RRS Charles Darwin

Cruise 93

Leg A: Fairlie to Fairlie, May 7 to 16, 1995

Leg B: Fairlie to Fairlie, May 16 to 30, 1995

LOIS Shelf Edge Study (SES) Cruise 2

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Summary and Scientific Overview

The LOIS Shelf Edge Study (SES) region lies between 7 and 10 °W, 56 and 57 °N, extending from the outer edge of the Malin shelf across the continental slope of the Rockall Trough. The main aims of cruise CD93 were to service moorings and carry out CTD surveys in the SES region, and to study selected sites in detail during the anticipated period of the spring phytoplankton bloom. In addition, marine optical measurements would be made with the hope of relating to aircraft remote sensing, Argos-tracked drifters were to be released, and benthic sampling was to be carried out. Both legs of the cruise are described in this report.

Cruise organisation

Charles Darwin sailed from Fairlie on 7 May and returned on 30 May. Figure 1 is a track plot. The cruise was divided into 2 legs by a port call at Fairlie on 16 May. The main aim during leg A was the servicing, during daylight hours, of moorings. This was carried out by Alan Harrison's team and the ship's officers and crew. Night-time was used for CTD stations and repositioning. Leg 'B' combined "survey" and "process" studies, involving biologists, chemists and sedimentologists. "Fast" CTD surveys were found easy to organise; the schedule for "slow" stations (used for process studies) and aircraft liason was harder to arrange. A steering group, consisting of the PSO and 1 member of each discipline (specifically, Paul Tett, Sarah Jones (SPM), Martyn Harvey (benthos), Linda Gilpin (production) and Jane Foster (geochemistry)) met at 1720 each day, the navigator of the NERC aircraft was contacted at 1740, and a programme for the next 24-48 hours published soon afterwards. A formal scientific discusion was held during the final passage.

Moorings

All mooring sites were serviced during leg A. In particular, the partial sediment trap mooring laid at N1500 in March was recovered and fully redeployed. South line mooring sites S140, S200, S300 and S700 were fully instrumented. Because of equipment losses between March and May, North line mooring sites N140, N200 and N300 were only partly instrumented, and, because of lack of time, the subsurface mooring at N700 was not laid. The Meteorological Buoy at S140 was recovered at the end of leg A and relaid early in leg B.

Losses began almost immediately, probably as a result of midwater trawling by large fishing boats. By the end of the cruise the position was:

- Waverider, Met. Buoy, and toroids at S140, S200, S300 and S700 confirmed in place visually and by Argos on 28 May: instruments removed from S200 on May 29;
- N1500 sediment trap mooring, and S300 and S700 subsurface moorings confirmed in place acoustically during leg B;
- N140 marker spar and U-mooring, and N700 spar, confirmed visually on 27 May;
- N200 spar and U-mooring lost (subsurface float, RCM and thermisor logger/chain recovered on May 28 after Argos alert);
- N300 marker spar missing on 27 May, status of subsurface mooring unknown;
- 140 U-mooring lost (subsurface float and S4 recovered after chance sighting on 14 May);
- S200 U-mooring lost without trace;
- The status of the RDI ADCP and the Bottom Pressure Recorder (BPR) at S140, and the BPRs at N140 and N1500, could not be investigated during leg B.

It was concluded that (i) toroids survive well, being easy to see and without invisible subsurface parts; (ii) especial care in laying U-moorings and marker spars in a tight line is repaid; (iii) Dutch and German, as well as French and Spanish, fishing communities should be notified of current mooring positions, and every effort should be made to restore moorings to these positions after servicing; (iv) intermediate buoyancy and Argus beacons are worthwhile.

Coring

Despite problems that developed with the Multicorer during the later part of the cruise, multicores were obtained (and some incubated for oxygen demand) at S700, R1000 and N1500; gravity cores were taken at R1000, N1500 and N2000.

CTD surveys

A total of 196 CTD casts were made during the cruise. In addition to the predefined "fast" survey of lines N, P, R and S carried out during leg B, CTD stations from lines N and S were worked whenever possible, allowing a time-series of contoured sections to be constructed. Table 1 lists and comments on these sections. In addition CTD stations were worked near Islay during each passage, at 2 sites in the deepest part of the Rockall Trough, and during drifter deployment and recovery.

The CTD system, including "tone-fire" water-bottle closing, worked well. Considerable effort was put into sensor calibration: frozen chlorophyll samples have been returned to DML to aid fluorometer calibration; SPM and POC samples were taken for transmissometer calibration, and dissolved oxygen concentrations determined chemically for calibration of the oxygen sensor, which had been reconfigured with a SeaBird pump.

"Slow" stations

During leg B, seven sites (S140, S200, S300, S700, R1000, N1500 and N2000) were worked in detail, including multiple CTD casts, and special water-sampling for geochemical measurements. Rates of photosynthesis, primary production, microplankton respiration, and particulate sinking, and optical properties were measured at most of these stations. The go-flo bottles, used for clean sampling, sometimes malfunctioned.

Drifters

Two kinds of Argos-tracked drifter experiment were carried out during leg B. Six drogued drifters were released at shelf and slope stations on the V-line, on behalf of DML and Southampton University. Two UWB instrumented drifters, each with a DML sedimentation trap at 75 m, were each released twice, and recovered 30-50 hours later. The traps mainly took copepods. In general, releases near the shelf-break tended to move northwards, parallel to the shelf-break; those in deeper water moved north-west.

Optics and remote sensing

The NERC aircraft, equipped with CASI and ATM, made a number of attempts to fly to the SES study area, but weather (mainly, the amount of cloud) prevented any effective overflights. Despite much effort by the aircraft's crew, short periods of (relatively) clear sky could not be used because of the delay involved in flying the plane from Coventry, with refueling stop at Caernarfon or Londonderry.

In-water optical measurements were made at about a dozen stations according to the SeaWiFs-compatable protocols developed by the UWB Marine Optics Group. These included measurements of radiance and irradiance made with four specialised sensors, and detailed measurements of light absorbers, especially phytoplankton pigments.

The spring bloom and its decline

The cruise was fortunate in coinciding with the increase and decline of the spring phytoplankton bloom. In the surface waters, phytoplankton were the main absorbers of light, and data from the CTD fluorometer and transmissometer well indicated the distribution of biomass. This information was supplemented by measurements of chlorophyll concentration made at optical stations during the cruise itself (most chlorophyll samples were not processed during the cruise itself, and data from moored instruments was not available until later). These data show that the bloom peaked during the first 2 weeks of May (certainly by May 15), and declined thereafter. By about 20 May there were indications of phytoplankton sinking to 200 m at some sites, and on May 24 large quantities of phytoplankton pigments (mainly pheopigments, but with about 20% chlorophyll or similar) were seen near the bed at N1500. There was no evidence for sinking phytoplankton in midwater in any CTD profile, and no mid-water bottle samples contained sinking phytoplankton. It is possible that the downwards transport was largely mediated by mesozooplankton.

Early in May, thermal layering was weak near the sea-surface, and the most obvious physical feature was a reduced salinity superficial layer extending across the slope waters from the outer shelf. The penetration of this layer weakened later in May, as thermal layer intensified. The shelf water may have had phytoplankton dominated by flagellates and small dinoflagellates, at least during the later stages of the bloom, whereas the oceanic bloom was clearly dominated by chain forming diatoms, especially *Chaetoceros*.

SPM

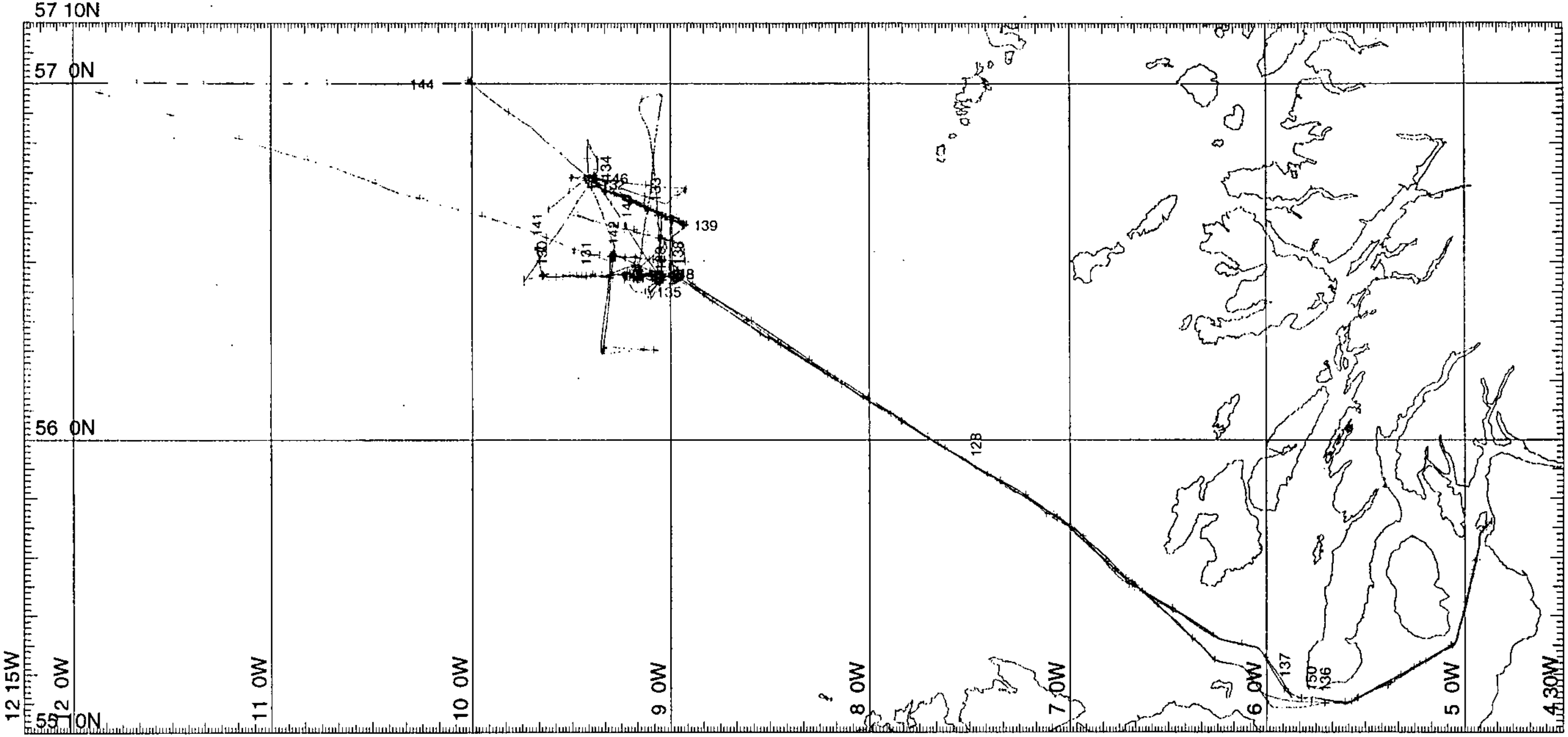
SPM was characterised using a Galai laser sizer at most CTD stations. In superficial waters, and in some near-bed samples, it was dominated by phytoplankton. Preliminary estimates gave 1 m d^{-1}, or slower, for the sinking rates of most near-surface phytoplankton. Midwater regions of enhanced turbidity were seen frequently at slope sites, typically at depths of 300 - 700 m. The transmissometer signal was not usually accompanied by a fluorescence signal, implying that the turbid material did not contain chlorophyll-like pigments.

Conclusions

With the exception of aircraft overflights, all objectives were acheived. Losses of moored instruments were of concern. We were fortunate to be able to observe the spring phytoplankton bloom and its decline.

Figure 1. Track plot. The heavily worked lines are the S and N lines in the SES region.

Table 1. List of sections. See also station lists.



MERCATOR PROJECTION

SCALE 1 TO 3000000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

GRID NO. 1

Track plotted from bestnav

RRS Charles Darwin 93 Leg B whole track

CD93: Summary of contoured sections across the slope.

Three methods were used:

F. "Fast survey", starting at one end and proceeding from site to site directly to other end, visiting all (or almost all) sites;

spF. Sparse "fast" survey: only some sites visited;

A. Assembled from sites visited over several days, including some occupied for "slow" stations or mooring servicing/calibration.

