:00:00
Event 8 of 22 = 03/01/2008 00:00:00
Event 9 of 22 = 03/16/2008 00:00:00
Event 10 of 22 = 04/01/2008 00:00:00
Event 11 of 22 = 04/16/2008 00:00:00
Event 12 of 22 = 05/01/2008 00:00:00
Event 13 of 22 = 05/16/2008 00:00:00
Event 14 of 22 = 06/01/2008 00:00:00
Event 15 of 22 = 06/16/2008 00:00:00
Event 16 of 22 = 07/01/2008 00:00:00
Event 17 of 22 = 07/16/2008 00:00:00
Event 18 of 22 = 08/01/2008 00:00:00
Event 19 of 22 = 08/16/2008 00:00:00
Event 20 of 22 = 09/01/2008 00:00:00
Event 21 of 22 = 09/16/2008 00:00:00
Event 22 of 22 = 10/01/2008 00:00:00

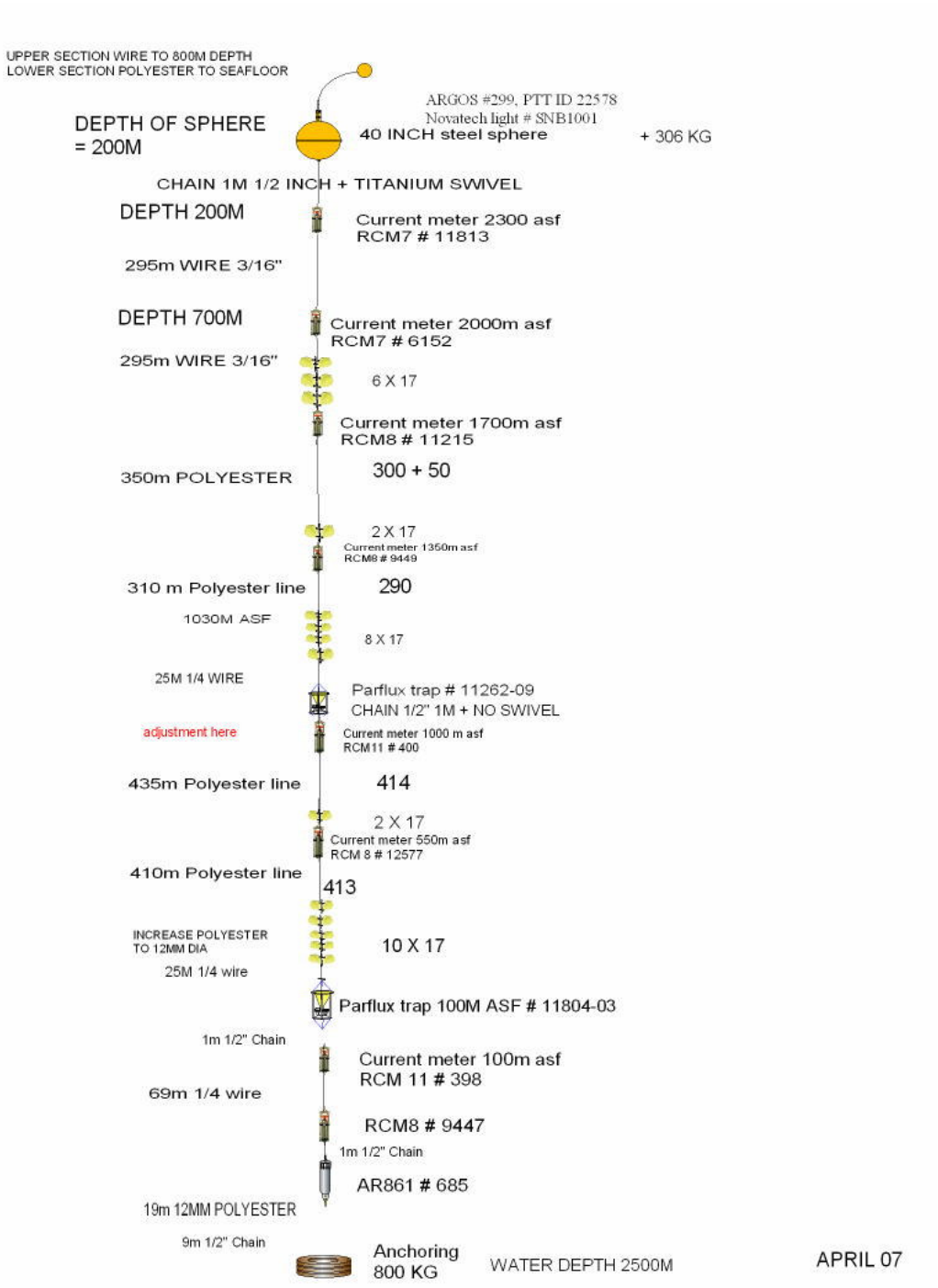

Figure 31: JC011 NW Mooring Deployment, Station 67.

JC011 NE Mooring Deployment, Station 96 (Figure 32).
Date: 9th August 2007
Position: 54º 00.02215 N 34º 10.56760 W
Depth: 2500m (EA600)

Order of events

Started 0907, recovery line and top buoyancy and top CTD # 10824
0919 CTD sn 10823
0934 LRADCP sn 5600, ARGOS sn 034
0943 RCM7 sn 11673
0951 RCM7 sn11674
1000 8 x 17" Spheres
1005 Sed trap sn 11262-05 (21 way)
1005 RCM11 sn382
1013 RCM8 sn 10277
1029 12 x 17" spheres
1035 Sed Trap sn 11262-01 (21 way)
1035 RCM11 sn 386
1042 RCM8 sn 9415
1116 Anchor released.

Deployment notes.

3 NM run in, weather flat calm, wind F1, small swell. As with the previous deployments, swath survey gave very good results and the mooring was deployed on exactly the right depth, no adjustment was required. Deep sediment trap seals leaked badly on deployment, there is a need to look at ways of deploying these vertically.

The SABLE iridium beacon transmitted until submerged at 10 min intervals. Didn't work on deck, suspect view shadow of pedestal.

CTD#10824 10min sampling, switch on @2100Z 8/8/2007
CTD#10823 10min sampling, switch on @2100Z 8/8/2007
LRADCP 5600 30min sampling, switch on @0745 9/8/2007
RCM7 11673 hourly sampling, switch on @ 0830Z 15/7/2007
RCM7 11674 hourly sampling, switch on @ 0730Z 14/7/2007
RCM11 382 hourly sampling, switch on @ 15300Z 8/8/2007
RCM8 10277 hourly sampling, switch on @ 1530Z 14/7/2007
RCM11 386 hourly sampling, switch on @ 15300Z 8/8/2007
RCM8 9415 hourly sampling, switch on @ 0730Z 14/7/2007

Schedule for both sediment traps:-

Event 1 of 22 = 08/16/2007 00:00:00
Event 2 of 22 = 09/01/2007 00:00:00
Event 3 of 22 = 10/01/2007 00:00:00
Event 4 of 22 = 11/01/2007 00:00:00
Event 5 of 22 = 12/01/2007 00:00:00
Event 6 of 22 = 01/01/2008 00:00:00
Event 7 of 22 = 02/01/2008 00:00:00
Event 8 of 22 = 03/01/2008 00:00:00
Event 9 of 22 = 03/16/2008 00:00:00
Event 10 of 22 = 04/01/2008 00:00:00
Event 11 of 22 = 04/16/2008 00:00:00
Event 12 of 22 = 05/01/2008 00:00:00
Event 13 of 22 = 05/16/2008 00:00:00
Event 14 of 22 = 06/01/2008 00:00:00
Event 15 of 22 = 06/16/2008 00:00:00
Event 16 of 22 = 07/01/2008 00:00:00
Event 17 of 22 = 07/16/2008 00:00:00
Event 18 of 22 = 08/01/2008 00:00:00
Event 19 of 22 = 08/16/2008 00:00:00
Event 20 of 22 = 09/01/2008 00:00:00
Event 21 of 22 = 09/16/2008 00:00:00
Event 22 of 22 = 10/01/2008 00:00:00

RDI LRADCP Ser No 5600 setup

CR1
CQ255
CF11101
EA0
EB0
ED0
ES35
EX11111
EZ1111111
WA50
WB1
WD111100000
WF704
WN74
WP20
WS800
WV175
TE00:30:00.00
TP01:30.00
CK
CS
;
;Instrument   = Workhorse Long Ranger

;Frequency = 76800
;Water Profile = YES
;Bottom Track = NO
;High Res. Modes = NO
;High Rate Pinging = NO
;Shallow Bottom Mode= NO
;Wave Gauge = NO
;Lowered ADCP = NO
;Beam angle = 20
;Temperature = 5.00
;Deployment hours = 8760.00
;Battery packs = 4
;Automatic TP = YES
;Memory size [MB] = 96
;Saved Screen = 1
;
;Consequences generated by PlanADCP version 2.04:
;First cell range = 16.62 m
;Last cell range = 600.62 m
;Max range = 559.69 m
;Standard deviation = 3.27 cm/s
;Ensemble size = 1634 bytes
;Storage required = 27.30 MB (28627680 bytes)
;Power usage = 1754.01 Wh
;Battery usage = 3.9
;
; WARNINGS AND CAUTIONS:
; There are no warnings or cautions present.

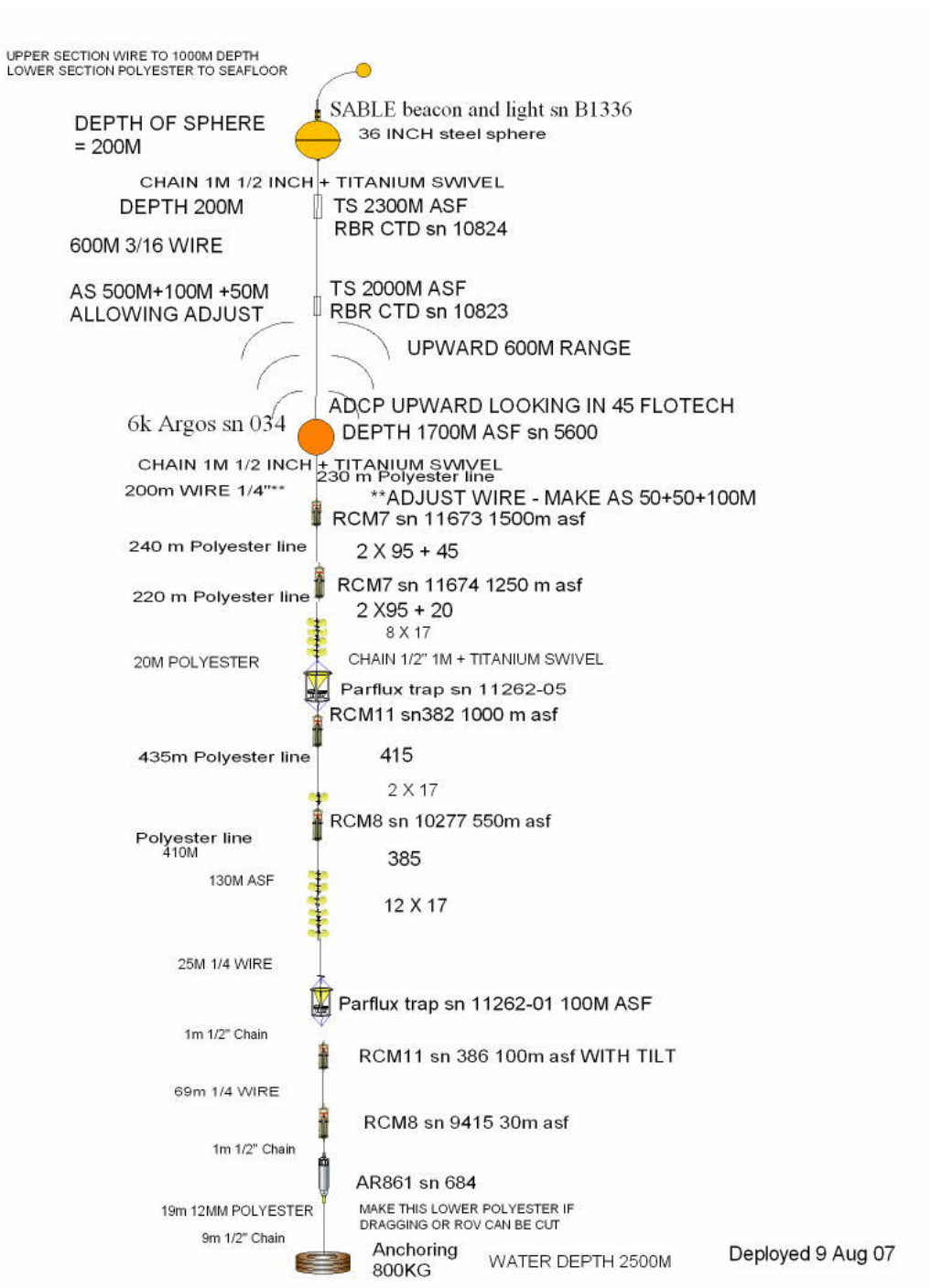

Figure 32: JC011 NE Mooring Deployment, Station 96.

Sediment Trap Sample Preservation
This method of sediment trap sample preservation has been taken from JGOFS Protocols 1994.

The method involves the use of formaldehyde (or the product Formalin, which is 40% formaldehyde). Formaldehyde is highly toxic and a CoSHH form regarding its use is attached to this document.

Basic Details of Method
The sediment trap sample jars are filled with filtered seawater to which sodium chloride is added to raise the salinity of the water by 5psu. A volume of formaldehyde is added to give a concentration of 2%.

Method
- If the formaline or formaldehyde requires buffering with sodium tetraborate (borax) add two or three spatula loads to the liquid. **Do not add any borax directly to the sediment trap bottles. Do this in a well ventilated place**

- Collect seawater from the same depths at which sediment traps are to be deployed. Failing this, use seawater of comparable salinity. Avoid using surface water in coastal regions that experience a high freshwater run off.

- Filter the seawater using the filtration apparatus. The Buchner flask has a maximum capacity of about 5l. The filter holder takes 47mm GF/C filters which are with the apparatus.

- Unscrew the sediment trap jars from the sediment trap carousel and collect the lids for the jars.

- Empty the contents (2.5g sodium chloride) of one of plastic jars into each of the sediment trap jars. Fill with filtered seawater to 4cm below the surface, replace the screw cap and invert several times to dissolve the salt.

- Conduct this next operation in a well-ventilated environment whilst wearing rubber gloves and safety glasses. Using an appropriate measuring cylinder, pour either 25mls of buffered Formaline or 10mls of buffered formaldeyde into each of the sediment trap sample cups. Carefully increase the volume of the liquid in the jar to 1cm below the surface with more filtered seawater if necessary. Replace the caps and **try not to shake the jars.**

- Carefully return the filled jars to the carousel in numerical order. The carousel moves from left to right or anticlockwise if looking down on to it. Place jar number one into the position immediately to the left of the funnel exit (this position is also numbered No.1). Place all other jars in numerical order to the left of the preceding one.

Pelagic investigation of the Mid-Atlantic Ridge

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Summary
The *RRS James Cook* permanently installed EK60 scientific echosounder (Simrad, Norway), was used to acoustically observe the water column, thus partially fulfilling the requirements of ECOMAR grant deliverable four. A pre-cruise calibration exercise was undertaken in Bantry Bay, Ireland 15 July 2007. During post-calibration processing 18, 38, 120 and 200 KHz frequencies were successfully calibrated (Table 3). A fault with 70 KHz frequency was detected, the cause of which requires further investigation (Figure 33). Pelagic acoustic sampling of the southern station commenced 2200GMT 21 July. A variety of line transects were run, during which other ship based active acoustic systems were turned off (Table 4). Acoustic sampling finished at the NE station 2235GMT 13 August 2007. When weather conditions permitted and other acoustic systems were shut down the EK60 water column observations were of exceptional quality, with the 18 KHz capable of sampling to the full depth at each study site. Again, where weather permitted the RMT 1+8 sampling was successful, with a total of eight hauls carried out during the cruise (Table 5). However, due to poor weather and problems with the acoustic systems, insufficient EK60 or RMT samples where collected at the southern stations to meet deliverable four. Greater ship time will be requested by PERG during the 2008 ECOMAR cruise to rectify this.

Materials and Methods
Equipment
The *RRS James Cook* is equipped with a permanently installed EK60 scientific echosounder (Simrad, Norway). The EK60 control PC is located in the main laboratory with the split-beam 18, 38, 70, 120 and 200 KHz transducers are mounted on the starboard drop keel (lowers to a maximum of 2.8 m below the hull). Pre-cruise EK60 calibration estimates (Table 3) were obtained from a calibration exercise performed in Bantry Bay, Ireland (51^{o} 55' N 009^{o} 47' W). During post-processing of calibration data it was discovered that the 70 KHz system was defective, the cause of this is unknown. Initial investigations were carried our onboard and it was discovered that there is a possible wiring problem in the 70 KHz junction box between the Simrad 70 KHz general purpose transceiver and the 70 KHz transducer installed in the starboard drop-keel. The 70 KHz system fault was discovered because of the unusual beam pattern map obtained during calibration post-processing (Figure 33). The usual circular beam pattern was instead elliptical, with no single target detections occurring outside of this ellipse. This suggests either multiple instances of incorrect wiring or a failure of two transducer sectors.

Table 3: Post-processed calibration values derived from observations made during the pre-cruise Bantry Bay calibration exercise.

Freq		KHz	18	38	70	120	200
Model			ES18-11	ES38-B	ES70-7C	ES120-7C	ES200-7C
Gain		dB	22.94	23.36	25.96	26.20	25.14
Sa Corr		dB	-0.09	-0.27	-0.33	-0.72	-0.28
2-way beam angle		dB	-17.3	-21	-21	-20.9	-20.9
Angle sensitivity	Along	Deg	13.9	21.9	23	23	23
	Athwart	Deg	13.9	21.9	23	23	23
Angle offset	Along	Deg	-0.03	0.2	0	0.01	-0.01
	Athwart	Deg	-0.03	-0.09	-0.15	0	0.05
3dB beamwidth	Along	Deg	12.48	8.05	2.9	6.56	6.9
	Athwart	Deg	11.67	7.45	8.49	6.73	7.02
Power		W	2000	2000	1000	500	300
Pulse length	(us)	micro S	1024	1024	1024	1024	1024
Alpha	(dB/km)	dB / km	2.7	9.8	22.7	37.3	52.6
Bandwidth		kHz	1.57	2.43	2.86	3.03	3.09
serial numbers	transducer		2067	30637	130	345	313
	GPT		102-203321	102-202585	102-202586	102-202587	102-202588

Table 4: Summary of dedicated EK60 activities. During these stations the EK60 was the only acoustic instrument actively transmitting. Since the EK60 was not the dedicated acoustic instrument this table does not include EK60 surveys conducted on the TOPEX/POSEIDON transect. All "at station" line transect survey designs were systematic with a random start point.

