CRUISE REPORT

R.R.S. CHARLES DARWIN - CRUISE CD110-B
Iberian Shelf Seas - 5th-19th January, 1998

Dr. Axel E.J. Miller - Principal Scientist

Strategic Research Project 4

Biogeochemistry, Tracers and Global Change

PLYMOUTH MARINE LABORATORY

CENTRE FOR COASTAL AND MARINE SCIENCES
UK NATURAL ENVIRONMENT RESEARCH COUNCIL

SUMMARY

RRS *Charles Darwin* cruise 110 was one of several planned at intervals of six months or less for the EU MAST project Ocean Margin Exchange (OMEX II-II) focusing on the NW Iberian continental shelf and slope. This cruise forms a contribution to Work Package II, whose purpose is to measure and model the mesoscale spatial and seasonal variability in the sources of water, particles, carbon and nutrient elements in contrasting shelf-influenced waters.

Leg B aimed to systematically map water properties from coastal to oceanic environments, along cross-shelf surface transects and throughout the water column. Due to persistent, extremely poor weather conditions, the scientific objectives were severely curtailed. Of the 74 stations along the nine latitudinal OMEX lines, only six stations were occupied, resulting in a total of 12 CTD casts. Attached to the CTD frame were two transmissometers, an optical back-scatter sensor (for investigations of pelagic nepheloid layers), a fluorometer, a dissolved oxygen probe, and an upwelling PAR sensor. Due to the high water-volume demands, a number of replicate CTD casts were undertaken at most stations. Casts were designated 'Biogeochemistry' (typically dissolved and particulate organic matter, five nutrients, pigments, bacterioplankton, phytoplankton and microzooplankton), 'Incubations' (focussed on primary production and dissolved organic carbon production) and 'Radionuclides' (radionuclides and suspended particulate matter), according to the range of parameters being sampled. In addition to the standard programme, a number of samples were collected for OMEX-community DOM and nutrients intercomparison exercises. Where weather conditions prevented deployment of the CTD, and where casts had not been accomplished during Leg A, XBT probes were launched (17 profiles).

Three water downwelling light field profiles were collected using a data-logging spectroradiometer rig. At two stations, one at the shelf edge and one in deeper water, particulate material samples were collected using the stand alone pumps (SAPs). The FLY (free-falling light yo-yo) turbulence probe was successfully deployed over 300m on seven occasions, from inshore to intermediate depth (~2800m) oceanic stations. A repeat series at one station within five hours provides a measure of short time-scale variability the shelf edge. A total of 17 WP2 and drifting (25m) zooplankton net hauls were completed (day and night). These provided integrated sampling over the surface 200m at stations from inshore to the oceanic (~3100 m), and complementary collection of live copepods for egg production experiments.

Surface mapping of pCO_2 and pH were an integral component of the cruise programme, using 'continuous' computerised logging system to collect data every minute. To provide complementary measurements over the broader OMEX grid area, a near-surface sampling regime was instigated. This entailed collection of samples for determination of a suite of biogeochemical parameters (including dissolved and particulate organic matter, five nutrients, pigments, radionuclides, SPM, bacterioplankton, phytoplankton and microzooplankton) from the non-toxic supply at each way-point on the OMEX grid. Continuous recording of the standard underway parameters utilised the ship-borne ADCP, thermosalinograph (temperature, salinity), on-deck transmissometer, fluorometer and PAR sensors.

The cruise was continuously hampered by the poor weather conditions. Scheduled over-the-side work with the CTD, FLY and SAPS was only possible on three days out of 11 in the working area. The only mooring work consisted of the collection of STABLE. In addition, an ADCP (presumed lost) which had been picked up by the Spanish Maritime Authorities was recovered in Vigo, but a current meter line mooring which had been located during Leg A was not recovered.

ACKNOWLEDGEMENTS

I should like to express my thanks to the ship's company of RRS *Charles Darwin* for their help and co-operation during the cruise; to RVS for its unerring support; and to the patience of the scientific party; for producing valuable observations, under the 'somewhat testing' winter conditions over the Galician shelf. I raise a toast to your memory, ladies and gentlemen.

'SEA CALM'

How still,
How strangely still
The water is today.
It is not good
For water
To be so still that way.

Langston Hughes, 1959

CONTENTS

2 OBJECTIVES

Overall the OMEX II-II objectives are to construct and understand the cycles of carbon and associated elements along the upwelling zone of the Iberian Margin. This cruise is a component of Work Package II (WP2), whose broad aim is to measure and model the mesoscale spatial and seasonal variability in the oceanic, coastal, and terrestrial sources of water, particles, carbon and nutrient elements in shelf, upwelling and slope waters.

Specific Objectives for *RRS Charles Darwin* Cruise 110 Leg B were:

B.1.1 CTDs and water-bottle rosette (12 x 10l Niskins) for:

- nutrients, DO, Talk, pH, DOC/TDN, pigments, chl-*a*;
- POC/PON, naturally occurring radionuclides, SPM (optical, filter);
- phytoplankton identification, primary production (1°P; PvI curves), DOC production; &
- bacteria (counts, biomass), microzooplankton biomass.

CTD stations should be on a grid closely matching that of CD105, *i.e.* sections at 41°25'N, 41°48'N, 42°N, 42°09'N, 42°20'N, ... (10' intervals) to 43°N, from ~100m water depth inshore to 10°W offshore. Priority will be given to OMEX reference stations along 43°N (Line N: SEFOS line 4), 42°40'N (Line P: OMEX mooring line), and 42°09'N (Line S: OMEX reference transect); which will be sampled to full depth. Additional CTD dips for large volume (40 litters) radionuclide sample collection - surface and bottom.

More intensive studies will be undertaken near any features observed from satellite images.

This incorporates objectives to:

- map five nutrients and DOM during winter in shelf, slope and adjacent ocean water;
- assess primary productivity; identify and quantify microplankton in the same context; &
- characterise suspended particle populations and estimate sinking particle fluxes.

B.1.2 Routine mid-day CTD casts (typically sampling over 10-120 m) for:

- nutrients, pigments, DOC/TDN;
- particulate (PvI curves) and dissolved (^{14}C incubation) organic carbon production; &
- mesozooplankton grazing experiments (50 liters each day at chl-*a* max.) and taxonomy.

This incorporates objectives from B.1.1, and to determine:

- 1°P in relation to light, phytoplankton communities and chlorophyll content; &
- light absorption by phytoplankton, photosynthetic pigments and detrital material.

B.2 IIM Spectroradiometer-optics rig at mid-day (60 mins duration; no water bottles) for:

- light attenuation measurements (5-60m), at primary production stations only; &
- second dip of rig after reversal of PAR sensor, to give ‘upwelling irradiance’.

B.3 SAPs down to 1200m (max. spread 50m on wire). Sampling along OMEX sediment trap line (42°40'N): one site near STABLE (~CD105, station 29). Occasional surface samples at 10-20m (maximum one hour wire time, when programme allows).

B.4 LHPR tows (typically for 2 hours near the middle of the day & night; on a minimum of 4 occasions each). Transects from N-S, and deep to shallow where possible.

B.5 WP2 and drifting zooplankton nets.
Daylight cast every day at primary productivity stations (WP2, x2 hauls, 5-60m); &
Night-time trawls at same stations as mid-day trawls (WP2, upper 200m) for:

- mesozooplankton ingestion, excretion, respiration; macrozooplankton identification; &
- material for mesozooplankton C/N ratio analysis (WP2).

Drifting zooplankton net for:

- collection of live copepods for mesozooplankton production measurements.

B.6 FLY (dissipation) shelf, break and ocean complementary to CTD sampling program:

- two tidal-cycle occupations (~12.5 hrs) along OMEX sediment trap line (42°40'N), near STABLE (P200; 42°40'N, 009°30'W); inshore (P100; 42°40'N, 009°13'W); &
- occasional extra profiles (one hour duration, after CTD) at OMEX reference stations).

B.7 Continuous ADCP (logging of clock *versus* GMT) and non-toxic supply monitoring:

- continuous logging of thermosalinograph, fluorometer, transmissometer and PAR;
- continuous (logging every minute) analysis for pCO_2 (water, atmosphere), pH, and O_2; &
- discrete sampling for nutrients, pH, TAlk, DO, phytoplankton pigments and chl-*a*.

B.8 Recover STABLE (deployed at 42°40'41''N, 009°30'30"W; at depth 202m).

B.9 Recover Galway current meters at about 700m water depth (released, but not recovered). Leg A2 had a range of 628m, at 42°40'10.5"N, 009°34'21.8"W.

B.10 Systematic XBTs (if conditions prevent CTDs) to fill gaps in grid from Leg A.

3 PERSONNEL

3.1 SHIP'S COMPANY

Name	Rank	Organisation
Bourne, Richard A.	Master	Research Vessel Services - Marine
Warner, Richard A.	Chief Officer	" " " "
Oldfield, Phil T.	Second Officer	" " " "
Holmes, John C.	Third Officer	" " " "
Adams, Andy P.	Chief Engineer	" " " "
McDonald, Berni J.	Second Engineer	" " " "
Crosbie, Jim R.	Third Engineer	" " " "
Parker, Phil G.	Electrical Engineer	" " " "
Baker, Jeff C.	Radio Officer	" " " "
Trevaskis, 'Trev'	Bosun	" " " "
Harrison, Martin A.	Petty Officer (Deck)	" " " "
Edwards, Timmy R.	Seaman 1A	" " " "
Perkins, Joe R.	Seaman 1A	" " " "
Cooper, Jed	Seaman 1A	" " " "
Buffery, Dave	Seaman 1A	" " " "
Healy, Tony	Motorman	" " " "
Bell, Ray	Senior Catering Manager	" " " "
Perry, Clive K.	Chef	" " " "
Duncan, Andy S.	M/Steward	" " " "
Link, Wally J.	Steward	" " " "
Carter, Shiela E.	Steward	" " " "

Address

Research Vessel Services, Southampton Oceanography Centre, Empress Dock, Southampton SO14 3ZH, UK

3.2 SCIENTIFIC PARTY

Name	Position	Institute	E-mail Contact Address
Miller, Axel E.J.	Principal Scientist	[1]PML	a.miller@pml.ac.uk
Spyres, 'George'	Scientist	"	g.spyres@pml.ac.uk
Salgado, 'Pepe' A.	"	[2]IIM	xsalgado@iim.csic.es
Martinez, Luisa	"	"	luimar@iim.csic.es
Tilstone, Gavin H.	"	"	gtilston@iim.csic.es
Barciela, Rosa M.	"	[3]UVigo	barciela@uvigo.es
Wilton, Ray J.	"	[4]UCNW	r.j.wilton@sos.bangor.ac.uk
Sherwin, Toby J.	"	"	t.j.sherwin@uces.bangor.ac.uk
Chou, Lei	"	[5]ULB	lchou@ulb.ac.be
Borges, Alberto M.	"	[6]ULge	alberto.borges@ulg.ac.be
Schmidt, Sabine	"	[7]CNRS	sabine.schmidt@cfr.cnrs-gif.fr
Isla, J. Alejandro	"	[8]UOviedo	jisla@sci.cpd.uniovi.es
Hirst, Andrew G.	"	[9]SOC	andrew.hirst@soc.soton.ac.uk
Teare, Dave	Instrumentation (TLO)	[10]RVS	dte@sot.soton.ac.uk
Benson, Jeffrey R.	Instrumentation	"	jrbn@soc.soton.ac.uk
Mitchell, Simon	Mechanical	"	simi@soc.soton.ac.uk
Phipps, Ritchie A.	Mechanical	"	rvsops@sot.soton.ac.uk
Duncan, Paul A.	Computing	"	pdu@soc.soton.ac.uk

Addresses

[1] Plymouth Marine Laboratory, Prospect Place, The Hoe, Plymouth PL1 3DH, UK

[2] Instituto de Investigacións Mariñas, CSIC, Eduardo Cabello 6, Vigo E-36208, SPAIN

[3] Facultad de Ciencias del Mar, Universidad de Vigo, Campus Lagoas-Marcosende, E-36200, SPAIN

[4] Unit for Coastal & Estuarine Studies, University of Wales, Bangor, Menai Bridge, Anglesey LL59 5EY, UK

[5] Chimie de l'Environment et Pollution des Eaux, Université Libre de Bruxelles, B-1050 Brussels, BELGIUM

[6] Université de Liège, Laboratoire d'Océanologie (Bât B6), B4000 Sart Tilman, BELGIUM

[7] Centre des Faibles Radioactivités, CNRS, Avenue de la Terrasse, F-91198 Gif sur Yvette Cedex, FRANCE

[8] Laboratorio de Ecología, Universidad Oviedo, C/ Catedrático Rodrigo Uría, (S/N) Oviedo 33071, SPAIN

[9] George Deacon Division, Southampton Oceanography Centre, Empress Dock, Southampton SO14 3ZH, UK

[10] Research Vessel Services, Southampton Oceanography Centre, Empress Dock, Southampton SO14 3ZH, UK

4 NARRATIVE

(All times GMT).

*See **Figure 1** for a general map of the area and a complete cruise track: Vigo-Vigo-Southampton, 6-16-19th January, 1998.*

*See **Figure 2** for a high-resolution map of the area and focused cruise track: Vigo-Vigo, 6-16th January, 1998.*

Monday 5th January *(Julian Day 005)*
RRS *Charles Darwin* arrived alongside Vigo quayside (Transatlantic Pier) at 09:42. Ten scientists disembarked after CD110 Leg A2, and 13 joined for Leg B. The ship's company mobilised the vessel for Leg B. For logistical considerations associated with set-up and securing of major apparatus and instrumentation, and in light of poor weather conditions forecast, the scheduled departure time (18:00, 05/01/98) was moved back to 09:00, 06/01/98. In consultation with John Huthnance (PSO, CD110-Leg A), attempted recovery of STABLE (John Humphries, POL; (42°40'34"N ; 009°29'36"W) and ADCP/current meter mooring (Martin White, UCG; by grappling around 42°40'10.5"N ; 009°34'21.8"W) were requested - at first opportunity (*i.e.* suitable weather window). The ship's Master was briefed on the planned scientific programme at 18:00.

Tuesday 6th January *(Julian Day 006)*
RRS *Charles Darwin* left the Vigo quayside (Transatlantic Pier) at 09:14; *en route* to the first station along reference line N (SEFOS line 4), N3300, at 43°20'N, 010°18'W. Passage to this most northwesterly station was designed to allow the scientific party adequate time for set-up and commissioning of equipment. The first 'general scientific meeting' was held in the main laboratory (1100): attended by the scientific party, RVS Scientific and the bosun. The scientific plan, focussing on the OMEX 'priority' stations, was proposed. The only matter brought forward concerned a malfunctioning (subsequently failed) scupper pump in the wet laboratory. Allberto Borges was to continuously monitor pCO_2, pH, TAlk and DO (dissolved oxygen) from the non-toxic supply, but unavoidable reduction of the sea water flow-rate restricted his capacity to pCO_2 and pH only. Fire muster and boat drill were held at 1615. By 19:30, the scheduled arrival at N3300 (22:30) had slipped to ~01:00, 07/01, due to deteriorating weather conditions (disparate directions of wind and ocean swell resulting in decrease of ship's speed to 3.5kts).

Wednesday 7th January *(Julian Day 007)*
Hove to at 00:00, due to worsening weather. Made position at 06:00, and hove to. Weather prevented any over-the-side deployments until daylight. Weather eased by 09:12, so returned to station N3300. Bridge confirmed that it would not be possible to hold station for over-the-side deployments, so science was limited to deployment of an XBT probe. In light of continuing poor weather forecasts, we planned to: surface sample from the non-toxic supply at standard OMEX station positions (Table 1). The sequence should be along west-east longitudinal transects inshore, then east-west offshore, in sequence form Line N to Line V. XBT casts should be made at stations not covered during Leg A, with the opportunistic CTD casts, light rig deployments, net hauls and LHPR tows when suitable weather windows were available. The first XBT deployment (Identifier "061", Table 3), failed (wire broke at ~600m); but a second attempt was successful. The first non-

toxic samples for biogeochemical parameters (Identifier "UW001", Table 3) were collected. Headed east to N3100, where samples UW003 were collected. Slightly ameliorated winds allowed the first deployment of Alejandro Isla's zooplankton net, (Identifier "01", Table 4). In response to a pre-cruise query (BODC) over the performance of an RVS fluorometer (serial no. 254), that was fitted into the 'on-deck' system, this instrument was replaced by the spare (serial no. 234). This resulted in ~30 minutes down-time for ship's Level B measurement of underway parameters, from ~15:45. Headed east to N2000 (Master changed position to 42°59'47"N, 009°49'56"W, because of heavy shipping traffic). Headed east to N2300, where samples UW005 were collected. Continued east; collecting surface samples whilst passing through stations N1600, N220, N170 and N100. Headed south to station O100, having requested a reduction of ship's speed (to 3kts), as underway sampling frequency was too high for scientific watch-keepers.

Thursday 8th January *(Julian Day 008)*
Heading west: passed through station O100 (UW010); hove to on station O140 (UW011); collecting surface samples whilst passing through stations O175, O1000 and O2000; hove to on station O2650 (UW015); continuing west. At 08:40, the Master reported a freshwater shortage and requested that the scientific sampling should be restricted to an area at least 20 miles offshore until after 22:00 tonight, to allow the ship's desalination plant sufficient production time. A scientific briefing was held, at 10:30, in the main laboratory to explain the situation. Planned to move from O3100 directly to Q2500: missing out the important Line P from the surface sampling, in the hope that it can be sampled in more detail should a suitable weather window appear. On station O3100 (UW016), where slightly ameliorated winds allowed the third and fourth deployments of AI's, and the first of Andrew Hirst's WP2 zooplankton nets (Table 4). Headed south to station Q2500, with speed at 5kts, to reduce sampling frequency for the watch-keepers. The force 7-8 NW winds were forecast not to change. Hove to on station Q2500 (UW017), then headed east to station Q2200 (UW018); where the winds were too strong for deployment of AH's WP2 net. Received an e-mail from Martin white, explaining that the Galway ADCP had been recovered by the 'Spanish maritime authorities', and would hopefully be made available for loading during our port call in Vigo in 16th January. Continued east, collecting surface samples whilst passing through station Q2000; still unable to stop for AH's WP2 net, due to strong winds.