Contoured sections (to 800m) have been plotted for: T:temperature, S:salinity, Fv:fluorescence voltage (also to 200m), Trv:transmissometer voltage, and DO:(uncalibrated, upcast only) oxygen.

Line	Dates (May)	Site range	Method	Comments
S	9-11	140-1500	A	T - downwelling on slope; S - lower salinity surface water on shelf; Fv - maximum greater, and extends deeper, over deep water; Trv - minima on shelf and over deep water; midwater and near-bed turbid regions at S200-S400.; DO - downwelling on slope.
N	12-14	140-1600	A	T - downwelling on slope; S - lower salinity surface water on shelf; Fv - maxima lower than previous S-line, but some plumes to 200 m; Trv - minima over shelf and upper slope; midwater and near-bed turbid regions S300-S500;
N	18-19	140-1500	F	T - ocean SML warmer than shelf, some downwelling on slope; S - lower salinity surface layer extends to N1300; Fv - highest over shelf and slope, plumes to 100 m; TrV - minima over shelf and slope; midwater turbid plume N500-N1300; DO - highest where Fv maximum. *Nutrient sections also available.*
P	19-20	1500-140	F	T - ocean SML warmest, downwelling on slope; S - low salinity shelf water only to P700; Fv - greatest fluorescence near shelf; plumes to 200 m; TrV - minima over shelf, sinking plumes?.
R	20	140-1500	F	T - ocean SML warmest; downwelling on slope; S - lower salinities mostly on shelf; Fv - greatest fluorescence over shelf, large sinking? plume to 150 m at R700-R100; Trv - minimum transmission over shelf, plume coincides with Fv. *Fv, Trv and DO also contoured on y-T section.*
S	21	1500-140	F	T - warmest SML now over slope, downwelling on slope; S - weak low-salinity layer extending to S850; Fv - maxima now lower than before, sinking plume at S1350-S1500; TrV - matches Fv, some near-bed turbid water on slope; DO - maxima less marked.
S	24-25	1500,1000,500,200	spF	T - SML warmer over shelf and slope, weak downwelling; Fv - maxima weak; TrV - turbid plume extending offshore from S500?; DO - maxima weak.
N	27	140-1500	spF	T - SML temperature layering strengthening everywhere, downwelling on slope; S - low-salinity water conifned to shelf; Fv - maxima weak, greatest on shelf; TrV - midwater turbidity at N500, extending in plume?; DO - structure weak.
S	(28-)29	1000-130	spF/A	T - SML temperature layering strengthening, downwelling on slope; S - low salinity water penetrates only to S300; Fv - fluorescence maxima strongest on shelf; TrV - transmission minima strongest on shelf/inner slope, turbid midwater at S500/S700; DO - mindwater minimum at S700.

LOIS - SES objectives

The objectives of the LOIS Shelf Edge Study are:

(a) to identify the time and space scales of ocean-shelf momentum transmission and to quantify the contributions to ocean-shelf water exchange by physical processes;

(b) to estimate fluxes of water, heat and certain dissolved and suspended constituents across a section from the shelf edge with special emphasis on net organic export from, and nutrient import to, the shelf;

(c) to relate sediment properties and fluxes to the physical context;

(d) to incorporate process understanding into models which will be tested by comparison with observations and provide a basis for estimation of fluxes integrated over time and the length of the shelf edge.

Seven SES cruises are planned during 1995-96, to study the shelf edge west of Scotland. The first cruise, Charles Darwin 91, took place in March 1995, and involved bathymetric, sea-bed and sediment survey, and the placing of a skeleton array of moorings.

Study region and survey strategy for Charles Darwin 93

SES mooring lines. The SES south mooring line (S) (which carries the majority of the sensors, including all those for chemistry and biology) runs E-W from 150S at about 56°24'N, 9°00'W to 700S, and the north mooring line (N) runs WNW from 130N at about 56°37'N, 8°55'W to the 1500N sediment trap mooring. The shelf break is at about 9°05'W on S and about 9°00'W on N. The **detailed study region** is bounded by these lines. A **"slow" survey**, with detailed pelagic and benthic sampling, will be carried out along S, with additional sampling near 1000R, 1500N, and 2000N.

The **Sea-soar survey** covers a somewhat larger area, with 4 cross-slope sections (S, R, P and N; each about 50 km long, 140-1600 m water depth) and 3 along-slope sections (50 km long) S-N from 56°18'N to 56°44'N, in water depths 170 (repeated), 500 and 1000m. The vehicle will be equipped with CTD and fluorometer.

The **"fast" (CTD) survey** will include stations on S, R, P and N. Stations outside the detailed study region may include W, stations on the DML **WOCE** line from the shelf break at 57°00'N, 9°00'W (DML station R1, 155m) and then to 57°09'N, 9°42'W (DML station O, 1900m). The **CTD system** will include transmissometer, fluorometer, oxygen sensor and PAR sensors, and a rosette equipped with twelve 10-litre Niskin bottles. The non-toxic supply will go to thermosalinograph, transmissometer, fluorometer, and these, together with a pyrrheliometer, will be logged continuously.

Objectives of CD93

Climate-forced numerical simulations suggest that thermal stratification should be commencing during the cruise, and the spring bloom of phytoplankton should take place in late May. Although moored instruments will monitor the time-course of the bloom, CD93 will also collect time-series of samples from "slow" survey stations. The NERC aircraft, with CASI and ATM, will overfly the detailed study region about once a week..

<u>Leg A</u>

(a) Service all moorings and add full suite of instruments.

(b) CTD profiles: to calibrate moored instruments; and at some other "fast" stations.

(c) Specialised optical measurements: for calibration of moored optical sensors; and to relate to CASI measurements during overflights by NERC aircraft.

(d) Opportunistic CTD stations during passage to and from study region.

Leg B

(a)* Sea-Soar survey, with 13 hrs of repeated runs along 170 m contour (near either Neap or Spring tides). Repeat about 7 days later.

(b) Slow survey. Four stations occupied for 24 hours each. Detailed optical measurements (during daytime), and repeated CTD-waterbottle casts at all mooring sites, penetrating to within 5 m (ideally 2 m) of the bed, providing: water for all required analyses, including chemistry, photosynthesis, respiration; and near-bottom water for core incubation. Special sampling for SPM. Benthic sampling with multi-corer and box corer.

(c) Drifter experiments. Release of 12 Argos-tracked drifters; release and recovery of 2 (optically instrumented) Argos-tracked drifters and in-situ productivity incubations.

(d) Fast CTD survey.

(e) Remote sensing. Darwin will sample close to an optically-instrumented (S) mooring with the aircraft overhead.

(f) Water sampling at dawn whenever possible for deck productivity incubation.

(g) Service surface optical and nutrient sensors from one mooring;

(h) Opportunistic CTD stations during passage to and from study region.

*Unavailability of Sea-Soar meant that objective (a) was not attempted.

Personnel

Officers and Crew (both legs)

Name	Position
Bourne, R.A.	Master
Noden, J.D.	C/O
Oldfield, P.T.	2/O
Crofts, M.L.	3/0
Baker, J.G.	R/O
Adams, A.P.	C/E
McDonald, B.J.	2/E
Slater, I.M.	3/E
Parker, P.G.	E/E
Trevaskis, M.	CPO(D)
Vettos, C.	SG1A
Luckhurst, K.R.	SG1A
Dean, P.H.	SG1A
Dickinson, R.	SG1A
Maclean, A.	SG1A
Healy, A.	MM1A
Bell, R.	SCM
Perry, C.K.	Chef
Kenny, C.J.	M/Stwd
Link, W.J.	Stwd
Shields, S.	Stwd

Scientists, leg A (7-16 May)

Name	Cabin	Main Task	From
Alan Harrison	9	Moorings	POL
Anne Hammerstein	4	Moorings/ optical instruments	UWB
Bill Miller	15	Instruments/RVS technical liason	RVS
Brian Grantham	2	Moored nitrate analysers and fluorometers	DML
Fernando Perez-Castillo	6	Sediment traps/transmissometer calibration	UWB
Graham Ballard	11	Moorings	POL
Hilary Wilson	3	CTD oxygen sensor calibration	UWB
Ivan Ezzi	1	Moored nitrate analysers and fluorometers	DML
Jake Loncar	17	Data	BODC
Jeff Jones	13	Mechanical	RVS
Kev Smith	14	Mechanical	RVS
Neil MacDougall	8	Moorings	DML
Paul Duncan	5	Computing	RVS
Paul Tett	CS	Chief Scientist	UWB
Phil Taylor	16	Instruments/moorings	RVS
Ru Morrison	7	Remote sensing sea-truth	UWB
Suse Kratzer	12	Colour sensor cal./phytoplankton/pigments	UWB
Tony Banaczek	10	Moorings	POL

Scientists, leg B (16 - 30 May)

Name	Cabin	Main task	From
Anne-Christine Le Gall	1	Geochemistry	Soton
Bill Miller	15	Instruments/RVS technical liason	RVS
Brian Grantham	2	Nutrients	DML
Hilary Wilson	4	Respiration, oxygen	UWB
Jane Foster	10	Geochemistry	Edin
Jeff Jones	13	Mechanical	RVS
John Hughes	9	Data	BODC
John Wynar	16	Instruments	RVS
Kev Smith	14	Mechanical	RVS
Linda Gilpin	3	Primary production	QUB
Lynda Mitchell	12	Benthos	DML
Martyn Harvey	11	Benthos	DML
Paul Duncan	5	Computing	RVS
Paul Smith	7	Remote sensing sea-truth	UWB
Paul Tett	CS	Chief Scientist	UWB
Ray Wilton	8	Drifters, optical instruments	UWB
Sarah Jones	17	SPM	UWB
Stuart Lowe	6	SPM	UWB

Leg A

SUNDAY MAY 7 (JULIAN DAY 127): Ship left Fairlie at 09 hr BST and made passage out of Firth of Clyde and then in direction of SES detailed study region. Conditions generally good; sky overcast with low cloud; swell increased towards Atlantic. Scientists engaged in preparing equipment and moorings. Flow-through system not running, and doubts about its logging software. CTD oxygen sensor not yet connected to pump. Two CTD stations in evening near Islay, the first including optical measurements.

MONDAY MAY 8 (DAY 128): Clocks to GMT. Continued passage. Forecast weather unsuitable for aircraft/CASI. Most work concerned preparation or deployment of S-line moorings. Arrived S140 at 08 hr and deployed bottom-mounted ADCP. Deployed surface-toroid mooring at S300. The S300 pop-up mooring apparently responded to distant interrogation but not when close. Recovered S140 U-mooring. Attempted optical station in afternoon: in order to get sun on starboard (hydrographic winch) ship lay broadside to NW wind: conditions impossible for moorings assembly on rear deck, so optical station aborted. Discussions about safety and reliability of anchor-first deployment of deep moorings, starting with replacement S300 pop-up. Conclusion: safety considerations preclude anchor-first except in calm conditions. CTD casts from 003 to 005 included some for moored instrument calibration. Two minutes silence observed at 1938. Remained at S300 for mooring gear tests and to interrogate existing S300 pop-up mooring.

TUESDAY MAY 9 (DAY 129): CTD stations overnight between S700 and S120 (casts 006 to 010). CTD DO sensor ducted through Seabird pump from cast 008 onwards: spikes in DO downcast caused concern, but upcast looked good. Weather at 0600 good, but forecast noon cloud cover too great for aircraft remote sensing. After breakfast, deploy S140 U-mooring. Continue acoustic search for S300 pop-up mooring, now thought to have moved from original location. Optical station at S300, using port side hydraulic crane to lower sensors. Concluded that S300 pop-up mooring has gone from area; a new pop-up mooring was deployed. During deployment it was discovered that nominal co-ordinates for site were at 340 m depth, so the mooring was finally deployed to the north of the S300 toroid, in 300 m depth. Recovered S200 U-mooring with toroid and deployed Waverider buoy at S140. CTD casts from 011 to 014, mainly for mooring calibration. Weather fine and conditions generally good during day.