Station No.	Date	Time	Latitude	Longitude	Comments
20	21-Jul	2200	48°43.21'N	28°14.68'W	Several deep scattering layers observed on 18 KHz. Large variation in layer structure occurring over regions of rapidly changing bathymetry.
			49°04.4'N	17°46.6'W	
24	23-Jul	0730	49°16.45'N	27°48.09'W	10 nautical mile transects, with 1 nautical mile line spacing and random start point. 3.5 transects completed. North-south orientation.
		1310	49°08.2'N	27°45.1'W	
31	25-Jul	0835	49°02.5'N	29°06.1'W	50 mile track at 7-8 knots in heavy weather downwind. Dense scattering layer observed at 50 m depth observed on 18 KHz
		1515	49°05.4'N	27°51.5'W	
33	25-Jul	2258	49°12.01'N	27°49.93'W	SE super station. 10 nautical mile transects, 1 nautical mile line spacing. 4 transects completed. East – West orientation
	26-Jul	0440	49°09.00'N	27°41.91'W	
37	26-Jul	2010	48°45.80'N	28°39.02'W	SW super station. 10 nautical mile transects, 1 nautical mile line spacing. 2 transects completed.
		2206	48°44.67'N	28°34.97'W	
77	05-Aug	1040	54°56.87'N	36°05.82'W	NW superstation. 9 nautical mile transects, 0.75 nautical mile line spacing. 3.5 transects completed. North-South orientation.
		1506	54°04.77'N	36°09.36'W	
86	07-Aug	1632	53°56.76'N	36°12.36'W	NW superstation. . 9 nautical mile transects, 0.75 nautical mile line spacing. 4 transects completed. East-West orientation
	08-Aug	0133	53°58.62'N	36°10.97'W	
112	12-Aug	0904	53°47.71'N	34°02.83'W	NE superstation. . 9 nautical mile transects, 0.75 nautical mile line spacing. 4 transects completed. East-West orientation. Break for the CTD + Optics casts (113)
		1613	54°02.70'N	34°09.4'W	
119	13-Aug	1745	54°04.55'N	34°07.97'W	NE superstation. . 9 nautical mile transects, 0.75 nautical mile line spacing. 3 additional transects completed. East-West orientation.
		2235	55°55.13'N	34°10.05'W	

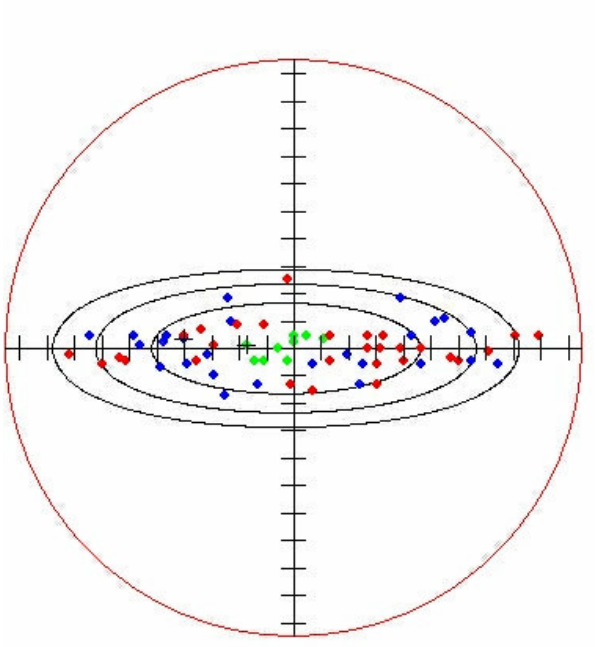

Figure 33: Defective 70 KHz beam pattern as obtained during post-processing of Bantry Bay calibration observations. The elliptical beam pattern (1 dB per contour) and no single-target detections of the calibration sphere suggest either physical damage to the transducer or incorrect wiring.

The importance of performing pre and post cruise calibration exercises, not only to obtain calibration parameters to allow quantitative assessment of the water column, but also as a gross error check is illustrated by Figure 33. Fortunately, because the purpose of this cruise is to investigate aggregating pelagic organisms it is likely that the results obtained from the Bantry Bay calibration will allow 70 KHz to be included in acoustic analysis of pelagic organisms.

Winches and control unit used during the calibration exercise were loaned from British Antarctic Survey (BAS).

EK60 operations

Except during CTD stations on the TOPEX/Poseidon transect and during lander recovery, the EK60 was run continuously throughout the cruise. Acoustic data collection extended from the drop keel, depth approximately 10 m to the maximum operating range of each frequency, which for 18 KHz was to the seabed. Data quality varied depending on sea state, direction of travel and the operation of other ship-based acoustic systems. Data acquisition was monitored using the EK60 control computer and a PERG PC running Echoview (SonarData, Tasmania) operating in live viewing mode. Vessel speed varied from 4 to 8.5 knots during EK60 survey. The variable speed was adopted to minimise bubble entrainment under the lowered drop keel, thus preserving data quality. An example echogram from the 18 KHz transducer is shown in Figure 34 and EK60 operation are summarised in Table 4.

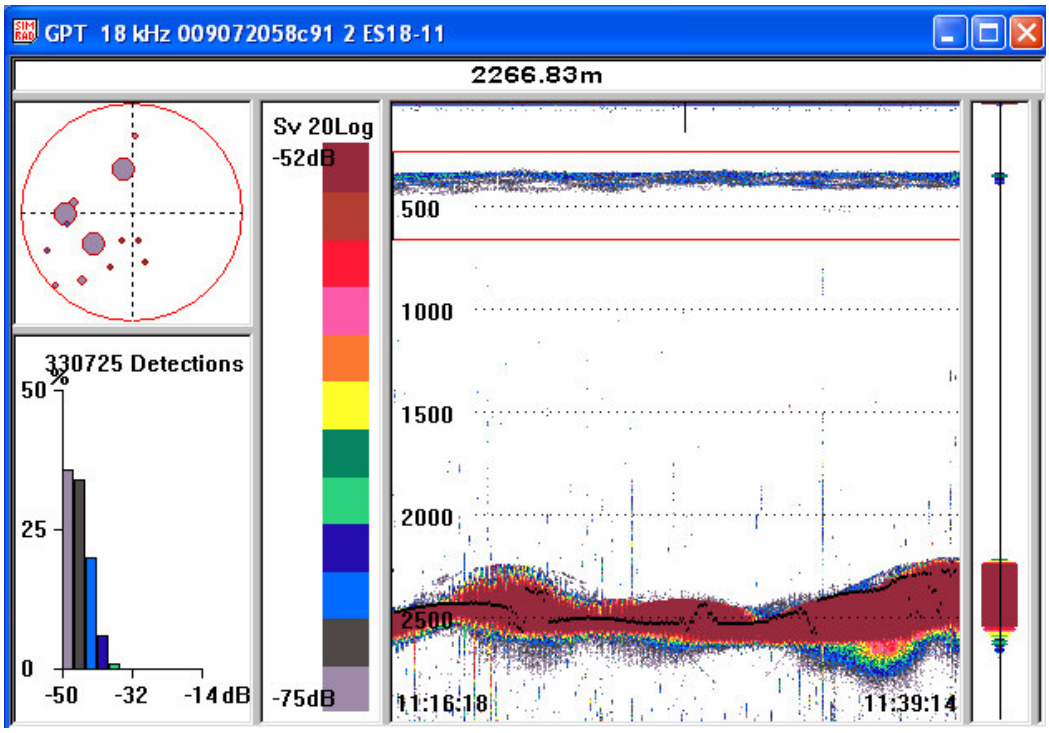

Figure 34: Example EK60 18 KHz echogram. The detected seabed has high acoustic scattering (shown in brown). A biological scattering layer has been detected in a depth band from approximately 250 to 350 m.

Rectangular Mid-water Trawl (RMT) 1+8 operations

The pelagic ecosystem was investigated using an RMT. The RMT is composed of two nets, an RMT1 (mesh size 0.33 mm, mouth area 1m²) and an RMT8 (mesh size 4.5 mm, mouth are 8m²).

The RMT 1+8 was fished on eight occasions (Table 5). Due to adverse weather only two of the original 4 stations were sampled. On all occasions trawling targeted biological scattering layers detected using the EK60.

Table 5: RMT deployments JC11

Date	Station	Location	Depth open (m)	Depth closed (m)	Time open	Time closed	Fishing time
25-Jul	38	SW	300	53	22:33:00	00:29:00	01:56:00
26-Jul	39	SW	521	403	01:51:00	03:20:00	01:29:00
07-Aug	92	NE	150	122	21:58:00	23:00:00	01:02:00
08-Aug	93	NE	506	463	00:22:00	01:22:00	01:00:00
08-Aug	94	NE	361	283	02:41:00	03:41:00	01:00:00
08-Aug	95	NE	75	31	04:35:00	05:06:00	00:31:00
09-Aug	102	NE	530	468	11:09:00	12:10:00	01:01:00
09-Aug	103	NE	225	70	13:33:00	14:32:00	00:59:00

Laboratory method: RMT samples

RMT1 samples were fixed on 4% borax-buffered formaldehyde on site, whereas RMT8 samples were split into dominant groups and sub-sampled for genetic analysis, stable isotope analysis, and lipid analysis. Respective sub-samples where either kept on alcohol at -20ºC, frozen at -80ºC then kept at -20ºC, or flash-frozen then kept at -80ºC. Bulk samples where fixed on formaldehyde

RRS James Cook RMT 1+8 deployment, recovery and in water operations
The RMT operates using acoustic signals at 10 KHz. Prior to JC009 a transducer was fitted to one of the dropkeels, and a waterfall display and beam steering unit were supplied in the main lab. During JC009 and 010 it became apparent that the waterfall display computer was faulty. A user supplied display was substituted. The ship-fitted system is still out of service.

The system as setup worked well in shallow depths both for sending and receiving acoustic transmissions. However, there are a number of points which need to be checked before it can be said that it is fully functioning:

1. Reception was as good, if not better, using the single element rather than the array which suggests either a wiring fault or a damaged array.
2. Beam steering was not used but the point above suggests it would not have been fully functioning.
3. System was only used in good weather, <sea-state4, so there is little indication whether bubbles below the hull would be a problem.
4. Some problems were encountered with opening/closing nets at deeper depths which may have been to do with beam angles from the dropkeel.

In light of the above, and if the RMT is used again especially to full ocean depth, a PES fish, or backward looking "dolphin" should be supplied as back-up to the drop keel mounted transducer.

Launching and recovering the system on RRS James Cook is a fairly simple procedure, though it is hampered by the pendulum arm which must be repositioned several times during deployment to keep it out of the way of the net or the trawl wire. It can be achieved without personnel coming within 2m of the open rail without a harness. This method utilises the "sentry boxes" in the crane pedestals and would not be possible on RRS Discovery. This process would need to be reviewed for launching the more complicated multinet version of the RMT

Sound speed and density of mycotphid tissue and seawater
Some myctophid species do not have gas-filled swimbladder. The absence of air makes them weak acoustic scatterers and hence the Target Strength (TS) caracteristics of individual fish becomes largely dependent on the sound speed contrast (h) and the density contrast (g). The low acoustic reflection of airless myctophids makes it difficult to detect them as single targets in the water column, especially when considering their depth distributions This makes theoretical modelling important to obtain estimates of TS and its frequency characteristics for comparison with *in situ* measurements.

The speed of sound in seawater and fish body was measured using T-tube with two 500 KHz transducers, a signal generator and oscilloscope (Figure 35). Density will be measured using the density-bottle method. The T-tube and signal generator were on loan from BAS.

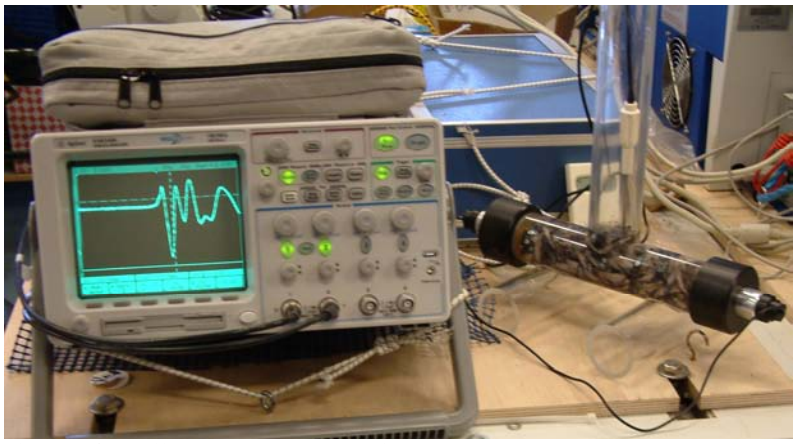

Figure 35: Oscilloscope, T-tube and signal generator.

Preliminary findings

Acoustic samples

Prior to quantifying differences in pelagic community structure, biomass, and spatial distribution between stations a significant amount of post-processing is required. A preliminary qualitative inspection of the acoustic echograms showed that differences in layer structure existed between the southern and northern and stations. Generally a greater number of layers were observed in the northern station and these layers exhibited frequency dependent acoustic reflectivity (Figure 36).

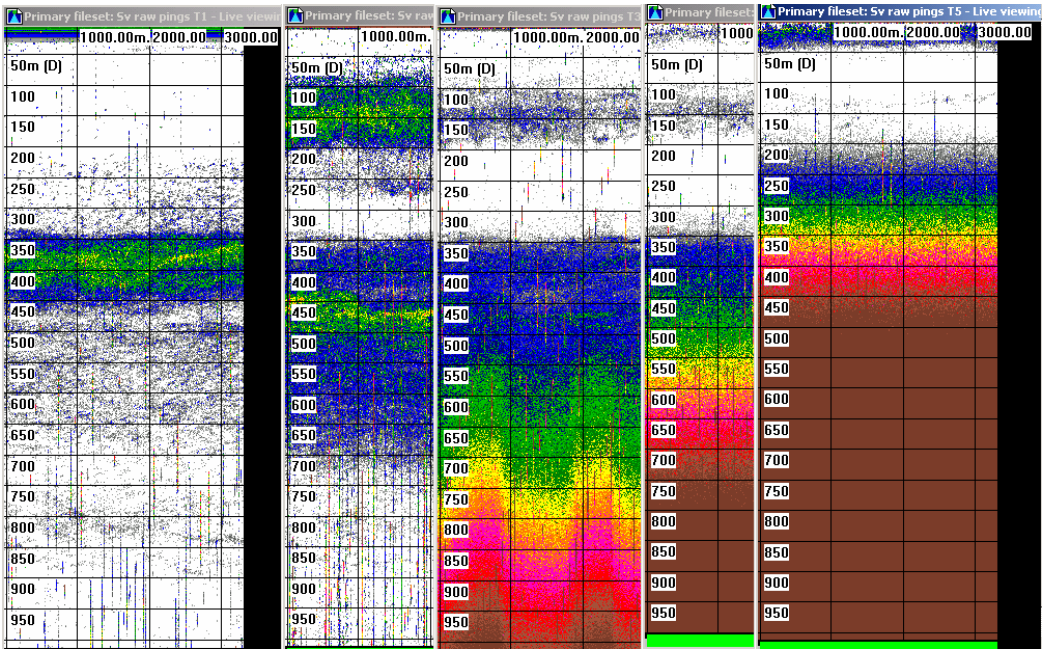

Figure 36: Example acoustic layers from northern stations over a depth of 1 km and an along transect sample of 3.2 km. Echograms shown are from five frequencies from left to right: 18, 38, 70, 120 and 200 KHz. Distinct scattering layers are shown in the 18 KHz echogram from 350 to 450 m, and the 38 KHz from 100 to 200 m , and 350 to 700 m. Time varied gain noise is evident of the 70, 120 and 200 KHz echograms.

Net samples

The Greatest zooplankton biomass and biodiversity was found on the NE station. Further, the catch was greater during the night and species present in the day were generally smaller with fewer species present. Preliminary analysis of zooplankton net samples species has yielded 20 species (Table 6).

Table 6: Preliminary description of RMT catch species identification

	Euphausiacea	Decapoda	Amphipoda	Copepoda	Pterapoda
Min. no of species	5	5	4	3	3

Sound speed and density of myctophid tissue and seawater

Only the species *Benthosema glaciale* was caught in sufficient numbers to conduct t-tube experiments. Previous x-ray studies conducted by PERG, National Research Institute of Fisheries Engineering and Hokkaido University showed that this species has, in many cases, an air filled swimbladder. Measurements of the sound speed in *B. glaciale*, were made and analysis of these observations is ongoing.

Research intentions

Net samples

Initially RMT1+8 samples will be identified and the zooplankton population described. These results will then be combined with the EK60 acoustic observations to estimate biomass and generate maps of zooplankton spatial distribution at each station. Key trophic species will be described using stable isotope and lipid analysis. Finally, there is potential to compare the MAR zooplankton community with others in the North Atlantic?

Acoustic research

A methods paper is required to describe the multi-species and frequency techniques that will be used to estimate biomass at the study stations. This paper will include the development of statistical techniques to quantify uncertainty in biomass estimates in areas with sparse net sampling. This will facilitate subsequent research that will fulfil the deliverable requirements.

Investigation of several anomalous acoustic scattering *clouds* discovered in the vicinity of sea mounts. These clouds were observed on the 18 and 38 KHz frequencies. At this time it is unclear whether these acoustic scattering clouds were physical turbulence or biological scatterers.

During the yo-yo CTD conducted at station 117 the EK60 38 KHz system collected data at a pulse rate of 1 pulse/60 sec. A comparison between turbulence derived from a lowered ADCP and the 38 KHz scattering layers will be undertaken.

Acoustic data were collected between CTD stations along the TOPEX/POSEIDON transect. Despite acoustic noise from the vessel mounted ADCPs it is hoped that these data will be used in a North-South comparison of zooplankton community structure in relation to environmental variables such as dissolved oxygen concentration.

Data disposition

Approximately 120GB of acoustic data are held by PERG in Simrad EK60 .RAW format. Additionally, calibration .RAW files and an EK60 science folder will remain onboard the *RRS James Cook*. The scientific systems manager, Mick Myers for cruise JC011 (mmy@noc.soton.ac.uk), has been advised of the locations of these data and information. RMT 1+8 samples are held by PERG for further analysis and eventual dissemination to the scientific community.

Assessment of delivery

The absence of pelagic net sampling at the SE and NW stations makes it difficult to isolate the effect of the sub polar front from the mid-Atlantic ridge, and an eventual comparison will be limited

to investigate their combined effect. Regarding the proposed genetic analysis, few species were present on both stations, reducing the number of candidates available for population comparison.

The six trawls and seven acoustic line transects at the NE station makes this an ideal site for the description of a single zooplankton community and its diel vertical migration.

Overall the lack of consistent combined net and acoustic sampling effort necessitates the development of methods to quantify uncertainty in acoustic biomass estimates in areas of sparse net sampling before the requirements of deliverable four can be met.

SHRIMP

Ian Rouse, National Oceanography Centre, Southampton (NOCS)

System description

SHRIMP – Seafloor High Resolution Imaging Platform – is NOCS's deep-towed video and camera imaging system. The system comprises of the vehicle attached to the main tow cable via an electro-optic swivel. At the ship is the vehicle's power supply, fibre-optic multiplexer, vehicle control computer, instrument data logger, DVD and video recorders and display monitors.

All signals and data to and from the vehicle are sent via a fibre-optic link. This consists of the main 6km combined conducting and fibre-optic tow cable, a Focal electro-optical swivel to decouple the vehicle from cable twist, an electro-optical slip ring on the ship's winch and two Focal 903 multiplexer units – one in the vehicle and one on the ship to send and receive the video and data signals.