Friday 9th January *(Julian Day 009)*
Continued east, collecting surface samples whilst passing through stations Q1500, Q600 and Q136 (Q1000 was not sampled, in error). It was not possible to sample the coastal stations Q100 and R100, due to the uncertain, shallow bathymetry and prevailing strength of the inshore winds. Headed south to R136, collecting surface samples whilst passing through; then on to stations R150, R200 and R600, collecting samples from the non-toxic at each station whilst hove to (in order to consider possibility of over-the-side deployments). At 10:00, the Master reported a continued freshwater shortage and requested that the scientific sampling should be restricted to an area at least 15 miles offshore for a period in excess of 24 hours, to allow the ship's desalination plant sufficient production time. Held a scientific briefing, in the main laboratory, to explain the situation. Planned to continue west along Line R, then move south from R2500, sampling at S2550, T2500, U2800, V3100 - giving a significant period outside the 15 mile 'exclusion zone' imposed due to the lack of freshwater. However, the wind speed increased to >40kts, from the south, so we had to alter the plan and head south, earlier than anticipated; resulting in a course for station S1000. The latest weather maps showed a significant strengthening of winds over the whole OMEX area, and large low-pressure systems building up to the west of our position, and out in the mid-Atlantic. Reached S1000 and hove to for collection of samples UW027 from the non-toxic supply. Wind conditions

allowed the fifth deployment of AI's zooplankton net; but the swell caused the wire to jump out of the block into the gear mechanism, so the haul was aborted. Headed for station T1000 at 2kts, to allow Simon Mitchell to repair and re-terminate the starboard winch wire. Toby Sherwin attended his meteorological package, situated on the monkey island. It had swivelled slightly on its access due to string winds: recording gusts in excess of 45kts during the previous 24 hours. Hove to on station T1000, where surface samples (UW028) were collected, and the second deployment of AH's WP2 net was made. Continued south to station U1000.

Saturday 10th January *(Julian Day 010)*

On station U1000, surface samples (UW029) were collected whilst AI's sixth net deployment was made. Headed south for station V2200 (continuation of the north-south latitudinal line), stopping at 41°36.04'N, 009°25.04'W, to sample a second additional station ("Extra 2", Identifier UW030) from the non-toxic supply. At 06:00 was informed that there was a possibility of a CTD deployment at station V2200. Relatively good weather had been forecast in the extreme east (force 3) and in the southwest (force 3-4) of Finisterre, with V2200 lying in between the two. Hove to on station, the first CTD deployment (Identifier 045, Table 5) was made to full depth. Although both transmissometers were cleaned, and 'zeroed' in air, for Ian Hall (Univ. Camb.), there was a problem with "Trans. 1". The solution was to change over one of the CTD signal break-out boxes for the spare; but this resulted in the loss of the upwelling PAR signal from future CTD deployments. A variety of biogeochemical parameters were sampled: details of which can be found with Table 5. After scientific sampling from the CTD was completed, we headed directly for the inshore station V110 (to obtain contrasting oceanographic regimes along the same longitudinal transect; in case the weather turned and restricted further over-the-side work). On station V110, the IIM spectroradiometer light rig was deployed for the first time, to obtain their profiles of downwelling, then upwelling irradiance (Identifiers 01 & 02, Table 6). During the second cast (for upwelling irradiance), the ocean swell caused the data-logging connection to twist; this prevented use of the system for future collection of upwelling profiles. Immediately after obtaining light profiles, three CTD casts to 100m were performed: CTD046, for P*v*I, and microzooplankton incubation experiments; CTD047,for general biogeochemical parameters; and CTD048, for radionuclide and suspended particulate matter (SPM) calibration material. Taking advantage of the continued 'good' weather, a series of zooplankton nets were also deployed; ending with AH's first 10m drifting net (Table 5), for collection of live copepods. A first attempt to deploy the UCNW Free-Falling Light Yo-yo (FLY) probe (Identifier 'Series *', Table 7) was aborted due to PC software problem. Headed west, towards V2400. FLY was successfully re-deployed during the passage, heading at 0.5kts towards V2400.

Sunday 11th January *(Julian Day 11)*

Hove to on station V2400 (UW031) from 00:26, due to bad weather: scientific programme suspended until daylight. Winds speeds were consistently 40-45kts from ~0100-0130 this morning; reaching 60kts ('violent storm', force 11) around 0430. Tomorrow's forecast was for southerly force 5-7, gusting force 8; but looking to pick up by 14th January. Made way north, hove to on station "Extra 3" for surface sampling (UW032), then continued north to U2000, collecting surface samples whilst passing through, and on to T1600, T2000, just south of T2100 (42°00.1'N , 009°49.8'W) and T2500, where surface samples were once again collected whilst hove to. The shipping forecast at 18:00 warned of gales, force 6-8, gusting force 9, from the SE in east Finisterre, and the NW in west Finisterre. Starting on station, FLY (Series 02) was deployed at 0.5kts; heading north for station S2600.

Monday 12th January *(Julian Day 012)*
Heading east, hove to on stations S2600, S2550 and S2250, for surface samples (UW038-040) collection. The shipping forecast at 06:00 was for cyclonic force 6-8, occasionally severe gale force 9. Continued east to S2000, collecting surface samples (UW041) whilst passing through. Vessel had to hove to at 12:00 (41°08.8'N , 009°33.9'W), due to adverse weather conditions (winds 150 true, 40-55kts, rough sea, heavy swell): scientific programme halted.

Tuesday 13th January *(Julian Day 013)*
During the night, we drifted SW to ~42°02'N , 009°30'W. At 06:00, winds up to severe gale, force 9, were forecast. Our passage was severely restricted by the wind and sea-state, and we made slow progress during the early part of the morning, back towards Line S. By 13:30, we had reached north of Line S, with our only option heading towards Line R. The bridge were instructed to continue NW, aiming for the most westerly station on Line P. From 14:00, a bi-hourly surface sampling programme was instigated, to track our steady progress NW. These samples are recorded as UW042-UW048 (*i.e.* "Extra 04-10") in the sampling log (Table 3).

Wednesday 14th January *(Julian Day 014)*
By 0200, the swell had eased sufficiently, enabling passage to station P2800, where vessel hove-to. Even though conditions for over-the-side science were still somewhat marginal the FLY probe was deployed (Series 3), steaming at 0.5kts. As the weather and sea-state had improved considerably, the CTD 049 was deployed to full depth; for the sampling of biogeochemical parameters. The intention, then, was to move east along Line P, sampling stations as required. However, there was little confidence in the weather conditions holding out, so, at 1105, a course was set for the known site (42°40'34"N , 009°29'36"W), where STABLE was grappled and recovered in daylight - just as the wind and swell began to worsen. Made way for the shelf break station, P200, to try and obtain samples in broadest oceanographic contrast to the deep water station P2800, sampled earlier. On station: AI's zooplankton net was deployed for the seventh and eighth times; followed by the IIM spectroradiometer light rig was (for downwelling irradiance); CTD 050 , down to 175 m, for incubation experiment samples; and AH's fourth WP2 net, and second 10m drifting net. These were followed by the first deployment of the Stand Alone Pumps (SAPs) during this cruise. In the first, of an intended series of three casts, two SAPs (Identifier "SAP1", Table 8) were set at shallow depths (25 m and 50 m), to pump for one hour. Whilst the SAPs batteries were re-charged, FLY was deployed (Series 4), moving at 0.5kts. After repositioning on station, and CTD 051 was deployed to 180 m, for the sampling of biogeochemical parameters. In the second cast of the series, two SAPs were set at intermediate depths (105 m and 155 m), to pump for one hour. Unfortunately, the sea state and weather conditions deteriorated rapidly (producing unworkable rolling and pitching of the ship), and the SAPs deployment had to be curtailed twenty minutes early. [The nature of sample collection from SAPs is such that premature retrieval renders the data unusable.]

Thursday 15th January (*Julian Day 015*)
A planned CTD cast for collection of radionuclides and SPM calibration material had to be aborted, due to a problem with the 'Level B' computing system. Hence, the deployment of FLY (Series 05) was brought forward in the programme. CTD 052 was deployed afterwards, to obtain samples for radionuclide and SPM calibration experiments. Headed for station P100, where FLY (Series 06) was deployed; followed by CTD 053 (biogeochemical parameters), before heading west for P1000. This station is close to the "IfM 2" sediment trap mooring (42°38.753'N , 009°41.859'W;

1450m), and provides an intermediate between the coastal P100, the shelf P200, and the oceanic P2800 stations already sampled along the transect. On station, CTD 054 (biogeochemical parameters) was deployed first; followed by a the first (shallow depths) in a series of three SAPs casts. Whilst the SAPs batteries were recharged, the IIM spectroradiometer was deployed (for downwelling irradiance); followed by CTD 055 (incubation experiments); and AH's WP2 zooplankton net. The second (intermediate depths) SAPs cast was followed by a FLY deployment (Series 07), and CTD 055 (radionuclides and SPM calibration), then the final (deeper) SAPs cast.

Friday 16th January *(Julian Day 016)*
The SAPs were recovered at 0106, and a course set for station S1000. This would allow surface sampling of stations along the OMEX Reference Line S: S1000, S600, S300, S150, S130, during our overnight passage to Vigo. The ship's logged underway parameters, and ULg's pCO_2 and pH measurements continued until 0700; when the non-toxic supply was turned off in preparation for the Vigo port call. At Vigo (with calm winds and bright sun !), scientists from IIM (Martinez, Salgado, Tilstone), UVigo (Barciela) and UOviedo (Isla) disembarked, together with scientific equipment. The trawled ADCP mooring (UCG) was loaded, for transportation to Southampton. After around six hours in port (and a very welcome respite from the 'hostile' weather conditions) we left the berth and commenced our passage to Southampton. The thermosalinograph and non-toxic supply were restarted and a bi-hourly DOC/TDN sampling programme was commenced. Continuous measurement of pCO_2 and pH (ULg) from Vigo to Southampton was also undertaken.

Saturday 17th January *(Julian Day 017)*
Continuation of underway sampling programmes, and decommissioning of scientific equipment.

Sunday 18th January *(Julian Day 018)*
During the early part of the morning, the vessel had to hove to, in light of strong winds (in excess of force 11) and heavy westerly swell. The discrete underway sampling programme was suspended. Nine hours later, the weather had abated sufficiently for us to resume passage. The Continuation of underway sampling programmes were resumed, and decommissioning of scientific equipment continued.

Monday 19th January *(Julian Day 019)*
Continuation of underway sampling programmes, and decommissioning of scientific equipment. The non-toxic supply was switched off during approach to The Needles, Isle of Wight, heralding the end of the scientific programme. By 1430, the vessel was securely moored outside SOC.

5 SCIENTIFIC & TECHNICAL REPORTS

5.1 DETERMINATION OF DISSOLVED ORGANIC CARBON AND NITROGEN

Georgina Spyres with Axel Miller

(Plymouth Marine Laboratory, UK)

INTRODUCTION

The Ocean Margin Exchange project is aimed at measuring and modelling exchange processes at ocean margins so as to develop global models in order to predict the impacts that environmental changes may have, specifically at the coastal zone. One of the key areas of investigation in the project (OMEX II – II Work Package II) is dissolved organic carbon (DOC) and its impacts on the marine carbon cycle. In turn, further investigations on the processes that control the fluxes of organic carbon at the ocean margin will aid in constructing and understanding the cycles of carbon and its associated elements, (*e.g.* dissolved organic nitrogen, DON). Shipboard analysis of DOC and DON involves the use of high temperature catalytic oxidation (HTCO) technique, a rapid and precise technique.

Cruise 110 – Leg B of the OMEX cruises is an opportune chance to measure organic matter under characteristic winter conditions of the area of study. The incident northward warm and saline current off the Iberian margin hinders shelf ocean exchange and evokes trapping of colder, fresh water from the rias that is enhanced in nutrients, potentially increasing biological production near the coast. Sample collection at the specified stations will enhance our understanding of processes on a spatial and temporal scale.

METHODOLOGY

The HTCO technique involves the direct injection of aliquots of seawater samples that have been filtered, acidified and decarbonated in the Shimadzu TOC 5000 analyser. The sample, carried by pure oxygen gas, is passed through a catalyst (Al/Pt) at high temperatures (680° - 900° C) and converted into CO_2 gas. The latter is quantitatively measured by a solid state Infrared Gas Analyser (IRGA) (i.e. LiCor 6252), which is not sensitive to the roll of a ship making it ideal for use in shipboard analyses. The data produced is recorded onto a PC-based integration system for subsequent reanalysis.

Total dissolved nitrogen (TDN) is determined through the use of an Antek 705D Nitrogen Specific Chemiluminescence Analyser. The nitric oxide radicals produced from the combustion of nitrogenous compounds in the seawater samples under an oxygen atmosphere at 680° C react with ozone to produce excited nitrogen dioxide species, which emit quantifiable energy as they return to their ground state. Nitrogen based nutrient data (obtained from X.A. Alvarez-Salgado, IIM, CSIC) is used to correct the concentration of TDN to produce a measure of DON.

OBJECTIVES

Determination of HTCO-DOC/DON along transects across the Iberian shelf. Priority is given to transects N, P, and S.

Collection of samples for a DOC intercalibration exercise among PML, IIM, and ULB.

Collection of samples for DOC and DON from the surface, and down the water column to be analysed on board, and preservation of samples for analysis at the PML.

Collection of data for the comparison of HTCO-DOC with inorganic carbon measurements (A. Borges, ULB).

In addition, measurements of HTCO-DOC/DON to be compared with subsequent measurements of Work Package 2 (*e.g.* pigments, salinity, oxygen, temperature).

SAMPLES COLLECTED

Samples were collected from all of the non-toxic supply (UW) stations during passage (Table 3), and from nine 'biogeochemistry' and 'incubations' CTD casts (Table 5). Additional samples were collected from the surface along the transect from Vigo to Southampton, giving a two-dimensional transect through oceanic, slope, shelf and coastal waters. At approximately bi-hourly intervals (commencing at ~18:00, Day 016), a sample was collected from the non-toxic supply; identified as DOC01 - DOC22.

SUMMARY OF ACHIEVEMENTS

Although, the prevailing weather conditions were unfavourable for CTD sampling, full depth profiles for a number of stations, several along transect P, were possible. Through CTD profiles of oxygen, temperature and salinity, a poleward slope current of warm, saline water was detected.

HTCO-DOC measurements were made on the first four CTD casts, the fourth being part of an intercalibration exercise among PML, IIM and ULB. Unfortunately, a limit on time hindered the reanalysis of the raw data and concentration profiles were not produced.

Participation in the on-going international DOC intercomparison programme, organised by J. Sharp (Univ. Delaware) and D. Hansell (Bermuda BSR) was successful. The DOC reference materials were used within specified analytical protocols. The reference samples are used to assist in the evaluation of the operation of the instrument, and monitor the consistency of the analyses over time.

Aliquots of all samples were preserved and archived for subsequent analysis at PML.

5.2 PRODUCTION OF DISSOLVED ORGANIC CARBON

Rosa M. Barciela Fernández

(University of Vigo, Spain)

OBJECTIVES

To describe the latitudinal and vertical production of dissolved organic carbon along the OMEX area.

METHODS

Quadruplicate water samples were collected from the Niskin Bottles at 4 depths (see below) on each CTD station (Table 5) for the determination of dissolved organic carbon (DOC) production. These samples were contained in 30ml glass bottles; spiked with 35µCiNaH$^{14}CO_3$ and incubated in an on-deck incubator for 2.5-3 hours at an irradiance level close to the original irradiance experienced by the phytoplankton cells. At the end of the incubation 10 ml of each sample were filtered by glass microfibre filters (GF/F) and added 0.5 ml of HCl. During 24 hours the samples were stirred for removal the inorganic ^{14}C and 3.5 ml of scintillation cocktail were added to each vial for later determination of radioactivity using a liquid scintillation counter.

After filtration the liquid was acidified with HCl to pH 2. During 24 hours the samples were bubbled for removal the inorganic ^{14}C and 14 ml of scintillation cocktail were added for later determination of radioactivity as described above.

Characteristics of the CTD stations sampled

Station	Latitude, N	Longitude , W	Depths (m)
V110	41º 25' 05"	009º 06' 06"	75, 51, 26, 8
P200	42º 40' 07"	009º 29' 53"	76, 52, 26, 8
P1000	42º 44' 11"	009º 35' 54"	78, 52, 29, 9

5.3 SHIPBOARD DETERMINATION OF MICRO-NUTRIENTS

Xosé Antón Alvarez-Salgado

(Instituto de Investigacións Mariñas, Vigo, Spain)

INTRODUCTION

Analysis of 5-nutrient salts aboard during two cruises (under summer/upwelling and winter/poleward conditions) is one of the commitments of the IIM-CSIC within the framework of the EC funded OMEX-II phase-II Work-Package 2. Cruise RRS Charles Darwin 110- leg B (January 6 to 16) bring us the opportunity to map the distribution of nutrient salts when the warm, salty and nutrient-poor poleward slope current off the Iberian Peninsula is usually observed. The poleward flow precludes shelf-ocean exchange provoking the accumulation of cold, fresh and nutrient-rich water from the rias (large indentations in the Galician coast) over the shelf.

METHODOLOGY

Samples are directly drawn from the Niskin bottles into 50ml polyethylene containers and preserved at 4 °C until subsequent analysis on board. Nutrients (in the micromolar range) are determined colorimetrically with an 'Alpkem Corporation' auto-analyser (Perstorp Analytical, Wisonville, USA), working under the principle of Segmented Flow Analysis (SFA). The signals from the five colorimeters are recorded in chart paper and peak height needs to be measured manually.