WEDNESDAY MAY 10 (DAY 130): CTD stations overnight between S1500 and S1000 (casts 015 to 018). Aircraft overflight requested at 0600 with prospect of clear sky. Overcast by 0900; however, agreed that aircraft would come for reconnaissance; flew by 1123-1140. Weather in afternoon improved: much clear sky; bright sun; NE wind. Deployed S200 U-mooring and toroid mooring, with optical station. Deployed S700 toroid mooring. S700 pop-up mooring interrogated and located. CTD casts 019 to 023 for calibration and optics.

THURSDAY MAY 11 (DAY 131): CTD stations overnight between S1300 and S850 (casts 024 to 026). At 0600 arranged for aircraft to fly to Londonderry. Forecast wind N/NE, 4/5; squally showers and sunny intervals. Drifted S700 pop-up mooring recovered, with some difficulty: only bottom 20 m remained, with 1 RCM and acoustic release. It was about 2 n.m. north of its deployed position. Aircraft cancelled at 1000 due to increased cloud. Deployed replacement S700 pop-up mooring, and then recovered BPR at S140. Optical stations at S700 and S140. CTD casts 027 to 029 for calibration and optics. Then passage towards

N1500, with CTD stations at S170 and R1000 (casts 030, 031), and search for missing original S300 pop-up mooring.

Losses of instruments with old S300 and S700 pop-up moorings made it impossible to deploy a full suite on the North line. Advice was sought overnight from T.Sherwin (UWB), who on Friday suggested deployment of sparsely implemented physics moorings at all N-line sites (N140, N200, N300, N700).

FRIDAY MAY 12 (DAY 132). CTD station and overnight in vicinity of N1500. Acoustic contact with partial sediment trap mooring. At 0800, wind (25+ knots) and swell from north too strong for safe recovery of pop-up mooring. Commenced CTD stations at N1600 (including optics), then decided to deploy U-mooring at N140, which was successfully achieved. CTD stations N170 to N500. CTD casts during day from 032 to 040.

SATURDAY MAY 13 (DAY 133). Overnight CTD stations continued from N700 to N1000 (casts 041 to 043). Early morning weather good (wind 10 kn. N, cloud 2/8). Agreed at 06 hr that aircraft would overfly; confirmed at 8hr and 10hr. N1500 sediment trap partial mooring successfully popped-up soon after 6 hr, and recovered using rubber boat. Trap had taken samples. RCM had data, but associated transmissometer was bent, perhaps at time of deployment. By noon wind had shifted to 15 knot from NW, cloud had increased, and there were squally showers. Aircraft radioed that had reached S line, but thick cloud prevented remote sensing. It returned to Coventry. Complete N1500 mooring (2 traps) deployed in afternoon, preceded by deployment of Bottom Pressure Recorder. In evening, deployed N200 mooring, and spooler test rig at 400m. Casts 044 to 047 for mooring calibration.

SUNDAY MAY 14 (DAY 134). Overnight CTD stations from N1400 to N1150, and N500, N300 (casts 048 - 052). Deployed N300 pop-up mooring with reduced instrumentation, and recovered spooler test. It had been planned to deploy N700 pop-up with sparse instrumentation. However, spar marker had gone. There was insufficient time to replace marker and deploy pop-up mooring; it was thought that instruments would be dangerously exposed without marker, so only new marker was deployed. Calibration CTD casts 053 - 054. On passage to S140 a drifting buoy was encountered and recovered: it was the subsurface float (with 1 S4 current meter) of the U-mooring deployed at S140 on 9 May). After placing a spar marker buoy near the S140 Met Buoy (ready for removal of the Met Buoy tomorrow), Darwin started at 20 hr to search acoustically to N and W of S140 site for the rest of the S140 U-mooring, and the old S300 mooring.

Day had commenced overcast and raining, with forecast of winds NW to NE, 3/4, and showers; aircraft was told no flight needed. By afternoon weather was fine, with periods of largely clear skies, and sea was becoming increasingly calm. Suggests need for aircraft to be temporarily based in Londonderry, able to respond to conditions in SES area at 2 hours notice, as opposed to 6 hours at present.

Results analysed by Sunday suggest that the Spring Bloom was underway on the outer shelf, with some S-line surface layer chlorophyll concentrations exceeding 3 mg/cubic metre.

MONDAY MAY 15 (DAY 135). Search for missing moorings ended at 03 hr without success. Full moon, weather fine, occasional showers, sea conditions good. CTD at S300 and S140 for DON and POC samples (casts 055,056). Recovered Met. Buoy and deployed toroid mooring at S140, followed by optical station for sensor calibration (cast 057). DGPS turned off at 1100. Weather and sea good, sky increasingly clear. Passage to Islay stations D and C (CTD casts 058, 059), after which Non-toxic supply was turned off. Continued passage to Mull of Kintyre.

TUESDAY MAY 16 (DAY 136). Clocks to BST. Passage through Firth of Clyde, arriving Fairlie 0830 BST. Disembark leg A personnel and gear, especially remaining moorings gear. Embark leg B personnel and gear, including Clean Chemistry Container (Radio-Isotope Container already aboard). Service Met. Buoy. Take on Argos drifters, delayed in transit from U.S. Sail Fairlie 2000 BST.

Leg B

WEDNESDAY MAY 17 (DAY 137). Clocks to GMT. Watches began 0300 as Islay C station was approached; non-toxic supply had been running for some hours. Acoustic fish not out; depths from hull transducer. Positions from ordinary GPS unless stated. Stations Islay C, Islay D and S130 worked (CTD casts 060-062) on passage to S140. Weather improving from overcast and rainy to mostly clear sky, low wind and good sea. Reached S140 at 1330. All surface moorings in place. Deployed Met. Buoy. Began CTD time series with cast 063 to provide water for variety of needs, including SPM (Jones, Lowe), chemistry (Foster, Le Gall, sometimes using Go-Flo bottles) and productivity (Gilpin). Optical measurements in afternoon (Smith). A new watch system was organised during the day, and to was agreed to have daily meetings of a small co-ordinating group (Foster, Gilpin, Harvey, Jones, Tett) to plan scientific schedule. Agreed no aircraft flight on Thursday.

THURSDAY MAY 18 (DAY 138). Continued CTD time series at S140 up to 1230 (cast 78), with productivity, optical and SPM settling tube measurements. After some further experiments with the plumbing of the DO sensor, it was decided to revert (cast 073) to the leg A configuration for the rest of the cruise. Successful coring (MC1 - MC3) at S700, and CTD cast 080, between 15hr and 22hr. S700 toroid and subsurface moorings in place: the subsurface mooring was confirmed acoustically after pellets were seen at the surface. Commence "Fast" CTD survey at N140 just before midnight (cast 081), including Go-Flo bottles. Conditions generally good during day, with showers and sunny intervals.

FRIDAY MAY 19 (DAY 139). Continue "Fast" CTD stations from N150 on N line (casts 082-090), reaching N1500 at noon. The stations were defined in advance, in relation to mooring position and the detailed map of bottom topography made by CD91. Commence P line at P1500, completing P850 before midnight (casts 091-094). Darwin made a course from P1500 to P140, identifying station positions by water depth as displayed on the Simrad echo sounder in the Main Laboratory. The station positions marked as a result are available for subsequent surveys. Wind increased during the day, and it was generally overcast, with showers. A problem in logging CTD bottle fire events to the level A computing system error (not all events were recorded) was identified for some earlier casts, but could not be repeated during tests. It was agreed that the NERC aircraft would attempt 2 overflights on Saturday, if the weather proved suitable.

SATURDAY MAY 20 (DAY 140). Continue "Fast" CTD stations on P line from P700 to P140 (casts 095-100), completing P140 by 08 hr. Sky overcast, and forecast of increasing winds and rain as depression approached, so overflights cancelled at 0725. "Fast" CTD stations on R line, from R140 to R1500 (casts 101-110). The procedure for identifying station positions according to water depth was the same as that used on the P line. In retrospect, however, it might have been faster to survey the course from R140 to R1500 without stopping, marking station positions as appropriate depth contours were passed, and then returning to known station positions. An analysis of cast 081 salinity data, with samples taken from alternating Niskin and Go-Flo bottles and compared with CTD salinity, gave some causes for concern, although routine salinity samples taken from a lower-water-column bottle on each cast have generally been in good agreement with the CTD. For example, 9 samples from casts 091-099 were on average 0.028 (s.d. 0.002) psu greater than the corresponding CTD value.

SUNDAY MAY 21 (DAY 141). "Fast" CTD stations (at pre-determined positions) on S line, starting at S1500 at 02 hr. Weather worsening: at 0630, low cloud, drizzle, wind 25 knots, 160°. 24-hr forecast for Malin includes winds to 6-7, turning to south. In conversation with fisheries protection vessel "Vigilante" soon after 10 hr, it was learnt that the large fishing vessels seen last week were probably Dutch or German, catching pelagic blue whiting. If they follow last year's behaviour, they will by now have followed the fish northwards, and their stay in the SES region may not have lasted more than a fortnight. Smaller Spanish (long-liner) and French (trawlers) continue in the SES area. "Vigilante" reports that some boats have complained that our moorings are not in the exact positions given by the preliminary notices.

Completed S-line at station S140 (casts 111 to 121). Swell increasing. Toroids at S700, S300, S200, S140, and Met Buoy and WaveRider at S140 all seen from bridge. The spar buoy marking S200 subsurface mooring was not seen, however, and could not be found between S200 and R200 on passage from S140 to R1000. Reached R1000 at 20 hr. Two failed Gravity Corer drops.

MONDAY MAY 22 (DAY 142). Continue overnight station at R1000. Weather and sea considered unsuitable for multicoring. Go-flo (122) and Niskin (123) CTD casts, followed by standard CTD casts (124-125) at 04 and 06 hr, then a mixed Niskin/Go-flo cast (126) and cast 127 for deep water. Settling velocity tubes taken. After this there was a successful Multicorer drop, ending 14 hr. Coring was interrupted to go to the drifter release line, V (at 56°15'N), reached at 16 hr. An optical station was carried out at V1000 (cast 128), and two UWB drifters were deployed over the stern. Each carried a colour sensors, a 70 m thermistor chain, and a DML sediment trap. They will be tracked by Argos and, at close quarters, by a VHF beacon. Between 19 hr and 23 hr, Darwin deployed 6 Argos-tracked drifters for DML/Southampton University, between V150 and V1000, with associated 100m CTD casts 129-131. Sky overcast, and some rain, but wind strength fell gradually during the day.

TUESDAY MAY 23 (DAY 143). Returned to R1000 to complete coring: 2 more successful drops of the Multicorer, and 1 successful drop of the Gravity corer. At 0540 commenced passage for station NR, at 57°N, 12°W for CTD station at 15 hr; then to N2300 (11°W) at 20 hr (casts 132, 133).

WEDNESDAY MAY 24 (DAY 144). Arrived N2000 (10°W) at 01 hr. CTD cast for simulated *in situ* production measurement, followed by standard CTD, successful Gravity Corer drop , and optical/CTD station (casts 134-136), ending at 10 hr. Passage to N1500 for standard (137) and geochemical (138) CTD casts, ending 16 hr. N1500 Sediment trap mooring release successfully acoustically interrogated; intermittent response from BPR. During day contour plots from the "Fast" surveys along N,P,R and S lines were examined, and thought to show evidence of sinking of fluorescent and light-absorbing material to 200m at some stations. Today's casts at N1500 showed increasing fluorescence, and decreasing transmission, in the 100 m above the sea-bed. Samples from this layer were rich in particulates and the remains of diatom chains, and it was tentatively concluded that this was recently sedimented material from the spring bloom, which had thus reached the bottom (1500 m) in a few days. There was no evidence of large particles in mid-water, so the downwards route was not clear.

Meanwhile, reports received from the Argos system, via the RVS computer and a twice-daily link from Darwin, showed that the UWB drifters were moving WNW. The ship headed for an estimated position SW of S1500, and homed in on the drifters using the signal from their VHF beacons. At 1830 they were seen in the water, and by 1912 both had been successfully and speedily recovered, sea conditions being good. The traps proved to have caught large numbers of *Calanus*-sized copepods and some other zooplankton and nekton. A single optical profile was made at the recovery site, followed by CTD cast 139 with Go-flo bottles for geochemical work (to test cleanliness of these bottles).