The vehicle's main imaging instruments are a forward looking Simrad charged coupled device (CCD) underwater colour video camera, downward looking Panasonic 3-chip colour video and Simrad silicon intensified target (SIT) underwater B&W video cameras and an Ocean Instrumentation Ltd (OIL) M7 stills camera with F1200 flash unit. Lighting for the video cameras is provided by two DeepSea Power & Light SeaArc 400W high intensity discharge (HID) light with daylight lamps and flood reflectors for even illumination. An AquaVision L3C-550 colour video camera was also used as a back-up to the Panasonic.

As well as the cameras, the SHRIMP vehicle has a range of attitude sensors: an Advances Orientation Systems Inc. (AOSI) EZ-Compass 3 provides pitch, roll, heading and case temperature data, a Simrad Mesotech 808-A altimeter with a 200m range for vehicle altitude measurement and an FSI CTD. All these instruments have serial outputs and feed directly to the Focal multiplexer.

Control commands from the ship to turn on/off lights and cameras are sent via the RS-232 link and operated upon by the vehicle computer. Video signals from the CCD and SIT cameras are fed directly to the ship via the Focal multiplexer's optical link.

Power for the vehicle is derived from a 1.5kVac supply fed from the ship. In the vehicle this is transformed down to 240Vac, which is used to power the underwater lights and also the instruments via standard mains power supplies.

At the ship a 240 to 1.5kV, 3kVA transformer provides power to the vehicle down the main tow cable. This high voltage supply is protected by a Bender GFI (ground fault indicator) unit. The top end Focal 903 multiplexer provides the RS-232 data link and the CCD and SIT video feed signal. The video signal is buffered and is fed to 3 video monitors, the two DVD and one Hi-8 video recorders. The SHRIMP deck unit computer displays and logs the RS-232 data from the vehicle as well as sending the commands to control the vehicle functions.

A replay computer is used to make copies of the DVDs as well as editing of video taken on the SHRIMP cameras.

Laboratory setup

The SHRIMP recording deck unit is mounted inside a transit case. It is an easy task to strap this down to a suitable bench. The bank of DVD and Hi-8 recorders was mounted next to the deck unit while the power supply was mounted on the starboard side of the main laboratory close to overhead racking to take the power cables to the junction box at the aft end of the lab.

Deployment, survey and recovery

Care must be taken when planning a SHRIMP survey run as the ship is only able to keep to a course close to the wind when slow-towing at 0.5 to 1.0knts, although with its DP capability this was less of a problem on the Cook. It is also best policy to ensure that the survey run is down slope as this reduces the risk of damaging the vehicle on the seafloor or worse, getting the vehicle stuck under an overhang. This technique also gives better video and photographic images as the vehicle is less likely to be bounced along the seafloor.

The SHRIMP vehicle weighs approximately 1000kg in air. It is an easy task to deploy it from the amidships gantry using just two stay lines. Deploying amidships reduces any pitch motion induced by the ship. It does still suffer somewhat from roll motion.

Once deployed the vehicle is switched on and checked for correct operation. If all is in order then it is paid away at 40m/s. Progress is initially monitored on the pressure gauge display progressing to the altitude monitor when within 200m of the seafloor. Visual contact is made when within 10-15m of the seafloor. A visual altimeter is formed by a 6kg lead weight on a 2.3m tether. This can be viewed on the video monitor and is used as a guide by the winch driver to keep the vehicle at the optimum height off the seafloor.

Once visual contact is made with the seafloor the winch driver keeps the vehicle at the optimum flying height by monitoring the visual altimeter. After a brief learning period all the winch drivers became highly adept at flying the vehicle.

During this cruise a Sonardyne USBL transponder was mounted on the vehicle. This enabled the vehicle to be accurately navigated to depths of 4000m.

At the end of the seafloor run the stills camera and DVD and video recorders are turned off and the vehicle usually recovered at 50m/s. Recovery is accomplished by bringing the vehicle to deck height and attaching two stay lines before bringing the vehicle aboard.

System performance

For this cruise the SHRIMP system had updated software to enable secure switching of vehicle functions. This had been a problem on previous cruises. No software related switching problems were experienced during the cruise.

DVD recording of the video images is now standard with the old Hi-8 video recorders providing a backup in case of mishap. A 4.7Gbyte DVD disc in standard play mode gives 2 hours of recording time.

New features for this cruise were a modified main cable termination and a new vehicle transformer housing, both done to improve reliability. Both these worked well with no problems directly attributable.

SHRIMP was deployed a total of 5 times during the cruise. The first deployment was cut short after just under 3 hours of seafloor time. The problem was traced to an internal connector in the vehicle not locating correctly.

On the second deployment the vehicle was struck by something mid water that shook up the whole vehicle. Although the run continued the vehicle suffered 2 GFI trips before a heavy bottom contact disabled the system. The vehicle recovered from the GFI trips and was restarted. On recovery it was found that the heavy transformer housing had moved and was jammed against vehicle cabling

clearly as a result of the buffeting the vehicle took on the way down. Further checks revealed a fault in the internal power supply to the vehicle camera and instrument enable card which also powered the ASOI sensor which had be jammed by the transformer. Replacing this supply and powering the enable card from the main CPU supply cured the problem and made for a more reliable design.

The third deployment went smoothly apart from 6 GFI trips. On each trip the vehicle recovered and was restarted. After this deployment the termination bottle was taken apart and examined for contamination. A very small quantity of water was found – less than 2ml – but no traces of shorting or other contaminants. The bottle was refilled with clean oil.

The fourth deployment was fine apart from 2 GFI trips just before operating depth was achieved. Again the vehicle recovered and was restarted. The seafloor run was uninterrupted. The fifth deployment was perfect with no trips.

There seems to be no obvious cause for the GFI trips although less trips were observed with clean oil in the termination.
The original AML Smart CTD was not available for this cruise so a hastily arranged FSI replacement had to be used. This necessitated rewiring, installing an RS-485 to RS-232 converter and rewriting the top end software. This was completed for run 4 and could now be adopted as the standard configuration.

Table 7: Run summary

Station No.	Date	Latitude	Longitude	Depth (m)	Remarks
14	20 Jul	49°05.38'N 49°05.40'N	27°54.29'W 27°52.01'W	2000 2613	Good video of the sea floor along a 1.5 miles transect. 177 still photographs taken
74	4 Aug	54°01.17'N 54°01.34'N	36°05.84'W 36°07.86'W	2266 2605	At least six species of fish plus enteropneustes and a variety of invertebrates. 333 still photographs.
80	5 Aug 6 Aug	54°03.80'N 54°02.29'N	36°15.17'W 36°15.58'W	2050 2377	Transect from north to south sediment covered slopes. 691 still photographs.
105	10 Aug	53°54.71'N 53°53.70'N	34°01.87'W 33°59.40'W	2439 2503	Crossed the track of trawl JC011/101 and recorded images. 259 still photographs.
110	11 Aug 12 Aug	54°01.13'N	34°08.99'W	2258 2493	Down a steep slope and across the megacorer site, spectacular footage. 707 still photographs.

Positions are given for start and end locations.

Summary
During the cruise SHRIMP provided nearly 20 hours of seafloor video. The vehicle itself is reliable considering some of the heavy bottom contact it was exposed to. Improvements, especially to the lighting, can provide scientists with an even better service in future.

OTSB trawl catches

Invertebrates:
Alan Hughes, Ben Boorman & Ian Cross
National Oceanography Centre, Southampton (NOCS)

Tonya Rogacheva
P.P. Shirshov Institute, Moscow, Russia

Demersal fish:
Nicola King, Jessica Craig, Claudia Alt, James Hawkins
Oceanlab, University of Aberdeen

Will Reid
Newcastle University

Jeff Mashburn
University of Durham

Seven otter trawl deployments were made (Table 8). On the first deployment (JC011/17) the net caught on the seafloor. After recovering it, the net was found to be ripped. This can only therefore be considered a qualitative sample, although the material obtained will be of taxonomic interest. The trawl also snagged the seafloor at the Northeast station (JC011/81), but on this occasion the trawl was lost. The other five deployments of the OTSB returned good catches: one from each of the Southern (JC011/23) and Northwestern (JC011/75) stations, and three from the Northeastern station (JC011/111).

Table 8: Summary of OTSB trawls

Station No.	Date	Latitude	Longitude	Depth (m)	Area trawled (ha)	Remarks
017	21 Jul	49°14.68'N	27°42.31'W	2700		Net ripped.
		49°03.43N	27°53.86'W			Qualitative sample.
23B	22 Jul	48°54.59'N	27°50.00'W	2718	3.01	Good catch
	23 Jul	49°15.85'N	27°50.00'W	2734		
75	5 Aug	53°51.10'N	36°11.36'W	2615	4.380	Good catch
		54°06.02'N	36°07.20'W	2630		
81	6 Aug	54°15.82'N	36°04.12'W	2562		Trawl lost
		54°09.78'N	36°05.99'W			
101	10 Aug	54°06.33'N	33°58.27'W	2405	5.558	Good catch
		53°47.47'N	34°02.89'W	2435		
106	11 Aug	54°05.68'N	33°58.54'W	2410	5.479	Good catch
		53°46.94'N	34°03.02'W	2445		
111	12 Aug.	54°05.68'N	33°58.54'W	2404	5.479	Good catch
		53°47.71'N	34°02.83'W	2430		

Overview of trawling operations, Ben Boorman, NOCS.
The OTSB can be launched and recovered on the RRS James Cook in the standard manner developed for RRS Discovery. However, it is complicated by the roller/pendulum arrangement on the aft gantry which is always in the way and needs to be repositioned regularly during operations to prevent fouling on wires and cranes. The double grooved block allows the wire to jump grooves unless the net is towed perfectly behind the ship and as such it would be dangerous to attempt to

turn the ship whilst towing with wire out. This may well cause problems in areas where cables are laid.

The net was fished on seven occasions in very rugged terrain. Without the use of swath data and the instant mapping using *Olex* no bottom trawling could have been attempted in these areas. It was hoped at the start of the cruise that accurate height of net off bottom and depth of net data would have been available in real time using commercial fishing sensors supplied by *Scanmar.* Unfortunately, no signals were ever received from the sea units below 1200m depth. It is unknown whether this was a problem of bubbles causing acoustic noise, signal strength or beam angles but one of the latter two seems most likely in this case. With this lack of information all the trawls were fished blind relying on experience of the operator. Unfortunately, during two trawls the net became fast on the bottom though it is believed that this would still have happened with working sensors. On both occasions the winch render facility came in to operation and wire was paid out until the ship could be stopped. The first time this occurred the net was freed by reversing the ship up to the net, hauling the wire in as it came slack and eventually the obstruction was cleared. On the second occasion the same operation was attempted but did not free the net and nor did turning the ship around and pulling in the opposite direction. The only option left was to pull until some part of the net system parted. Unfortunately this resulted in the loss of all but the swivel assembly at the top of the net. All the main warp was recovered but the outboard 3000m had been overstressed and consequently had to be discarded.

Overall, the quantity and quality of the catches from such difficult terrain were very pleasing. If such an exercise is attempted again, in similar terrain in new areas, it would be sensible to consider whether more video footage of proposed trawl runs could be obtained; there would need to be a cost/benefit assessment of ship time against likely equipment losses.

Megafaunal ecology, Alan Hughes, NOCS

Following recovery of the trawls, all specimens were identified to the lowest possible taxonomic group, and wet weight biomasses were obtained. Samples were taken for isotopic (Ben Wigham and Will Reid) and genetic (Jeff Mashburn) studies, with the majority of the specimens being fixed in 10% Formalin for future taxonomic and ecological studies.

The megafauna in all the trawls recovered was rich and varied, as well as being quite different at all three sites. At the Southern station (JC011/23), holothurians accounted for 56% of the megafaunal biomass. The holothurians at this site were dominated by *Abyssocucumis abyssorum* and *Benthodytes* sp. Also present in notable numbers, and biomass, was the small opportunistic species *Amperima rosea*, two species of *Peniagone*, *Paelopatides grisea* and two species of *Pseudostichopus*. Asteroids were also represented in high numbers, notably Brisingids and Porcellenasterids. A large, dead, fragment of black coral was also recovered in this sample.

The trawl carried out at the Northwest station (JC011/75) returned quite a different megafaunal community to that at the southern station. Holothurians only accounted for approximately 42% of the biomass, with mollusks and asteroids and echinoids accounting for 19%, 18% and 10% respectively. The holothurians were dominated by unidentified species of *Benthodytes* and *Bathyplotes*, with a species of *Gephyrothuria*, and *Pseudostichopus* species also abundant. Asteroids were particularly notable in the catch, and were dominated by large numbers of an unidentified species. Also present in large numbers were porcellenasterids and brisingids. The echinoids were dominated by the tests of a *Phormosoma* species. Only a few mollusks were recovered, although their biomass was dominated by one large octopus.

Three replicates were carried out at the Northeast station (JC011/101, 106 and 111). The first of these trawls was notable for the large biomass recovered, which was dominated (78%) by

holothurians. The holothurians were dominated by a few large specimens of *Paelopatides grisea*. and *Benthothuria* sp., together with many small specimens of *Peniagone marecoi*. Also very noticeable in the sample were large numbers of the asteroid *Plinthaster*, together with large numbers of a large sipunculan. These same species also dominated the next two trawls carried out at this station, although their relative abundances varied considerably, giving some idea of the variable nature of the megafaunal assemblages in this region.

With only one replicate at both the Southern and Southwestern stations, it is difficult to make accurate comparisons between the sites. However, several trends are clearly suggested. Several species appear to have a limited distribution, and were only found at on station: for example, an alcyonarian (*Anthomastus* sp.) which was common at the Southern station was not found at either of the two northern stations, while the large sipunculan which was found in large numbers in the Northeastern station, was present in low numbers at the southern station (to the east of the ridge), while it was absent from the Northwest station. In general, holothurians were dominant in terms of both biomass and abundance in all the trawls, although there were few shared species north and south of the Charlie Gibbs Fracture Zone.

The presence of the small holothurian *Peniagone marecoi* in large numbers at the Northeast station is worthy of particular note. This species was only recently discovered, during the MarEco cruise to the mid-Atlantic ridge, and appears to be a species which is only found in the northern Mid-Atlantic Ridge region. This suggests that a specific ridge fauna exists which is quite distinct from that observed along continental margins.

Table 9: Megafaunal fresh wet weight biomass (g per hectare)

Station No.	23	75	101	106	111
Porifera	33.16	43.29	13.28	30.04	58.19
Cnidaria	168.94	1.19	72.04	5.00	0.00
Annelida	20.53	0.68	6.51	9.31	6.57
Vermes	39.20	22.24	324.07	133.93	207.81
Crustacea	214.29	83.88	123.14	86.55	74.43
Pycnogonida	8.84	40.55	2.34	0.04	0.51
Mollusca	174.75	444.75	93.56	64.79	2.01
Asteroidea	367.51	425.18	1214.65	714.98	864.59
Ophiuroidea	9.97	74.29	3.17	1.53	3.07
Echinoidea	7.18	235.84	58.73	49.13	84.32
Holothuroidea	1355.74	994.38	6737.35	1629.31	2428.91
Total	**2400.10**	**2366.28**	**8648.87**	**2725.02**	**3730.41**

Demersal ichthyofaunal assessment – Nicola King, Oceanlab, University of Aberdeen.

Aims and objectives
The aims and objectives were to assess the demersal ichthyofaunal biodiversity, abundance and biomass at the stations north and south of the sub-polar front which traverses the mid-Atlantic ridge, and to determine any differences in biodiversity, abundance and biomass between the three regions. Demersal fish trawl data will be accumulated over the 3 consecutive ECOMAR cruises resulting in a synthesis paper. Demersal fish specimen identification from trawls will also be used to verify fish imaged within PAL lander still images, and DOBO lander video (See page 119 - 127).

Trawl processing
Fish data were retrieved from 5 OTSB trawls from a total of 7 that were conducted (see station list for further details). Two trawls were conducted at the southeastern station (one failed to retrieve a significant number of fish), 2 trawls at the northwestern station (one trawl was lost completely) and 3 at the northeastern station.

Both demersal and pelagic specimens within the trawl were identified to the lowest taxonomic level possible. Specimens that could not be identified to species level on board have been kept, and white muscle samples have been taken for phylogenetic analyses in some cases. All fish were given an individual number for tracing, and where possible total wet weight, total length, standard length, head length and pre-anal length were recorded.

Further data was specifically taken for the macrouridae (rattails), which were sexed, stomach, gonad and liver weight recorded (when not regurgitated), and the stomach fullness and sexual maturity assessed. Otoliths were also taken from *Coryphaenoides brevibarbis, C. armatus* and *Antimora rostrata.*

Preliminary results
Ten taxonomic groups were sampled at the SE station, 9 at the northwestern station and 16 at the northeastern station (Table 10). The NE station was the most diverse, however this is due to the increased sampling at this site compared to the SE and NW; 3 trawls vs. 1 trawl. A total of 702 fish were caught, totalling approximately 111 kg wet weight.

At the SE station the biomass was dominated by *Halosauropsis macrochir* and Alepocephalids, at the NW station the biomass was heavily dominated by *Antimora rostrata*, and at the NE site the domiant groups in terms of biomass were *Antimora rostrata* and *C. brevibarbis* (Figure 37). *Coryphaenoides brevibarbis* was numerically dominant species at the NW and NE site and the second most dominant in the SE, where *H. macrochir* was the most abundant species (Figure 38).

Analysis
Analysis of the OTSB trawl data will consist of a) statistical determination of differences in biodiversity, biomass and abundance between the southern and northern stations, and sites east and west of the ridge; data will be analysed once further trawling has been conducted on subsequent ECOMAR cruises, b) length-weight relationships of all demersal fish taxa for all regions where sufficient data is available, and the appropriate statistics to determine if there are differences in the length-weight relationships between sites, c) official identification of difficult specimens by taxonomists, and d) stomach content analysis for all species sampled.

Specifically for the macrouridae length frequency analysis will be conducted to determine age classes, and analysis of condition using the liver and gonad weight. Stomach content analyses will also be used to determine the demersal fish diet, and will be used to complement trophic level

studies using stable isotopes carried out by Will Reid at Newcastle University (see following section).

White muscle samples were taken from all specimens of *Coryphaenoides armatus* for a study on the population genetic structure of previous MAR-ECO specimens of the Mid-Atlantic Ridge. For an additional population genetic study, tissue samples were taken from *Antimora rostrata, C. armatus, C. leptolepis, C. brevibarbis*, *Halosauropsis macrochir,* and *Polyacanthonotus challengeri* by Jeff Mashburn on behalf of Dr Rus Hoelzel at the University of Durham (Table 11). Liver, muscle and gonad samples were also taken for specimens of *A. rostrata* and *C. armatus* to determine lipid content changes over the 3 year ECOMAR project duration.

Table 10: Trawl composition summary (non-transformed data). The total trawl swept area (km^{-2}) is provided for each haul. Total number of fish and biomass (kg) per trawl are listed for each species, in each trawl.