OBJECTIVES

Our main objectives during this cruise are:

To produce full-depth 5-nutrients profiles at the stations where the CTD probe is dipped. Preference should be given to OMEX key lines N, P and S.

To measure 5-nutrients from the 4 m deep non-toxic underway supplies, where other discrete samples are going to be collected too.

To measure ammonium and phosphate from the incubation experiments by A. Isla (Univ. of Oviedo, Spain).

To take replicate samples for an intercalibration among the OMEX partners with nutrient duties (IIM, PML, ULB and VUB). Samples should be frozen to -20°C and distributed to the different labs through scientists on board. Samples should be collected in the OMEX reference stations along the S line.

To test the 'Alpkem Corporation' analyser over a seagoing research platform.

SAMPLES COLLECTED

Due to the inclement weather conditions during the cruise, full-depth profiles of 5-nutrients were only collected on eight CTD casts (Table 5). In addition, discrete samples (a number of 48) were taken from the non-toxic underway supply at any time we intercept a station in the cruise schedule (Table 3). Ammonium and phosphate has been determined in the incubation experiments run by A. Isla to assess excretion rates at stations N3100, 03100 and P200. All samples were analysed on board.

SUMMARY OF ACHIEVEMENTS

The 'Alpkem Corporation' analyser is able work within high standards of accuracy at sea, even under the inclement weather conditions during the cruise.

A poleward slope current has been observed, carrying warm and salty water (14.5-16.0 °C and salinity >35.8 respectively, from the underway supply). A quick look to the recorder chart paper shows that nitrate, phosphate and silicate levels are low within the poleward domains. On the contrary, the concentration of nitrate, phosphate and silicate sharply increases at the stations over the shelf, where the poleward slope current confines the continental water. Nitrite and ammonium remains low (<0.05 $\mu mol \cdot kg^{-1}$ and ~0.0 $\mu mol \cdot kg^{-1}$, respectively) in both the oceanic and coastal domains.

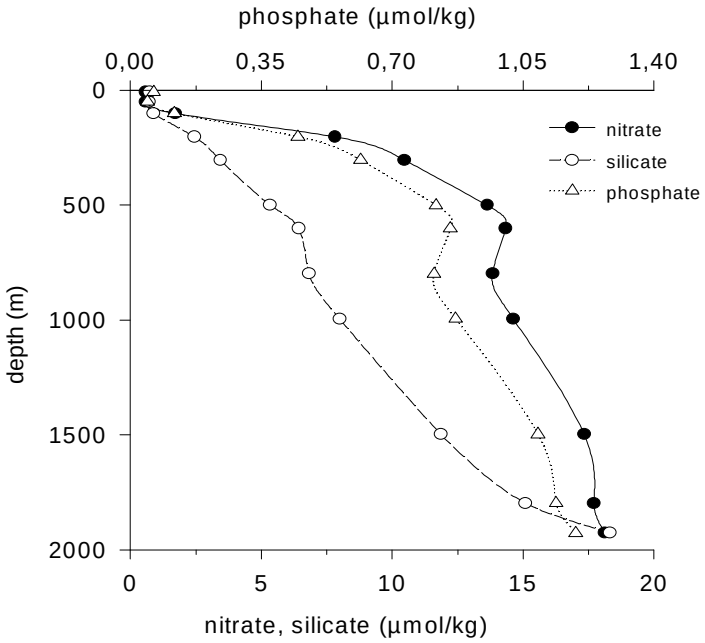
A full-depth profile of nitrate, phosphate and silicate in an oceanic station is shown (Figure A). Low concentrations were recorded in the ~100m deep upper mixed layer. Nutrient levels increased down to the bottom within the expected ranges for the water masses involved: Eastern North Atlantic Central Water (ENACW), Mediterranean Overflow Water (MOW) and Labrador Sea Water (LSW). The most striking feature over the shelf is the sharp transition from the poleward (low nutrients) to the coastal (high nutrients) domains. In addition, bottom waters over the shelf show very high nutrient levels.

Samples for the intercalibration experiment were collected at two CTD stations (Table 5), one on the shelf (P200) and one on the slope (P1000). Weather conditions prevented us from taking the samples at the reference stations in line S. They were directly drawn into flasks provided for the different partners (IIM, 50 ml polyethylene; PML, 50 ml polycarbonate; ULB, 100 ml polycarbonate; VUB, 50ml polyethylene). The unfiltered samples were frozen at -20 °C after collection.

Summary of samples collected for the nutrient intercalibration exercise

CTD-Cast	Station	Depths (m)
051	P200	9, 52, 76, 106, 155, 180
055	P1000	7, 52, 103, 147, 205, 302, 423, 600, 796, 994

Figure A Full-depth profiles of nitrate, phosphate and silicate at station V2200



5.4 PHYTOPLANKTON COUNTS, P-E CURVES AND BIO-OPTICAL PARAMETERS.

Gavin Tilstone & Luisa Martinez

(Instituto de Investigacións Mariñas, Vigo, Spain)

INTRODUCTION

Upwelling predominates along the Galician coast from April to September. And downwelling from September to October. During the winter period a poleward slope current of saline, warm oceanic water usually occurs, that blocks the exchange between the slope and the open ocean and confines coastal water over the shelf which promotes the sinking of particulate organic matter. Primary production is expected to be low and particulate matter high during the poleward current. To date, very little data has been collected during this time of the year and the CD110B cruise therefore offers the opportunity to quantify phytoplankton community primary production and light absorption and particulate matter light absorption during the winter poleward current.

OBJECTIVES

1. To map the phytoplankton community distribution and biomass along the OMEX II-II WP2 transects from 43° N to 41° N.

2. To study differences between P-I values, spectral underwater light field, phytoplankton light absorption spectra, phytoplankton carbon content and the derived corresponding bio-optical parameters such as spectral photosynthetic parameters, maximum quantum yields, daily-integrated primary production and carbon-specific phytoplankton growth rates at OMEX II coastal and oceanic stations during the winter pole-ward current.

3. Using data from previous OMEX II cruises and this cruise, to study the seasonal variation in these variables.

METHODOLOGY

Phytoplankton samples were taken at different stations along the OMEX II transects and preserved using KI. Phytoplankton counts and identification will be done in the laboratory using an inverted microscope.

Primary production was measured using $NaH^{14}CO_3$ inoculations and short term incubations (3 hours). Fixed C14 will be measured at IIM labs. using a Packard scintillation counter.

Phytoplankton and detrital light absorption spectra were derived from measurements on GF/F filters using spectrflourometry and spectrphotometry techniques.

The downwelling spectral light field of the water column was measured using a LiCor spectroradiometer in order to calculate integrated primary productivity and phytoplankton light absorption.

SAMPLES COLLECTED

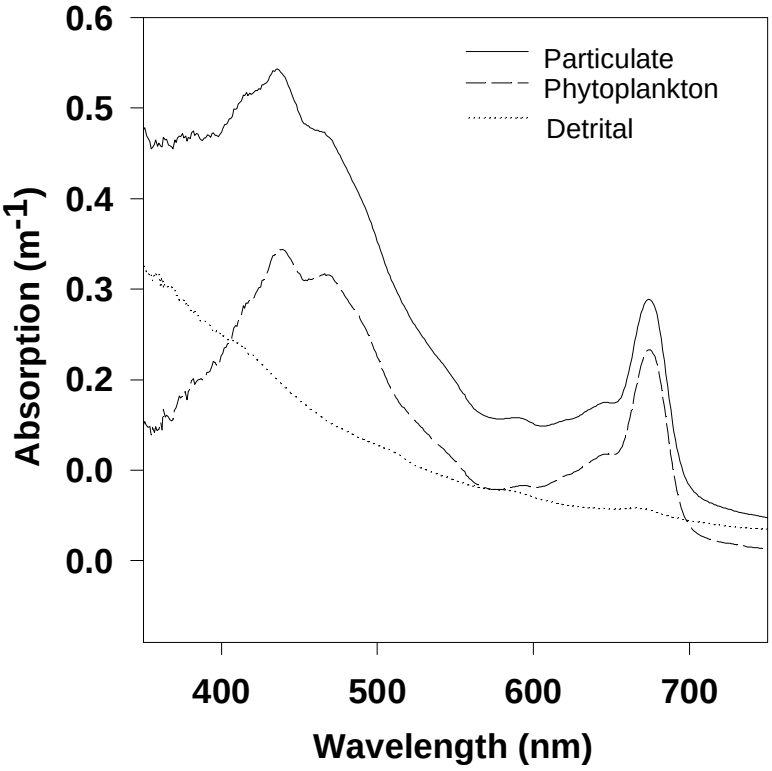
Samples were collected from all from all of the non-toxic supply (UW) stations during passage (Table 3), and from 'biogeochemistry' and 'incubations' CTD casts (Table 5). Additional samples, for determination of primary production and light absorption, were collected from the following UW stations: 26, 27, 32-36, & 41-43. Details of spectroradiometer casts are provided in Table 6.

PRELIMINARY RESULTS

Fifty-three stations were sampled for phytoplankton, 14 stations for primary production and bio-optics, 5 CTD casts and 3 spectroradiometer profiles were made. Despite the fact that bad weather stopped sampling on the 12th and 13th Jan., sufficient reference sites were sampled over the shelf to give an idea of the primary production during poleward and high mixing conditions.

Figure A presents light absorption data at the chlorophyll-*a* max (26 m) at station V110.

Fig. A Particulate, phytoplankton and detrital light absorption at station V110 26m.



A comparison with data collected during the OMEXII Belgica cruise in June 1997 indicates that detrital light absorption is 4 times higher in the red end of the spectra in winter, whereas phytoplankton absorption is 2 times lower.

5.5 MESOZOOPLANKTON RESPIRATION AND EXCRETION

Jose Alejandro Isla de la Roz

(Departamento de Biologia de Organismos y Sistemas, Universidad Oviedo, Spain)

INTRODUCTION

Respiration and excretion are two of the principal metabolic processes of zooplankton, which are fundamental in understanding the secondary production in the ocean. During this cruise, we expect to obtain data from the poleward current (which is the typical winter situation on this area) and to measure its effects on these metabolic processes. Few studies have compared respiration and excretion rates between coastal and slope locations, which differ hydrographically, and this cruise also offers an opportunity to do this.

METHODOLOGY

My initial plan for this cruise was do two hauls each day with a WP2 net (triple) plus an additional haul at midnight. Since one cod-end was lost on the first day due to large swells, I was subsequently only able to take two samples by haul. Haul samples were filtered. The two samples from the first tow were analysed for gut contents and C/N analysis. From the second tow, samples were taken for taxonomic composition and zooplankton were collected for on deck incubations using the following size classes: 200-500 μm, 500-1000 μm, and >1000 μm.

The zooplankton for incubations were placed in filtered seawater at 16 ^{o}C. After 1-2 hours acclimatisation, zooplankton were transferred to incubation bottles and placed in on deck incubators. Two bottles with filtered seawater only were used as controls, which we used as background measures for nutrients and oxygen. After 16 hours of incubations, sub-samples were collected from all bottles for nutrients, oxygen, and C/N analysis. One sample for C/N analysis and another sample for gut contents were taken from the night hauls.

OBJECTIVES

The main objective of this study was to calculate excretion and respiration rates of mesozooplankton, and see if these metabolic rates are affected by the zooplankton size class and by the biological variables such as C/N ratio, taxonomic groups and gut contents, and physical hydrographic variables. Samples from daytime and night-time hauls were analysed for C/N and gut contents to look for diel differences. (My initial idea was to take the samples along an OMEX line, and to have the CTD data from the stations where I would collect the zooplankton for the incubations, but…)

I must analyse the samples in Oviedo to have some conclusion, but I'm not very optimistic because of the very few stations sampled.

SAMPLES COLLECTED

Summary of samples collected and the analyses which will be performed on them

Station	Day	Time	Incubation	Taxonomic Composition	Gut Content	C/N
N3100	7 Jan	15:00	X	X	X	X
O3100	8 Jan	13:30	X	X	X	X
U1000	10 Jan	00:04	-	-	X	X
V110	10 Jan	17:00	-	-	X	X
P200	14 Jan	14:30	X	X	X	X

Greater details of the net haul sampling stations are given in Table 4.

5.6 MESOZOOPLANKTON IDENTIFICATION AND QUANTIFICATION

Andrew Hirst

(Southampton Oceanography Centre, Empress Dock, Southampton, SO14 3ZH)

INTRODUCTION

Mesozooplankton are the dominant trophic link between primary production and fish. They constitute an important pathway by which material is transformed in the upper mixed layer, and transported into the ocean interior through their vertical migration, respiration, and the sinking of faecal pellets, dead bodies, eggs, and exuvae. Understanding their role in the movement of carbon and nutrients is essential in describing the fluxes of these materials. Investigations of copepods are important since they typically constitute the largest fraction of the mesozooplankton, and are the dominant metazoan grazers in the world's oceans.

OBJECTIVES

The objectives of this cruise were to collect quantitative mesozooplankton samples using the Longhurst-Hardy Plankton Recorder (LHPR) and vertical tows of WP2 nets. Our specific aims were to continue the spatio-temporal mapping of mesozooplankton biomass and taxonomic composition within the epi-pelagic region (0-200m) of the OMEX II area, samples having previously been collected in this region using such methods in the summer of 1997 (cruise CD105 B). Describing biomass and its variability is particularly important as this term typically explains most of the natural variability in grazing and production in any region.

This was to be the first OMEX II cruise in which weight-specific growth measurements (g) were to be made, together with quantitative estimates of biomass (B), and secondary production (Bg). The technique chosen to determine growth was the egg production method.

ACHIEVEMENTS

Quantitative Sampling

Due to bad weather, much of the sampling program could not proceed as planned. Vertical nets tows collected using a WP2 200 mm net were however completed at the locations, integrated over the depths indicated in Table 4. Tows were vertical from 200 m to the surface, unless the water depth was insufficient, in which case ~90% of the water depth was sampled. No LHPR samples were collected because of the unfavourable weather conditions.

Growth Rate Determination

At the V110 and P200 sites a 200 mm drifting net was used to collect live copepods from a depth of 25 m. Water was also collected using Niskin bottles form this depth, and after pre-screening through a 64 mm mesh, was used as a natural food source. Adult females were separated using a binocular microscope and incubated in the natural seawater at ~15.5 °C for a period of 24 hours, after which live animals were preserved in 4% borax buffered formaldehyde-seawater. These samples will be analysed later in the laboratory with respect to the body weights of adult females, and the number and weight/diameter of eggs produced.

5.7 PARTICULATE ORGANIC CARBON, CHLOROPHYLL & ELEMENTAL COMPOSITION

Lei Chou

(Laboratoire d'Océanographie Chimique, Université Libre de Bruxelles, Belgium)

PARTICULATE ORGANIC CARBON AND CHLOROPHYLL

Objectives

To determine the surface and vertical distributions of particulate organic carbon and chlorophyll along the OMEX II transects in winter situations.

Sample Collection

Underway particulate organic carbon (POC) and chlorophyll samples were collected from the ship's non-toxic supply. Two litres of water were filtered for POC onto 47mm GF/F filters pre-ashed at 500 °C during 4 hours and about 250ml were filtered for chlorophyll onto 25mm GF/F filters. The filters have been kept frozen. Analyses will be performed on these samples for POC by high temperature catalytic combustion and for chlorophyll by fluorometry. POC and chlorophyll samples were also collected from the CTD casts in the upper 200 meters. Table 3 summarises the positions respectively for underway samples collected, and Table 5 for CTD sampling stations.

COMPOSITION OF PARTICULATE ELEMENTS

Objectives

To characterise the suspended matter by its composition to evaluate the sources, biogeochemical behaviour in the water column and fate of particulate material during winter conditions.

Samples Collected

Particulate matter was collected by *in situ* filtration of large volumes of seawater at various depths using the Stand Alone Pumps (SAPs) where a polypropylene filter holder was housed directly on top of the pump. Nuclepore filters of 293 mm diameter and 0.4 µm porosity were used. Filters are kept frozen until analysis. Suspended matter will be analysed for major and trace elements. They include Al, Si, Fe, Na, K, Mg, Ca, Mn, Cr, Co, Ni, Cu, Zn, Cd and Pb.

Due to large swells, many filters recovered were not in good condition, *e.g.* displaced or torn. SAP operations including station numbers and sampling depths are summarised in Table 8.

5.8 NATURALLY OCCURRING RADIONUCLIDES: PARTICLE FLUXES & SCAVENGING

Sabine Schmidt

(Centre des Faibles Radioactivités, CNRS, Gif sur Yvette Cedex, France)

OBJECTIVES

Estimate of scavenging intensity and vertical particle fluxes in winter conditions

METHODS

Suitable tools for calculating the intensity of chemical scavenging are the different isotopes of the natural radioactive decay series. In particular the radiogenic isotopes of thorium, all supplied to the ocean by decay of dissolved parents, have been currently used for determining the rate at which they are removed from the water column and consequently the residence time of particles. ^{234}Th (24.1 days) / ^{238}U and ^{228}Th (1.9 years) / ^{226}Th are the more appropriate couple to follow processes occurring in the euphotic layer. The determination of activity ratio over the studied area will bring an overall view of the spatial variability of instantaneous particle fluxes.

Each seawater sample is filtered trough a 0.45 µm filter. After addition of ^{229}Th yield tracer and Fe carrier, separation of dissolved ^{234}Th from its ^{238}U parent is carried out on board by anion exchange, within 24 hours after seawater collection. Within two months after the cruise, particulate Th will be directly measured on the filter with a low background-high efficiency detector. Back to the laboratory, purification of dissolved Th will be achieved. Chemical yield will be determined by a-counting of ^{229}Th, and dissolved $^{234/228}$Th activities by g-counting.

Radium is extracted from seawater by co-precipitation with $BaSO_4$. At the lab, the precipitate will be rinsed, dried, prior Radium measurements by gamma spectrometry.