Darwin then moved to S1500 and S1000 for CTD casts (140,141). This was a successful and eventful day, the only disappointment being that cloud cover prevented remote sensing overflights.

THURSDAY MAY 25 (DAY 145). CTD cast (143) at S500. Arrived at "Slow" station S200 for CTD cast at 03 hr for simulated *in situ* production, followed by casts (144-150) for purposes including optics, geochemistry and dissolved oxygen. The S300 mooring acoustic release was successfully interrogated; there may have been a response from the acoustic release on missing S200 U-mooring at about 4 km. The 2 UWB drifters were re-launched about 3 n.m. north of S200, avoiding the nets of a large (Irish) trawler working nearby.

At about noon a message was received, via POL and Clyde Coastguard, that a POL buoy had been seen at 57°06'N, 009°15'W by the French fishing vessel "Heliotrope". Work at S200 was thus terminated early with the initiation of a Settling Velocity Tube experiment, and "Charles Darwin" proceeded at 14 hr to check the moorings at S140, since it was thought that the buoy might be the POL Meteorological Buoy. The Met. Buoy was however in place at S140, as were all other surface moorings. The next hypothesis was that the out-of-position buoy was a spar from the U-mooring at N200. This site was checked: there were no surface signs of either the U-mooring with spar, or the marker spar. Acoustic search at first gave confusing results, but finally suggested that the U-mooring acoustic release was not present. Another message from POL stated that the only POL spar was the marker at N140. This was checked and found in place, together with the DML spar and pellets of the N140 U-mooring. It was finally concluded that the out-of-position buoy was probably the original N700 marker spar, deployed in March and found missing during leg A.

"Charles Darwin" then proceeded to N1500, arriving at 19 hr, and commencing the "slow" station with CTD casts for geochemistry and for deep water samples (151-152). Multicorer sampling was commenced at 23 hr. During the day the sky was mostly completely cloudy, and the wind strength increased during the afternoon.

FRIDAY MAY 26 (DAY 146). Multicore sampling continued at N1500 to 05 hr. Three drops were carried out, each returning only 4 or 5 out of 8 cores; the coring mechanism may have been damaged during a recent fall on deck. A new termination was made for the CTD cable. Standard, go-flo and optical protocol casts (153-156) were made, an optical station worked, and Settling Velocity Tubes filled, before leaving the site at 15 hr to recover the UWB drifters. Both had moved northwards and into slightly shallower water on the shelf. They were encountered about 6 n.m north of N140, and both recovered, in worsening weather, between 1708 and 1830; during recovery of the second drifter, its sediment trap caught on the rudder, but was brought inboard safely. An short optical station was worked, and a double CTD cast (157-158) carried out for precise oxygen measurement and optical protocol samples, at the drifter recovery site.

Thereafter the ship returned to N1500, commencing a Multicorer drop at 22 hr. This was recovered successfully, but only 4 cores were obtained, due to continuing problems with the mechanism.

Some of the casts at N1500 showed increased chlorophyll fluorescence, and decreased transmission, in a layer exceeding 100 m thick above the sea-bed, as had been observed on Wednesday.

SATURDAY MAY 27 (DAY 147). Work at N1500 concluded with a gravity core. An abbreviated "fast" survey of the N-line was begun at N140 at 03 hr, and concluding at N1500 at 13 hr (casts 159-165). Although there were sunny periods during the morning, the general tendency of the weather was to stronger winds (up to 25 knots) and more cloud, and so the planned overflight was cancelled once the plane had reached Caernarfon. A "slow" station was commenced at S300 at 16 hr, with SVTs and CTD casts (166-172) for a variety of purposes, including a Go-flo cast for geochemistry.

SUNDAY MAY 28 (DAY 148). CTD casts continued at S300, including water for respiration measurement, and ending with an optical station at 10 hr (casts 173-181). The P/S came on watch at 0400 to find the lab. decorated with balloons for his birthday. The S200 toroid was recovered by the crew, Bill Miller supervising, and all instruments safely removed before the mooring itself was returned to its original position. An optical station was worked here (cast 182). At 14 hr, just as the ship was about to proceed to S700, Phil Taylor telephoned from RVS to notify an Argos alert. Beacon 24574 had been reported at 56°55'N, 9°06'W. Darwin proceeded to this position in good weather, and directly detected the beacon's transmissions to find it at 56°58', 09°03'W at 17 hr. Thus the subsurface buoy, 1 current meter and 1 thermistor chain/logger from the N200 U-mooring were recovered.

Darwin then returned to S700 to start the "slow" station at 22 hr. Settling Velocity Tubes were filled, and water taken for geochemistry and standard purposes.

Early in the morning the sky had been relatively clear of cloud. By 09 hr, however, when the NERC aircraft telephoned from Caernarfon, cloud cover had increased to 5/8 and it seemed likely to increase further. The overflight was therefore cancelled, and the aircraft returned to Coventry. In the afternoon there was a long period of sunshine; however, small, transitory clouds and humid haze probably rendered conditions unsuitable for remote sensing. Nevertheless, a flight might have been asked for had the aircraft been at Londonderry. This conclusion emphasises the need for flights to be able to occur at relatively short (i.e. 1-2 hrs) notice: probably impossible in the SES region because of lack of a suitable airport with overnight hanger facilities for the aircraft.

MONDAY MAY 29 (JULIAN DAY 149). Continued "slow" station at S700 until 04 hr (casts 183-188).An abbreviated "fast" survey of the S-line was then carried out, starting at S1000 and concluding at S140 (including optical measurements) at 11 hr (casts 189-193); the resulting contour plots, which included some data from the "slow" stations at S700 and S300, showed a midwinter maximum of turbidity, and minimum of oxygen, at S700. During the return passage to Fairlie, CTD stations were worked at S130 (8°30'W) and Islay D and C (casts 194-196). After Islay C, at 21 hr the thermosalinograph was turned off and the echo-sounding 'fish' brought inboard.

At dawn the sky was largely clear, although it began to cloud over soon afterwards. However, in the expectation of variable weather, Air Atlantic was contacted at Coventry airport at 8 hr to request continuation of the day's flight beyond Caernarfon. At 0930 the aircraft contacted 'Charles Darwin' on VHF radio, reporting its approach from the south-east over largely continuous and multi-layered cloud. With no prospect of a suitable break in the cloud, this final mission was terminated at 0945, and the aircraft returned to Coventry.

Following the CTD cast at S130, a scientific de-briefing meeting was held in the Chief Scientist's cabin. The cruise had been fortunate in coinciding with the Spring Phytoplankton Bloom and its decline, as shown by measurements of fluorescence, extracted chlorophyll and surface-layer nutrients. At some stations (mostly on or near the shelf, according to first impressions), phytoplankton dominated by diatoms (especially *Chaetoceros* and *Rhizosolenia*) has been succeeded by one dominated by small flagellates and dinoflagellates (such as *Prorocentrum*). The cruise had, perhaps, even more luckily, seen features that suggested the sinking of surface-layer phytoplankton to depths of 100-200 m, and the sudden appearance of the remains of phytoplankton in near-bed water at, especially, N1500, where cores showed increased benthic oxygen demand. Two major questions were raised. Why had the bloom developed a higher biomass at the shelf edge that in oceanic waters? And how had phytoplankton reached the sea-bed so rapidly once the bloom had ended?

The bedwards transport was discussed at some length. No evidence of sinking phytoplankton had been found at depths between 200 and the near-bed at stations such as N1500. The turbid regions found in midwater on the upper slope were low in fluorescence and contained few obvious phytoplankton remains. With the support of the evidence of mesozoooplankton caught by the drifting traps, the maximum of ammonium at about 100 m depth, and the lack of respiration in the size fraction < 2 µm, it was hypothesised that zooplankton were the primary agents of the downwards transport, through some combination of vertical migration and defecation.

It was agreed that a most interesting data set had been collected, and that it would be desirable to have a follow-up meeting in about three months, after completion of processing of samples taken during the cruise.

TUESDAY MAY 30 (JULIAN DAY 150): Clocks were returned to BST. Following the end-of-cruise party, some of the scientists remained on deck overnight, reporting phosphorescence in the water once the ship had entered the Firth of Clyde. "Charles Darwin" docked at Fairlie soon after 08 hr. Demobilisation was completed by 16 hr.

Technical Reports

Moorings (A.Harrison, leg A)

At the 10 sites on the two sections visited during the cruise, mooring operations took place at all except site S1500 where the BP recorder could not be found. A total of 7 mooring recoveries were made, of which 2 were damaged by trawling, with 17 deployments/ redeployments and 3 moorings lost without trace.

The mooring team comprised staff from RVS, DML and POL, providing specialists for each type of mooring and instrumentation, except for the Met. Buoy which was returned to Fairlie for servicing. The emphasis of the work was on preparation of new equipment rather than turning round recovered items, allowing longer lead-in time to each mooring deployment. Future cruises will not, however, have this benefit. The use of 2 winches was a big improvements over cruise CD91 when there was only one, allowing two moorings to be prepared independently thus saving time and sharing the work load of the team.

The weather was good throughout CD93A cruise period with only half a day when mooring work could not take place, otherwise there was no restriction to deck work.

Planning for Challenger cruises and the mooring strategy will need to address these points when the emphasis will be on re-cycling moorings and instruments, and searching for missing/damaged moorings expected from the heavy trawling activity in the area. The use of marker buoys and ARGOS beacons suggest that this risk can be reduced for surface moorings, but sub-surface moorings are more vulnerable.

DML moored instruments and water-column measurements (I Ezzi, leg A).

Two W.S.Ocean NAS2 nitrate analysers (deployed on CD92, 17/4/95) were recovered from S200 (surface and 192m). Instruments were deployed at S200 (surface and 192m), S700 (surface and 209m) and S140 (142m only). One instrument malfunctioned and was not deployed (S140 surface). Preliminary analysis of data from the two recoveries shows a continuing problemsof variability of the on board standard and in cadmium column performance. These problems were also evident during bench testing and calibration of instruments to be deployed.

One Chelsea Instruments Aquatracka logging fluorometer was recovered from S200 (surface) and calibrated using a *Skeletonema* culture from CCAP before and after cleaning of window. Four other instruments were calibrated and deployed at S200 (surface and 51m), S700 (surface and 40m) and S140 (surface).

At almost all CTD stations, water from 5m, 30m and 60m was filtered, and filters frozen for chlorophyll determination at DML, to provide for calibration of the CTD fluorometer. The non-toxic sea water supply was sampled at each CTD station for chlorophyll determination for calibration of deck tank fluorometer.

At stations N1500, S150 and S300 water from a range of was filtered and frozen for subsequent analysis for DON at DML by Fa Chen (POL)

Particulates and Sediment Traps (F. Perez-Castillo, leg A)

The partial (and perhaps damaged) sediment trap mooring laid at N1500 by CD91 was sucessfully recovered on 13 May, with 1 trap, current-meter/transmissometer and acoustic release. The mooring was redeployed later the same day, with two Parflux mark 7G-21 sediment traps at 1000m and 1400m (100m above sea-bed), and an RCM+Transmissometer.

The traps have a turret containing 22 bottles. Each bottle was marked by engraving as: XIII A No. bottle (1000m trap) and XIII B No. bottle (1400m trap). The bottles were then washed with Decon-90 detergent and rinsed with distilled water. On May 10, three days before deployment, a preservative was prepared from GF/C filtered deep seawater from 700m at N700, 5% formaldehyde, NaCl and Borax. Bottles were filled with the preservative and fitted in each trap. Finally, traps were programed for 22 events at seven day intervals starting on May 14, at mid day and ending on October 8, 1995.

In order to calibrate the CTD-Transmissometer, 2 l water samples were taken from several CTD casts, and filtered through GF/C fiber-glass pre-weighted filters. Filters were rinsed with 50 ml of distilled water, frozen and returned to UWB forgravimetric analysis of SPM. Transmissometer air and and blanked voltages were regularly noted.

Seawater samples were taken at several depths from CTD Casts at S140, S300, S700 and N1500. 500 ml were filtered through pre-combusted GF/F filters. The filters were frozen and brought back to DML for analysis of particulate organic carbon and nitrogen.