Station	**JC011/017 SE**		**JC011/023 SE**		**JC011/075 NW**		**JC011/101 NE**		**JC011/106 NE**	
Distance towed (nm)	**2.30**		**1.89**		**2.75**		**3.49**		**3.44**	
Total swept area (km^{-2})	**0.04** (trawl snagged, cod end torn)		**0.03**		**0.04**		**0.06**		**0.05**	
Total trawl catch	**No. of fish**	**Biomass (kg)**	**No. of fish**	**Biomass (kg)**	**No. of fish**	**Biomass (kg)**	**No. of fish**	**Biomass (kg)**	**No. of fish**	**Biomass (kg)**
Halosauropsis macrochir	1	0.07	24	2.30	4	1.48	5	1.80	5	1.08
Synaphobranchus kaupii			1	0.02			1	0.19	1	0.29
Antimora rostrata			1	0.79	23	23.05	8	5.34	11	9.88
Coryphaenoides armatus			4	1.03	2	1.31	3	0.73	14	4.23
Coryphaenoides leptolepis			1	0.24	2	1.22	1	0.17	1	0.06
Notacanthus bonapartei			1	0.07						
Alepocephalidae			5	2.33	2	2.52	7	> 6.15	1	0.10
Coryphaenoides brevibarbis			13	0.70	45	1.21	98	5.82	95	6.91
Polyacanthonotus challengeri	2	0.15	1	0.12						
Pelagic fishes	6 + scraps	0.09	11 + scraps	1.55	24 + scraps	0.66	44 + scraps	0.81	42 + scraps	0.79
Hariotta sp.					2	0.05				
Juvenile and unidentified macrourids			3	0.03	9	0.10	9	0.15	7	0.15
Bathyraja sp.							1	>3.00		
Unidentified							1	0.02		
Fish eggs							-	0.02		
Bathysaurus ferox									1	0.36
Spectrunculus sp.									1	1.22
Coryphaenoides mediterraneus									1	0.84
Total	**9**	**0.31**	**65**	**9.18**	**113**	**31.6**	**178**	**24.2**	**138**	**25.9**

M6	**JC011/111 NE**	
Distance towed (nm)	**3.44**	
Total swept area (km^{-2})	**0.05**	
Alepocephalidae	4	1.97
Bathysaurus ferox	2	0.96
Histiobranchus bathybius	1	0.53
Coryphaenoides armatus	6	1.30
Coryphaenoides mediterraneus	2	0.59
Unidentifiable macrourids	5	0.08
Antimora rostrata	12	8.60
Halosauropsis macrochir	4	1.15
Coryphaenoides brevibarbis	58	3.19
Pelagic fishes	57 + scraps	1.12
Total	**151**	**19.49**

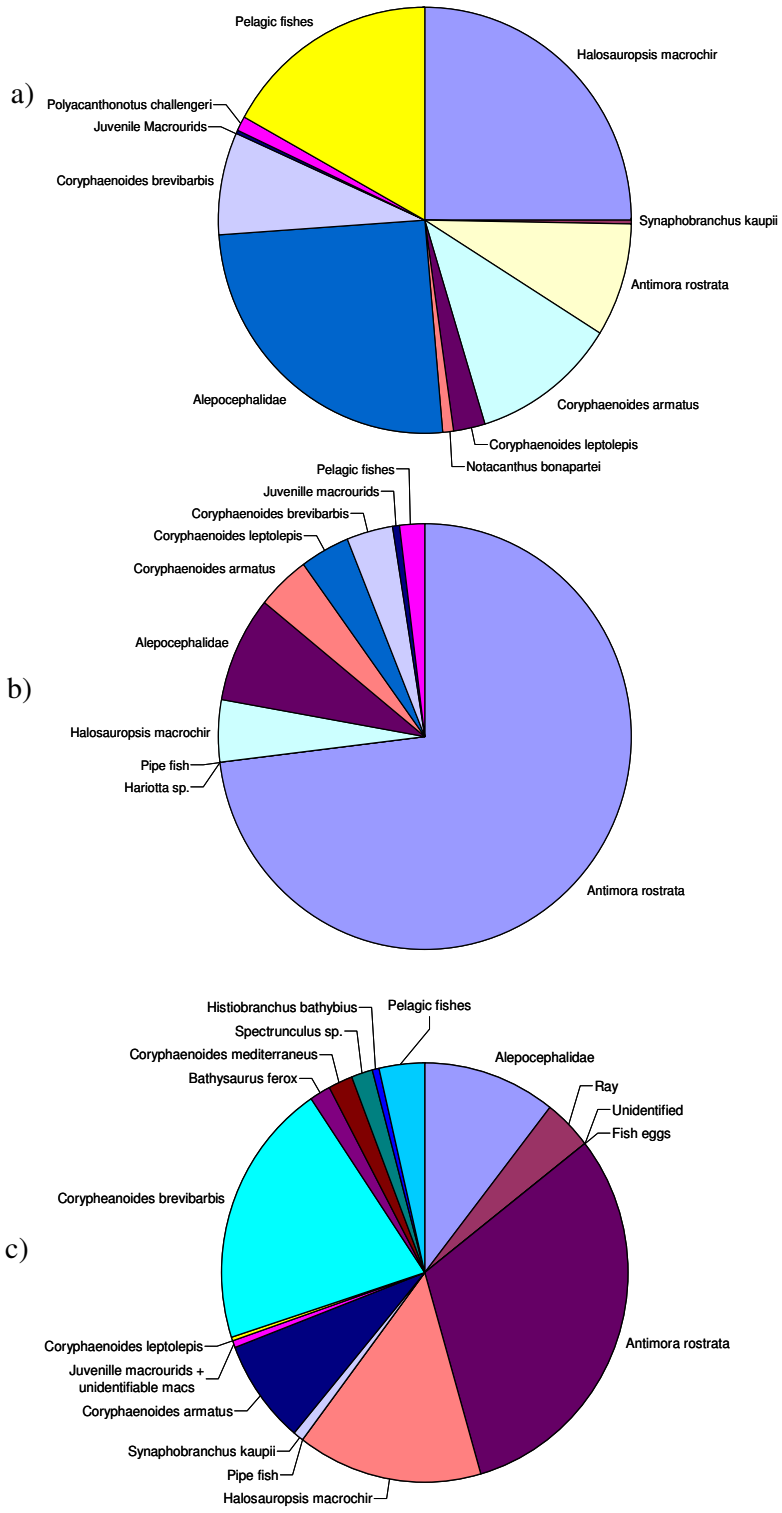

Figure 37: Comparison of demersal fish contributions to mean biomass for the a) southeastern site (n = 1), b) northwestern site (n = 1) and c) northeastern site (n = 3).

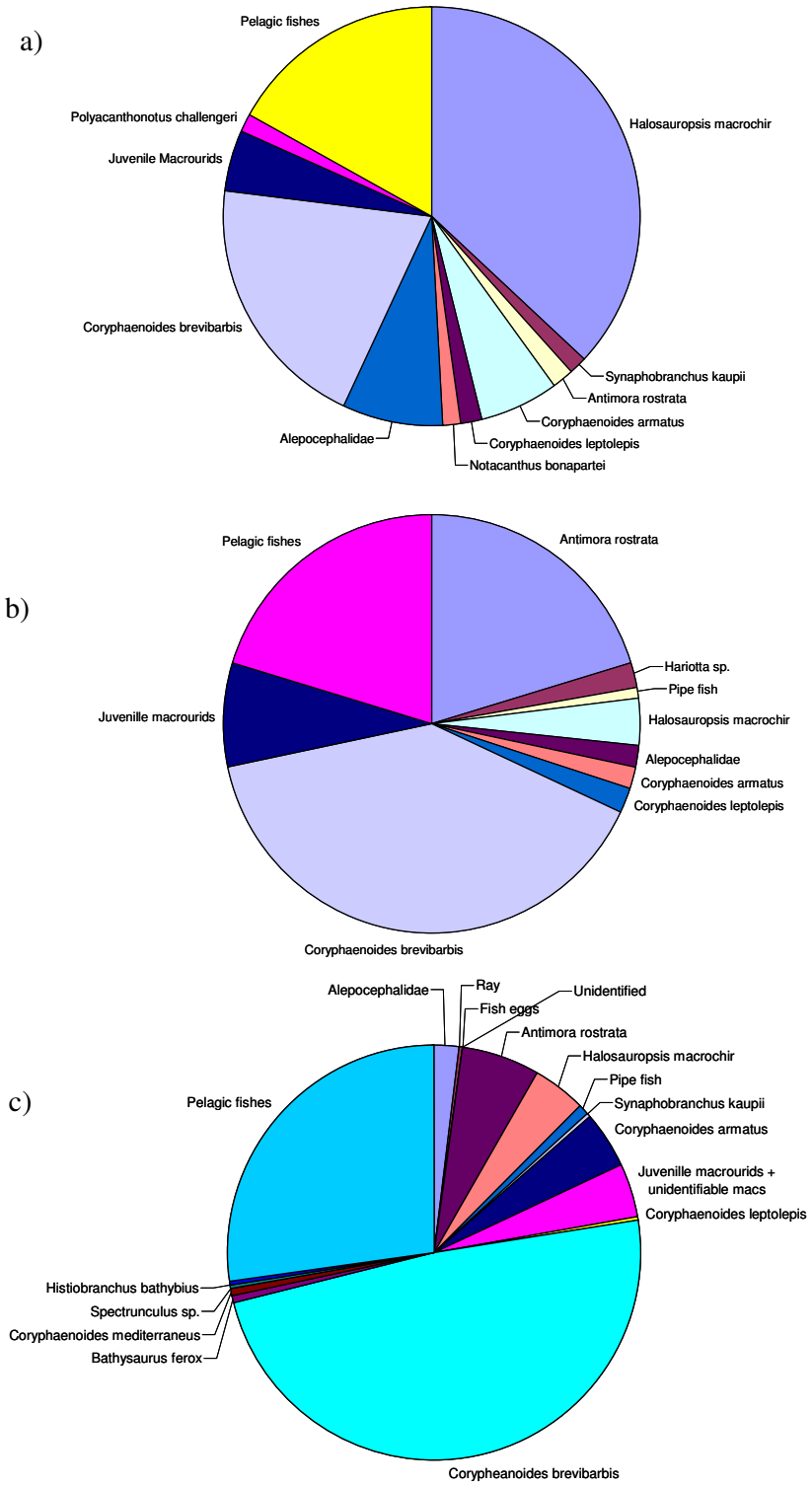

Figure 38: Comparison of demersal fish contributions to mean abundance for the a) southeastern site (n = 1), b) northwestern site (n = 1) and c) northeastern site (n = 3).

Table 11: Number of individuals of benthic taxa collected for phylogenetic and population-genetic analyses. University of Durham, taken by Jeff Mashburn on behalf of Prof. Rus Hoelzel.

FISH	
Antimora rostrata	53
Coryphaenoides armatus	6
Coryphaenoides brevibarbis	219
Coryphaenoides leptolepis	2
Halosauropsis macrochir	42
Polyacanthonotus challengeri	1
HOLOTHURIANS	
Abyssocucumis abyssorum	6
Amperina rosea	6
Benthodytes sp.	5
Deima sp.	2
Gephyrothyria sp.	6
Molpadia musculus	6
Peniagone marecoi	36
Pseudostichapus spp.	9
unidentified 1	2
unidentified 2	2
ASTEROIDS	
Porcellenasteridae	
Hyphalaster sp.	2
Porcellanaster sp.	3
others	4
other asteroids	3
OPHIUROIDS	4
MUNIDAE	4

Food webs and trophic community structure of ocean ridge systems.

William Reid, Andrew Oliphant & Ben Wigham
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Mid-ocean ridge systems are a unique ecosystem in the deep sea, with large expanses of hard substrate, complex topography and oceanography, hydrothermal activity and an absence of terrigenous input of sediment and organic matter. While the hydrothermal vent sites on the Mid-Atlantic Ridge (MAR) have been well studied, little attention has been given to the ecology and biology of "non-vent" sites. Northern sections of the MAR which are believed to be devoid of hydrothermal activity, with sites north and south of Arctic sub-polar front and Charlie Gibb Fracture Zone, were chosen to examine the food web structure of the "non-vent" fauna. These sites differ as a result of their overlaying primary productivity in the surface waters and it is hypothesised that this will affect benthic diversity and biomass. The aims of this work are to compare the food web structure north and south of the sub-polar front in relation to variability in overlying productivity and to assess the potential for chemosynthetic energy sources to be incorporated into "non-vent" ridge organisms. This will be achieved using a triple stable isotope approach of ^{15}N, ^{13}C and ^{34}S.

Samples of sediment, invertebrates and fish tissue were collected from each of the superstations using the megacorer, NOC Amphipod trap and the semi-balloon Otter Trawl (OTSB).

Megacorer samples (Stations 21, 27, 71 and 100).
These were processed in two ways. Firstly, the surface sediment of each core was delicately removed. In the southern stations this included the phytodetritus that appeared on the surface of each core. Secondly, the top 10 mm were sampled. These samples were collected to provide information on what the deposit feeders were actively feeding on and the spatial differences in stable isotope signatures between each site. A total of 60 sediment samples were collected. Two stations were sampled at the southern location because the glass vials broke when they were frozen. Although the samples remained intact, it was felt that a second sample should be taken as back-up.

Mobile megafauna: Amphipod trap (Stations 79, 98 and 114) and OTSB (Stations 17, 23, 75, 101, 106 and 111).
Amphipods were only caught at the northern stations. Samples caught in the OTSB were sorted to lowest taxonomic level and then the most abundant invertebrate and fish species were selected for stable isotope analysis. 2 - 5g of tissue was removed from each specimen when they were large enough and the whole specimen was taken if it was a small individual. In a number of cases multiple specimens were placed in a single glass vial, in order to have sufficient tissue for processing in the laboratory. All samples were frozen and stored at -80^{o}C. A summary of the number of individuals sampled can be seen in the table 12 below. A total of 331 invertebrates and 229 fish samples were collected during the cruise.

Table 12: Summary of samples collected during JC011 by Newcastle University for stable isotope analysis. (A = amphipod trap, M = megacorer, O = semi-balloon otter trawl)

		South				**North west**			**North east**					
Station Number		17	21	23	27	71	75	79	98	100	101	106	111	114
Gear		O	M	O	M	M	O	A	A	M	O	O	O	A
Sediment Sample	Surface layer		2		2	1				1				
	Top 1 cm		2		2	1				1				
Invertebrates														
Cnidaria	Pennatulacea sp			7										
Crustacea	Amphipoda spp							7						
	Amphipoda sp 1								5					
	Amphipoda sp 2													18
	Decapoda Natantia 1	3												
	Decapoda Natantia A	2		8			6				6	5		
	Decapoda Natantia B						7				6	5		
	Galatheidae (Munidopsis sp red morph?)			8										
	Galatheidae sp										2			
	Munidopsis sp						1							
	Polycheles sp			2			6				5	5	5	
	Glyphocrangon sp			7							1	1		
	Ostracoda sp							16						
Chelicerata	Pycnogonida sp						6							
Asteroidea	Brisingidae sp			8			6							
	Hymenaster sp			7							5	5	5	
	Plinthaster sp						5				5	5	4	
	Plutonaster sp			6										
	Ptenodiscus sp						10						5	
	Porcellanasterid A			7										
	Porcellanasterid B			43			10							
	Ophiuroidea sp						9				2	1		
Echinoidea	Echinoidea sp										6	5	5	
Holothuroidea	*Amperima* sp.	2												
	Benthothuria sp			3							3			
	Benthodytes sp			5										
	Pelopatides grisea										5	3		
	Peniagone sp A			4										
	Peniagone longipapillata			4										
	Peniagone marecoi										12	6	5	
Foraminfera	*Rhizaminia algiformis*												1	
Polychaeta	Polynoidae sp			6										
	Polynoidae sp 2										4	3	3	
Mollusca	Octopoda			1			2				1	1		
	Gastropoda sp A			1										
	Gastropoda sp B			1										
Sipuncula											6	5	3	
Fish														
	Alepocephalus bairdii[$]						2							
	Alepocephalus sp[$]										1		3	
	Antimora rostrata			23							8	9	12	
	Bathylagus euryops[$]			3							3			
	Bathysaurus ferox											1	2	
	Coryphaenoides armatus			4			2				3	13	5	
	Coryphaenoides			7			14				23	16	2	

	brevibarbis													
	Coryphaenoides leptolepis						2							
	Coryphaenoides mediterraneous												2	
	Cyclothone sp[$]										12			
	Euryphatynx pelecanoides[$]						2					1		
	Gonostoma bathyphilum[$]			1			1						1	
	Histobranchus bathybarus												1	
	Halosauropsis macrochir			22			4				5	5	4	
	Lampanyctus macdonaldi[$]			1			1					1		
	Melamphaida sp 1[$]	1												
	Melamphaida sp 2[$]	1												
	Polyacanthonotus challengeri	2												
	Poromitra megalops[$]				3									
	Rajidae sp										1			
	Serrivomer beani[$]											2		
	Stomias boa ferox[$]						2					3		
	Synaphobranchus kaupi											2		

[$] = Pelagic species

Megacorer

Alan Hughes, Ben Boorman & Ian Cross
National Oceanography Centre, Southampton (NOCS)

Will Reid & Ben Wigham
Newcastle University

Table 13: Details of megacorer deployments, together with information on the use of the cores. Cores for Foraminiferal analyses were sectioned to 0.0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2.0-3.0, 3.0-4.0 and 4.0-5.0 cm sediment depth, and fixed in 10% buffered Formalin. Macrofaunal cores were sectioned to 0-5 and 5-10 cm sections, sieved on a 250 μm mesh, and fixed in 10% buffered formalin. Cores which were frozen, were sectioned in 0.0-1.0, 1.0-2.0, 2.0-3.0, 3.0-4.0 and 4.0-5.0 cm sediment depth, and stored at -80 ºC. UN = University of Newcastle.

Station No.	Date	Latitude	Longitude	Depth (m)	Remarks
21	22 Jul	49°05.40'N	27°50.22'W	2734	5/6 cores. 1x Foraminifera, 2 x UN, 1 x live sorting,
27	23 Jul	49°05.42'N	27°50.24'W	2763	6/6 cores. 1 x Foraminifera, 2 x frozen, 3 x UN
32	25 Jul	49°05.42'N	28°50.24'W	2773	6/6 cores. 1 x good core for Foraminifera, 5 x disturbed cores sieved for macrofauna
71	4 Aug	54°01.00'N	36°13.3'W	2566	2/6 cores. 1 x frozen, 1 x UN.
78	5 Aug	54°01.00'N	36°08.36'W	2566	1/6 cores. 1 x Foraminifera
84	7 Aug	54°01.00'N	36°08.40'W	2570	5/8 cores. 2 x Foraminifera, 1 x frozen, 1 x UN, 1 x live sorting.
100	9 Aug	54°00.65'N	34°10.42'W	2500	8/8 good cores. 2 x Foraminifera, 1 x Frozen, 1 x UN, 4 x macrofauna
109	11 Aug	54°00.65'N	34°10.42'W	2495	8/8 good cores. 1 x Foraminifera, 1 x frozen, 6 x macrofauna.
116	12 Aug	54°00.65'N	34°10.42'W	2495	7/8 good cores. 2 x Foraminifera, 1 x live sorting, 1 x frozen, 3 x macrofauna.

The megacorer was deployed three times at each station. At the southern station (JC011/21, 27 and 32), the corer was deployed with six coring units attached, and the first two deployments at this site returned deep cores (32 to 48 cm) containing homogeneous light brown mud containing occasional pteropod shells (Figure 39). All cores contained phytodetritus in varying amounts, from a few millimeters to 2 cm thick (Figure 40). The third deployment at this site returned five shallow, slightly disturbed cores, together with one undisturbed core.