SAMPLES COLLECTED

Surface seawater was sampled at:
UW009, UW015, UW018, UW020, UW023, UW027, UW028, UW038 (Table 3)

A vertically integrated sample between surface and 100 m depth was taken at:
V2200 and P2800 stations (Table 5)

Three vertical profiles were sampled at:
V110 (8, 50, 85, 104 m), P200 (25, 50, 171, 180 m) & P1000 (7, 51, 100, 202 m) (Table 5).

5.9 INORGANIC CARBON BIOGEOCHEMISTRY IN SURFACE WATERS: pCO_2, TALK & pH

Alberto Borges

(Unité d'Océanographie Chimique, University of Liège, Belgium)

OBJECTIVES

* Mapping of pCO_2, pH and O_2 in subsurface seawater within the OMEX grid.
* Vertical profiles of pH, TAlk and O_2.
* Underway discrete samples for TAlk, O_2 and chlorophyll-*a*.

AIM OF THE WORK

The description of inorganic carbon variations is aimed at understanding the processes controlling the pCO_2 distribution in the margin areas. In the long term it will be possible to comprehend and quantify the impact of margin areas in the global carbon cycle.

METHODOLOGY

* Underway measurements of pCO_2 (dissolved and atmospheric), pH and O_2 (using respectively an infrared gas analyser connected to an equilibrator, a combined electrode and a polarographic electrode) using a fully automated, PC-controlled acquisition system.
* pH, TAlk and O_2 measurements from Niskin samples, using respectively a combined electrode, the Grant electro-titration method and the Winkler method.

CRUISE ACHIEVEMENTS

* Continuous underway measurements of pCO_2 (dissolved and atmospheric), pH.
* pH, TAlk and O_2 measurements from Niskin samples at six CTD stations (Table 5).
* Discrete underway samples for TAlk, O_2 and chlorophyll-*a* (Table 3).

GENERAL COMMENTS

I would like to thank the ship's crew, the R.V.S. staff and scientists for their helpful collaboration and for achieving a very agreeable and friendly cruise despite the weather conditions. However, I would like to point out one problem concerning the sink of the wet lab, where the underway pCO_2 acquisition was installed. Due to a malfunction of the evacuation pump of the sink and the absence of a spare, start of the underway measurements was greatly delayed during the first day of the cruise and the acquisition had to be shut down during the night of the 12th to prevent the flooding of the wet lab. Furthermore, the capacity of the sink to evacuate water was limited so that it I was not able to run the underway oxygen probe. This is a minor problem that I'm sure will rapidly solved and will not arise again.

5.10 TURBULENCE OBSERVATIONS

Toby Sherwin & Ray Wilton

(Unit for Coastal and Estuarine Studies, University of Wales, UK)

AIMS & OBJECTIVES

The FLY turbulence probe makes direct measurements of velocity shear at high frequency. From these measurements it is possible to infer the magnitude of vertical mixing and parameterise it in terms of a diffusion coefficient or mixing time. One of the novel objectives of OMEX II is to make turbulence measurements in conjunction with observations of biological and biochemical variables in order to provide a better understanding of their vertical distribution. In WPII the intention is to measure the spatial distribution of turbulence, although it is recognised that the distribution in the surface waters will tend to be dominated by wind effects - particularly in the open ocean. Below the wind mixed layer, and on the shelf, other factors due to mixing water masses and tidal stirring will be important.

SAMPLES COLLECTED

The measurements were made by making a series of drops of the FLY probe to depths of up to 300 m from the stern of the ship as she moved slowly ahead. On each occasion a series of drops were made in order to permit a statistical picture of the distribution of turbulence to be developed. In the event, seven drops were made successfully (Table 7). In addition to the FLY a recording meteorological package was attached to the monkey island of the ship and made good measurements of wind, temperature and relative humidity throughout the cruise. Sample data from the package are illustrated in Figure 7.

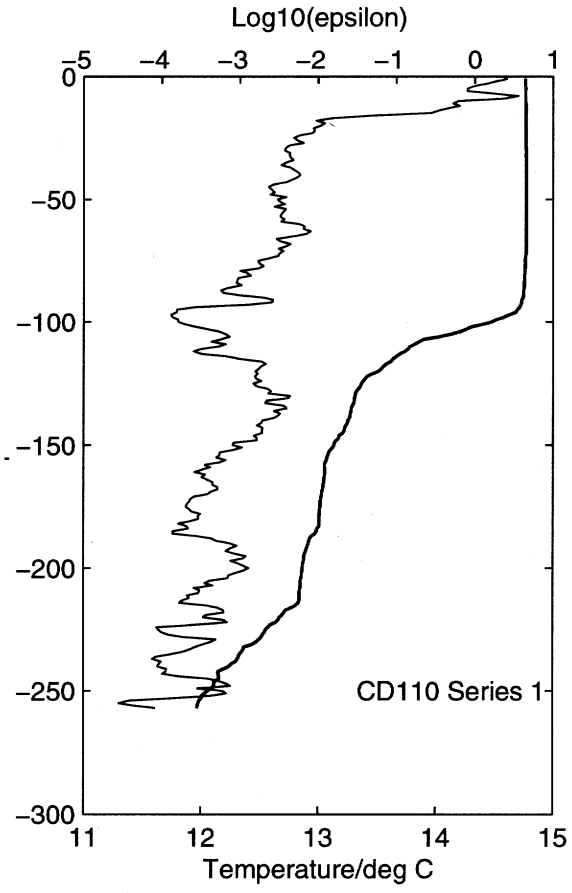
PRELIMINARY RESULTS

Very high levels of turbulent dissipation (epsilon) were observed in the top 20 m of the water column at all stations - presumably the response to the severe conditions encountered during the cruise. Relatively high levels were encountered down to the thermocline where there tended to be a drop in turbulence, particularly in cases where the temperature gradient was sharp (see attached figure). In some deep ocean profiles the turbulence levels then increased again at deeper depths. Somewhat surprisingly, in view of the potential for tidal stirring on the shelf, the turbulence levels at P100 were relatively small except very close to the seabed.

CONCLUSIONS

Despite the disappointingly small number of profiles, some spatial variation in the distribution of turbulence dissipation was observed, particularly at the depth of the thermocline in the ocean. It should be possible to derive some realistic estimates of the vertical diffusion coefficient under severe wind conditions in winter.

Figure A Vertical profiles of turbulence dissipation & temperature near station V1150.



Turbulence dissipation (epsilon) and temperature (thicker, smoother line).
[The values or epsilon should be treated as nominal at present.]

5.11 RVS TECHNICAL SUPPORT

Dave Teare, Jeff Benson, Simon Mitchell, Ritchie Phipps & Paul Duncan

(Research Vessel Services, Southampton Oceanography Centre, UK)

5.11.1 CTD SYSTEM *(Dave Teare, Jeff Benson)*

In total 11 CTD casts were made on this leg of the cruise, this number was limited to periods when weather conditions and sea state allowed the safe handling of the CTD frame on deck. In addition to the CTD itself, the following sensors were available:

1. Transmissometer 1
2. Transmissometer 2
3. Fluorometer
4. Light Back-Scatter Sensor
5. Up-welling irradiance sensor
6. Down-welling irradiance sensor

For the first cast, sensors 1 to 6 were connected, and then sensor 5 was removed for all the subsequent casts. This was a result of a serious noise problem in sensor 1 that was traced to a malfunctioning breakout box. The breakout box was replaced by another breakout box that does not have enough 12 VDC outputs to accommodate all 6 sensors, therefore the up-welling irradiance sensor was removed for the duration of the cruise.

Throughout this leg of the cruise, the maximum depth to which the CTD could be deployed was determined from the 10kHz pinger traces on the ship's EA 500 echo sounder.

5.11.2 UNDERWAY RECORDING *(Jeff Benson, Dave Teare)*

Surface sampling system
The system was run continuously throughout leg B with a break of a few hours while docking at Vigo during offloading of a portion of the scientific party. The starboard PAR light sensor that was not operating during Leg A was repaired during the in-port in Vigo between Legs A and B.

Chernikeef log and Simrad echo sounder
The Chernikeef log was used continuously throughout leg B without any problems. The Simrad EA 500 echo sounder was used continuously without any problems for depths greater than its minimum range of approximately 50m.

ADCP system
The ADCP shipboard system was operated continuously from Leg A through Leg B without problems.

5.11.3 XBT DEPLOYMENT *(Jeff Benson, Dave Teare)*

A total of 19 XBT's were dropped over the course of Leg B, beginning with drop number 61 and continuing sequentially through drop number 79. The drops were of two probe types, T-5 for 760 metres to 1830 metres of depth, and T-7 for less than 760 metres. Of these 19 drops, 2 were partial profiles with problems attributed to probe malfunction, such as the wire breaking prior to bottom depth being reached, but were included among the successful drops. The successful launches were conducted as an alternative to CTD stations when weather and sea-state dictated that performing a CTD cast was not possible. A listing of the launches and relevant details is given in Table 2. This listing indicates the drop number, date, time, position and transmit status. Copies of the XBT log sheets, water column profile, and data disk files of all successful drops have been passed to BODC.

5.11.4 SHIPS SYSTEMS *(Simon Mitchell, Ritchie Phipps)*

Introduction
The term 'Ships Systems' is here intended to cover the items of scientific equipment not covered in other parts of the end of cruise report. These include:

- The ships scientific winches and associated gantries, power and control systems.
- The non-toxic and ultra pure water systems.
- The freezer and refrigeration systems.
- The containerised laboratories.

Scientific winches
The following winches have been employed during leg B:

20T coring winch. (Recovery of stable)
Hydrographic winch. (Plankton nets)
10T conducting winch. (CTD)

In general the winches have performed without failure in accordance with the requirements of the scientific program. Not withstanding the limitations imposed by sea state. Problems have arisen with the winch control displays in the main lab and Stbd. gantry. Fortunately, these have been an inconvenience to the RVS technicians only and have not hampered scientific operations or compromised safety.

Non-toxic and ultra pure water
The non-toxic supply has operated without significant interruption throughout leg B, while the ultra pure water system has been heavily used and has required the replacement of one first stage filter.

Freezer and refrigeration
These have performed without fault providing storage at + 5 and -20 degrees C.

Containerised laboratories
These have been used continuously during leg A and have operated within specification.

5.11.5 COMPUTING *(Paul Duncan)*

Introduction
The RRS Charles Darwin is fitted with a fairly standard RVS ABC computer system, comprised of Mk I and Mk II Level A computers, a Mk II Level B computer and a Sun SPARC station IPC based Level C system.

Data Logged
During the cruise a variety of data were logged. Navigational data from the Ship's gyro, Chernikeeff log, Trimble 4000 GPS, Decca Mk 53G GPS and the Ashtech GG-24 combined GPS and GLONASS receiver. Scientific instruments logged include the Neil Brown Mk IIIB CTD, and its associated bottle firing system, the Simrad EA-500 echo sounder, and the RVS SIG designed surface logging system which includes a thermosalinograph, fluorometer, transmissometer and port and starboard light meters.

In addition, data was logged through Levels A & B and time-stamped using the Ship's clock. The ship-borne ADCP system was logged directly to the Level C. The ADCP clock was around two days out for the entire cruise and log sheets detailing the differences between ADCP clock and Ship's clock were kept.

Events
The first five CTD (bogus) casts were actually deck data, and not logged, although there is some deck-logged data in the ctdp016d stream. On day 359 the B-C ethernet link failed just after lunch. Data backed up on the Level B, and the link was later re-initialised. No data was lost. At around 16:45 the same day, the Level B went into "Black Hole" mode, which triggered the "Red Alert" alarm. The system was restarted and logging continued again. On day 007, at around 17:00, the surface logging was re-started after the fluorometer was changed. On day 015, at approximately 01:00, "Black Hole" number three occurred. Unfortunately, after this, the Level A logging the CTD started crashing each time data was applied. It tried talking to it using "SPORT 2", one of the Ship's terminal servers, but unfortunately this had crashed, and each time an attempt was made to re-boot it (including power-cycling), the "diagnostic error" LED would stay lit. Eventually I talked to the Level A using one of the SIG CTD Pcs. Everything seemed fine with the Level A and as soon as the CTD data was connected to it, it suddenly started working again. On day 019, at approximately 09:50, I was informed that the "Red Alert" alarm was sounding again. It turned out that the Level B had gone into "Black Hole" mode at 09:30, so we lost around twenty-five minutes of data.

Two types of plot were produced for each CTD cast (*e.g.* Figures 4 & 5). Charts were produced showing positions of the cruise track and sampling stations (CTD casts, XBTs). Bottle data were produced for selected CTD casts.

5.12 ADDITIONAL SCIENTIFIC NOTES

Explanatory text relating to collaborations with scientists not onboard

(OMEX II WP2 & WP3 Partners)

5.12.1 BACTERIOPLANKTON *(Helena Galvao, Univ. Algarve, hgalvao@mozart.si.ualg.pt)*

Vials and fixative for collection of ~100 bacterioplankton samples were brought onboard by Carla Garcia (CD110A). The group of Alvarez-Salgado (IIM) agreed to collect samples, and arrange transport to UA. It was requested that sample collection be concentrated on the three OMEX reference transects (stations and depths at the sampling scientist's discretion). Samples were collected from all of the non-toxic supply (UW) stations along the 'N' and 'S' OMEX reference lines during passage (Table 2), and through the upper 200m from four CTD casts (Table 5). Water (20ml) samples were fixed onboard, with 25% glutaraldehyde (1.6ml). These will subsequently be filtered, prior to determination of bacteria counts and biomass using 'Acridine Orange Direct Count' with epifluorescence microscopy.

5.12.2 MICROZOOPLANKTON *(Elaine Fileman, PML, ese@wpo.nerc.ac.uk)*

Microscopic analysis can be used to determine both the community structure and the biomass of autotrophic plankton. The most appropriate method involves epifluorescence microscopy, which allows the differentiation of autotrophs from heterotrophs based on the presence of red chlorophyll autofluorescence. Organisms can be separated into cyanobacteria, cryptomomand, various sizes and species of dinoflagellates and other flagellates. Samples were collected from all of the non-toxic supply (UW) stations along the 'N' and 'S' OMEX reference lines during passage (Table 3) and through the upper 200m from four CTD casts (Table 5). Microzooplankton were preserved through the addition of water (~500ml) to 1% Lugols, for the subsequent determination of total biomass and species composition in the laboratory.

5.12.3 PIGMENTS *(Stuart Gibb, PML, swg@wpo.nerc.ac.uk)*

The photosynthetic pigments, particularly chlorophyll *a* (Chl-*a*) have long been recognised as unique molecular markers of phytoplankton biomass. The use of high performance liquid chromatography (HPLC) allows both a more accurate estimate of Chl-*a* and the rapid separation and quantification of up to 50 additional chloropigments and carotenoids in extracts of marine plankton. Many other chlorophyll and carotenoid pigments exhibit strong chemotaxonomic associations which may be used to oceanographically map the distribution of phytoplankton assemblages. Samples were collected from all of the non-toxic supply (UW) stations during passage (Table 3) and through the upper 200m from six CTD casts (Table 5), and Water (~2000ml) was filtered through glass fibre filters (GF/F). Filters were stored under liquid nitrogen (-196°C) to be analysed subsequently in the laboratory.

5.12.4 SUSPENDED PARTICULATE MATTER *(Ian Hall, Uni. Cam., ih10006@esc.cam.ac.uk)*

The objective was to calibrate the transmissometers by determining the suspended particulate matter content at a given depth. Suspended particulate matter (SPM) was collected by *Sabine Schimdt & Lei Chou*, filtering waters from selected CTD bottles onto pre-weighed Nuclepore filters of 47 mm diameter and 0.4 µm porosity. The filters were rinsed well with *Milli-Q* water to eliminate salt and then air-dried. They are kept frozen until analysis. The filters will be re-weighed to determine the suspended particulate matter content which can then be used to calibrate the transmissometer probes on the CTD rosette. Particles collected will also be examined for morphology/mineralogy using the Scanning Electron Microscope (SEM). The stations and depths where the SPM was sampled are given below; further details are presented in Table 5.

Summary of SPM samples for transmissometer calibration

CTD Cast	Station	Depth (m)
047	V110	100
048	V110	50
051	P200	105
051	P200	154
054	P1000	796
056	P1000	50

5.12.5 SATELLITE IMAGERY *(Steve Groom; RSDAS; sbg@wpo.nerc.ac.uk)*

Cloud cover was extensive throughout the cruise, so that only two AVHRR satellite images were transferred to the ship. Very sparse coverage on day 006, illustrating sea surface temperature (SST) between 14-16° offshore, beyond the 200m depth contour. On day 008 coverage was much better, with a clear image for the area below 42°N. SST ranged from 14.5-15°C close to the coast, up to 16.5°C offshore, under the *Navidad* condition; a broad (~100 km), double-tongued band of warmer waters advected apparently from the south along the slope towards Cape Finisterre (Figure 6).

6 Conclusions

Oceanographic conditions

The upper mixed layer generally varied from around 75 to 140m depth, bounded below by a pycnocline that existed in all water of depth 150m or more. This suggests continued deepening since the end of CD110 Leg A. Transmittance was less and fluorescence was typically enhanced in the mixed layer, suggesting a baseline primary production. Below the surface mixed layer, the Eastern North Atlantic Central Water (ENACW) predominates, until mixing at intermediate depths with high-salinity Mediterranean Outflow Water (MOW); the latter typically exhibiting maxima between 800-1200m. Below that, dissolved oxygen increased towards 2000m indicating the influence of Labrador Sea Water (LSW). Transmittance was usually reduced and optical back-scatter increased near the bottom, due to resuspension of bottom sediments.