RVS Computing (P.Duncan, leg A)

During this cruise navigational, CTD, and surface variables were logged with varying degrees of success. The Ship's ADCP, normally logged direct to the Level C was not logged during leg A due to the failure of an RS-232 buffer box. The logged packages were:

GPS_4000, a new Trimble GPS receiver with differential capability which was used in conjunction with the Racal *Skyfix* differential correction service. Differential GPS results in position fixes accurate to 7-10 metres. *Skyfix* was used between 10:26 GMT on 8th May (Julian day 128) and 11:00 GMT on 15th May (Julian day 135). The receiver also had a Rubidium time standard connected, allowing it to give position fixes when only two satellites are available - normally at least three satellites are required.

DECMK53G, the Decca Mk53G navigation receiver was mounted on the bridge and normally operated in GPS mode, giving positions accurate to within 100m.

LOG_CHF, the Chernikeeff log with fore/aft and port/starboard ship's speed through the water.

GPS_TRIM, a Trimble 4000AX GPS Surveyor receiver, approximately five years old, with no differential capability.

RVS_CTDR. This version of the Level A CTD software sent unfiltered data to the Level B, and suffered from problems of serial data overrun. As a result, some bottle data from the first twenty CTD casts has missing samples. After this the RVS_CTDF software was used.

RVS_CTDF, filtered the data, and sent it to the Level B at one second intervals.

EA500D1. The Simrad EA500 echo sounder gave the depth of water underneath either the Ship's hull or the PES Fish. This software occasionally sent two records with the same time stamp, upsetting the *prodep* software used to correct depth for Carter area.

BIN_GYRO. This Level A was connected to the Ship's gyro compass and gave the true heading. The data was combined with the data from the Chernikeeff log to give relative motion, which was in turn fed to the *bestnav* program for linking with GPS.

SURFLOG1, a PC based Level A giving thermosalinograph, fluorometer, transmissometer and light records, but providing data of suspect status for the fluorometer, transmissometer and light sensors during leg A.

MX1107. The Magnavox MX-1107 satellite navigation receiver received fixes much less frequently than GPS, typically once every four hours. Between fixes the receiver used log and gyro inputs for dead reckoning, and was only on board as a backup system in case the three GPS receivers failed.

BOTTLES. The Level A took data from the bottle firing system, typically giving a one or zero value when a bottle was fired. The associated time stamp was used during the generation of bottle data.

The level B disk drive had been replaced during the handover period for this cruise, and the level B software was re-installed. It was then discovered that the Level B would not send data to the Level C over the Ethernet, despite being able to use *telnet*, *ftp* and *ping* successfully. Eventually it was decided to use a serial link. This worked but the link sometimes failed, causing a backlog which took a long time to recover. On the 10th May the link speed was uprated from 9600 to 19200, reducing the time any backlog took to transfer. The Level C system worked well. All CTD casts were recorded in real units. Plots and bottle data were output for each CTD cast, and some contour plots were produced for temperature, salinity, fluorescence, transmission and oxygen.

CTD oxygen sensor (H.Wilson, legs A & B)

The objective was to calibrate the Beckman Polarographic Oxygen Sensor mounted on the CTD and coupled to a SeaBird pump, using dissolved oxygen (DO) determined by microWinkler titration of water-bottle samples..

The first CTD cast with the sensor and pump both operating was 008. The downcast profile showed two unexpected high spikes in the top 100m, but the upcast appeared normal. Oxygen current was observed whilst the CTD was held just below the surface. It showed no great or rapid changes, confirming that the sensor was performing stably. On the next cast, the CTD was sent to 100m then brought up near to the surface and sent down again. On this second downcast (010), the spikes were no longer present, and the profile looked as expected. It appears that air became trapped when the sensor inlet pipe penetrated the water. The air was pushed through by pressure causing a rapid and high oxygen current change. Once this had taken place, the readings became normal and stable. It was decided only to consider the upcast data for calibration of the sensor.

The first water samples for DO were taken on the 11th May, on cast 026, followed by samples from five other casts, giving a good range of oxygen values. These were matched with the corresponding measurements of oxygen concentration calculated from the sensor data. There was a fair correlation between the values of oxygen obtained by micro-Winkler titration and calculated sensor values ($n=31$, $r^2=0.87$). Some of the values from the sensor seemed high, suggesting the error was not due to the titration method, and need further investigation.

The sampling strategy initiated during CD93A was continued during leg B, namely trying to obtain as wide a range as possible of values of dissolved oxygen. Discrete samples were taken over the whole profile at five stations. Replicate samples were also taken at several depths at other stations to estimate the error of the micro-Winkler titrations.

The leg B results showed an improved correlation between the oxygen values calculated from the sensor and those measured by micro-Winkler titration ($r^2=0.99$, df=26), with a residual standard deviation of 0.203 μM. This should allow results from the oxygen sensor to be used with some confidence.

Bio-optical measurements (S. Kratzer, J Morrison, leg A)

Some or all of the following four optical instruments were deployed at optical stations. The first two fulfil SeaWiFS requirements.

(1) Biospherical Instruments PRR-600 submarine reflectance radiometer and PRR-610 surface reference sensor, measuring upwelling radiance at 412, 443, 490, 510, 555, 665 and 683 nm, downwelling irradiance at 412, 443, 490, 510, 555 and 665 nm and PAR, and depth, temperature, pitch and roll. On loan to UWB for evaluation purposes from Biospherical Instruments..

(2) Satlantic submarine reflectance radiometer, measuring depth and upwelling radiance and downwelling irradiance at the same wavelengths as the PRR-600 but without the 683 nm upwelling and PAR. There is no surface reference unit. The instrument is NERC owned, based at PML, and was purchased as part of the SeaWiFs Exploitation Initiative.

(3) Biospherical Instruments INF-300 submarine natural fluorometer and QSR-240 surface reference unit, measuring upwelling radiance at 683 nm (the peak wavlength of the solar-induced fluorescence of chlorophyll a in living phytoplankton), downwelling scalar PAR irradiance and reference surface scalar PAR irradiance. On loan to UWB from MAFF.

(4) UWB-SOS self-logging submarine 4-Colour Sensor, measuring either downwelling or upwelling irradiance (depending on orientation) at 440, 490, 570 and 670 nm. The instrument's depth measuring capability was not working, probably because of software problems, during leg A.

The main problem in optical oceanography is avoidance of ship shadow. On station the ship was kept head to wind and the position of deployment, on the sunny side of the ship, was dependant on the position of the sun. Three possible sights for deployment were used, the hydro wire, located mid ships on the starboard side, and the two cranes at the sides of the aft deck. The aft deployments required partial or total manual lifting, which was particularly difficult with the relatively heavy Satlantic instrument.

At each optical station, the CTD-rosette was used to take water samples from the following optical depths: 0.2, 0.5, 0.8 1.3, 1.8, 2.3 and 2.8, which were estimated from an initial Secchi depth measurement. Chlorophyll a and phaeopigment concentrations were measured for all these optical depths, using GF/F filtration, extraction into 90% acetone measurement on board the ship with a Turner Fluorometer.

For optical depths 0.5 and 2.3, water was filtered for a range of measurements: (a) 2 l were filtered onto GF/F filters for the absorption spectra of the total particulate material, measured from 350-750 nm, using a Shimadzu 1201 spectrophotometer and then extracted in 90% acetone; (b) the extracts were scanned the next day by the same spectrophotometer, allowing the calculation of chlorophyll a, b and c, the phaeopigment and the total carotenoid concentrations; the chlorophyll a concentrations of the extracts were also measured by the Turner Fluorometer; (c) for the determination of SPM (suspended particulate matter) 2 l of sample were filtered through pre-weighed 47 mm GF/F filters, which were then rinsed with distilled water, dried, and returned to Menai Bridge for further weighing; (d) 0.5 l of sample was filtered onto 25 mm GF/F filters which were immediately frozen in liquid nitrogen, for subsequent HPLC abalysis of pigment composition at PML.

Yellow substances at o.d. 0.5 were measured by spectrophotometrically scanning sea water filtered through 0.2 μm membrane filter, using distilled water as a blank and a 10 cm pathlength. Water from the same depth was passed through 2 μm and 0.2 μm Nucleopore filters in order to measure the chlorophyll and phaeopigment concentrations of the >2 μm and 0.2-2 μM size fractions by acetone extraction and fluorometric measurement. Finally, subsamples from the same depth were preserved with acidified Lugol's Iodine or alkaline Formaldehyde, for subsequent microscopic analysis of phytoplankton species composition at UWB.

Seven optical stations were worked during leg A, and a further 7 during leg B.

UWB Drifter Deployment and Recovery (R.Wilton, leg B)

Two UWB drifters, equipped with Argos PTT, VHF beacon, 4 colour irradiance sensor, hull thermistor, 70m thermistor chain, sediment trap and data logger were deployed on two occasions during CD93B as outlined below. The DML sediment traps attached to the end of the thermistor chain required some buoyancy in the form of two 15kg floats to support them without sinking the drifters. The damping effect of the of this arrangement meant that the drifters were occasionally submersed under wave crests. However, this did not appear to have degraded the number or quality of fixes by the Argos satellite, with updates between 3-4 hours being typical. A pellet line attached to the lifting eye of the buoy aided recovery.

PTT No.	Release Details Date/Time	Lat N	Lon W	Recovery Details Date/Time	Lat N	Lon W
3798	22/05/95 16:51	56.254	9.337	24/05/95 19:12	56.442	9.737
3797	22/05/95 17:13	56.247	9.343	24/05/95 18:52	56.445	9.742
3797	25/05/95 11:46	56.518	9.044	26/05/95 17:32	56.570	8.945
3798	25/05/95 12:01	56.514	9.042	26/05/95 18:30	56.697	8.924

SPM measurements (S.Jones, S.Lowe, leg B)

The main objectives were: to analyse spm concentration by gravimetric filtration of water samples, primarily for transmissometer calibration; to determine particle size distribution using a Galai laser sizer ; and, to use settling velocity tubes to estimate particle sinking rates. Some samples were also taken from water and "fluff" overlying Multicorer samples.

During both fast and slow CTD surveys, water samples were taken from as many casts as possible. In general, samples were taken from surface and near-bed Niskin bottles and at depths corresponding to maximum transmittance. Samples were filtered immediately on arrival at the surface through Whatman GF/C filters, rinsed with distilled water, air dried and then frozen. As much as 9 l was filtered in the case of maximum transmittance and between 4 and 6 l for surface samples. Frozen samples were returned to UWB for gravimetric analysis for SPM.

Voltages output from the 25 cm transmissometer on the CTD were corrected using the following equation:

$$V = (A / B).(X - Z)$$

where V = corrected output voltage.

A = Air calibration value = 4.82 volts (3-7-89).

B = Present air calibration value = 4.79 volts.

X = Raw data value.

Z = Zero offset with ligth path blocked = 0.002 volts.

The corrected voltages were converted to beam attenuance coefficients, c, using :

$$c = - 4 \ln(20.V)$$

where T = T(z)/100. A transmissometer calibration will be obtained by regressing beam attenuance on SPM concentration.

Particle size distributions (2 - 600 μm) were measured with a Galai CIS100 laser sizer which detects the time of intersection of a moving laser beam with a suspended particle. Samples, generally from surface and near bed, were taken immediately from the CTD. The laser unit also houses a video microscope camera to both directly monitor particles and capture images for 2-D shape analysis. After some initial difficulties, images of selected samples were video-recorded for subsequent particle shape determinations.

To determine particulate sinking rates, settling velocity tubes were used to sample water at 5 m depth at each of the slow stations. The apparatus allows capture of a virtually undisturbed parcel of water, and was used in fours. After sampling, the tubes were placed upright on deck and enclosed in water-jackets fed with surface seawater. One pair was sampled for total SPM (determined gravimetrically on 0.4 μm Cyclopore filters), the third tube was sampled for particulate organic carbon (POC) (and nitrogen), and the fourth for chlorophyll (and pheopigments). The procedure involved drawing subsamples at times of 2, 8, 20, 40, 80, 160, 360, 450, 600 minutes after erection. Problems were encountered as the membrane filters used for SPM clogged rapidly due to the phytoplankton present. As a result, settling velocity determinations restricted to chlorophyll and POC at most stations. Chlorophyll was analysed fluorometrically on board ship, whereas POC (and SPM) samples were returned to shore laboratories for analysis.