Coring at the Northwest station (JC011/71, 78 and 84) was less successful. The first deployment returned four out of six cores, with two of the coring units failing to trigger. The surficial sediments in these four cores was a light brown mud 10-15 cm deep. Beneath this lay a darker band, of variable depth, but generally about 5 cm thick, below which lay soft, grey mud (Figure 39). The sediments at this site were extremely soft, and no phytodetritus was apparent on the surface of the cores. From the first deployment, two of the four good cores returned were lost on deck. The remaining two cores were slightly disturbed in constant environment laboratory while transferring them to the extruders. In the second deployment at this station, five of the six coring units failed to trigger, although one good core was returned (39 cm deep), similar to those obtained on the first deployment. On the third deployment (JC011/84), the number of coring units was increased to eight, and five cores were returned, similar to those from the first deployment. Three core units

failed to trigger on this deployment. The reason why such a large number of the core units failed to trigger at this station is unclear. All the coring units appeared to work well on deck, and the failures may reflect the unusually soft sediment at this station, which may not have offered adequate resistance to trigger them.

Eight core units were used on the corer for all deployments at the Northeast station (JC011/100, 108 and 116). The first deployment recovered a full set of undisturbed cores, 22-35 cm deep. These appeared similar to those returned at the northwest station, with a light brown surface layer approximately 10 cm deep, darker brown layer generally 4-7 cm deep below this, and light grey mud deeper in the core (Figure 39). The sediments at this station seemed slightly coarser than that at the Northwest station, however, which may have been why the success rate of the corer was higher. The second and third deployments at this station were also very successful, and returned an excellent set of samples.

Cores from each of the sites were processed for a variety of analyses. For the examination of benthic Foraminifera, cores were sectioned to 5 cm sediment depth, and fixed in buffered 10% Formalin. On return to the laboratory, these samples will be wet-sorted for benthic foraminifera, including soft shelled and agglutinated taxa, as well as metazoan meiofauna. Cores were also sectioned and frozen, for particle size and various geological analyses. Where "excess" cores were obtained, these were sieved using a 250 μm mesh for benthic macrofauna; although these samples are too small to provide quantitative macrofaunal samples, they may provide material for taxonomic studies. Newcastle University sampled cores from four stations, which covered the three superstations (see Food webs and trophic community structure for more details).

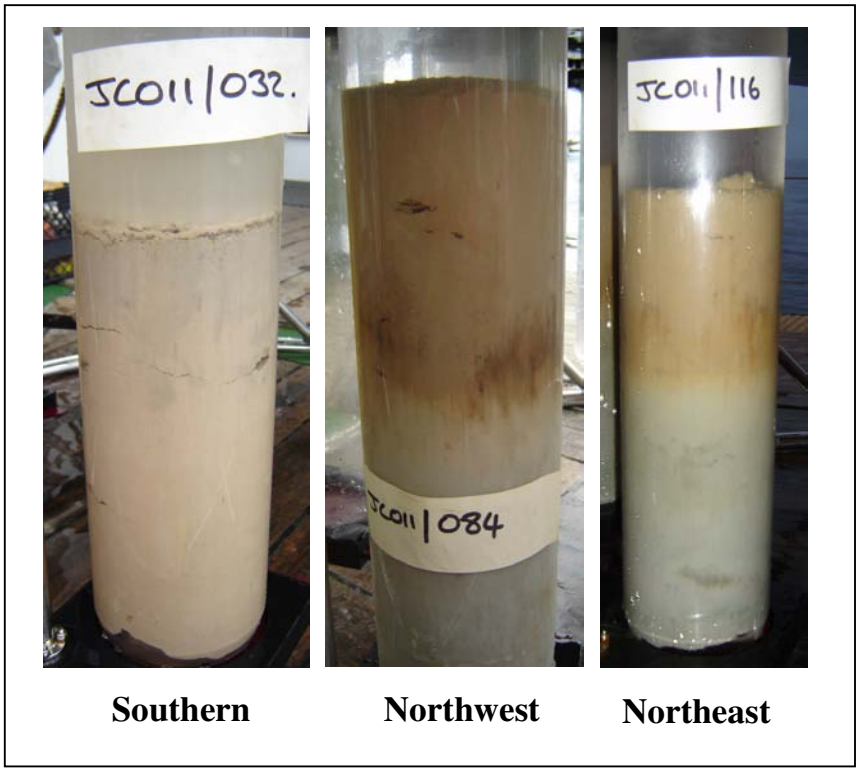

Figure 39: Representative photographs of cores from each of the three stations sampled. The internal diameter of the core tubes is 100 mm.

Figure 40: Detail of a core from the Southern station, showing a thick layer of phytodetritus on the surface of the core.

Amphipod Trap

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The Amphipod Trap was deployed on four occasions, one time each at the southern (JC011/13) and NW (JC011/79) stations, and twice at the NE station (JC011/98 and 114). Unusually, no amphipods at all were recovered from the deployment at the southern station. The deployment at the NW station (JC011/79) was notable for the presence of a large specimen of *Eurythenes gryllus*, as well as large numbers of a large, apparently undescribed ostracod, together with large numbers of smaller amphipods. The two deployments at the NE station (JC011/98 and JC011/114) both returned large catches (several hundred individuals) of small amphipods. In all deployments at the northern stations, the vast majority of individuals were in the bottom, "square" trap, with only a handful (<10 individuals) in the top, cylindrical trap.

The amphipod material will be returned to NOCS (*Discovery Collections*) for further examination by Tammy Horton. Amphipods and ostracods were also collected for isotopic analysis by William Reid and Ben Wigham (Newcastle University) for food web analysis (see Food webs and trophic community structure section for more details).

Table 14: Details of the stations where the Amphipod Trap was deployed. *Dates are for deployment and recovery.

Station No.	Date*	Latitude	Longitude	Depth (m)	Remarks
13	19 Jul 20 Jul	49°01.16'N	27°42.29'W	2627	Nothing captured.
79	5 Aug 7 Aug	53°56.44'N	36°11.56'W	2564	A large catch, including a large *Eurythenes gryllus.*
98	9 Aug 11 Aug	54°04.08'N	34°09.43'W	2500	Large catch of small amphipods
114	12 Aug 13 Aug	54°02.31'N	34°09.60'W	2453	Large catch of small amphipods.

Figure 41: The large specimen of Eurythenes gryllus caught in deployment JC011/79. (Photograph ©David Shale).

Figure 42: The apparently undescribed ostracod found in high numbers in both the OTSB trawl and amphipod trap at the Northwest station. One specimen was also recovered in the amphipod trap at the Northeast station.

Bathysnap

Ben Boorman
National Oceanography Centre Southampton (NOCS)

Table 15: Bathysnap deployment details.

Station No.	Date	Latitude	Longitude	Depth (m)
72	4 Aug	53°57.87'N	36°11.49'W	2536

The bathysnap time lapse camera was deployed at the Northeast station. This was set to take a photograph of the seafloor every 8 hours, and will be recovered in summer 2008.

Baited lander and SIT camera studies

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Ichthyofaunal assessment using the Photographic and Acoustic Lander (PAL) at southern and northern stations on the Mid-Atlantic Ridge (MAR).

Technology

The Photographic and Acoustic Lander (PAL) is a free-fall lander equipped with a digital stills camera (Kongsberg Maritime, OE14-208), flash unit (Kongsberg Maritime, OE11-242), RDI Teledyne 300 kHz Sentinel ADCP (property of SAMS), conductivity, temperature and depth unit (Seabird, SBE 37; property of SAMS), rechargeable Lithium battery pack, custom built digital recording device and hydrophone, and twin acoustic ballast release system (MORS AR and RT). The ADCP was programmed to measure current velocity, temperature and depth at 5 second intervals at 2 m depth bins, up to 50 m above the ADCP head, except for during the first deployment when the measurement interval was 1 s. The CTD unit measured conductivity, temperature and depth at 5 s intervals. The camera was programmed to take digital photographs at 60 s intervals, with an average of 1800 photos per deployment.

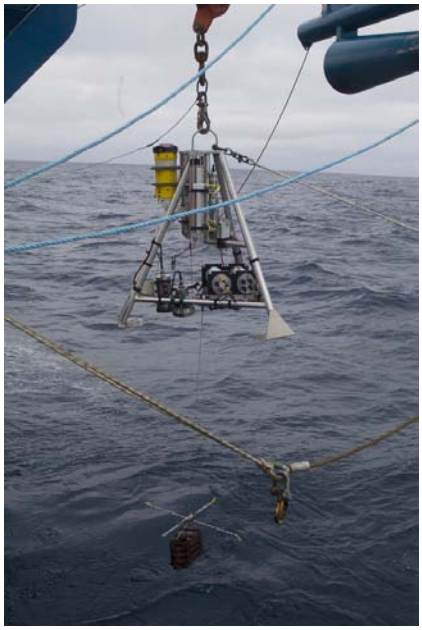

Figure 42: Photographic and Acoustic Lander (PAL) being deployed. Photo courtesy of David Shale.

Deployments

The PAL lander was deployed at 6 stations. Capturing 10,892 images, at depths ranging from 2487 - 2570 m UC (Table 16), and 144 hours of digital hydrophone recordings of the scavengers attending the bait.

Table 16: PAL deployment positions.

Dep.	Station	Latitude (N)	Longitude (W)	Depth (m) UC	Date	Time camera on (GMT) (hh:mm)	Number of images
1	JC011/017	49° 02.016'	27° 42.155'	2513	19/07/07	20:19	1694
2	JC011/022	49° 01.995'	27° 42.113'	2513	22/07/07	11:41	1738
3	JC011/073	53° 56.85'	36° 11.59'	2570	04/08/07	15:54	1763
4	JC011/083	53° 56.861'	36° 11.471'	2567	06/08/07	20:28	1217
5	JC011/097	54° 05.261’	34° 09.239'	2496	09/08/07	12:40	3028
6	JC011/115	54° 03.368'	34° 09.465'	2487	12/08/07	17:37	1452

Preliminary result

Dominant species attending the bait, in the southern stations are the blue hake, *Antimora rostrata* (Günther, 1878), the pudgy cusk eel, *Spectrunculus grandis* (Günther, 1877), and the abyssal grenadier, *Coryphaenoides armatus* (Hector, 1875), with intermittent visitation by deepwater rays (*Bathyraja* sp.?), the deepwater arrowtooth eel, *Histiobranchus bathybius* (Günther, 1877), Kaup’s arrowtooth eel, *Synaphobranchus kaupii* Johnson, 1862, shortnosed rabbitfish, *Hydrolagus affinis*? (de Brito Capello, 1868), the deep-sea spiny eel, *Halosauropsis macrochir* (Günther, 1878), and several species of macrourid. In the northern stations the blue hake and the abyssal grenadier were the most prevalent scavenging species observed, with several other species; the pudgy cusk eel, the deepwater arrowtooth eel, the deep-sea spiny eel, the highfin lizardfish, *Bathysaurus mollis* Günther, 1878, the shortnosed rabbitfish and several species of macrourid.

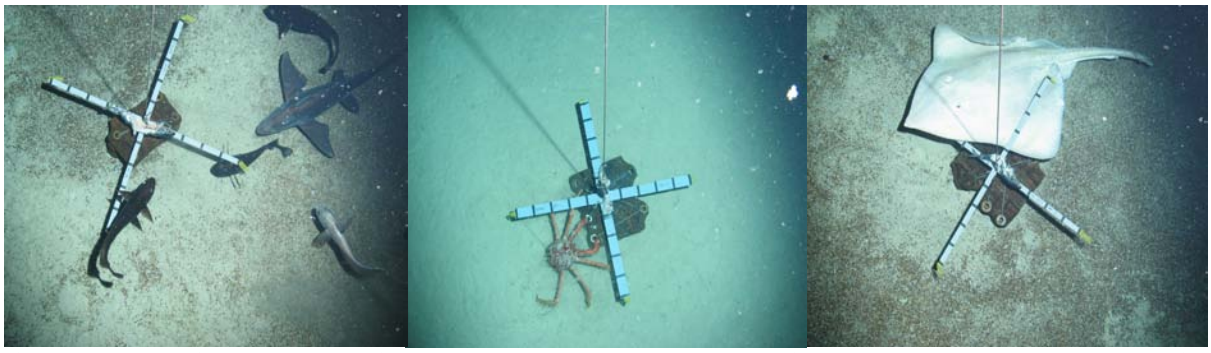

Figure 43: Images from the PAL lander. (a) Blue Hake, *Antimora rostrata*, chimaera, *Hydrolagus affinis*, and a species of macrourid, JC011/017, deployment 1 (b) *Neolithodes* sp., JC011/083, deployment 4, (c) *Bathyraja* sp.?, JC011/022, deployment 2.

Invertebrates observed at the bait were decapod shrimps, lophonenteropneusta, ophiuroidea, scyphozoa, and amphipoda. Amphipods were not present in significant numbers during both southern deployments, however were present in high numbers during all four northern deployments. Large specimens of *Eurythenes gryllus* were photographed during deployments 3, 4 and 5 at the northwest site. Several lophonenteropneusts were observed during deployment 2 in the south. Pycnogonida were observed during both deployment 3 and 4, and a stone crab (*Neolithodes* p.) was recorded at the bait during deployment 4 (Figure 43 b).

Abundant aggregations of marine snow were present in the northern deployments but were not visible at the southern station. In the south the sediment was littered with pteropod shells, where as in the north the substrate was soft and uniform in colour.

Analysis:
Analysis of the PAL data will consist of a) image analysis; simple time series counts, length frequency determination, bait visitation by individuals, local abundance estimation calculation for the numerically dominant species, confirmation of species identification, behavioural observations, and b) collation and interpretation of ADCP data in relation to the scavenging fauna observed. The hydrophone recordings from the PAL deployments will be analysed using acoustic interpretation software.

Benthic bioluminescence and pelagic bioluminescence profiles on the MAR.
Background
In the marine environment, a large number of organisms have the capacity to emit visible light, bioluminescence. The Oceanlab ISIT (Intensified Silicon Intensifier Target) camera is designed to record deep-sea bioluminescence. The ISIT lander has been previously employed within the NE Atlantic to record benthic bioluminescence at artificial food falls, where the number of bioluminescent events was found to decrease with depth. Patches of elevated levels of bioluminescence were later credited to the presence of the ostracod *Vargula norvegica*.

The ISIT camera has also been used in free fall mode to conduct profiles of stimulated bioluminescence in the water column as a proxy for estimating biomass. A previous study, employing the ISIT profiler technique, conducted along the Mid-Atlantic Ridge, in 2004, observed a trend of decreasing stimuable bioluminescence through the water column with depth. In addition, enhanced abundance of bioluminescence was recorded within an anti-cyclonic eddy in the Sub-Polar Frontal Zone, and over the Faraday Seamount.

Technology
The ISIT camera records in monochrome on a 60-minute mini DV tape. On this cruise the ISIT camera was utilised in two modes; the Benthic-ISIT lander and the Pelagic-ISIT profiler.

Benthic – ISIT lander
The camera was mounted on the ISIT lander, orientated downward over a bar baited with mackerel (*Scomber scombrus*, 500g) with a fabric current indicator in view (Figure 44). The camera was programmed to film for 2 min 30 s followed by 15s with the scene illuminated separated by 5 min intervals, resulting in 60 min of footage. The whole sequence lasted for 155 min on the seafloor.

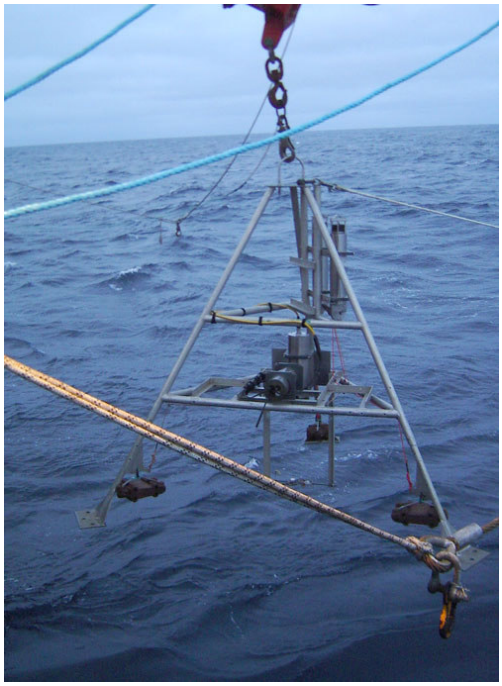

Figure 44: Intensified Silicon Intensifier Target (ISIT) Lander.

Pelagic - ISIT profiler

The camera was mounted on the vane of the CTD rosette, downward, facing over an impact mesh 50 cm from the camera faceplate (Figure 45). The camera was programmed to record constantly for 1 h during the CTD descent (approx. 300m – 3600m). On descent through the water column the mesh screen stimulates bioluminescent events by impacting organisms. The CTD was lowered at a rate of 1 ms^{-1}.

Figure 45: ISIT/SIT camera mounted in profile on the CTD.

Objectives:
In the benthic deployments we aimed to detect non-stimulated bioluminescent activity using the ISIT lander and mackerel bait. This is the first study of benthic bioluminescence in this region.

Using the ISIT profiler we measured the abundance of bioluminescent fauna through the water column in a south to north transect crossing through the Sub-Polar Front.

Deployments
Benthic
The ISIT lander was successfully deployed 3 times south of the CGFZ at 2450 m (JC011/012), at 1701 m (JC011/026) and on the summit of a seamount at 796 m (JC011/19) (Table 17). At station JC011/026 an amphipod trap was also attached within the field of view of the camera.

Table 17: ISIT lander deployment summary table.

Deployment	Station	Latitude (N)	Longitude (W)	Date	Depth	Program start time (GMT)
1	012	49˚ 01.488’	27˚ 43.590’	19/07/07	2450m	22:40:32
2	019	48˚ 27.626’	28˚ 09.981’	21/07/07	796m	21:19:08
3	026	49˚ 02.211’	27˚ 55.602’	23/07/07	1701m	17:05:50

Pelagic
The ISIT camera was deployed at station JC011/045 in the ISIT profiler mode. This was subsequently replaced by a Silicon Intensified Camera (SIT) due to failure of the ISIT housing. The SIT vertical profiler was deployed at a further 16 stations (JC011/052-060, 062-066,070,071) to maximum depths of ca. 3600 m (Table 18). Recording failed at stations JC011/055,057,062,064 due to issues with moisture levels within the housing.

Preliminary results
ISIT lander
On the seamount (JC011/019) 42 benthic bioluminescent events, of various types were recorded. These include streaks, swirls and diffuse glowing events of varying size and duration. During the periods of illuminated recording observations of fish included *Coryphaenoides* sp., *Synaphobranchus kaupii* and *Lepidion eques*. Fewer benthic bioluminescent events were recorded at the two deeper sites: 2 bioluminescent events at JC011/012 and 1 bioluminescent event at JC011/026. Fish observed at JC011/012 include *Spectrunculus grandis* and *Antimora rostrata*, while at JC011/026 amphipods and an eel were observed. Amphipods and ostracods were collected in the amphipod trap attached to the lander at JC011/026.