Near the coast there was usually a plume of fresher, cooler water with lower transmittance and higher fluorescence. This is the poleward slope current, carrying warm and salty water (14.5-16.0 °C and salinity >35.8 respectively), with relatively low nutrient concentrations. This *Navidad* effectively 'traps' continental waters at the coast, resulting in higher nutrient concentrations and consequently higher biological activity. Most exceptionally along the transect of line Q, the 'double-tongued' nature of slope current observed from satellite imagery (Figure 6) is clearly illustrated by the underway temperature, salinity and fluorescence profiles (*e.g.* Figure 3).

Scientific operations

The cruise was adversely affected by poor weather, especially swell from a near continuous succession of storms over the Atlantic further to the west. The period from 10-14th January was characterised by an intense and persistent low-pressure system, eloquently illustrated by the meteorological data in Figure 7. Winds were extremely fierce (gusting up to 60 knots) over the whole of Finisterre; indeed over most of the eastern north Atlantic. Frequently, the entire OMEX-defined working area was characterised by continued heavy swell, often confounded by disparate local wind direction. This combination often prevented over-the-side science, and on occasion restricted passage between stations. Even when locally conditions were more favourable, the conflict between directions of swell and wind was a barrier to scientific activity.

Although little scientific time was 'formally' lost, the planned programme was severely curtailed by the weather conditions. Over-the-side deployment was only possible on three days out of 11 in the working area, similarly to Leg A. Without the immediate implementation of the near-surface sampling regime, only nominal coverage of the OMEX grid would have resulted from the cruise. The ease of deployment of FLY under conditions of considerable swell resulted in a significant data set for upper ocean turbulence, whilst many other measurements were significantly limited; the LHPR could not be deployed at all.

Ship-board facilities

The ship's facilities were generally suitable for the envisaged scientific programme, with only a few notable exceptions. In the first instance, one of the scientific party requested that the bridge officers on watch would record wind speed and direction on an hourly basis, on pre-

printed forms. The Master felt that the request was unreasonable, and refused to put the request forward. The scientific party would like to voice their disappointment with this decision.

In the laboratory, a malfunctioning (subsequently failed) scupper pump in the wet laboratory restricted the number of continuously measured near-surface parameters, due to the reduction of the sea water flow-rate. Approximately half-way through the cruise the remaining systems had to be closed down due to an unacceptable level of flooding in the wet laboratory. This was very frustrating for the scientist directly involved and disappointing in general. It is hoped that in the future, a spare for this low-cost pump will be carried on-board as a matter of policy.

Another matter of concern was the ship's ability to meet the scientific and victualling freshwater requirements. On the morning of only the third day of the cruise, the Master reported a freshwater shortage and requested that the scientific sampling should be restricted to an area at least 20 miles offshore until after 22:00 that night, to allow the ship's desalination plant sufficient production time. The following morning a similar request was made, this time restrict the scientific sampling to an area at least 15 miles offshore for a period in excess of 24 hours. It was suggested that, the problem was an over-consumption of freshwater by the *Milli-Q* water purifying system. However, this perception of the installation and use of clean water systems aboard ship as a 'luxury' is a false one. The apparatus are not a luxury, but are an integral part of modern science - none more so than in the field of practical marine chemistry. And as our (The scientific community's) demands are more likely to increase than decrease, RVS needs to thoroughly investigate how they can meet this need, rather than the scientists having to change and compromise their scientific programmes.

7 SCIENTIFIC LOG

Tuesday 6th January *(Julian Day 006)*

0906 SBE; Commenced Singling up for'd and aft.
0914 All gone and clear for'd and aft.
0915 ADCP recording commenced.
0918 Pilot Disembarked.
1051 Commenced recording thermosalinograph from the non-toxic supply.
1100 Vessel clear of Vigo North Channel; Full Away on Passage.

Wednesday 7th January *(Julian Day 007)*

0030	N3300	43 00.0 N	010 18.0 W	Vessel hove to in adverse weather.
0912		43 04.7 N	010 26.4 W	Weather eased sufficiently-return to stn.
1106	N3300	43 00.0 N	010 18.0 W	XBT deployed - failed (id 061).
1114	N3300	43 00.1 N	010 18.0 W	XBT deployed.
1134				Non-toxic sampling (UW001); depart stn.
1429	N3100	43 00.1 N	010 01.1 W	XBT deployed.
1453	N3100	43 00.2 N	010 01.2 W	Zooplankton net deployed (i/b 1509).
1550	N3100	42 59.9 N	010 01.2 W	Zooplankton net deployed (i/b 1609).
1729	N2000	42 59.8 N	009 50.0 W	XBT deployed.
1908	N2300	42 59.9 N	009 42.9 W	Hove to, non-toxic sampling (dep 1948).
2018	N1600	43 00.0 N	009 39.0 W	Passing through.
2100	N220	43 00.0 N	009 31.0 W	Passing through.
2117	N170	43 00.0 N	009 27.5 W	Passing through.
2136	N100	43 00.0 N	009 24.0 W	Passing through.

Thursday 8th January *(Julian Day 008)*

0042	O100	42 52.0 N	009 19.2 W	Passing through.
0154	O140	42 50.0 N	009 24.1 W	XBT deployed.
0304	O175	42 50.1 N	009 30.0 W	Passing through.
0554	O2000	42 50.2 N	009 46.1 W	Passing through.
0840	O2650	42 50.0 N	010 00.0 W	XBT deployed.
1242	O3100	42 50.0 N	010 17.8 W	XBT deployed.
1330	O3100	42 50.1 N	010 17.2 W	Zooplankton net deployed (i/b 1447).
1354	O3100	42 50.2 N	010 16.9 W	WP2 zooplankton net deployed (i/b 1408).
1421	O3100	42 50.1 N	010 17.6 W	Zooplankton net deployed (i/b 1439).
1852	Q2500	42 30.2 N	010 00.4 W	XBT deployed.
2126	Q2200	42 29.9 N	010 49.8 W	XBT Deployed.
2333	Q2000	42 30.0 N	009 39.7 W	Passing through.

Friday 9th January *(Julian Day 009)*

0059	Q1500	42 30.0 N	009 32.0 W	Passing through.
0204	Q1000	42 30.0 N	009 26.3 W	Passing through.
0212	Q600	42 30.0 N	009 25.6 W	Passing through.
0355	Q136	42 30.0 N	009 16.8 W	Passing through.
0716	R150	42 19.9 N	009 12.1 W	Hove to, sampling (dep 0736).
0842	R200	42 20.1 N	009 17.5 W	Hove to, sampling (dep 0850).

1029	R600	42 20.0 N	009 27.3 W	Hove to, sampling (dep 1036).
1630	S1000	42 09.1 N	009 27.9 W	Hove to, sampling (dep 1650).
1941	T1000	42 00.2 N	009 27.9 W	WP2 zooplankton net deployed (i/b 2018).

Saturday 10th January *(Julian Day 010)*

0004	U1000	41 48.1 N	009 28.0 W	plankton net deployed (i/b 00:20).
0025	U1000	41 48.1 N	009 28.0 W	XBT deployed.
0330		41 36.0 N	009 25.0 W	Vessel hove to.
0410		41 36.0 N	009 24.7 W	XBT deployed.
0722	V2200	41 25.2 N	009 23.1 W	CTD deployed to 1940 m (i/b 09:42).
1221	V110	41 25.2 N	009 05.6 W	Light meter deployed (i/b 1308).
1323	V110	41 25.2 N	009 06.0 W	CTD deployed to 100 m (i/b 1345).
1451	V110	41 25.2 N	009 06.0 W	CTD deployed to 100 m (i/b 1511).
1601	V110	41 25.1 N	009 06.0 W	CTD deployed to 100 m (i/b 1618).
1646	V110	41 25.6 N	009 05.5 W	WP2 zooplankton net deployed (i/b 1659).
1705	V110	41 25.6 N	009 05.5 W	Zooplankton net deployed (i/b 1711).
1720	V110	41 25.6 N	009 05.5 W	10m drifting zooplankton net deployed (i/b 1746).
1808	V110	41 26.3 N	009 05.0 W	FLY deployed at 0.5 kts.
1828		41 26.2 N	009 04.7 W	FLY Recovered to resolve software problem.
2105		41 26.1 N	009 14.2 W	FLY deployed.
2203		41 25.8 N	009 14.5 W	FLY recovered.

Sunday 11th January *(Julian Day 011)*

0027	V2400	41 25.1 N	009 31.0 W	XBT deployed.
0036		41 25.1 N	009 30.8 W	Hove to in adverse weather: science suspended.
0918		41 14.9 N	009 25.9 W	Weather moderating; set course 360 true.
1044	V2400	41 24.7 N	009 30.5 W	Vessel hove to on station (dep 10:48).
1212		41 36.0 N	009 32.0 W	XBT deployed.
1346	U2000	41 48.0 N	009 33.0 W	Passing through.
1504	T1600	42 00.1 N	009 32.9 W	XBT deployed.
1705	T2100	42 00.1 N	009 49.8 W	Vessel hove to, sampling.
1855	T2500	42 00.1 N	010 00.3 W	Vessel hove to, sampling.
2018		42 02.2 N	010 03.9 W	FLY deployed at 0.5 kts.
2309		42 00.4 N	010 04.9 W	FLY recovered.

Monday 12th January *(Julian Day 012)*

0246	S2600	42 09.0 N	010 18.0 W	XBT deployed.
0640	S2550	42 09.0 N	010 00.0 W	XBT deployed.
0918	S2250	42 09.1 N	009 44.4 W	XBT deployed - failed.
0925	S2250	42 09.1 N	009 44.7 W	XBT deployed.
1048	S2000	42 09.2 N	009 39.4 W	Passing through.
1200		42 08.8 N	009 33.9 W	Vessel hove to: science ceased due to adverse weather conditions. Wind 150 true. 40/55 kts. Rough sea, & heavy swell.
1800		42 04.9 N	009 26.9 W	Wind 140 true, speed 45 kts. Baro: 989.2.

Tuesday 13th January *(Julian Day 013)*

0000		41 59.1 N	009 34.8 W	Wind 260 true, speed 42 kts. Baro: 1003.4.
0600		42 04.5 N	009 50.4 W	Wind 290 true, speed 40 kts. Baro: 1010.1.
1200		42 13.9 N	010 03.5 W	Wind 310 true, speed 34 kts. Baro: 1016.6.
1800		42 20.0 N	010 20.8 W	Wind 300 true, speed 30 kts. Baro: 1021.6.

Wednesday 14th January *(Julian Day 014)*

0000		42 33.7 N	010 43.2 W	
0200		42 39.3 W	010 47.7 W	Swell eased sufficiently to set course for stn.
0427	P2800	42 40.1 N	010 17.9 W	Vessel hove to.
0454	P2800	42 40.6 N	010 18.9 W	FLY deployed (i/b 0608).
0648	P2800	42 39.4 N	010 18.0 W	CTD deployed to 2795 m (i/b 0918).
1324		42 40.9 N	009 30.3 W	STABLE grappled.
1330		42 41.0 N	009 30.2 W	STABLE recovered.
1430	P200	42 40.0 N	009 29.8 W	Zooplankton net deployed (i/b 1446).
1513	P200	42 40.0 N	009 29.9 W	Zooplankton net deployed (i/b 1528).
1537	P200	42 40.1 N	009 29.9 W	Light meter deployed (i/b 1555).
1555	P200	42 40.1 N	009 29.8 W	CTD deployed to 175 m (i/b 1622).
1728	P200	42 40.1 N	009 29.4 W	WP2 zooplankton net deployed (i/b 1739).
1745	P200	42 40.0 N	009 29.3 W	10m drifting zooplankton net deployed (i/b 1806).
1840	P200	42 39.5 N	009 29.4 W	SAPs deployed at 25 m and 50 m (i/b 2027).
2032	P200	42 39.0 N	009 29.9 W	FLY deployed at 0.5 kts (i/b 2141).
2206	P200	42 40.2 N	009 30.0 W	CTD deployed to 180 m (i/b 2233).
2248		42 40.4 N	009 29.6 W	SAPs deployed-aborted due to weather (i/b 0000).

Thursday 15th January *(Julian Day 015)*

0104	P200	42 39.6 N	009 29.7 W	FLY deployed (i/b 0207).
0230	P200	42 40.0 N	009 29.8 W	CTD deployed to 170 m (i/b 0255).
0429	P100	42 39.4 N	009 12.7 W	FLY deployed (i/b 0533).
0557	P100	42 40.1 N	009 12.6 W	CTD deployed to 90 m (i/b 0610).
0952	P1000	42 40.2 N	009 36.6 W	CTD deployed to 1000 m (i/b 1042).
1124	P1000	42 40.3 N	009 37.3W	SAPs deployed at 7 m & 53 m (i/b 1318).
1344	P1000	42 40.2 N	009 36.0 W	Light meter deployed (i/b 1351).
1358	P1000	42 40.2 N	009 35.6 W	CTD deployed to 300 m (i/b 1420).
1513	P1000	42 40.1 N	009 35.5 W	Light meter deployed (i/b 1523).
1534	P1000	42 40.2 N	009 36.0 W	Plankton net deployed (i/b 1551).
1620	P1000	42 39.6 N	009 35.4 W	SAPs deployed at 100 m & 150 m (i/b 1838).
1910	P1000	42 39.7 N	009 36.3 W	FLY deployed (i/b 2024).
2046	P1000	42 40.0 N	009 36.4 W	CTD deployed to 200 m (i/b 2108).
2122	P1000	42 39.9 N	009 36.4 W	Begin deploying SAPs at 200 m & 425 m.

Friday 16th January *(Julian Day 016)*

0106	P1000	42 39.6 N	009 36.6 W	SAPs recovered.
0118	P1000			Completed science, all secure, course 168 true.

0434	S1000	42 09.0 N	009 28.0 W	Alter course 090 true.
0442	S600	42 09.0 N	009 26.3 W	Passing through.
0528	S300	42 09.0 N	009 19.0 W	Passing through.
0641	S150	42 09.2 N	009 08.4 W	Passing through.
0700	S130	42 09.2 N	009 03.0 W	Passing through; non-toxic supply switched off.

0800 SBE/EOP; Approaching Vigo South Entrance.
0904 Pilot Embarked.
0928 First Lines Ashore.
0936 Vessel securely moored, starboard side alongside, Transatlantic Pier, Vigo.

Port-Call: Five Spanish institute scientists disembarked with related equipment. Galway trawled ADCP loaded, plus freshwater, provisions, *etc*.

1554 Stand-by engines; commenced singling up.
1600 All gone and clear; vessel leaving berth.
1700 Vessel clear of Vigo north channel; full away on passage towards Southampton.
1704 Thermosalinograph and non-toxic supply were restarted.
1800 Commencement of bi-hourly surface sampling through non-toxic supply.

Saturday 17th January (*Julian Day 017*)

1200	45 18.8 N	008 16.3 W	Course 027 true, speed 11.4 kts.

Sunday 18th January (*Julian Day 018*)

0600	48 26.0 N	006 00.9 W	Vessel hove to in strong winds and heavy swell. Wind: 270 true, 45/50 kts, gusts to 60 kts; rough sea and heavy westerly swell.
1200	48 25.7 N	006 13.0 W	
1500	48 24.9 N	006 22.8 W	Weather eased sufficiently to resume passage.

Monday 19th January (*Julian Day 019*)
1100 Non-toxic supply switched off:- end of scientific programme.
14:30 Vessel securely moored, starboard side alongside, SOC, Empress Dock, Southampton.

Originally compiled by R.A. Bourne, Master.