At the beginning of the fast CTD survey, SPM was dominated by the surface phytoplankton bloom. Video images identified diatoms (*Chaetoceros* and *Rhizoselenia*) and small flagellates. Particles were generally individual specimens with the occasional aggregate comprising linked, clumped diatom chains. Transmission readings indicated that the highest SPM concentrations were present in the upper 100 m of the water column. SPM decreased in this layer during the leg. Strongly-attenuating near-bed layers were observed in deeper waters later in the leg. Video images showed that particles were made up of aggregated surface phytoplankton species, benthic diatoms and what appeared to be small inorganic flocculated particles. Some mystery surrounds the formation of these deep layers, as mid-water SPM concentrations remained very low and particle size very small.

Preliminary analysis of chlorophyll data indicates that settling rates in the near surface were low (c. 85% less than 0.2m/day, 97% less than 10m/day, 99% less than 100m/day). Over several days, settling at these rates may be capable of producing the localised 'plumes' of high fluorescence observed extending down to 150m during the fast CTD survey. However, the fact that aggregation and rapid settling of chlorophyll-rich material were not directly observed between this depth and the near-bed nepheloid layer suggests that an additional process was occuring. Significant numbers of grazing zooplankton (copepods) were observed on filters from samples throughout the water column, and in drifting sediment traps at 80m. It is possible that these migrating organisms could be responsible for clearing upper ocean layers of spm by feeding on surface phytoplankton and defecating deeper in the water column.

One Multicorer sample was analysed during the cruise. This involved siphoning off the supra-surface 'fluff' layer and the water retained above the core. The particle size distribution was bimodal, ranging from 5-500um, and might have comprised an unaltered 'surface' sub-population and a sub-population characteristic of aggregation products.

During the cruise the performance of the laser sizer was assessed by running replicate samples. These tests suggested that the sizer performed consistantly, with good agreement between repleciates, but perhaps some flocculation occuring whilst samples wait for analysis.

Some filters processed in the wet lab were contaminated by fibrous fluff, usually blue (but sometimes purple). This has not been observed during identical processing on RRS Challenger. It is a particular problem for spm determination, which requires accurate measurement of dry weight of filters.

Nutrients (B.Grantham, leg B)

Nutrient analysis during leg A was aimed at providing calibrations for the moored NAS2 nitrate analysers. Calibrations were taken from CTD profiles at the time of deployment and from samples of the on-board standards carried by the analysers. A full transect of the N line was also acheived during leg A. Most analyses were carried out during leg B, when concentrations of ammonium, phosphate, silicate and nitrate+nitrite were measured in water samples taken at representative depths (including near-bed) throughout the water column from most CTD casts.

Nutrient concentrations were also measured during leg B in water overlying sediment cores taken with the Multicorer, and in Geochemical water samples (to relate to metal concentrations and to provide further information on the depth of sampling when bottle misfires were suspected). During both legs, silicate was measured in sediment trap water samples (the preservatives used in the traps interefered with other nutrient analyses).

The Autoanalyser, a Lachat Quikchem 8000 flow-injection analyser performed well and >1200 samples were analysed. The only serious problem arose early in leg B when the ammonium channel began giving sharp double-spiked peaks for samples exceeding 35 psu. This effect was not apparent with less saline samples or the standards made up in distilled water. Evidently the buffering effect of the EDTA reagent was insufficient at high salinities to prevent the formation of calcium and magnesium hydroxide precipitates which were causing the spiking. The problem was overcome by increasing the concentration of the EDTA buffer.

Geochemistry (J.Foster, A.-C. Le Gall, leg B)

Edinburgh aims were to investigate the magnitude of chemical scavenging using natural radioisotopes of ^{210}Pb and ^{210}Po, and to determine spatial and temporal characteristics of particle removal processes. In the case of the radio-isotopes, 20 litre water samples at 6 depths, plus a non-toxic sample, were collected from S140, S200, S300,S700, R1000, N1500. The water was filtered for particulate (>0.45μm) and dissolved (<0.45μm) material, subsequent analysis to be carried out in Edinburgh. Water samples were also collected, using Go-Flo bottles at up to 6 dephs at S140, N140, R300, R1000, N1500. About 3 litres of water were filtered, the filter papers being destined for thin-film XRF analysis of major elements.

Southampton objectives were: to collect water and particulate samples from the water column above the shelf hedge for metal analysis; and to measure Aluminium concentrations in the water column. Water was collected at up to 6 depths from S140, N140, R300, R1000, 56.449°N 9.739°W, S200, N1500, S300 and S700 using Go-Flo bottles on the CTD rosette. At most stations, the content of each Go-Flo was filtered through 0.4 μm Nucleopore filters; some of the filtered water was saved for laboratory analysis of dissolved trace metals, and the filter was saved for the analysis of particulate trace metals. Filtered and unfiltered water were also fluorometrically analysed on board for dissolved and total aluminium.

Previous use had shown lack of reliability in the closing mechanisms of the GoFlo bottles. A salinity samples was therefore drawn from each Go-Flo and compared with CTD salinity at the same nominal depth. Go-flo samples were discarded when their salinity differed significantly from that of the CTD. After cast 122, it was apparent that there was also a contamination problem, and the top and bottom valves of each Go-Flo were cleaned. Samples of cast 139 taken only for aluminium suggested that the contamination had disappeared.

Microplankton respiration (H.Wilson, leg B)

Respiration work concentrated on the slow stations, at S140, S300 and N1500. At S140, samples were taken from the surface mixed layer, from mid-depths and bottom water as a trial run. At N1500, samples were taken from the surface layer and from a bottom sample, and water from 80m was taken at V1000. Samples from S300 were taken from 15m in the surface mixed layer. Samples were incubated for 24 hours in darkness, at temperatures close to ambient, to estimate microplankton and (after filter-fractionation) bacterial respiration rates. Samples were also taken for further estimation of chlorophyll *a* concentration in the <200 μm and <2 μm fractions, and for enumeration of bacteria and protozoa.

Many of the changes in oxygen concentration were small or insignificant in both fractions. Early on in the cruise at S140, microplankton respiration rate was significant in surface waters, and bacterial respiration rate was high at a depth of 80m. Towards the end of the cruise at S300, there was significant oxygen uptake by both microplankton and bacteria at 15m. Measurements at V1000 showed no significant uptake of oxygen in the bottom mixed layer. At N1500 measurements were made at 5 and 1480 m. The <200µm fraction was respiring at a rate of 0.055 µM hr^{-1}; the small (<2 µm) fraction showed no significant oxygen uptake in the case of samples from either 5 or 1480 m. This was surprising as there seemed to be an accumulation of chlorophyll and pheopigments in this deep part of the water column.

Primary production (L.Gilpin, leg B)

The object of this work was to determine the species composition, size distribution and photosynthetic characteristics of the phytoplankton in the SES region during the cruise. Stations were sampled to provide examples of shelf, shelf break and oceanic regions:

Cast	Stn	P:I	S.I.S.	Size Fractionated Chl	Phytoplankton
63	S140	5m		5,15,30,60,100, 132m	5,15,30,60,100, 132m
76	S140	5m		5m	5m
78	S140	20m		1,6,11,20,30,60m	1,6,11,20,30,60m
90	N1500	5m		5m	5m
91	P1500			5m	5m
92	P1300	5m		5m	5m
100	P140	5m		5m	5m
103	R200	5m		5m	5m
105	R500	5m		5m	5m
108	R1000			5m	5m
114	S1000	5m		5m	5m
117	S500			5m	5m
118	S300	5m		5m	5m
121	S140	5m		5m	5m
134	N2000	7m x4	yes	1,7,12,18,22,29,33,38,42,50m	1,7,18,29,50m
143	S200		yes	1,4,7,11,12,17,20,23,25,30m	1,11,20,30m
147	S200	14m		14m	14m
153	N1500	5m		5m	5m
160	N150	4m x3	yes	2.5,4,7,11,13,17,20,23,25,30m	2.5,4,11,20,30m

The photosynthetic characteristics of the planktonic assemblages were determined for 20 samples from a photosynthesis versus irradiance (P:I) curve produced following sample inoculation with ^{14}C sodium bicarbonate and incubation in a range of irradiances (1.5 - 1500 µE m^{-2} s^{-1}) using a photosynthetron. Following the incubation, any remaining inorganic ^{14}C was displaced by acidification and the incorporation of ^{14}C in the particulate component was measured onboard with a LKB Scintillation Counter.

Primary production in the euphotic zone was determined in three 24-hr incubations under simulated *in situ* (SIS) conditions. Water samples were collected from a pre-dawn CTD cast at 10 depths selected to represent 97, 55, 32.6, 19.9, 13.8, 6.9, 4.6, 3, 2.1 and 1% surface incident irradiance. Samples were treated in accordance with JGOFS Level 1 protocols, and triplicate 60ml samples, and one dark bottle, from each depth were inoculated with ^{14}C bicarbonate and placed in an on-deck incubator used to simulate *in situ* light level and approximate spectral quality at each depth. Following incubation, samples were fractionated using 18, 2 and 0.25 µm polycarbonate membrane filters and the particulate incorporation of labelled bicarbonate was measured by scintillatiom.

Size-fractionated chlorophyll was determined by acetone extraction of 18, 2, and 0.25 µm filters, followed by fluometric measurement, at 19 stations including all those where P:I or on-deck incubations were carried out. Duplicate plankton samples from each station were preserved in 50ml amber bottles using Lugol's iodine and Glutaraldehyde solutions.

The GP container provided ample working space, but leaked. Two on-deck incubators were plumbed into the non-toxic supply which also fed two container labs and the transmissometer tank. With only one non-toxic supply to the aft deck area this required much ancillary plumbing. During the fast CTD survey sampling at several stations was missed when these were occupied during darkness; requirements for sampling for diel processes should be carefully considered during cruise planning.

Benthic coring (M.Harvey, L.Mitchell, leg B)

Cores were obtained from three stations. Prior to the third (N1500) the corer head became inexplicably detached from the frame and fell to the deck, damaging to the firing mechanism. A a result, four deployments of the corer were necessary to obtain a sufficient number of cores. At the first two stations visited (S700 and R1000) the multicoring was preceded by a CTD cast to obtain 120 litres of water from within 10 metres of the sea bed, to be used for core incubations. The constant temperature room was used for these incubations so that in situ temperatures could be maintained. The multicorer was deployed three times.
Two cores from each deployment were taken for measurement of sediment oxygen uptake rate and nutrient fluxes. Oxygen uptake rates showed a 2.5x increase at the deepest station for which data are available (N1500) compared with values obtained on CD92A in early April.

One core from each deployment was sectioned into 5cm depth horizons and subcores taken from these to determine the sediment sulphate reduction rate and porosity. One core was taken, sectioned similarly, and the sediment in each horizon was centrifuged and the resultant pore water filtered and frozen for subsequent determination of its sulphate content. One core from each deployment was saved for subsequent carbon isotope analysis, one core for ^{210}Pb, and one core for meiofauna characterization. One core was saved for determination of trace organics at Liverpool University.

The Sholkovitz gravity corer was deployed at R1000 but failed to penetrate the sediment. The RVS gravity corer was therefore used instead, and proved highly successful. The cores obtained from it were in excess of one metre in length and will be used for measurement of ^{210}Pb.

BODC data logging (J.Loncar, leg A; J.Hughes, leg B)

The following tables summarise sampling events recorded by BODC.

Leg A
CD93AMR.XLS : Moorings - deployments, recoveries, losses.
CD93ACTD.XLS : All CTD casts.

Leg B
CD93BMR.XLS : Moorings - deployments, recoveries.
CD93BCTD.XLS : All CTD casts.
CD93FAST.XLS : CTD casts during main “Fast” survey of 18 - 21 May.
CD93SLOW.XLS : All events at “Slow” stations.
CD93BCOR.XLS : All coring events, succesful or not.
CD93BDRF.XLS : UWB and DML/Soton drifter experiments.