ISIT profiler
In a preliminary analysis, bioluminescent events were depth integrated into approx. 30 m segments for station JC011/052. These results indicate a peak in the abundance of bioluminescent events at ca. 400 m, followed by a decrease with depth (Figure 46). Patches of increased abundances of bioluminescent sources are also present between ca. 1800 m and 2300 m.

Table 18: ISIT/SIT profiler deployments. No data indicates where the camera did not record due to humidity issues.

Deployment (camera used)	Station	Latitude (N)	Longitude (W)	Date	CTD max Depth (m)	Program start time (GMT)
4 (ISIT)	045	49˚ 39.220’	30˚ 28.220’	28/07/07	3628	15:17:06
5 (SIT)	052	50˚ 58.360’	32˚ 01.596’	29/07/07	3715	21:53:45
6 (SIT)	053	51˚ 13.032’	32˚ 19.734’	30/07/07	2954	03:39:13
7 (SIT)	054	51˚ 25.212’	32˚ 35.016’	30/07/07	3119	08:01:30
8 (SIT)	055	51˚ 39.773’	32˚ 53.544’	30/07/07	3726	13:11:22 (no data)
9 (SIT)	056	51˚ 51.876’	33˚ 09.150’	30/07/07	3519	18:29:30
10 (SIT)	057	52˚ 06.329’	33˚ 28.076’	30/07/07	3625	23:14:36 (no data)
11 (SIT)	058	52˚ 18.334’	35˚ 44.016’	31/07/07	3906	04:17:10
12 (SIT)	059	52˚ 30.294’	34˚ 00.108’	31/07/07	3062	09:13:41
13 (SIT)	060	52˚ 44.587’	34˚ 19.633’	31/07/07	3711	14:13:40
14 (SIT)	062	52˚ 56.451’	34˚ 36.065’	31/07/07	2252	23:02:03 (no data)
15 (SIT)	063	53˚ 10.631’	34˚ 56.016’	01/08/07	2826	03:08:19
16 (SIT)	064	53˚ 24.637’	35˚ 16.230’	01/08/07	2564	07:36:34 (no data)
17 (SIT)	065	53˚ 36.459’	35˚ 33.204’	01/08/07	1894	12:34:12
18 (SIT)	066	53˚ 48.120’	35˚ 50.370’	01/08/07	1670	16:23:41
19 (SIT)	070	54˚ 09.062’	36˚ 21.803’	04/08/07	2004	03:34:16
20 (SIT)	071	53˚ 59.745’	36˚ 07.676’	04/08/07	2569	07:25:10

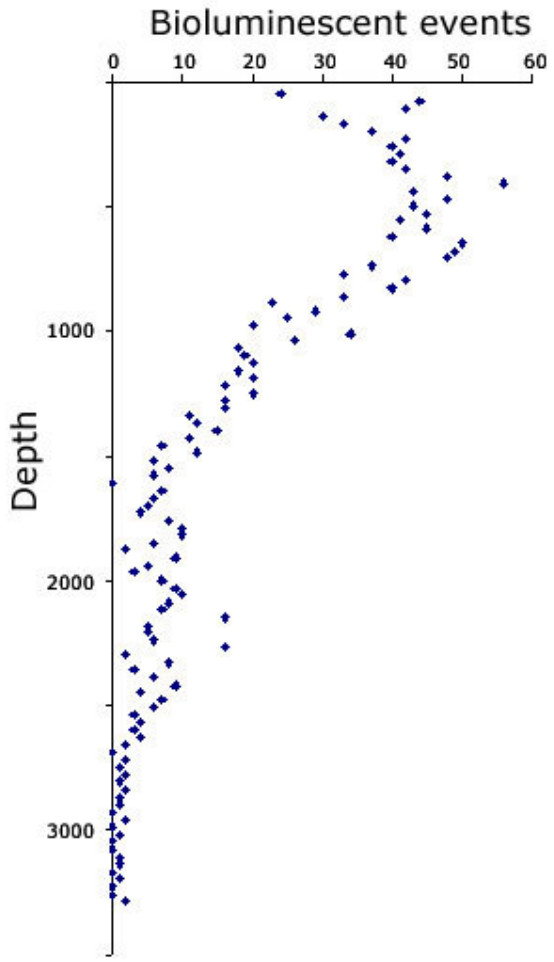

Figure 46: Profile of number of stimuable bioluminescent events at JC011/052.

Analysis
Analysis of ISIT profiles will consist of image analysis; time series counts of bioluminescent events and shape and size classification of events. Results from the bioluminescence profiles will be analysed in conjunction with the concurrent CTD and echo-sounder data (EK60).

Future work
Further lander deployments are plannedat the northern stations during the 2008 ECOMAR cruise, including complementary amphipod trap deployments.

Periodic bait release in the Charlie-Gibbs fracture zone: Deep Ocean Benthic Observatory (DOBO)
Technology
The Deep Ocean Benthic Observer (DOBO) is an autonomous lander vehicle designed to undergo long duration experiments at depth. Its titanium frame bears 2 deep-sea power and light batteries, a controller unit, a custom built digital camera which records compressed moving JPEG video directly to a removable hard disk, and two LED flash units slaved to the camera, illuminating the periodic bait release unit at the base of the lander (Figure 47). An upward looking 300KHz acoustic Doppler current profiler (ADCP) (Workhorse Sentinel WHS300-I-SP4, RD Instruments, USA) is mounted at the top of the lander (2.33 m above ground) and records current velocity and direction in successive 3 m depth cells in the water column over 50 pings per 30 min period.

Figure 47: DOBO camera (a), controller (b), ADCP (c), acoustic releases (d) and LED light (e).

The lander freefalls to the seafloor with the weight of two 60 kg steel ballast bars yoked to the lander with twin acoustic releases (AR 661 B2S-DDL and RT 661 B2S-DDL, Oceano France). Ballast is released by acoustic signal from the ship and the lander surfaces by virtue of positive buoyancy. Sixteen syntactic floats (TS2-6000, CRP Group, UK) on the frame, and four on the mooring line return the lander to the surface. The DOBO mooring is equipped with a VHF radio beacon (RF-700A1, Novatech, Canada) and strobe (ST400-A, Novatech, Canada), both activated upon surfacing, and an orange flag to aid with location and recovery.


Figure 48: DOBO lander being deployed.

The DOBO periodic bait release unit consists of one open mackerel and eight mackerel carcasses sealed in individual plastic tubes. Bait tubes are tethered to an autosampler mechanism programmed to release at 30-day intervals. This results in an identical bait presentation of one mackerel carcass every thirty days. The camera can record up to 20 h of footage; 2 hours allocated to each mackerel bait, with increasing intervals between recording sequences as the time from bait release increases. The DOBO lander will be recovered during the ECOMAR RRS Discovery cruise in 2008, and will be turned over and redeployed.

Figure 49: Mackerel bait in position before the bait release tubes were filled with seawater and cocked.

Deployment

The DOBO lander was deployed at 52° 41.346' N, 35° 04.166' W in the Charlie-Gibbs Fracture Zone on 31/07/07, to a depth of 3690 m.

Analysis

Analysis of the DOBO data post-recovery in 2008 will consist of a) image analysis; simple time series counts, length frequency determination, bait visitation by individuals, abundance estimate calculation, confirmation of species identification, behavioural observations, and b) collation and interpretation of ADCP data.

Physical measurements from the PAL lander

Andrew Dale
Scottish Association of Marine Science

Instrumentation
An upward-looking RDI Workhorse Sentinel 300 khz ADCP (SN 6358) was mounted towards the top of the PAL lander frame (Figure 50) such that the transducer heads were 1.6 m above the base of the frame (and around 4 m above the bed when deployed). A Seabird SBE37 CTD (SN 4607) was also attached to the side of the lander frame such that its pumped intake was 1.03 m above the base of the frame (around 3.4 m above the bed when deployed).

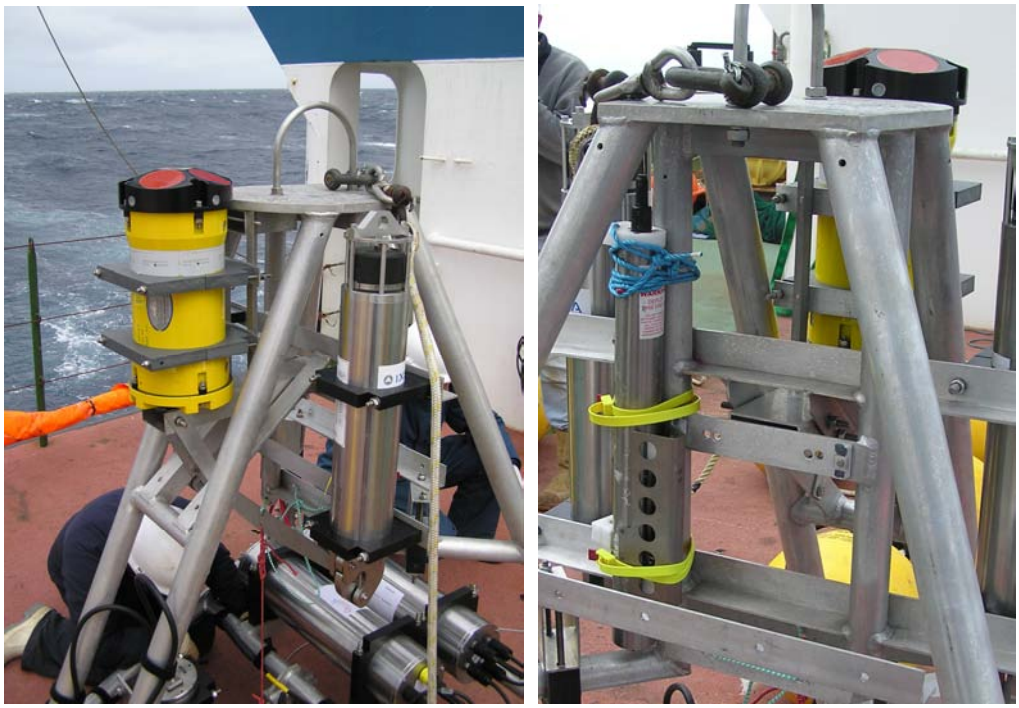

Figure 50: ADCP and CTD unit on the PALander.

For the first deployment, the ADCP logged an ensemble every second with one ping per ensemble. This record was found to be rather noisy and slow to upload, so subsequent deployments used a 5 second ensemble (9 pings). Vertical bin length was 2 m, with the first bin centred 4.23 m above the transducer (around 8.2 m off the bed). The CTD logged at 5 second intervals for all deployments (this being the most rapid available with the SBE37).

The ADCP did not return reliable velocity measurements above around bin 25 (55 m above the bed) due to weak echo return. During lander descents and ascents the range was greater, so the poor performance appears to have been due to unfavorable conditions in the lower water column.

It was also noted that the temperature sensor on the ADCP was unreliable, showing variability with a range of order 0.1 C at times when the CTD did not show such variability. ADCP temperatures typically rose when currents were weak. It is possible that heat generated when the instrument is in operation is more rapidly dissipated when currents are strong.

Summary of observations
The PAL lander was deployed a total of six times, twice each at the SE, NW and NE superstations respectively. The SE location was a saddle point on the flanks of a seamount, the NW site was a

gently slope between two flat basins, and the NE site was a flat, north-south-oriented sedimentary basin.

Temperature records reveal topographic influences, with the SE site showing a temperature range of 0.1 C (Figure 51), an order of magnitude greater than that observed at the other sites. During the first deployment at the SE site, two rapid decreases in temperature were recorded, one soon after the lander reached the bed and the second a tidal cycle later. These temperature changes were accompanied by a change in current direction and strength (from a flow to the E to a stronger flow to the SW) and appear to have been caused by a nonlinear, bore-like internal tide.

A tidal signal is apparent in the currents at each location, with the strongest (to ~10 cm/s) during the final deployment (Figure 52), at the NE site, which occurred during spring tides. The weakest currents (less than 5 cm/s) were encountered during the fourth deployment, at the NW site, during neap tides.

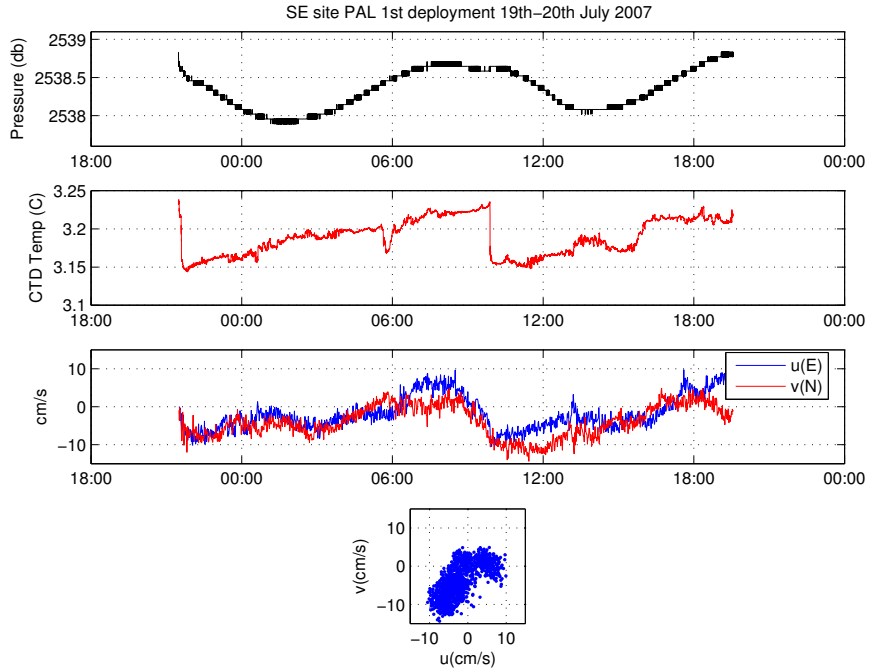

Figure 51: Time series of CTD pressure, CTD temperature, and ADCP velocity at 8 m above the bed during the 1st PAL deployment, 19th-20th July 2007. The lower panel is a scatter plot of velocities averaged over one-minute intervals, showing two dominant flow directions – to the E and to the SW..

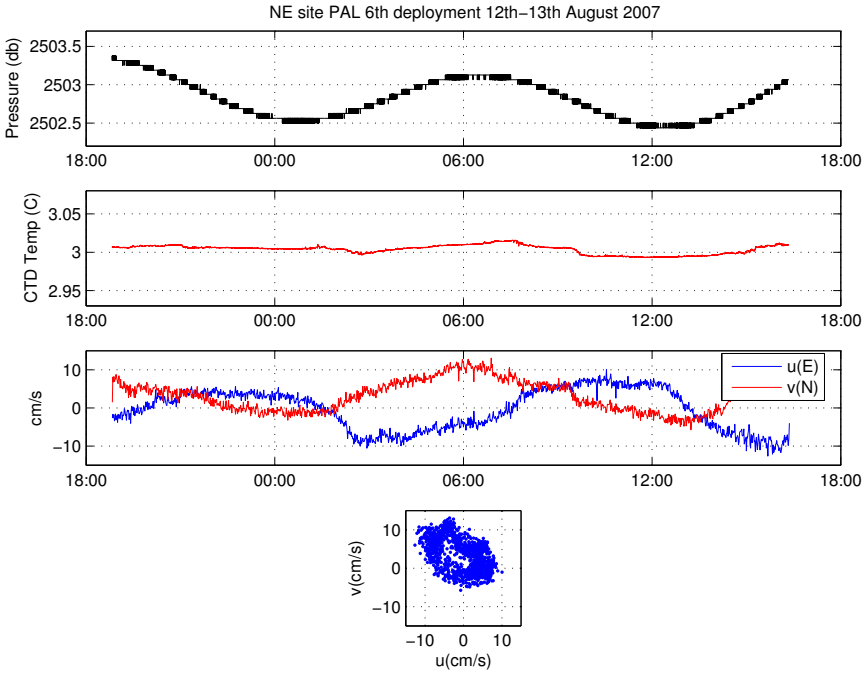

Figure 52: Time series of CTD pressure, CTD temperature, and ADCP velocity at 8 m above the bed during the 6th PAL deployment, 12th-13th August 2007. The lower panel is a scatter plot of velocities averaged over one-minute intervals, showing a tidal ellipse and apparent small mean flow to the NW.

Seabird & Cetacean Cruise Report – JC11

Mick Mackey
University College Cork

Introduction

As part of the Trans North Atlantic Sightings Survey (TNASS), I was employed by the North Atlantic Marine Mammal Commission (NAMMCO) to conduct standard line transect surveys of the cetacean (i.e. whales, dolphins and porpoises) populations that inhabit the offshore waters of the Mid Atlantic Ridge (MAR). This involved visual surveys conducted from the deck forward of the bridge and passive acoustic surveys of cetacean vocalisations using a hydrophone array deployed from the ship's stern. I was also employed by the University of Aberdeen to conduct opportunistic surveys of offshore seabird populations to assess abundance, distribution, feeding behaviour and plumage variations.

Overview

Visual and acoustic surveys were conducted between July 16th and August 16th 2007. Standard line transect surveys of seabird and cetacean populations can only be conducted when the ship is in transit. Due to a combination of ship downtime, on-station activities and poor weather conditions, line transit surveys could only be conducted during 25 of the 32 days available survey days. Acoustic surveys were conducted when the ship was steaming to and from the MAR study area. In addition, opportunistic acoustic surveys were conducted while over the MAR. However, opportunities were limited due to short transit distances between most station locations. When the ship was on station, observations of the Northern Fulmar (*Fulmarus glacialis*) were conducted to assess spatial variations in numbers. These stationary counts were conducted 26 separate occasions.

Results

Cetaceans: Visual Sightings

Seven species of cetaceans were identified during the course of the study. The included the Common Dolphin (*Delphinus delphis*), Striped Dolphin (*Stenella coeruleoalba*), Atlantic White-sided Dolphin (*Lagenorhynchus acutus*), Long-finned Pilot Whale (*Globicephala melas*), Northern Bottlenose Whale (*Hyperooden ampullatus*), Sowerby's Beaked Whale (*Mesoplodon bidens*) and Sperm Whale (*Physeter macrocephalus*). In addition, a number of sightings involved unidentified categories including unidentified dolphins, baleen whales and beaked whales.

The most numerous and frequently encountered species was the Common Dolphin (Figure 53) with 270 animals being observed during 27 encounters (average group size = 10 animals). The vast majority of the Common Dolphin observations were recorded during the first day as the ship steamed west over the Porcupine Seabight.


Figure 53: A pair of Common Dolphins approach the R.R.S. James Cook.

The second most numerous and frequently encountered species was the Long-finned Pilot Whale, which was observed on 12 separate occasions totaling approximately 200 animals (average group size ≈ 18 animals). Nine sightings were recorded at the southwest station and involved adult females, immature and juvenile pilot whales in tight clusters (Figure 54) – no large male animals were observed at the southwest station. The largest group of Pilot Whales, involving 60 – 70 animals, was observed at the northwest station. The group was spread over a large area heading purposely in a northwest direction and included large males. Seventeen Sperm Whales were observed during 9 encounters, with group sizes varying between one and five animals. The largest group was observed over the Porcupine Seabight.


Figure 54: A tightly bunched group of adult female, immature and juvenile Long-finned Pilot Whales.