TABLES

Table 1 *OMEX II-II WP2 sampling grid positions.*

SITE	Latitude ° N	Longitude ° W	Latitude ° ' N	Longitude ° ' W	Bottom m	Priority Status
Line N @ 43°00'N (SEFOS line 4)						
N30	42.998	9.303	42 59.9	009 18.2	45	4
N100	42.999	9.397	43 00.0	009 23.8	122	1
N220	43.002	9.517	43 00.1	009 31.0	214	1
N1600	43.001	9.649	43 00.0	009 38.9	1526	1
N2000	42.998	9.832	42 59.9	009 49.9	2095	4
N2300	42.999	9.718	43 00.0	009 43.1	2257	1
N3100	43.000	10.014	43 00.0	010 00.8	3100	4
N3300	43.001	10.299	43 00.1	010 18.0	3350	1/2
Line O @ 42°50'N						
O140	42.834	9.400	42 50.0	009 24.0	143	4
O175	42.836	9.492	42 50.1	009 29.5	178	2
O1000	42.834	9.629	42 50.1	009 37.8	~1000	2
O2000	42.835	9.765	42 50.1	009 45.9	~2000	2
O2650	42.834	9.999	42 50.0	009 59.9	2652	4
Line P @ 42°40'N (OMEX Mooring Line: Traps & Current Meters)						
P100	42.666	9.210	42 40.0	009 12.6	101	1
P130	42.667	9.366	42 40.0	009 22.0	131	4
P200	42.667	9.500	42 40.0	009 30.0	168	1
P500	42.666	9.552	42 40.0	009 33.1	508	4
P1000	42.666	9.602	42 40.0	009 36.1	976	1
P2000	42.667	9.847	42 40.0	009 50.8	1998	1
P2250	42.667	10.000	42 40.0	010 00.0	2261	4
P2800	42.666	10.299	42 40.0	010 18.0	2805	1/2
Line Q @ 42°30'N (SEFOS line 4)						
Q100	42.495	9.178	42 29.7	009 10.7	100	2
Q136	42.500	9.279	42 30.0	009 16.8	137	2
Q600	42.504	9.428	42 30.2	009 25.7	631	4
Q1000	42.500	9.438	42 30.0	009 26.3	1040	2
Q1500	42.500	9.534	42 30.0	009 32.0	1526	4
Q2000	42.500	9.662	42 30.0	009 39.7	1995	2
Q2200	42.500	9.836	42 30.0	009 50.2	2225	4
Q2500	42.496	10.014	42 29.7	010 00.8	2539	4

Table 1 *OMEX II-II WP2 sampling grid positions (continued)*

SITE	Latitude ° N	Longitude ° W	Latitude ° ' N	Longitude ° ' W	Bottom m	Priority Status
Line R @ 42°20'N						
R100	42.332	-9.001	42 19.9	009 00.0	93	2
R150	42.332	-9.200	42 19.9	009 12.0	154	4
R200	42.333	-9.286	42 20.0	009 17.1	234	2
R600	42.347	-9.457	42 20.8	009 27.4	586	4
R1000	42.340	-9.498	42 20.4	009 29.9	932	2
R1500	42.334	-9.626	42 20.1	009 37.6	1481	4
R2000	42.336	-9.778	42 20.1	009 46.7	2002	2
R2500	42.334	-10.003	42 20.0	010 00.1	2534	4
Line S @ 42°09'N (OMEX Reference Transect)						
S90	42.152	-8.957	42 09.1	008 57.4	92	1
S130	42.149	-9.051	42 08.9	009 03.0	131	4
S150	42.150	-9.140	42 09.0	009 08.4	148	1
S200	42.148	-9.326	42 08.9	009 19.6	225	1
S600	42.150	-9.437	42 09.0	009 26.2	596	4
S1000	42.151	-9.465	42 09.1	009 27.9	1035	1
S2000	42.148	-9.654	42 08.9	009 39.2	1994	1
S2250	42.151	-9.736	42 09.1	009 44.1	2260	4
S2550	42.150	-10.002	42 09.0	010 00.1	2535	4
S2600	42.148	-10.302	42 08.9	010 18.1	2773	1
Line T @ 42°00'N						
T100	42.000	-9.001	42 00.0	009 00.0	100	2
T150	42.000	-9.229	42 00.0	009 13.7	146	2
T1000	42.000	-9.444	42 00.0	009 26.7	998	2
T1600	41.998	-9.548	41 59.9	009 32.9	1675	2
T2000	41.999	-9.674	41 59.9	009 40.4	1989	2
T2100	41.999	-9.834	42 00.0	009 50.0	2125	2
T2500	42.003	-10.014	42 00.2	010 00.8	2567	2
Line U @ 41°48'N						
U100	41.798	-9.015	41 47.9	009 00.9	92	4
U120	41.799	-9.150	41 47.9	009 09.0	117	4
U150	41.801	-9.286	41 48.0	009 17.2	152	4
U1000	41.800	-9.434	41 48.0	009 26.0	1006	4
U2000	41.799	-9.553	41 48.0	009 33.2	2097	4
U2500	41.800	-9.800	41 48.0	009 48.0	2504	4
U2800	41.800	-10.068	41 48.0	010 04.1	2820	4

Table 1 *OMEX II-II WP2 sampling grid positions (continued)*

SITE	Latitude ° N	Longitude ° W	Latitude ° ' N	Longitude ° ' W	Bottom m	Priority Status
Line V @ 41°25'N (SEFOS line 3)						
V55	41.412	-8.874	41 24.7	008 52.4	57	4
V75	41.416	-8.965	41 25.0	008 57.9	78	4
V110	41.416	-9.099	41 25.0	009 05.9	108	3
V160	41.419	-9.187	41 25.1	009 11.2	156	3
V1150	41.418	-9.281	41 25.1	009 16.9	1986	3
V2200	41.416	-9.401	41 24.9	009 24.1	2141	3
V2400	41.417	-9.518	41 25.0	009 31.1	2565	4
V2600	41.416	-9.651	41 25.0	009 39.1	2697	4
V2800	41.417	-9.782	41 25.0	009 46.9	2586	4
V3100	41.417	-9.950	41 25.0	009 57.0	3221	4

Status 1 Highest priority and should be sampled on all WP2 cruises.
These define the three seaward boundaries of the WP2 box.

Status 2 Second priority, extending the southern margin to 42°N.

Status 3 Third priority, extending the southern margin to the *SEFOS Line 3*.
These incorporate Portuguese current meters.

Status 4 Lowest priority, denoting additional stations within the study area.

Table 2 *XBT casts*

Sample No.	Station	Time GMT	Julian Day	Latitude N	Longitude W	Trace Depth, m	~Mixed Layer, m	Comments
061 *	N3300	11:06	007	43°00.00'	010°18.05'	600	No record	Wire broke
062	N3300	11:14	007	43°00.10'	010°18.04'	1800	110	Some bad data ?
063	N3100	14:28	007	43°00.16'	010°01.09'	1800	110	
064	N2000	17:29	007	42°59.77'	009°49.96'	1800	60-100 +	
065	O140	01:54	008	42°49.98'	009°24.04'	175	100	
066	O2650	08:40	008	42°50.03'	009°59.98'	1800	100	Some bad data ?
067	O3100	12:42	008	42°50.02'	010°17.83'	1800	50-90 +	
068	Q2500	19:04	008	42°30.16'	010°00.37'	1800	120	
069	Q2200	21:26	008	42°29.90'	009°49.80'	1800	80	
070	U1000	00:25	010	41°48.10'	009°27.96'	1800	125	
071	Extra 1	04:10	010	41°36.05'	009°24.71'	1800	>75	Some bad data ?
072	V2400	00:27	011	41°25.08'	009°31.20'	1800	>75	
073	Extra 2	12:12	011	41°35.95'	009°32.03'	1800	90	
074	T1600	15:01	011	42°00.07'	009°33.00'	1600	125	
075	T2500	19:09	011	42°00.31'	010°00.31'	1800	100	
076	S2600	02:46	012	41°09.05'	010°18.01'	1800	140	
077	S2550	06:04	012	41°09.08'	010°00.25'	1800	50-90 +	
078	S2250	09:18	012	41°09.06'	009°44.39'	-	No record	Wire fault
079	S2250	09:25	012	41°09.12'	009°44.66'	1800	100	

* *Cast failed at 600m*

\+ *Unclear from scale of record*

Table 3a *Underway stations - parameters sampled*

Sample No.	Station	IIM Nutrients	IIM Phyto.	PML/UoP DOC/TDN	PML Pigments	PML Microzoo.	ULg TAlk	ULg Diss. O_2	ULg Chl-*a*	Algarve Bacteria	ULB Chl-*a*	ULB POC/PON	CNRS Radionuc.
UW001	N3300	x	x	x	x	x	x	x	x	x	x	x	--
UW002	Extra 1	x	x	x	x	x	--	--	--	x	x	x	--
UW003	N3100	x	x	x	x	x	x	x	x	x	x	x	--
UW004	N2000	x	x	x	x	x	x	x	x	x	x	x	--
UW005	N2300	x	x	x	x	x	x	x	x	x	x	x	--
UW006	N1600	x	x	x	x	x	x	x	x	x	x	x	--
UW007	N220	x	x	x	x	x	x	x	x	x	x	x	--
UW008	N170	x	x	x	x	x	--	--	--	x	x	x	--
UW009	N100	x	x	x	x	x	--	--	--	x	x	x	--
UW010	O100	x	x	x	x	--	x	x	x	--	x	x	--
UW011	O140	x	x	x	x	--	x	x	x	--	x	x	--
UW012	O175	x	x	x	x	--	--	--	--	--	x	x	--
UW013	O1000	x	x	x	x	--	--	--	--	--	x	x	--
UW014	O2000	x	x	x	x	--	--	--	--	--	x	x	--
UW015	O2650	x	x	x	x	--	--	--	--	--	x	x	x
UW016	O3100	x	x	x	x	--	--	--	--	--	x	x	--
UW017	Q2500	x	x	x	x	--	x	x	x	--	x	x	--
UW018	Q2200	x	x	x	x	--	x	x	x	--	x	x	x
UW019	Q2000	x	x	x	x	--	x	x	x	--	x	x	--
UW020	Q1500	x	x	x	x	--	x	x	--	--	x	x	x
UW021	Q600	x	x	x	x	--	x	x	--	--	x	x	--
UW022	-	-	-	-	-	-	-	-	-	-	-	-	-
UW023	Q136	x	x	x	x	--	x	x	--	--	x	x	x
UW024	R150	x	x	x	x	--	x	x	--	--	x	x	--
UW025	R200	x	x	x	x	--	--	--	--	--	x	x	--
UW026	R600	x	x	x	x	--	--	--	--	--	x	x	--
UW027	S1000	x	x	x	x	--	x	x	x	x	x	x	--

Table 3a *Underway stations – parameters sampled (continued)*

Sample No.	Station	IIM Nutrients	IIM Phyto.	PML/UoP DOC/TDN	PML Pigments	PML Microzoo.	ULg TAlk	ULg Diss. O_2	ULg Chl-*a*	Algarve Bacteria	ULB Chl-*a*	ULB POC/PON	CNRS Radionuc.
UW028	T1000	x	x	x	x	--	x	x	x	x	x	x	x
UW029	U1000	x	x	x	x	--	x	x	x	--	x	x	--
UW030	Extra 2	x	x	x	x	--	x	x	x	--	x	x	--
UW031	V2400	x	x	x	x	--	x	x	x	--	x	x	--
UW032	Extra 3	x	x	x	x	--	x	x	x	--	x	x	--
UW033	U2000	x	x	x	x	--	x	x	x	--	x	x	--
UW034	T1600	x	x	x	x	--	x	x	x	--	x	x	--
UW035	T2000	x	x	x	x	--	x	x	x	--	x	x	--
UW036	T2100	x	x	x	x	--	x	x	x	--	x	x	--
UW037	T2500	x	x	x	x	--	x	x	x	--	x	x	--
UW038	S2600	x	x	x	x	x	x	x	--	x	x	x	x
UW039	S2550	x	x	x	x	x	x	x	--	x	x	x	--
UW040	S2250	x	x	x	x	x	x	x	x	x	x	x	--
UW041	S2000	x	x	x	x	x	x	x	x	x	x	x	--
UW042	Extra 4	x	x	x	x	--	--	--	--	--	x	x	--
UW043	Extra 5	x	x	x	x	--	--	--	--	--	x	x	--
UW044	Extra 6	x	x	x	x	--	--	--	--	--	x	x	--
UW045	Extra 7	x	x	x	x	--	--	--	--	--	x	x	--
UW046	Extra 8	x	x	x	x	--	--	--	--	--	x	x	--
UW047	Extra 7	x	x	x	x	--	--	--	--	--	x	x	--
UW048	Extra 8	x	x	x	x	--	--	--	--	--	x	x	--
Missing	S1000	-	-	-	-	-	-	-	-	-	-	-	-
Missing	S600	-	-	-	-	-	-	-	-	-	-	-	-
Missing	S300	-	-	-	-	-	-	-	-	-	-	-	-
Missing	S150	-	-	-	-	-	-	-	-	-	-	-	-
Missing	S130	-	-	-	-	-	-	-	-	-	-	-	-

Table 3b *Underway stations - supporting measurements (uncalibrated)*

Sample No.	Station	Time GMT	Julian Day	Latitude N	Longitude W	Temp °C	Salinity	Fluor. V	Trans. V	Ppar V	Spar V	Comments
UW001	N3300	11:18	007	43°00.14'	010°18.04'	14.412	35.816	1.193	4.180	-0.721	-0.644	Hove-to on station
UW002	Extra 1	13:16	007	42°59.92'	010°09.64'	-	-	-	-	-	-0.904	Steamed through position
UW003	N3100	14:39	007	43°00.16'	010°01.20'	14.239	35.798	1.207	4.177	-0.512	-0.655	Hove-to on station
UW004	N2000	17:30	007	42°59.77'	009°49.95'	14.596	35.829	0.319	4.358	0.325	0.269	Hove-to on station
UW005	N2300	19:30	007	43°00.28'	009°43.18'	14.752	-	0.270	4.457	2.987	2.750	Steamed through position
UW006	N1600	20:18	007	43°00.02'	009°39.05'	14.961	35.877	0.291	4.461	2.985	2.749	Steamed through position
UW007	N220	21:00	007	43°00.03'	009°30.96'	15.100	35.872	0.298	4.464	2.995	2.761	Steamed through position
UW008	N170	21:20	007	43°00.00'	009°26.96'	15.440	35.827	0.303	4.430	2.991	2.756	Steamed through position
UW009	N100	21:40	007	42°59.63'	009°23.66'	15.014	35.421	0.306	4.368	2.989	2.759	Steamed through position
UW010	O100	00:40	008	42°50.20'	009°19.22'	15.418	35.355	0.442	4.297	3.011	2.775	Steamed through position
UW011	O140	01:40	008	42°50.02'	009°24.10'	15.559	35.514	0.290	4.356	3.008	2.770	Hove-to on station
UW012	O175	03:00	008	42°50.06'	009°29.62'	15.095	35.122	0.452	4.298	2.994	2.758	Steamed through position
UW013	O1000	04:30	008	42°50.09'	009°38.26'	15.352	35.895	0.286	4.464	2.986	2.749	Steamed through position
UW014	O2000	06:00	008	42°50.17'	009°46.68'	15.216	35.901	0.255	4.481	2.991	2.752	Steamed through position
UW015	O2650	08:37	008	42°50.01'	009°59.98'	14.373	35.813	0.248	4.499	-0.386	-0.331	Hove-to on station
UW016	O3100	12:25	008	42°49.97'	010°17.99'	14.586	35.838	0.300	4.487	-0.549	-0.710	Hove-to on station
UW017	Q2500	18:55	008	42°30.07'	010°00.35'	14.958	35.871	0.289	4.491	2.983	2.748	Hove-to on station
UW018	Q2200	21:13	008	42°30.00'	009°50.03'	15.186	35.891	0.299	4.478	2.982	2.745	Hove-to on station
UW019	Q2000	23:32	008	42°30.02'	009°39.79'	15.382	35.925	0.251	4.489	2.978	2.742	Steamed through position
UW020	Q1500	01:00	008	42°30.01'	009°31.90'	15.875	35.821	0.189	4.363	2.975	2.737	Steamed through position
UW021	Q600	02:13	008	42°30.01'	009°25.56'	15.793	35.803	0.185	4.383	2.976	2.740	Steamed through position
UW022	-	-	-	-	-	-	-	-	-	-	-	Missed from numbering sequence
UW023	Q136	04:01	008	42°29.82'	009°16.54'	15.206	34.918	0.434	4.265	2.976	2.742	Steamed through position
UW024	R150	07:15	008	42°20.01'	009°12.16'	15.458	35.389	0.313	4.362	2.969	2.736	Steamed through position
UW025	R200	08:38	008	42°19.99'	009°16.99'	15.666	35.955	0.238	4.489	-0.184	-0.283	Steamed through position
UW026	R600	10:30	008	42°20.01'	009°27.34'	15.346	35.900	0.300	4.486	-0.514	-0.642	Steamed through position
UW027	S1000	16:35	009	42°09.15'	009°27.85'	15.272	35.901	0.335	4.467	-0.321	-0.454	Steamed through position

Table 3b *Underway stations – supporting measurements (uncalibrated) (continued)*

Sample No.	Station	Time GMT	Julian Day	Latitude N	Longitude W	Temp °C	Salinity	Fluor. V	Trans. V	Ppar V	Spar V	Comments
UW028	T1000	19:43	009	42°00.17'	009°27.91'	15.287	35.881	0.284	4.486	2.952	2.717	Steamed through position
UW029	U1000	00:04	010	41°48.07'	009°28.12'	15.632	35.973	0.317	4.484	2.961	2.725	Hove-to on station
UW030	Extra 2	03:40	010	41°36.07'	009°24.93'	15.530	35.954	0.269	4.486	2.964	2.728	Steamed through position
UW031	V2400	00:18	011	41°25.09'	009°31.14'	15.803	-	0.305	4.480	2.955	2.719	Hove-to on station
UW032	Extra 3	12:10	011	41°35.96'	009°32.06'	15.499	35.971	0.352	4.475	-0.525	-0.684	Steamed through position
UW033	U2000	13:45	011	41°47.70'	009°33.04'	15.465	35.937	0.383	4.459	-0.449	-0.604	Steamed through position
UW034	T1600	15:00	011	42°00.08'	009°33.04'	15.234	35.885	0.394	4.463	-0.420	-0.571	Hove-to on station
UW035	T2000	16:09	011	42°00.04'	009°40.24'	15.222	35.893	0.406	4.467	-0.413	-0.542	Steamed through position
UW036	T2100	17:02	011	42°00.14'	009°49.59'	15.158	35.882	0.390	4.467	0.025	-0.059	Steamed through position
UW037	T2500	18:37	011	42°00.05'	010°00.46'	15.014	35.876	0.375	4.473	2.972	2.737	Hove-to on station
UW038	S2600	02:37	012	42°09.03'	010°17.96'	14.895	35.836	0.371	4.470	2.968	2.733	Hove-to on station
UW039	S2550	06:10	012	42°09.04'	010°00.19'	-	-	-	4.488	2.981	-	Hove-to on station
UW040	S2250	09:05	012	42°09.04'	009°44.18'	15.024	35.908	0.363	4.475	-0.107	-0.214	Hove-to on station
UW041	S2000	10:50	012	42°09.14'	009°39.37'	15.171	35.891	0.362	4.478	-0.161	-0.276	Steamed through position
UW042	Extra 4	14:01	013	42°16.46'	010°08.94'	14.487	35.829	0.372	4.464	-0.723	-0.856	Steamed through position
UW043	Extra 5	16:00	013	42°18.49'	010°14.52'	14.694	35.845	0.392	4.464	-0.619	-0.760	Steamed through position
UW044	Extra 6	18:00	013	42°20.14'	010°21.00'	14.420	35.831	0.366	4.457	1.077	1.116	Steamed through position
UW045	Extra 7	20:00	013	42°23.09'	010°29.10'	14.450	35.846	0.376	4.458	3.026	2.794	Steamed through position
UW046	Extra 8	22:00	013	42°28.06'	010°36.52'	14.113	35.788	0.383	4.462	3.035	2.801	Steamed through position
UW047	Extra 7	00:00	014	42°33.74'	010°43.25'	14.086	35.784	0.396	4.458	3.022	2.790	Steamed through position
UW048	Extra 8	02:00	014	42°39.30'	010°47.66'	13.946	35.769	0.361	4.460	3.036	2.802	Steamed through position
Missing	S1000	04:34	016	42°09.00'	009°28.00'	15.113	-	0.367	-	-	0.2770	Steamed through position
Missing	S600	04:42	016	42°09.00'	009°26.30'	15.085	35.923	0.380	4.206	3.001	2.770	Steamed through position
Missing	S300	05:28	016	42°09.00'	009°19.00'	-	-	-	-	-	-	Steamed through position
Missing	S150	06:41	016	42°09.20'	009°08.40'	15.534	-	0.320	4.111	3.002	2.768	Steamed through position
Missing	S130	07:00	016	42°09.20'	009°03.00'	15.509	35.670	0.375	3.957	3.002	2.768	Steamed through position