Cruise CD93 Leg A Moorings									
TBEGNS	SITE	LAT	LAT	LAT	LON	LON	LON	WDEPTH	TYPE
DEPLOYMENTS									
8/5/95 8:42	S140	56	27.63	56.46	8	57.91	-8.97	150	RDI ADCP and PRESSURE RECORDER
8/5/95 12:20	S300	56	27.28	56.45	9	3.91	-9.07	300.5	TOROID BUOY
9/5/95 9:31	S140	56	28	56.47	8	57.55	-8.96	148.5	'U' SHAPE CURRENT METER MOORING
9/5/95 16:21	S300	56	27.49	56.46	9	3.78	-9.06	262	SUBSURFACE CURRENT METER MOORING
9/5/95 20:10	S140	56	27.88	56.46	8	58.54	-8.98	151	WAVERIDER
10/5/95 13:48	S200	56	27.3	56.46	9	2.8	-9.05	203	'U' SHAPE CURRENT METER MOORING
10/5/95 16:39	S200	56	26.86	56.45	9	2.88	-9.05	196	TOROID BUOY
10/5/95 20:24	S700	56	27.2	56.45	9	9.45	-9.16	698	TOROID BUOY
11/5/95 13:22	S700	56	27.63	56.46	9	9.86	-9.16	711	SUBSURFACE CURRENT METER MOORING
12/5/95 18:26	N140	56	36.59	56.61	8	56.06	-8.93	139	'U' SHAPE CURRENT METER MOORING
13/5/95 11:35	N1500	56	42.56	56.71	9	24.45	-9.41	1486	BOTTOM PRESSURE RECORDER
13/5/95 16:48	N1500	56	43.1	56.72	9	24.5	-9.41	1496.5	SEDIMENT TRAP MOORING
13/5/95 21:12	N200	56	37.69	56.63	8	59.74	-9	200	'U' SHAPE CURRENT METER MOORING
14/5/95 11:26	N140	56	36.52	56.61	8	56.35	-8.94	136	BOTTOM PRESSURE RECORDER
14/5/95 13:34	N300	56	37.59	56.63	9	1.15	-9.02	304	SUBSURFACE CURRENT METER MOORING
14/5/95 17:11	N700	56	38.96	56.65	9	6.51	-9.11	699	SPAR MARKING BUOY
14/5/95 19:45	S140	56	27.1	56.45	8	58.09	-8.97	150	SPAR MARKING BUOY
15/5/95 10:25	S140	56	27.98	56.47	8	57.71	-8.96	148	TOROID BUOY
RECOVERIES									
8/5/95 15:07	S140	56	28.7	56.48	8	57.87	-8.96	150	'U' SHAPE CURRENT METER MOORING
9/5/95 18:00	S200	56	27.24	56.45	9	3.21	-9.05	230	'U' SHAPE CURRENT METER MOORING
11/5/95 6:22	S700	56	29.49	56.49	9	10.84	-9.18	711	SUBSURFACE CURRENT METER MOORING
11/5/95 14:30	S140	56	27.49	56.46	8	58.23	-8.97	140	BOTTOM PRESSURE RECORDER
13/5/95 6:15	N1500	56	44.14	56.74	9	26.07	-9.43	1559	SEDIMENT TRAP MOORING
LOSSES									
27/3/95 13:50	N700	56	38.83	56.65	9	6.75	-9.11	702	SPAR MARKING BUOY
28/3/95 15:30	S300	56	27.3	56.46	9	4.63	-9.08	296	SUBSURFACE CURRENT METER MOORING
29/3/95 10:40	S700	56	27.73	56.46	9	9.68	-9.16	695	SUBSURFACE CURRENT METER MOORING
31/3/95 10:08	S1500	56	27.08	56.45	9	38.48	-9.64	1500	BOTTOM PRESSURE RECORDER
9/5/95 9:31	S140	56	28	56.47	8	57.55	-8.96	148.5	'U' SHAPE CURRENT METER MOORING

Rec 15/5/95 0716 S140 MET BUOY

CD93A CTD Casts					
Cast	Start Date/Time	End Date/Time	Site	Comments	
CTD1	7/5/95 18:55	7/5/95 19:18	Islay 'C'	118 m, not logged	
CTD2	7/5/95 21:10	7/5/95 21:22	Islay 'D'		
CTD3	8/5/95 9:16	8/5/95 9:48	S140	transmissometer calibration	
CTD4	8/5/95 12:39	8/5/95 13:10	S300		
CTD5	8/5/95 17:07	8/5/95 18:06	S300	transmissometer&RCM calibration	
CTD6	9/5/95 1:12	9/5/95 2:11	S700		
CTD7	9/5/95 3:05	9/5/95 3:34	S500		
CTD8	9/5/95 4:22	9/5/95 4:43	S300		
CTD9	9/5/95 5:15	9/5/95 5:49	S200	DO sensor running	
CTD10	9/5/95 6:38	9/5/95 7:07	S140		
CTD11	9/5/95 9:59	9/5/95 10:40	S140	transmissometer&RCM calibration	
CTD12	9/5/95 13:00	9/5/95 13:46	S300		
CTD13	9/5/95 18:33	9/5/95 19:10	S200		
CTD14	9/5/95 21:20	9/5/95 21:42	S300		
CTD15	10/5/95 0:22	10/5/95 1:38	S1500		
CTD16	10/5/95 2:22	10/5/95 3:36	S1400		
CTD17	10/5/95 5:10	10/5/95 5:18	S1000	100 m cast to purge oxygen plumbing	
CTD18	10/5/95 5:20	10/5/95 6:15	S1000		
CTD19	10/5/95 7:24	10/5/95 7:46	S200		
CTD20	10/5/95 10:12	10/5/95 10:49	S200	transmissometer calibration	
CTD21	10/5/95 15:00	10/5/95 15:27	S200		
CTD22	10/5/95 16:56	10/5/95 17:19	S200		
CTD23	10/5/95 21:04	10/5/95 21:44	S700	no light meters	
CTD24	11/5/95 0:25	11/5/95 1:34	S1300		
CTD25	11/5/95 2:27	11/5/95 3:46	S1150		
CTD26	11/5/95 4:54	11/5/95 5:46	S850		
CTD27	11/5/95 8:50	11/5/95 9:15	S700	transmissometer calibration	
CTD28	11/5/95 10:18	11/5/95 11:14	S700		
CTD29	11/5/95 16:14	11/5/95 16:40	S140		
CTD30	11/5/95 17:34	11/5/95 17:55	S170		
CTD31	11/5/95 20:41	11/5/95 21:32	R1000		
CTD32	12/5/95 0:01	12/5/95 1:15	N1500		
CTD33	12/5/95 9:55	12/5/95 11:40	N1600		
CTD34	12/5/95 12:38	12/5/95 13:11	N1600	shallow PAR meter cast for OPTICS	
CTD35	12/5/95 16:00	12/5/95 16:46	N140	RCM&transmissometer calibration	
CTD36	12/5/95 19:30	12/5/95 19:45	N140		
CTD37	12/5/95 20:44	12/5/95 20:55	N170		
CTD38	12/5/95 21:35	12/5/95 21:50	N200		
CTD39	12/5/95 22:29	12/5/95 22:53	N300		
CTD40	12/5/95 23:31	13/5/95 0:08	N500		
CTD41	13/5/95 0:59	13/5/95 1:44	N700		
CTD42	13/5/95 2:33	13/5/95 3:20	N800		
CTD43	13/5/95 4:00	13/5/95 4:57	N1000		
CTD44	13/5/95 9:51	13/5/95 11:11	N1500	1500-200 m bottles	
CTD45	13/5/95 12:15	13/5/95 12:30	N1500	100-surface bottles	
CTD46	13/5/95 19:27	13/5/95 19:54	N200	RCM&transmissometer calibration	
CTD47	13/5/95 21:49	13/5/95 22:10	N200		
CTD48	14/5/95 0:22	14/5/95 1:35	N1400		
CTD49	14/5/95 2:31	14/5/95 3:31	N1300		
CTD50	14/5/95 4:29	14/5/95 5:20	N1150		
CTD51	14/5/95 6:32	14/5/95 7:03	N500		
CTD52	14/5/95 7:46	14/5/95 8:03	N300		
CTD53	14/5/95 9:05		N300	RCM&transmissometer calibration	
CTD54	14/5/95 13:48	14/5/95 14:28	N300		
CTD55	15/5/95 4:26	15/5/95 4:55	S300		
CTD56	15/5/95 5:54	15/5/95 6:17	S140	transmissometer calibration	
CTD57	15/5/95 11:18	15/5/95 11:35	S140		
CTD58	15/5/95 18:33	15/5/95 18:43	Islay 'D'		
CTD59	15/5/95 20:15	15/5/95 20:30	Islay 'C'		

CD93B Moorings					
Stn	**Buoy Description**	**Event type**	**Date & Time**	**Lat N**	**Lon W**
S140	POL Met Buoy	Deployment	17/05/95 14:08	56.455	8.972
	•				
S200	Toroid (with ARGOS beacon 22184,	Recovery	28/05/05 11:22	56.447	9.049
	thermistor,transmissometer,				
	fluorometer,colour sensor &				
	nitrate analyer)				
S200	Toroid (with ARGOS beacon 22184)	Deployment	28/05/95 14:11	56.448	9.047
N200	Sub-surface sphere (with ARGOS	Recovery	28/05/95 17:44	56.968	9.051
	beacon 24574)				

CD93B CTD casts							
Cruise	**Cast**	**Start date&time**	**End date&time**	**Stn**	**Lat N**	**Lon W**	**Comments**
CD93B	CTD60	17/05/95 03:27	17/05/95 03:42	Islay C	55.588	6.676	
CD93B	CTD61	17/05/95 05:15	17/05/95 05:25	Islay D	55.756	6.998	
CD93B	CTD62	17/05/95 11:30	17/05/95 11:44	S130	55.285	8.502	
CD93B	CTD63	17/05/95 14:36	17/05/95 14:51	S140	56.469	8.963	
CD93B	CTD64	17/05/95 15:41	17/05/95 15:53	S140	56.470	8.955	
CD93B	CTD65	17/05/95 16:41		S140	56.468	8.953	
CD93B	CTD66	17/05/95 19:04	17/05/95 19:25	S140	56.462	8.959	Geochemistry
CD93B	CTD67	17/05/95 21:01	17/05/95 21:16	S140	56.461	8.958	Geochemistry
CD93B	CTD68	17/05/95 22:55	17/05/95 23:14	S140	56.462	8.963	Go-flo
CD93B	CTD69	18/05/95 00:37	18/05/95 00:50	S140	56.463	8.957	
CD93B	CTD70	18/05/95 02:58	18/05/95 03:13	S140	56.462	8.959	
CD93B	CTD71	18/05/95 04:39	18/05/95 04:48	S140	56.465	8.958	
CD93B	CTD72	18/05/95 04:50	18/05/95 05:02	S140	56.465	8.958	
CD93B	CTD73	18/05/95 06:46	18/05/95 06:55	S140	56.463	8.954	
CD93B	CTD74	18/05/95 06:56	18/05/95 07:04	S140	56.462	8.953	
CD93B	CTD75	18/05/95 07:06	18/05/95 07:16	S140	56.462	8.952	
CD93B	CTD76	18/05/95 09:15	18/05/95 09:27	S140	56.463	8.955	
CD93B	CTD77	18/05/95 10:20	18/05/95 10:30	S140	56.458	8.959	
CD93B	CTD78	18/05/95 11:10	18/05/95 11:26	S140	56.459	8.968	
CD93B	CTD79	18/05/95 14:40	18/05/95 14:48	S700	56.462	9.163	Aborted at 30m (buoy!)
CD93B	CTD80	18/05/95 15:18	18/05/95 15:58	S700	56.476	9.166	
CD93B	CTD81	18/05/95 23:48	19/05/95 00:10	N140	56.604	8.941	Go-flo/Geochemistry
CD93B	CTD82	19/05/95 01:05	19/05/95 01:25	N150	56.618	8.992	
CD93B	CTD83	19/05/95 02:00	19/05/95 02:23	N200	56.619	9.011	
CD93B	CTD84	19/05/95 02:55	19/05/95 03:29	N300	56.629	9.028	
CD93B	CTD85	19/05/95 04:21	19/05/95 04:52	N500	56.632	9.073	
CD93B	CTD86	19/05/95 05:36	19/05/95 06:15	N700	56.645	9.113	
CD93B	CTD87	19/05/95 07:00	19/05/95 07:45	N850	56.656	9.151	
CD93B	CTD88	19/05/95 08:32	19/05/95 09:30	N1000	56.676	9.197	
CD93B	CTD89	19/05/95 10:25	19/05/95 11:29	N1300	56.699	9.328	
CD93B	CTD90	19/05/95 12:13	19/05/95 13:24	N1500	56.735	9.406	
CD93B	CTD91	19/05/95 14:45	19/05/95 16:00	P1500	56.651	9.615	
CD93B	CTD92	19/05/95 17:53	19/05/95 19:00	P1300	56.631	9.463	
CD93B	CTD93	19/05/95 20:11	19/05/95 21:07	P1000	56.604	9.285	
CD93B	CTD94	19/05/95 22:18	19/05/95 23:06	P850	56.598	9.226	
CD93B	CTD95	20/05/95 01:13	20/05/95 01:58	P700	56.590	9.183	
CD93B	CTD96	20/05/95 02:49	20/05/95 03:24	P500	56.578	9.114	
CD93B	CTD97	20/05/95 04:12	20/05/95 04:32	P300	56.568	9.052	
CD93B	CTD98	20/05/95 05:21	20/05/95 05:37	P200	56.566	9.031	
CD93B	CTD99	20/05/95 06:21	20/05/95 06:36	P150	56.563	9.003	
CD93B	CTD100	20/05/95 07:27	20/05/95 07:42	P140	56.551	8.935	
CD93B	CTD101	20/05/95 08:28	20/05/95 08:47	R140	56.500	8.931	
CD93B	CTD102	20/05/95 09:51	20/05/95 10:05	R150	56.503	8.991	
CD93B	CTD103	20/05/95 11:05	20/05/95 11:25	R200	56.506	9.038	
CD93B	CTD104	20/05/95 12:59	20/05/95 13:30	R300	56.505	9.060	Go-flo/Geochemistry
CD93B	CTD105	20/05/95 14:37	20/05/95 15:12	R500	56.507	9.106	
CD93B	CTD106	20/05/95 15:55	20/05/95 16:35	R700	56.515	9.172	
CD93B	CTD107	20/05/95 17:11	20/05/95 17:51	R850	56.514	9.231	
CD93B	CTD108	20/05/95 18:37	20/05/95 19:30	R1000	56.515	9.297	
CD93B	CTD109	20/05/95 20:50	20/05/95 21:55	R1300	56.530	9.488	
CD93B	CTD110	20/05/95 23:02	21/05/95 00:19	R1500	56.537	9.677	
CD93B	CTD111	21/05/95 01:35	21/05/95 02:47	S1500	56.460	9.636	
CD93B	CTD112	21/05/95 03:43	21/05/95 04:42	S1300	56.463	9.504	
CD93B	CTD113	21/05/95 05:27	21/05/95 06:22	S1150	56.466	9.395	