The most significant sighting of the five-week study was the observation of 5 adult Sowerby's Beaked Whales in perfect sea conditions. The identification of this rarely sighted species was confirmed from a series of photographs (Figure 55). Another interesting record involved a single

Northern Bottlenose Whale observed as the ship steamed over the southwestern station. The three encounters of Striped Dolphins were limited to the outgoing transit to the southwestern station, while the largest of the three Atlantic White-sided Dolphin encounters involved a group of 50 – 60 animals milling about in the vicinity of the northwestern station.

Figure 55: A group of rarely sighted Sowerby's Beaked Whales observed during the outward transit.

Cetaceans: Acoustic Recordings

The hydrophone and its associated hardware and software was used to record high and medium frequency vocalizations of porpoises, dolphins and toothed whale species (e.g. Sperm Whale, Long-finned Pilot Whale). The hydrophone is not sensitive below 2kHz and is therefore unsuitable for the detection of any baleen whale species. The 200m hydrophone was deployed during transit periods that exceeded 1½ hours. This included the outgoing and incoming transits, which totaled five to six days of recordings. While over the MAR, the hydrophone was deployed a further 5 times and resulted in approximately ten hours of recordings. The recordings will be analysed by researchers at the Sea Mammal Research Unit in St Andrews.

Seabirds

Sixteen species of seabird have been observed during the five-week study period. The most numerous and frequently encountered species was the Northern Fulmar (Figure 56), particularly in the north western sector of the survey region where groups of up to 300 birds were recorded sitting around the ship. Although ever-present, the Northern Fulmar was recorded in very low concentrations during the outgoing transit and while on-station in the southwestern region of the study area.

Figure 56: Northern Fulmars competing for fishing discards.

The Great Shearwater (*Puffinus gravis*) was consistently observed over the MAR in moderate concentrations together with the occasional Sooty Shearwater (*Puffinus griseus*), as they migrate northwards from their island breeding grounds off the east coast of South America. A northwestern movement of Manx Shearwaters (*Puffinus puffinus*) were recorded throughout the final day as the ship steamed east over the Rockall Trough.

Figure 57: A juvenile Arctic Tern surveys the surface during its southward migration.

Both juvenile and adult Arctic Terns (*Sterna paradisaea*) (Plate 557) were observed throughout the study period in small groups of up to seven birds as they migrate south to the Southern Ocean. All four skua species commonly observed off Ireland and Britain have been noted over the MAR. The Arctic Skua (*Stercorarius parasiticus*) has been frequently recorded harassing the flock of Great Shearwaters (Figure 58).

Figure 58: A group of Great Sheawaters being harassed by a skua.

The identity of the most interesting seabird sighting for the trip has yet to be confirmed. A gadfly petrel was photographed over the southwestern station.. This bird may be a Zino's Petrel (*Pterodroma maderia*), Europe's rarest breeding seabird. Formerly believed to be extinct during the 1960's, Zino's Petrel is now classified as Critically Threatened with a current population of 250 to 400 birds. The photograph has been sent on to a number of petrel experts for confirmation.

Sunfish

Observations of the Sunfish (*Mola mola*) were also opportunistically recorded throughout the study. Eight Sunfish (Figure 59) were observed during the outward transit and at the southwestern and northwestern stations. One individual was observed breaching clear of the surface. Most sunfish were approximately 1m in diameter, although two larger individuals (i.e. ≈2m) were observed.

Figure 59: A small Sunfish sits at the surface.

Photography of Deep Sea Fauna

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The aim of this cruise from my perspective was to document as many of the new and familiar species from mid-water trawls and benthic trawls as possible.

The first leg of the cruise was dogged by bad weather and this seriously affected the trawling. The two southern stations were combined but we still only managed to achieve one OTSB sample. The second half of the cruise was divided between two stations on either side of the MAR to the north of the Charlie Gibbs Fracture zone.

When finally we got the chance to fish the RMT 1+8 in combination with information provided by the EK60 echo sounder, interesting specimens began to appear. Examples of the specimens collected are illustrated below.

When the trawls came in I had the privilege to be first there to remove the best specimens for photography. The OTSB often produced surprises, collecting animals from the midwater column and these were in near perfect condition, such as the mysid *Gnathophausia*, illustrated below. The rest of the catch was meticulously sorted into buckets each representing a faunal group, by a team on enthusiastic scientists so I had a second chance to view and select the unusual and interesting specimens I had not seen before. The advantage with the benthic samples was that there were always specialists on hand to identify the subjects.

At the North West station, from the large tub of material I managed to select a small ostracod for my photographic tank. It looked interesting. On recovery of the amphipod trap from the same station we caught not only the largest amphipod I had ever seen a *Eurythenes gryllus,* but also dozens more of the ostracod. It was only found in the lowest trap which sits about 15cm above the bottom, indicating it is a truly benthic species. The advantage of being on a ship like the James Cook in this 'digital world' is that I could email pictures to specialists back at NOC. Mike Thurston provided me with near instant identifications for the amphipods and Dr Martin Angel was my specialist for the ostracods. He confirmed that this large ostracod, at 6mm long is potentially a new species[3]. The sample was then treated differently in preparation for DNA analysis. We did find one more specimen of the ostracod on the western side of the MAR, which unfortunately dispelled my theory that it was only to be found on the eastern side. However, it is another indication of the localised populations to be found in the unusual environments along the MAR.

The RMT samples were my goal as they are 'clean', compared with the benthic samples and require less cleaning before they are placed in my tanks. Also, the animals are often alive. This is the perfect combination for photography, as demonstrated by the specimens below. Cephalopods always provide me with a challenge. In their living state they are so colourful, the jewelled squid *Histioteuthis* demonstrated this perfectly with its array of photophores. Other squid like the tiny juvenile Cranchiid is transparent with expanding and contracting chromatophores. Species from the upper layers of the ocean are the amphipods, which are not only resilient but also varied in form from the transparent *Phronima* to the colourful *Lanceola* and *Eurythenes*. Of the fish species that were collected, good specimens of *Stomias* and myctophids of the genera *Myctophum* and *Notoscopelis* were often in the samples. One species, which is sometimes classed as common, is the viperfish *Chauliodus sloani*. We only collected one, but this one was in excellent condition.

[3] This was subsequently identified as *Azygocypridina imperialis*.

Figure 60: *Histioteuthis* sp.

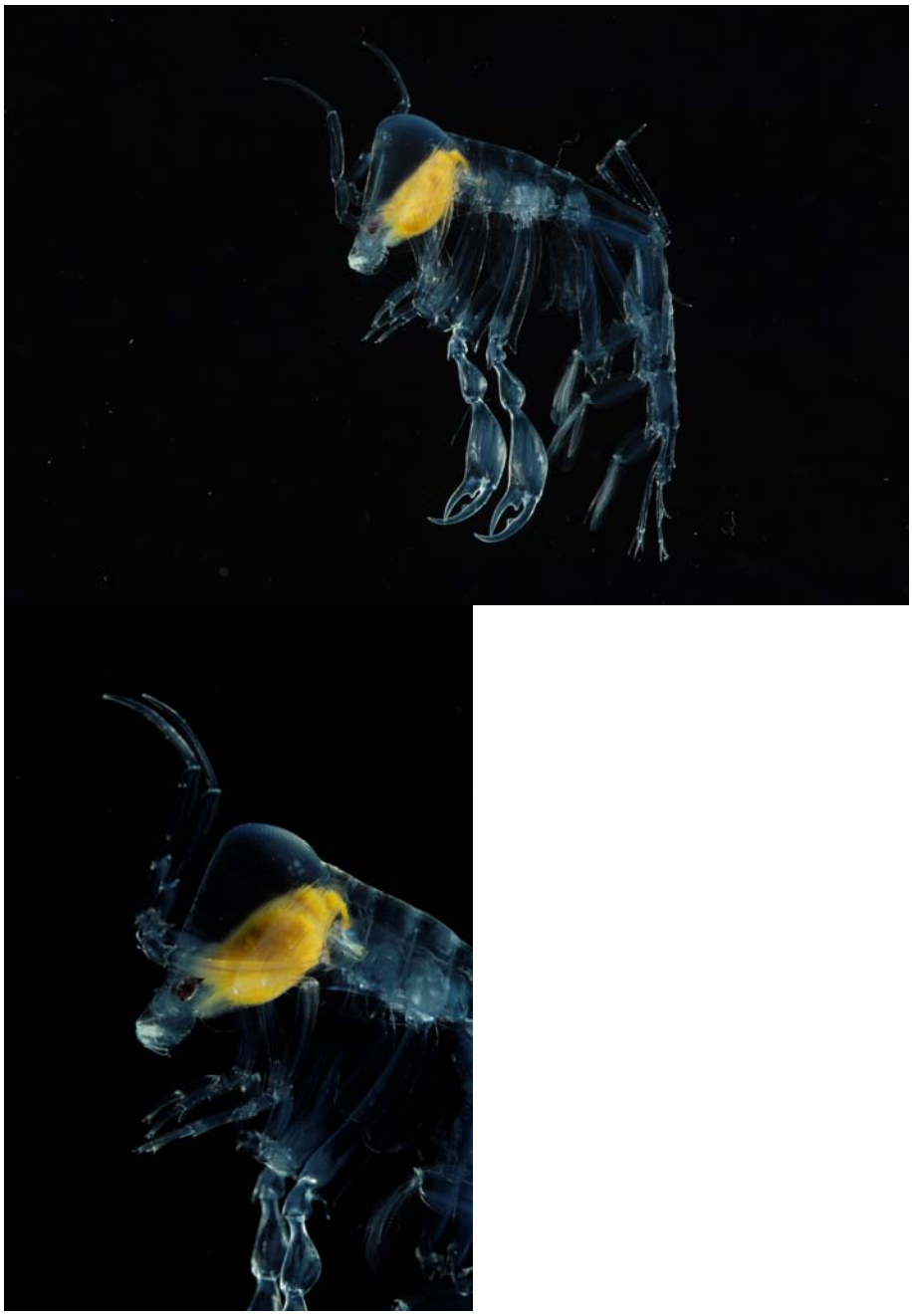

Figure 61: *Phronima sedentaria*

Figure 62: *Lanceola sayana*

Figure 63:
Ventral view of the myctophid
Notoscopelus sp.

Figure 64:
The Fangtooth fish
Anoplogaster cornutus

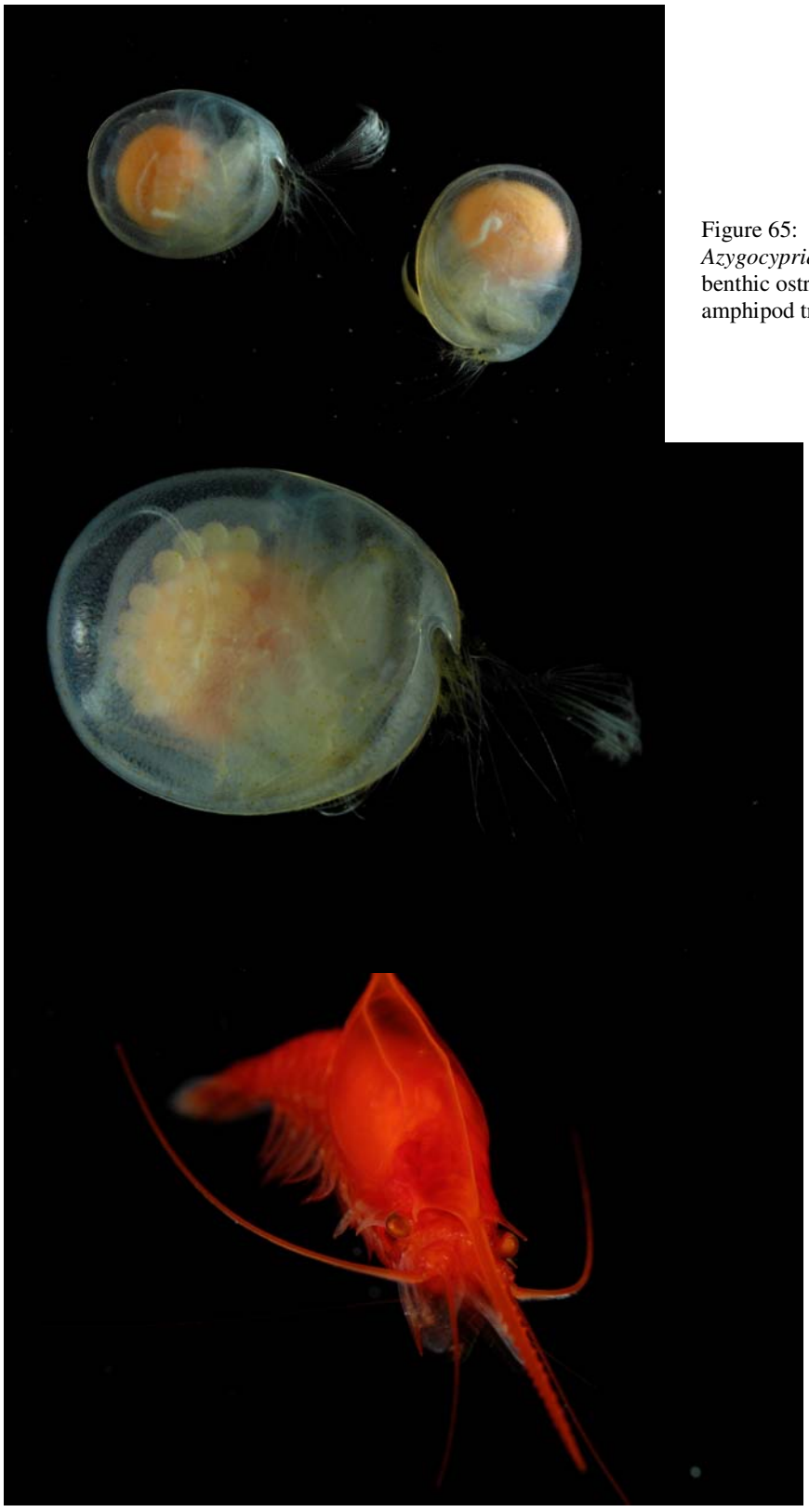

Figure 65:
Azygocypridina imperialis a benthic ostracod from the amphipod trap

Figure 66:
A deep-sea mysid *Gnathophausia sp.*

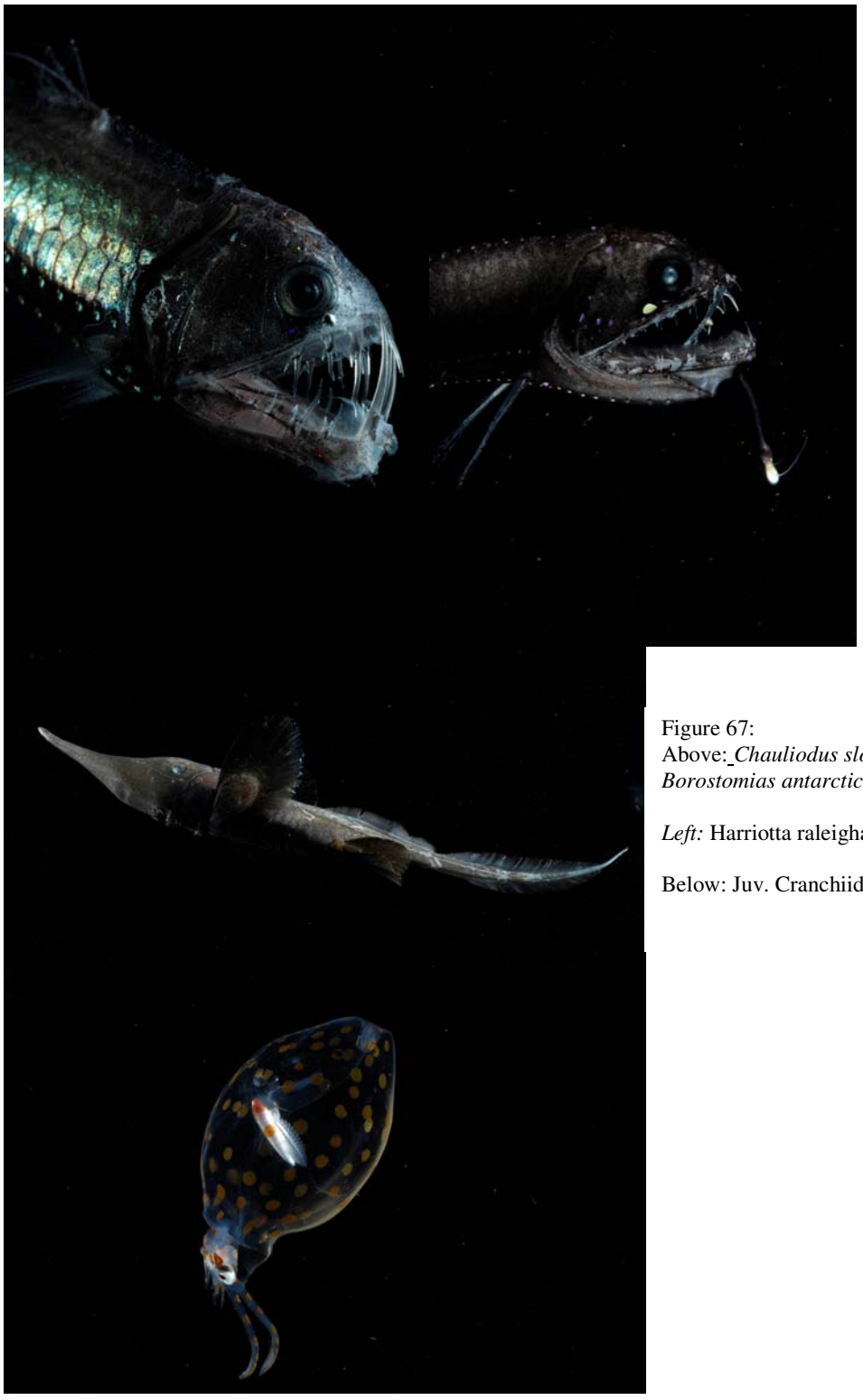

Figure 67:
Above: *Chauliodus sloani*
Borostomias antarcticus

Left: Harriotta raleighana

Below: Juv. Cranchiid squid

Figure 68: A large 10cm specimen of the amphipod *Eurythenes gryllus*

When more of these specimens have been fully identified and the final images edited I will have added some more unique photographs to my collection and made available to scientists and researchers images that I hope they will be proud to use to generate more interest for marine science.