Table 4 *Zooplankton Net Hauls*

Sample No.	Station	Time GMT	Julian Day	Latitude N	Longitude W	Sample Depth, m	Description
01	N3100	14:53	007	43°00.19'	010°01.32'	200	WP2 (Isla)
02	N3100	15:50	007	42°59.91'	010°01.25'	200	WP2 (Isla)
03	O3100	13:30	008	42°50.08'	010°17.26'	200	WP2 (Isla)
04	O3100	13:54	008	42°50.19'	010°17.02'	200	WP2 (Hirst)
05	O3100	14:53	008	42°50.06'	010°17.64'	200	WP2 (Isla)
*** 06**	T1000	19:41	009	42°00.18'	009°27.94'	200	WP2 (Hirst)
*** 07**	U1000	00:04	010	41°48.07'	009°28.06'	200	WP2 (Isla)
08	V110	16:46	010	41°25.40'	009°05.81'	90	WP2 (Hirst)
09	V110	17:05	010	41°25.62'	009°05.81'	90	WP2 (Isla)
10	V110	17:20	010	41°25.82'	009°05.81'	25	Drifting (Hirst)
11	P200	14:30	014	42°40.11'	009°29.86'	200	WP2 (Isla)
12	P200	15:13	014	42°40.00'	009°29.90'	200	WP2 (Isla)
13	P200	17:28	014	42°40.10'	009°29.28'	165	WP2 (Hirst)
14	P200	17:45	014	42°40.10'	009°29.20'	25	Drifting (Hirst)
15	P1000	15:34	015	42°40.18'	009°36.11'	200	WP2 (Hirst)

* *Denotes 'Night' hauls*

Table 5 *CTD casts*

No.	Station	Time GMT	Julian Day	Latitude N	Longitude W	Cast Depth, m	Description
045	V2200	07:22	010	41°25.15'	009°23.80'	1926	Biogeochemistry
046	V110	13:23	010	41°25.09'	009°06.14'	106	Plankton Incubations
047	V110	14:51	010	41°25.01'	009°06.20'	108	Biogeochemistry
048	V110	16:01	010	41°25.02'	009°06.05'	103	Radionuclides / SPM
049	P2800	06:48	014	42°39.76'	010°18.02'	2791	Biogeochemistry
050	P200	15:55	014	42°40.12'	009°29.88'	187	Plankton Incubations
051	P200	22:06	014	42°40.22'	009°30.07'	195	Biogeochemistry
052	P200	02:30	015	42°39.93'	009°29.70'	187	Radionuclides
053	P100	05:57	015	42°40.15'	009°12.65'	104	Biogeochemistry
054	P1000	09:52	015	42°44.15'	009°36.22'	984	Biogeochemistry
055	P1000	13:58	015	42°40.18'	009°35.90'	900	Plankton Incubations
056	P1000	20:46	015	42°40.10'	009°36.47'	1014	Radionuclides / SPM

[045] *DO, TAlk, pH, DOC/TDN, Nutrients, Chl-a, Phytoplankton, Pigments, Bacterioplankton, Radionuclides.*

[046] *Microzooplankton grazing, Phytoplankton / PvI / 1°P / Light Absorption, DOC Production, Nutrients, DOC/TDN.*

[047] *DO, TAlk, pH, DOC/TDN, Nutrients, Chl-a, Phytoplankton, Pigments, POC/PON, SPM.*

[048] *Radionuclides, SPM.*

[049] *DO, TAlk, pH, DOC/TDN, Nutrients, Chl-a, Phytoplankton, Pigments, POC/PON, Microzooplankton, Bacterioplankton, Radionuclides.*

[050] *Microzooplankton grazing, Phytoplankton / PvI / 1°P / Light Absorption, DOC production, Nutrients, DOC/TDN., Bacterioplankton*

[051] *DO, TAlk, pH, DOC/TDN, Nutrients, Chl-a, Phytoplankton, Pigments, POC/PON, Microzooplankton, SPM.*

[052] *Radionuclides.*

[053] *DO, TAlk, pH, DOC/TDN, Nutrients, Chl-a, Phytoplankton, Pigments, POC/PON, Microzooplankton, Bacterioplankton.*

[054] *DO, TAlk, pH, DOC/TDN, Nutrients, Chl-a, Phytoplankton, Pigments, POC/PON, Microzooplankton.*

[055] *Microzooplankton grazing, Phytoplankton / PvI / 1°P / Light Absorption, DOC production, Nutrients, DOC/TDN., Bacterioplankton, DO, TAlk, pH.*

[056] *Radionuclides, SPM.*

Table 6 *Spectroradiometer casts (water light field)*

No.	Station	Time GMT	Julian Day	Latitude N	Longitude W	Cast Depth, m	Description
01	V110	12:21	010	41°25.13'	009°05.88'	40	Downwelling light
02*	V110	13:23	010	41°25.09'	009°06.14'	50	Upwelling light
03	P200	15:37	014	42°40.12'	009°29.87'	50	Downwelling light
04	P1000	15:13	015	42°40.10'	009°35.50'	15	Downwelling light

* *Cast failed due to twisting of the logger connector, under stress from the swell.*

Table 7 *FLY deployments*

Series	Station	Time GMT	Julian Day	Latitude N	Longitude W	Deployed Depth, m	Duration h:min	No. of Drops
*	~V110	18:08	010	41°26.3'	009°05.0'	280	0:20	1
01	~V110	21:07	010	41°26.1'	009°14.2'	300	0:52	6
02	T2500	20:20	011	42°02.2'	010°03.9'	300	2:24	15
03	P2800	04:58	014	42°40.6'	010°18.9'	300	1:04	6
04	P200	20:34	014	42°39.0'	009°14.2'	300	1:05	8
05	P200	01:06	015	42°39.6'	009°29.7'	300	1:01	8
06	P100	04:30	015	42°39.4'	009°12.7'	300	1:01	12
07	P1000	19:14	015	42°39.7'	009°36.3'	300	11:05	6

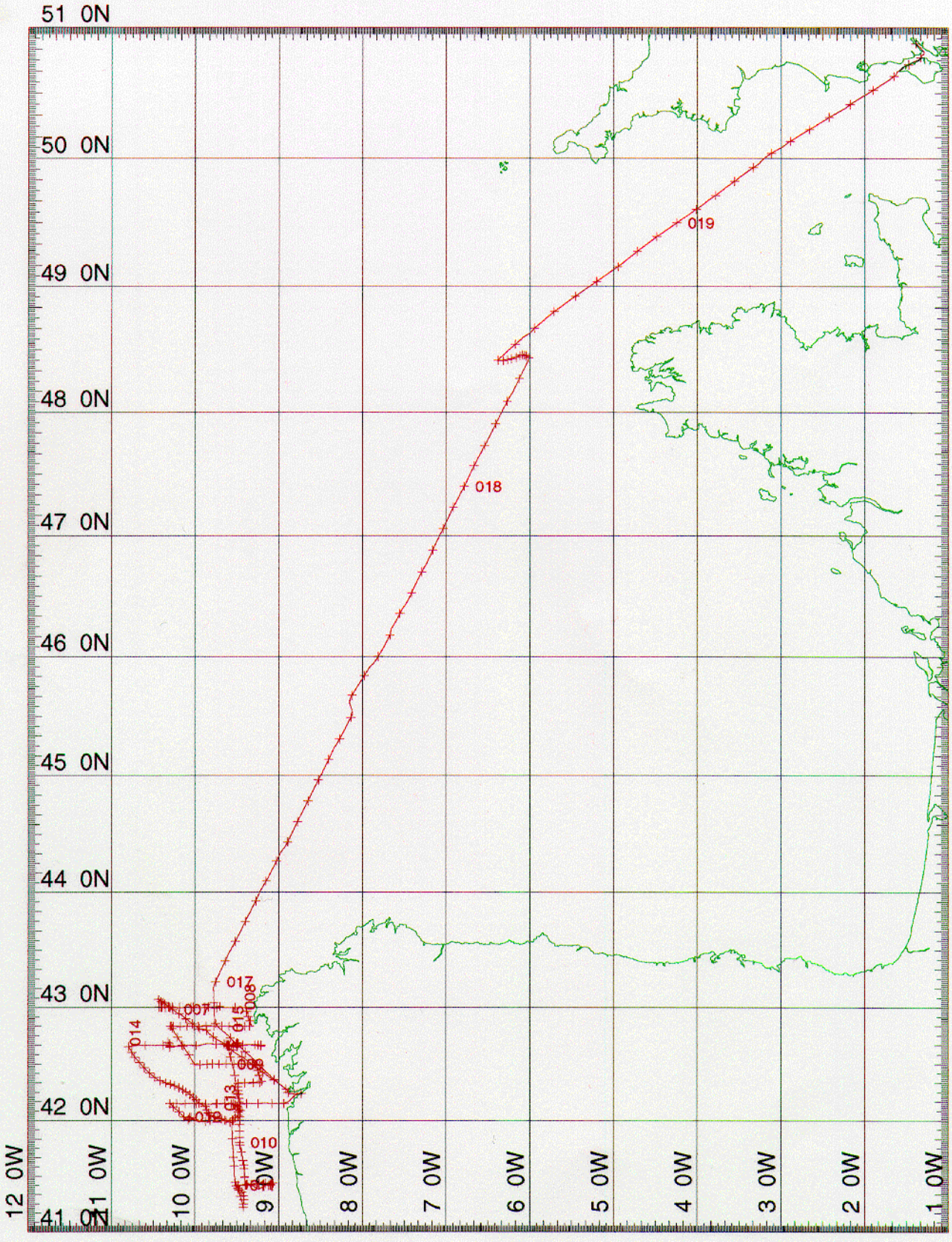
* *Deployment aborted due to PC software problem*

Table 8 *Stand Alone Pump (SAP) casts*

No.	Station	Time GMT	Julian Day	Latitude N	Longitude W	Sampling Depth, m	Comments
SAP1	P200	18:40	014	42°39.50'	009°29.40'	25	
						50	
***SAP2**	P200	22:48	014	42°40.38'	009°29.05'	105	Failed to pump
						155	Filtering during recovery
SAP3	P1000	11:24	015	42°40.25'	009°37.40'	7	
						53	
SAP4	P1000	16:20	015	42°39.97'	009°35.86'	100	
						150	
SAP5	P1000	21:22	015	42°39.90'	009°36.40'	200	Filter torn, no sample
						500	Not much on filter

* *Forced to bring up the pump due to increasing wind condition.*

Figure 1 *General area map and cruise track: Vigo-Vigo-Southampton*



MERCATOR PROJECTION

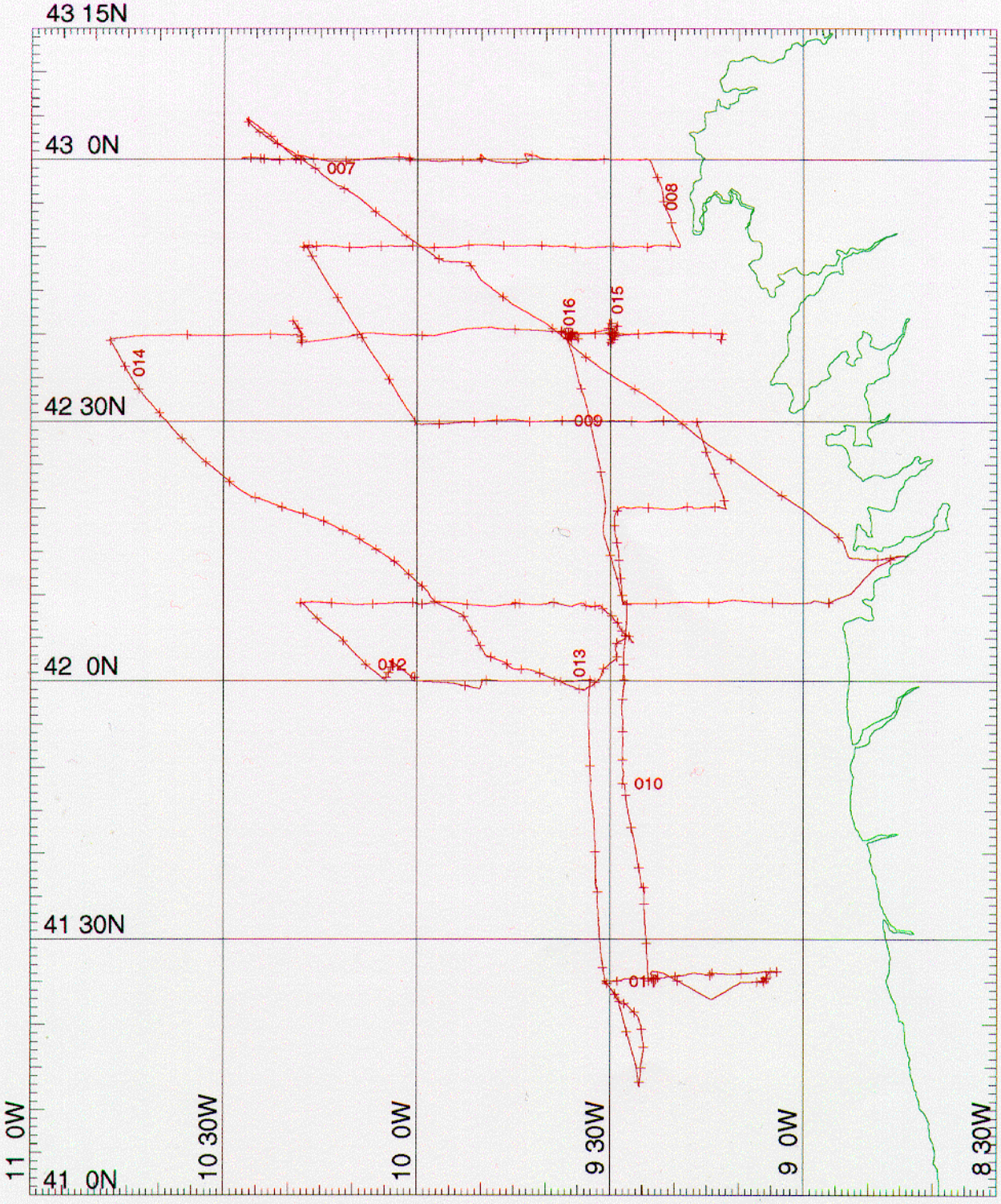
GRID NO. 1

SCALE 1 TO 7500000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

RRS Charles Darwin Cruise 110B Whole Cruise Track

Figure 2 *High resolution area map and cruise track: Vigo-Vigo*



MERCATOR PROJECTION

GRID NO. 1

SCALE 1 TO 1750000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

RRS Charles Darwin Cruise 110

Figure 3 *Surface variables recorded for day 008*

Under the Navidad condition; a broad (~100 km), double-tongued band of warmer water is advected northwards along the slope towards Cape Finisterre. This poleward slope current, carrying warm and salty water, is clearly illustrated by the underway temperature, salinity and fluorescence profiles between 01:00 and 03:00 hours.

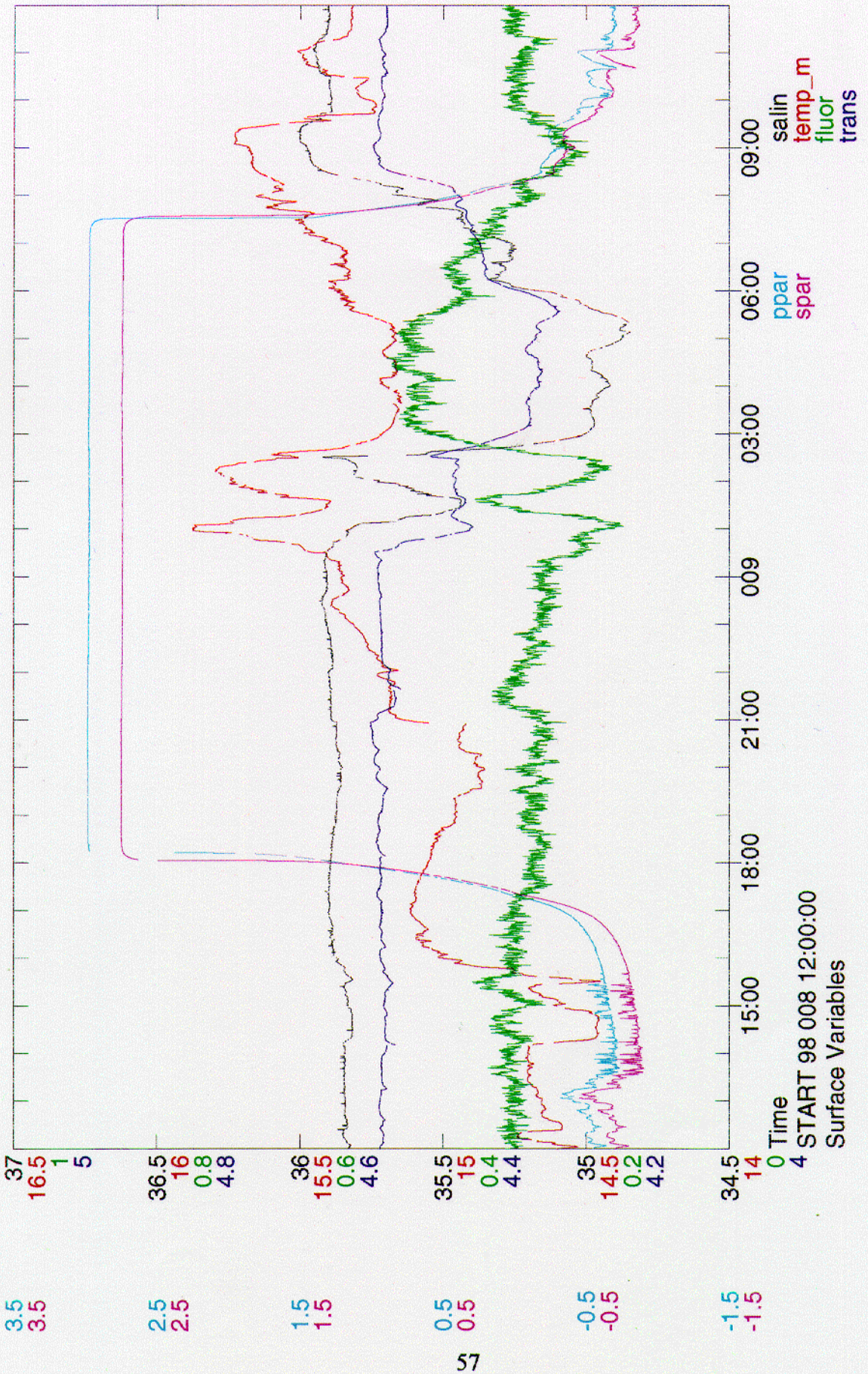


Figure 4 *Intermediate depth CTD plot focusing on general biogeochemical parameters*

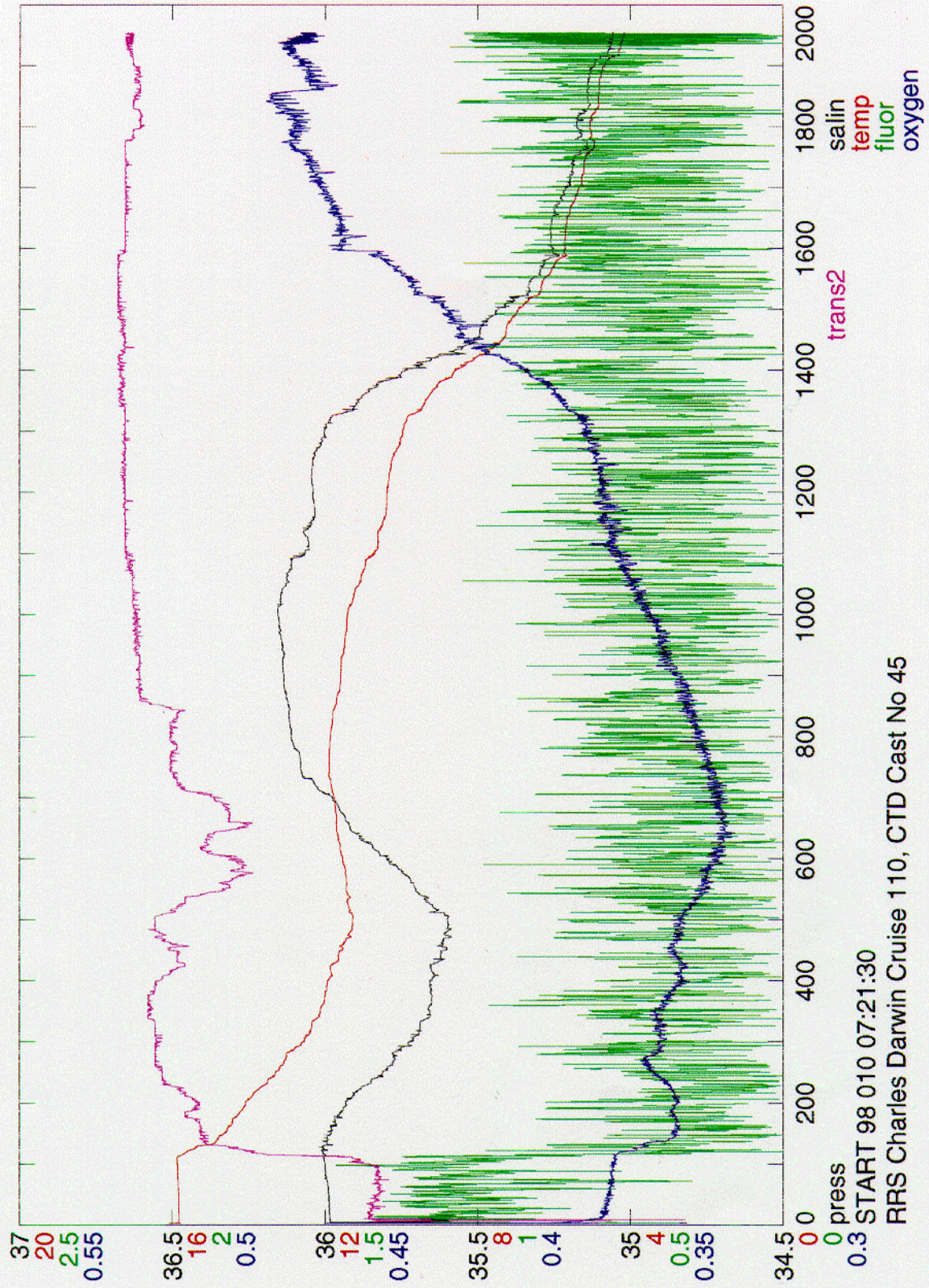


Figure 5 *Shallow depth CTD plot focusing on optical back-scatter and transmission*

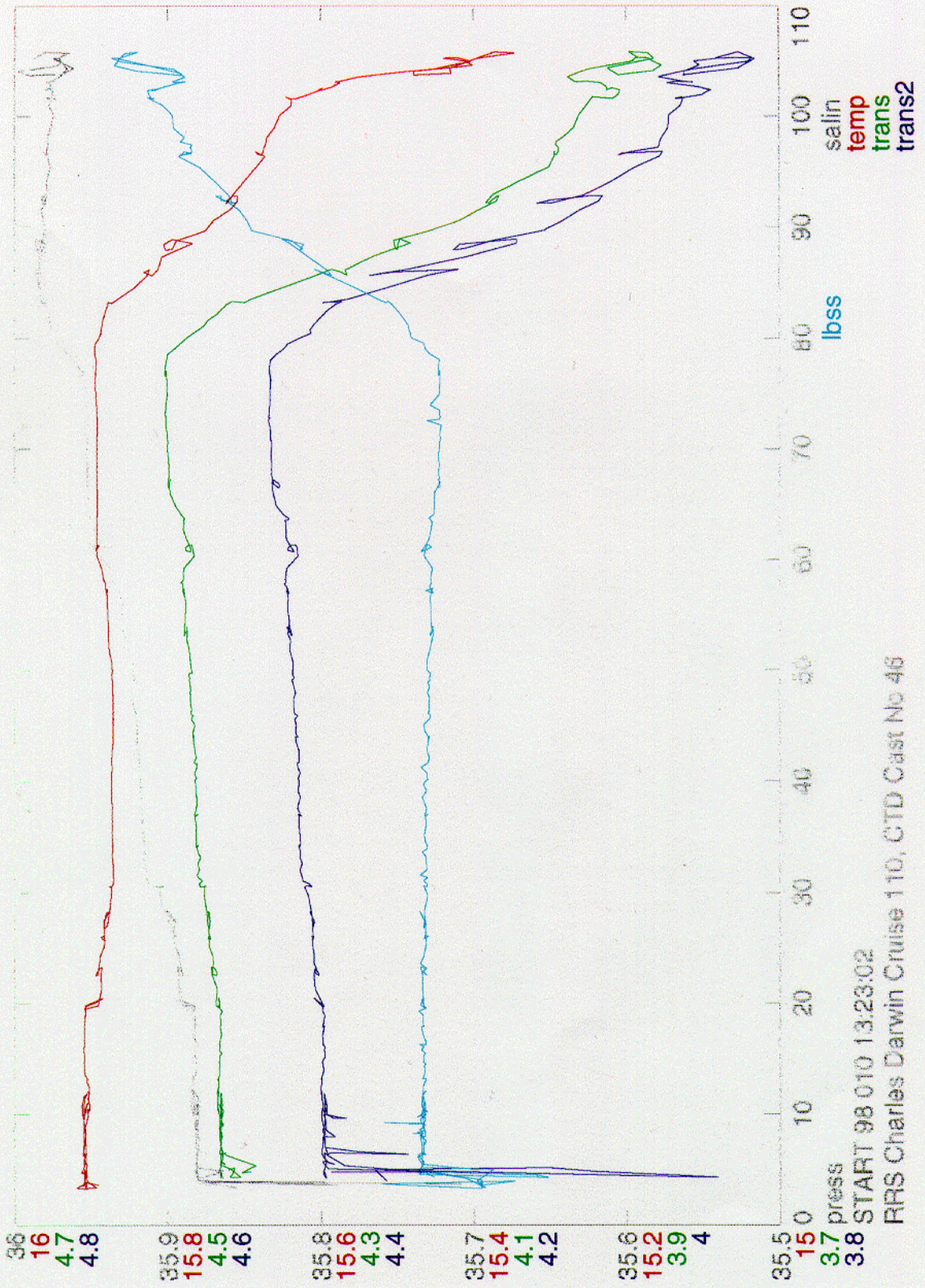
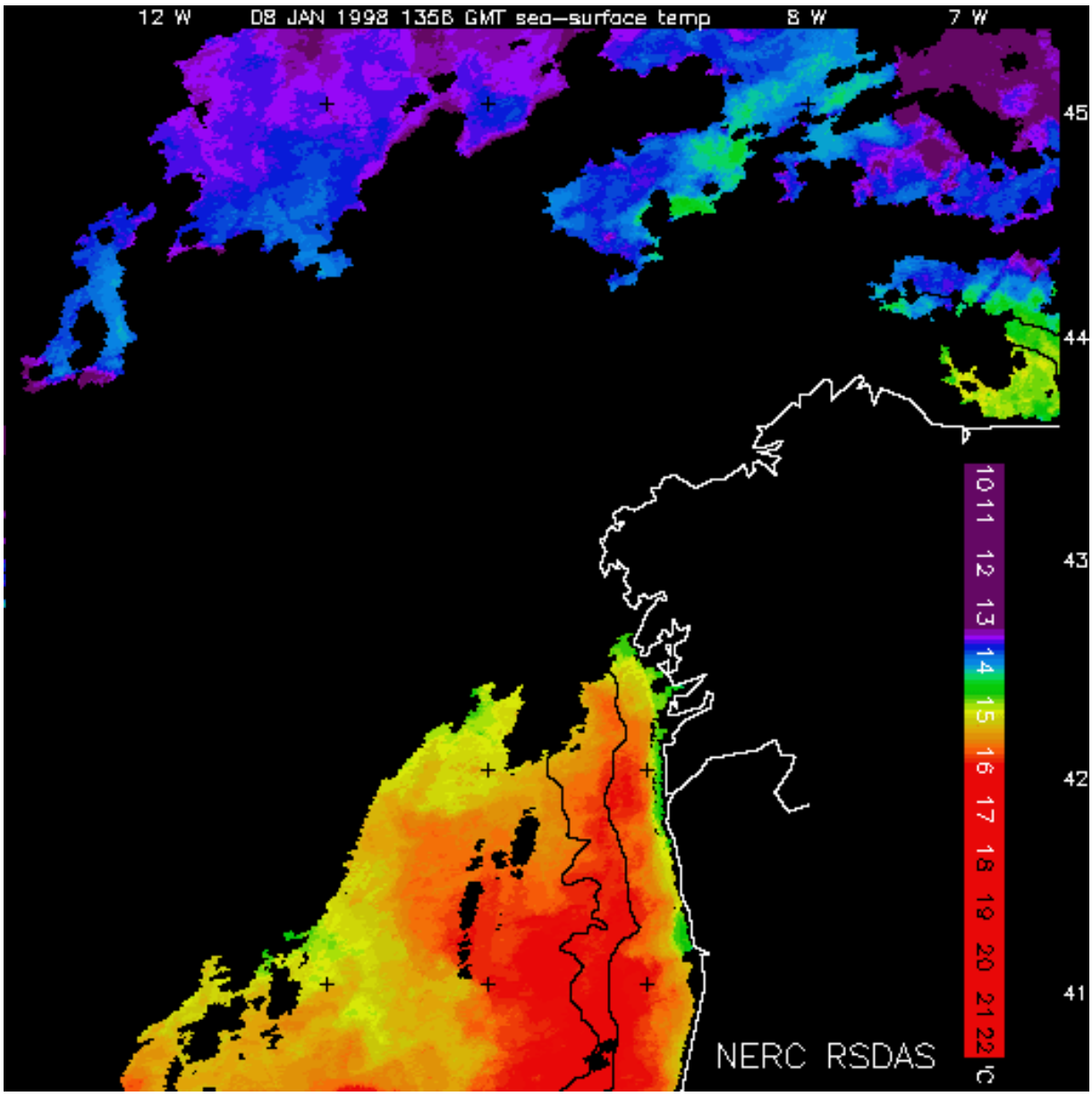


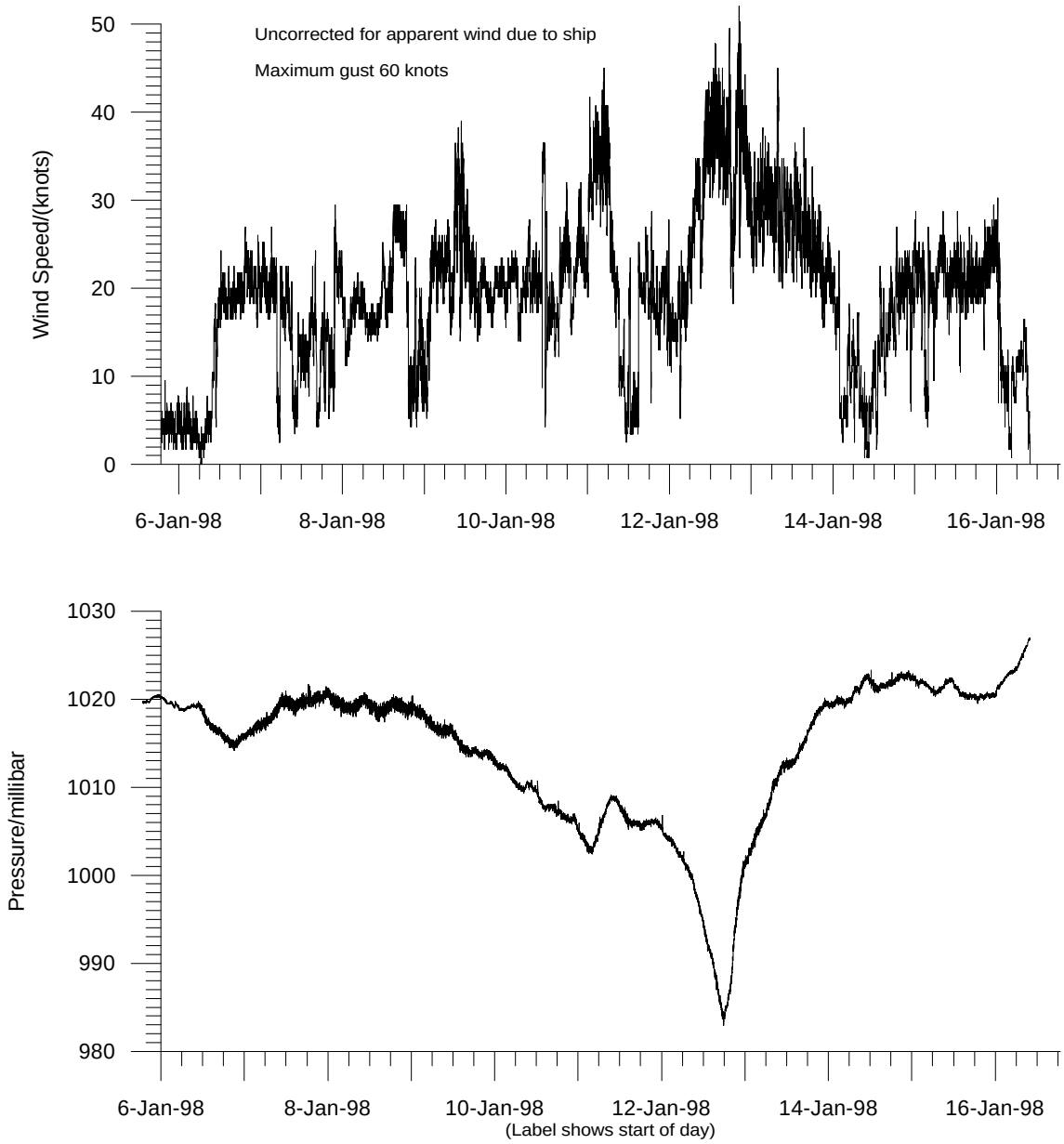
Figure 6 *AVHRR satellite colour image illustrating SST for day 008.*



Under the Navidad condition; a broad (~100 km), double-tongued band of warmer water is advected northwards along the slope towards Cape Finisterre. This poleward slope current effectively 'traps' continental waters at the coast, resulting in higher nutrient concentrations and consequently higher biological activity.

Image courtesy of RSDAS, Plymouth Marine Laboratory

Figure 7 *Summary of weather conditions throughout the cruise*



A recording meteorological package, attached to the monkey island of the ship, produced measurements of wind, temperature and relative humidity throughout the cruise. From 10th to 14th January an intense and persistent low-pressure system prevailed. Winds were extremely fierce (severe gales, gusting up to 60 knots) over the whole of Finisterre, and most of the eastern north Atlantic. Throughout the cruise, the OMEX-defined working area was characterised by near continual heavy swell, often confounded by disparate local wind direction.

Courtesy of Toby Sherwin, University of Wales