Appendix I Station List - RRS James Cook Cruise No . 011 July-August 2007 ECOMAR

Station No.	Date	Time GMT	Latitude	Longitude	Gear	Depth (m)	Remarks
001	16 Jul	0240 1705	51° 25.8'N 50°51.2'N	11° 01.5'W 15°02.6'W	Whale Hydrophone	Surface tow	156 miles, towed from port stern boom.
002	16 Jul	1720 2025	50° 51.2'N	15° 02.7'W	CTD + test	To 3000	CTD lowered with releases strapped on for acoustic tests. The PML optical rig was also deployed during this time.
003	16 Jul 17 Jul	2100 0855	50° 22.9'N 50° 22.9'N	18° 17.4'W 18° 17.4'W	Whale Hydrophone	Surface tow	103 miles.
004	17 Jul	0925 1554	50° 22.9'N 50° 07.6'N	18° 17.4'W 20° 02.7'W	Whale Hydrophone	Surface tow	69 miles.
005	17 Jul	1610 2015	50° 07.8'N	20° 03.9'W	CTD + test	To 3800	CTD lowered with releases strapped on for acoustic tests. The PML optical rig was deployed twice during this time.
006	17 Jul 19 Jul	2026 0045	50° 07.8'N 49° 00.2'N	20° 03.9'W 27° 40.6'W	Whale Hydrophone	Surface tow	304 miles.
007	19 Jul	0120 0353	49° 00.0'N	27° 40.8'W	CTD + SVP	2860	Collection of sound velocity data to calibrate the sonars
008	19 Jul	0400 1525	49°00.00'N 49°04.84'N	27°40.80'W 27°50.78'W	Swath Bathymetry		Successful survey along two transects over the ridge between the SE and SW stations and over a sea mount .
009	19 Jul	1536 1620	49°04.84'N	27°50.78'W	CTD & Optics	To 200	The PML optics package deployed off the Starboard aft crane at the same time as the CTD rosette.
010	19 Jul	1917	49°01.92'N	27°40.82'W	SE Mooring	2500	Mooring deployed with sediment traps, current meters etc. To be recovered during *RRS Discovery* Cruise in 2008.
011	19 Jul	2044	49°02.02'N	27°42.15'W	PAL	2512	Presence of large fish confirmed.
012	19 July 20 July	2248 1013	49°01.45'N	27°43.59'W	ISIT	2450	Little bioluminescence detected

013	19 Jul 20 Jul	2328 1230	49°01.16'N	27°42.29'W	Amphipod Trap	2627	Very little captured.
014	20 Jul	0054 0643	49°05.38'N 49°05.40'N	27°54.29'W 27°52.01'W	Shrimp	2000 2613	Good video of the sea floor along a 1.5 miles transect
015	20 Jul	1425 1458	49°04.54'N	27°50.80'W	CTD & Optics	To 200	Optical studies at the SE CTD station
016	20 Jul	1545 1808	49°04.83'N	27°50.79'W	CTD	2747	Full depth cast at the SE CTD station
017	21 Jul	0210 1405h	49°14.68'N 49°03.43'N	27°42.31'W 27°53.86'W	OTSB	2687 2727	The net stuck fast on sea bed topography, retrieved after much delay with a small catch.
018	21 Jul 27 Jul	1933 1030	48°44.26'N	28°10.34'W	Acoustic Lander	1073	Adjacent to the summit of a sea mount on the west side of the ridge Failed to surface on 27 July recovery .
019	21 Jul 22 Jul	2120 1612	48°43.59'N	28°09.86'W	ISIT lander	796	On the summit of a seamount on the west side of the ridge. A significant number of luminescent events were observed.
20	21 Jul	2200	48°43.21'N 49°04.4'N	28°14.68'W 17°46.6'W	EK60 survey		A line downwind from the SW to the SE station. Good clean records
21	22 Jul	0736 1015	49°05.40'N	27°50.22'W	Megacorer	2734	Good set of 5 cores in soft sediment with fluff on top
22	22 Jul	1206	49°02.00'N	27°42.11'W	PALander	2546	Deployment slightly delayed by loss of two floats
23A	22 Jul	1804 1852	48°43.21'N	28°09.72'W	CTD	To 450	Curtailed owing to water leak into cable. On summit of sea mount.
23B	22 Jul 23 Jul	2320 0716	48°54.59'N 49°15.85'N	27°50.00'W 27°50.00'W	OTSB	2631 2724	Good catch
24	23 Jul	0730 1310	49°16.45'N 49°08.2'N	27°48.09'W 27°45.1'W	EK 60 survey		Grid survey design for 6h over the SE station
25	23 Jul	1445 1637	49°02.20'W	27°55.62'W	CTD & Optics	1704	On the summit of the eastern ridge above the median valley

26	23 Jul 25 Jul	1712 2307	49°02.22'W	27°55.58'W	ISIT	1701	On the summit of the eastern ridge above the median valley
27	23 Jul	1820 2106	49°05.42'N	27°50.24'W	Megacorer	2763	6 good cores were obtained
28	24 Jul	0000 0325	48°56.41'N	28°03.93'W	CTD	3810	Deep CTD on the east slope of the median valley. End 12m above bottom
29	24 Jul	0501 0815	48°54.58'N	28°05.33'W	CTD	4043	Deep CTD in the centre of the median valley.10m above bottom
30	24 Jul	1058 1423	48°54.09'N	28°08.37'W	CTD	3878	Deep CTD on the west slope of the median valley. Optics work cancelled owing to bad weather
31	25 Jul	0835 1515	49°02.5'N 49°05.4'N	29°06.1'W 27°51.5'W	EK 60 survey		50 mile track at 7-8 knots in heavy weather downwind.
32	25 Jul	1545 1829	49°05.42'N	28°50.24'W	Megacorer	2773	Cores somewhat disturbed but one good with phytodetritus
33	25 Jul 26 Jul	2258 0440	49°12.01'N 49°09.00'N	27°49.93'W 27°41.91'W	EK60 survey		Grid survey design over the SE super station
34	26 Jul	1126 1327	48°53.26'N	28°20.21'W	CTD + Optics	1568	On the crest of the ridge on the west side of the median valley.
35	26 Jul	1641	48°46.80'N	28°38.43'W	SW Mooring	2500	The SW mooring deployed to be recovered and serviced in 2008
36	26 Jul	1745 2001	48°45.80'N	28°38.41'W	CTD	2550	Western end of the southern transect
37	26 Jul	2010 2206	48°45.80'N 48°44.67'N	28°39.02'W 28°34.97'W	EK60 survey		Grid survey design over the SW super station
38	26 Jul 27 Jul	2213 0047	48°44.67'N 48°41.30'N	28°34.97'W 28°41.15'W	RMT 8+1	300-53	Mid water trawl over the SW station

39	27 Jul	0105 0354	48°41.30'N 48°37.40'N	28°41.15'W 28°46. 4'W	RMT 8+1	521- 400	Mid Water trawl over the SW station
40	27 Jul	0720 0833	48°43.21'N	28°10.21'W	CTD + Optics	837	On the summit of the sea mount at the west side of the median valley
41	27 Jul	1221 1746	48°45.00'N 48°51.50'W	28°17.00'W 29°35.30'W	Whale Hydrophone	Surface Tow	52 miles run between the SW station and start of the Topex Poseidon Transect.
42	27 Jul 28 Jul	1803 0140	48°51.54'N	29°35.33'W	CTD TP1	3510	1st CTD of the Topex Poseidon transect. Hauling was very slow owing to winch problems. EK 60 monitoring to next station
43	28 Jul	0445 0730	49°09.73'N	29°55.25'W	CTD TP 2	3260	Good fast winch operation in calm weather conditions. EK 60 monitoring to next station
44	28 July	1013 1303	49°26.29'N	30°13.65'W	CTD + Optics TP 3		Good operating and weather conditions continued. EK 60 monitoring to next station
45	28 Jul	1523 1813	49°39.22'N	30°28.21'W	CTD + ISIT TP 4	3626	With ISIT camera for bioluminescence profiling. Camera failed at maximum depth having recorded a good profile. EK 60 monitoring to next station
46	28 Jul	2020 2327	49°51.68'N	30°42.44'W	CTD TP 5	3575	EK 60 monitoring to next station
47	29 Jul	0147 0432	50°04.11'N	30°56.80'W	CTD TP 6	3133	EK 60 monitoring to next station
48	29 Jul	0647 0927	50°16.45'N	31°11.29'W	CTD + Optics TP 7	3567	Foggy visibility 400m. EK 60 monitoring to next CTD station
49	29 Jul	0940 1123	50°16.45'N 50°28.34'N	31°11.29'W 31°25.67'W	Whale Hydrophone		Streamed for one leg of 15.5 miles between CTD stations.
50	29 Jul	1145 1433	50°28.86'N	31°25.91'W	CTD TP 8	3279	EK 60 monitoring to next station

51	29 Jul	1658 1937	50°43.64'N	31°43.66'W	CTD + SIT TP 9	3330	With SIT camera from SHRIMP EK 60 monitoring to next station
52	29 Jul 30 Jul	2158 0109	50°58.36'N	32°01.61'W	CTD + SIT TP 10	3693	EK 60 monitoring to next station
53	30 Jul	0344 0603	51°13.03'N	32°19.73'W	CTD + SIT TP 11	2939	EK 60 monitoring to next station
54	30 Jul	0814 1047	51°25.21'N	32°35.02'W	CTD, SIT Optics TP 12	2848	EK 60 monitoring to next station
55	30 Jul	1318 1627	51°39.77'N	32°53.54'W	CTD + SIT Optics TP 13	3540	EK 60 monitoring to next station
56	30 Jul	1835 2103	51°51.88'N	33°09.16'W	CTD + SIT TP 14	3528	EK 60 monitoring to next station
57	30 Jul 31 Jul	2322 0228	52°06.33'N	33°28.08'W	CTD + SIT TP 15	3620	EK 60 monitoring to next station
58	31 Jul	0425 0716	52°18.35'N	33°44.01'W	CTD + SIT TP 16	3911	EK 60 monitoring to next station
59	31 Jul	0919 1145	52°30.29'N	34°00.12'W	CTD + SIT Optics TP 17	3073	EK 60 monitoring to next station
60	31 Jul	1419	52°44.59'N	34°19.64'W	CTD + SIT Optics TP 18	3059	EK 60 monitoring to next station.
61	31 Jul	2033	52°41.35'N	35°04.17'W	DOBO	3690	Deployed in the north valley of the CGFZ . To be recovered on Discovery cruise in 2008
62	31 Jul 1 Aug	2308 0112	52°56.45'N	34°36.07'W	CTD + SIT TP 19	2252	North of the CGFZ.. EK60 monitoring to the next station
63	1 Aug	0318 0529	53°10.64'N	34°56.02'W	CTD + SIT TP 20	2775	Eastern ridge. EK 60 monitoring to the next station
64	1 Aug	0802 1020	53°24.74'N	35°16.13'W	CTD + SIT Optics TP 21	2558	EK 60 monitoring to the next station
65	1 Aug	1238 1430	53°36.46'N	35°33.20'W	CTD + SIT Optics TP 22	1894	EK 60 monitoring to the next station
66	1 Aug	1628 1753	53°48.15'N	35°50.42'W	CTD + SIT TP 23	1614	

67	1 Aug	2323	53°59.33'N	36°07.39'W	NW Mooring	2500	The NW super station mooring deployed for recovery in 2008
68	2 Aug	0040 0648	53°56.87'N 54°09.27'N	36°13.3'W 36°21.81'W	Swath Bathymetry		EM120/OLEX survey. Rough weather conditions restricted choice of track.
69	4 Aug	0340 0536	54°09.01N	36°21.64'W	CTD + SIT TP 25	2094	Northwest end of the Topex-Poseidon transect
70	4 Aug	0730 0953	53°59.74'N	36°07.67'W	CTD + SIT TP 24	2570	Near the North West superstation central position.
71	4 Aug	1016 1312	54°01.00'N	36°13.3'W	Megacorer	2566	In the centre of the sedimentary basin. Two good cores
72	4 Aug	1520	53°57.87'N	36°11.49'W	Bathysnap	2536	Long term, time lapse photo lander deployed to be recovered in 2008
73	4 Aug 5 Aug	1626 2022	53°56.85'N	36°11.59'W	PALander	2573	One mile from Bathysnap
74	4 Aug	1757 2259	54°01.17'N 54°01.34'N	36°05.84'W 36°07.86'W	Shrimp	2266 2605	At least six species of fish plus enteropneustes and a variety invertebrates. Good data.
75	5 Aug	0048 0848	53°51.10'N 54°11.14'N	36°11.36'W 36°05.66'W	OTSB	2605 2630	A good catch including over 20 *Antimora rostrata* and an ostracod *Azygocypridina imperialis*.
76	5 Aug	0925 1018	54°11.14'N	36°05.66'W	CTD + Optics	To 60m	
77	5 Aug	1040 1506	54°56.87'N 54°04.77'N	36°05.82'W 36°09.36'W	EK60 survey		Pelagic biomass survey of the NW superstation
78	5 Aug	1540 1828	54°01.00'N	36°08.36'W	Megacorer	2566	In the centre of sedimentary basin one good core only

79	5 Aug	1951	53°56.44'N	36°11.56'W	Amphipod trap	2564	Good catch in bottom trap with large *Eurythenes* and the ostracod *Azygocypridina imperialis*
80	5 Aug 6 Aug	2222 0306	54°03.80'N 54°02.29'N	36°15.17'W 36°15.58'W	SHRIMP	2050 2377	Transect from north to south sediment covered slopes
81	6 Aug	0512 1656	54°15.82'N 54°09.78'N	36°04.12'W 36°05.99'W	OTSB	2600	Reverse tow over the same ground as JC011/ 075. Trawl stuck fast, all gear lost beyond the swivel
82	6 Aug	1708 1755	54°09.85'N	36°05.96'W	CTD + Optics	To 60m	
83	6 Aug 7 Aug	2108 1550	53°56.86'N	36°11.47'W	PALander	2567	
84	7 Aug	0754 1130	54°01.00'N	36°08.40'W	Megacorer	2570	5 cores
85	7 Aug	1245 1320	53°56.50'N	36°11.40'W	CTD + optics	To 65m	
86	7 Aug 8 Aug	1632 0133	53°56.76'N 53°58.62'N	36°12.36'W 36°10.97'W	EK 60 survey		Survey to 36°30'W followed by an EW survey grid over the NW station
87	8 Aug	0200 2105	53°58.60'N 54°00.00'N	36°15.40'W 33°51.11'W	Swath, EK 60, Whale Hydrophone		Monitoring across the transect between the NW and NE stations between CTD stations. Depth, pelagic biomass and cetacean sounds .
88	8 Aug	0514 0643	53°59.40'N	36°46.70'W	CTD	1648	Western crest of the ridge
89	8 Aug	0823 1056	54°00.10'N	35°17.60'W	CTD + Optics	2814	To the bottom of the mid axial valley
90	8 Aug	1225 1401	54°00.00'N	34°57.00'W	CTD	1333	Eastern crest of the ridge
91	8 Aug	1707 1904	54°00.00'N	34°17.99'W	CTD	2290	Eastern flank of the ridge

92	8 Aug	2120 2322	54°00.12'N 54°01.24'N	33°50.18'W 33°55.38'W	RMT 8 + 1 Trawl	150 - 200	Midwater trawl at NE station targeted at identified layers in the EK60 records
93	8 Aug 9 Aug	2336 0200	54°01.24'N 53°59.70'N	33°55.38'W 33°48.40'W	RMT 8 + 1 Trawl	550 – 450	Midwater trawl at NE station targeted at identified layers in the EK60 records
94	9 Aug	0216 0400	53°59.70'N 54°01.00'N	33°48.40'W 33°54.40'W	RMT 8 + 1 Trawl	350 - 250	Midwater trawl at NE station targeted at identified layers in the EK60 records
95	9 Aug	0425 0520	54°01.05'N 54°01.61'N	33°54.52'W 33°57.12'W	RMT 8 + 1 Trawl	75 - 30	Midwater trawl at NE station targeted at identified layers in the EK60 records
96	9 Aug	1115	54°00.05'N	34°10.61'W	NE Mooring	2500	NE mooring deployment. To be recovered and redeployed in 2008.
97	9 Aug	1251 1420	54°05.26'N	34°09.24'N	PAL	2500	Good deployment with images of fishes/
98	9 Aug 11 Aug	1313 1215	54°04.08'N	34°09.43'W	Amphipod trap	2500	Large catch of small amphipods
99	9 Aug	1426 1633	54°00.00'N	33°57.97'W	CTD + Optics	To 60m	
100	9 Aug	2030 2400	54°00.65'N	34°10.42'W	Megacorer	2500	In the small sedimentary basin next to the NE mooring. A full set of 8 cores were obtained.
101	10 Aug	0137 0908	54°06.33'N 53°47.47'N	33°58.27'W 34°02.89'W	OTSB	2405 2435	Towing southwards on plain SE of the mooring. Good diverse catch
102	10 Aug	1015 1249	53°46.75'N 53°43.80'N	34°03.02'W 33°58.60'W	RMT 8 + 1	520 – 430	Lot of myctophids
103	10 Aug	1311 1450	53°43.80'N 53°41.40'N	33°58.60'W 33°55.40'W	RMT 8 + 1	150 – 50	Lot of copepods
104	10 Aug	1500 1649	53°41.90 53°54.72'N	33°55.40'W 34°01.85'W	Swath + Whale Hyd		Line from trawl end position to SHRIMP start

105	10 Aug	1654 2350	53°54.71'N 53°53.70'N	34°01.87'W 33°59.40'W	SHRIMP	2439 2503	Crossed the track of trawl JC011/101 and recorded images
106	11 Aug	0133 0846	54°05.68'N 53°46.94'N	33°58.54'W 34°03.02'W	OTSB	2410 2445	Good catch
107	11 Aug	0905 1125	53°47.32'N 54°04.18'N	34°03.09'W 34°09.23'W	Whale Hydrophone		
108	11 Aug	1310 1342	54°05.40'N	34°09.2'W	CTD + Optics	To 60m	Relatively calm sunny weather
109	11 Aug	1530 1805	54°00.65'N	34°10.42'W	Megacorer	2495	8 good cores
110	11 Aug 12 Aug	1907 0018	54°01.13'N 54°00.43'N	34°08.99'W 34°11.06'W	SHRIMP	2258 2493	Down a steep slope and across the megacorer site, spectacular footage.
111	12 Aug.	0147 0846	54°05.68'N 53°47.71'N	33°58.54'W 34°02.83'W	OTSB	2404 2430	Good catch along the same track as previously at this station
112	12 Aug	0904 1613	53°47.71'N 54°02.70'N	34°02.83'W 34°09.4'W	EK 60 + Whale Hyd		Grid survey at the NE station with a break for the CTD + Optics casts (113)
113	12 Aug	1338 1432	54°03.01'N	34°05.98'W	CTD + Optics	To 60m	Casts timed for the MODIS satellite overpass but skies clouded over just before the event.
114	12 Aug 13 Aug	1725 1540	54°02.31'N	34°09.60'W	Amphipod trap	2453	A good catch of amphipods in the lower trap
115	12 Aug 13 Aug	1754 1715	54°03.37'N	34°09.47'W	PALander	2482	*Antimora rostrata* appearing in the images
116	12 Aug	1833 2142	54°00.65'N	34°10.42'W	Megacorer	2495	7 good cores
117	12 Aug 13 Aug	2215 1423	54°00.65'N	34°10.42'W	YoYo CTDs	2470	Nine CTD casts in succession with no bottles.
118	13 Aug	1505 1533	54°02.30'N	34°09.78'W	CTD + Optics	To 55m	Casts done at the amphipod trap recovery position
119	13 Aug	1745 2235	54°04.55'N 55°55.13'N	34°07.97'W 34°10.05'W	EK60 survey		Grid survey at the NE station
120	13 Aug 16 Aug	2242 0819	55°55.13'N 55°22.20'N	34°10.05'W 06°15.80'W	Whale Hyd		Along the passage to the Clyde. 940 miles run

NB: Trawl depths are maximum and minimum depths for each tow. Deployment and recovery positions are given.
For landers, times are flag sinking times and surface times.

APPENDIX II

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