CD93B CTD casts							
Cruise	Cast	Start date&time	End date&time	Stn	Lat N	Lon W	Comments
CD93B	CTD114	21/05/95 07:21	21/05/95 08:08	S1000	56.464	9.295	
CD93B	CTD115	21/05/95 09:25	21/05/95 10:08	S850	56.470	9.219	
CD93B	CTD116	21/05/95 11:14	21/05/95 11:50	S700	56.470	9.157	
CD93B	CTD117	21/05/95 13:06	21/05/95 13:34	S500	56.457	9.094	
CD93B	CTD118	21/05/95 14:15	21/05/95 14:38	S300	56.465	9.053	
CD93B	CTD119	21/05/95 15:26	21/05/95 15:46	S200	56.463	9.040	
CD93B	CTD120	21/05/95 16:40	21/05/95 16:53	S160	56.462	9.011	
CD93B	CTD121	21/05/95 17:41	21/05/95 18:03	S140	56.400	8.955	
CD93B	CTD122	21/05/95 23:52	22/05/95 00:44	R1000	56.520	9.283	Go-flo
CD93B	CTD123	22/05/95 02:20	22/05/95 03:11	R1000	56.516	9.289	Geochemistry
CD93B	CTD124	22/05/95 04:01	22/05/95 04:52	R1000	56.517	9.289	
CD93B	CTD125	22/05/95 06:08	22/05/95 06:58	R1000	56.518	9.296	
CD93B	CTD126	22/05/95 08:41	22/05/95 09:50	R1000	56.517	9.292	Go-flo
CD93B	CTD127	22/05/95 10:32	22/05/95 11:18	R1000	56.519	9.290	For deep water
CD93B	CTD128	22/05/95 17:27	22/05/95 17:51		56.244	9.346	Optical dip (nr V1000)
CD93B	CTD129	22/05/95 19:26	22/05/95 19:36	V150	56.251	9.062	
CD93B	CTD130	22/05/95 20:34	22/05/95 20:42	V200	56.257	9.146	
CD93B	CTD131	22/05/95 22:05	22/05/95 22:15	V1000	56.258	9.334	
CD93B	CTD132	23/05/95 14:44	23/05/95 16:31	NR	56.999	12.025	
CD93B	CTD133	23/05/95 20:15	23/05/95 21:52	N2300	56.999	11.000	
CD93B	CTD134	24/05/95 01:16	24/05/95 01:39	N2000	56.999	9.999	Production cast
CD93B	CTD135	24/05/95 02:15	24/05/95 03:47	N2000	57.003	10.000	
CD93B	CTD136	24/05/95 09:33	24/05/95 09:59	N2000	57.008	10.019	Optical dip
CD93B	CTD137	24/05/95 13:06	24/05/95 14:19	N1500	57.734	9.400	
CD93B	CTD138	24/05/95 15:13	24/05/95 16:29	N1500	56.740	9.391	Geochemistry
CD93B	CTD139	24/05/95 19:46	24/05/95 20:02		56.449	9.739	Go-flo
CD93B	CTD140	24/05/95 20:56	24/05/95 22:09	S1500	56.463	9.646	
CD93B	CTD141	24/05/95 23:40	25/05/95 00:32	S1000	56.462	9.309	
CD93B	CTD142	25/05/95 01:29	25/05/95 01:58	S500	56.468	9.101	
CD93B	CTD143	25/05/95 03:04	25/05/95 03:28	S200	56.465	9.044	Production
CD93B	CTD144	25/05/95 04:12	25/05/95 04:32	S200	56.463	9.046	
CD93B	CTD145	25/05/95 06:06	25/05/95 06:25	S200	56.462	9.044	
CD93B	CTD146	25/05/95 08:10	25/05/95 08:30	S200	56.464	9.046	Go-flo
CD93B	CTD147	25/05/95 09:20	25/05/95 09:45	S200	56.463	9.042	Optical
CD93B	CTD148	25/05/95 10:44	25/05/95 10:54	S200	56.466	9.043	DO cast
CD93B	CTD149	25/05/95 10:57	25/05/95 11:12	S200	56.467	9.042	DO cast
CD93B	CTD150	25/05/95 12:43	25/05/95 13:08	S200	56.465	9.046	Geochemistry
CD93B	CTD151	25/05/95 19:19	25/05/95 20:21	N1500	56.736	9.392	Go-flo
CD93B	CTD152	25/05/95 21:08	25/05/95 22:09	N1500	56.733	9.390	
CD93B	CTD153	26/05/95 07:13	26/05/95 08:24	N1500	56.734	9.388	
CD93B	CTD154	26/05/95 09:12	26/05/95 10:28	N1500	56.731	9.396	
CD93B	CTD155	26/05/95 12:06	26/05/95 12:28	N1500	56.733	9.393	Optical
CD93B	CTD156	26/05/95 13:29	26/05/95 14:45	N1500	56.735	9.386	Go-flo
CD93B	CTD157	26/05/95 19:09	26/05/95 19:22		56.702	8.926	
CD93B	CTD158	26/05/95 19:23	26/05/95 19:41		56.702	8.927	
CD93B	CTD159	27/05/95 03:06	27/05/95 03:25	N140	56.604	8.928	
CD93B	CTD160	27/05/95 03:52	27/05/95 04:09	N200	56.617	8.991	
CD93B	CTD161	27/05/95 04:59	27/05/95 05:23	N300	56.629	9.023	
CD93B	CTD162	27/05/95 06:08	27/05/95 06:47	N700	56.644	9.108	
CD93B	CTD163	27/05/95 07:36	27/05/95 08:24	N1000	56.671	9.199	
CD93B	CTD164	27/05/95 09:48	27/05/95 10:54	N1300	56.697	9.332	
CD93B	CTD165	27/05/95 12:01	27/05/95 13:11	N1500	56.736	9.396	
CD93B	CTD166	27/05/95 15:41	27/05/95 16:07	S300	56.465	9.056	
CD93B	CTD167	27/05/95 16:57	27/05/95 17:15	S300	56.462	9.055	Go-flo

CD93B CTD casts							
Cruise	**Cast**	**Start date&time**	**End date&time**	**Stn**	**Lat N**	**Lon W**	**Comments**
CD93B	CTD168	27/05/95 17:57	27/05/95 18:18	S300	56.464	9.059	
CD93B	CTD169	27/05/95 19:28	27/05/95 19:53	S300	56.462	9.062	Geochemistry
CD93B	CTD170	27/05/95 20:59	27/05/95 21:24	S300	56.465	9.068	
CD93B	CTD171	27/05/95 22:08	27/05/95 22:20	S300	56.464	9.070	
CD93B	CTD172	27/05/95 23:00	27/05/95 23:23	S300	56.468	9.059	
CD93B	CTD173	28/05/95 00:02	28/05/95 00:22	S300	56.469	9.060	
CD93B	CTD174	28/05/95 01:08	28/05/95 01:31	S300	56.467	9.060	
CD93B	CTD175	28/05/95 02:06	28/05/95 02:25	S300	56.466	9.061	
CD93B	CTD176	28/05/95 03:09	28/05/95 03:31	S300	56.465	9.059	
CD93B	CTD177	28/05/95 04:10	28/05/95 04:26	S300	56.464	9.058	
CD93B	CTD178	28/05/95 05:06	28/05/95 05:23	S300	56.466	9.053	
CD93B	CTD179	28/05/95 06:16	28/05/95 06:32	S300	56.464	9.061	
CD93B	CTD180	28/05/95 07:11	28/05/95 07:31	S300	56.463	9.064	
CD93B	CTD181	28/05/95 09:26	28/05/95 09:47		56.462	9.057	Optical cast
CD93B	CTD182	28/05/95 13:16	28/05/95 13:43	S200	56.455	9.052	Optical cast
CD93B	CTD183	28/05/95 21:50	28/05/95 22:29	S700	56.464	9.151	
CD93B	CTD184	28/05/95 23:27	29/05/95 00:08	S700	56.468	9.163	Go-flo
CD93B	CTD185	29/05/95 00:41	29/05/95 01:24	S700	56.469	9.161	Geochemistry
CD93B	CTD186	29/05/95 02:02	29/05/95 02:40	S700	56.468	9.162	
CD93B	CTD187	29/05/95 03:06	29/05/95 03:33	S700	56.468	9.164	
CD93B	CTD188	29/05/95 04:06	29/05/95 04:37	S700	56.467	9.161	
CD93B	CTD189	29/05/95 05:38	29/05/95 06:24	S1000	56.464	9.302	
CD93B	CTD190	29/05/95 06:59	29/05/95 07:37	S850	56.461	9.225	
CD93B	CTD191	29/05/95 08:17	29/05/95 08:45	S500	56.467	9.102	
CD93B	CTD192	29/05/95 09:22	29/05/95 09:42	S200	56.462	9.046	
CD93B	CTD193	29/05/95 10:59	29/05/95 11:15	S140	56.462	8.969	
CD93B	CTD194	29/05/95 13:27	29/05/95 13:41	S130	56.288	8.503	
CD93B	CTD195	29/05/95 18:58	29/05/95 19:11	Islay D	55.741	6.986	
CD93B	CTD196	29/05/95 20:31	29/05/95 20:44	Islay C	55.575	6.648	

CD93B - main FAST CTD SURVEY (lines N,P,R,S)						
Stn	Cast	Start date&time	End date&time	Lat N	Lon W	Depth
N140	CTD81	18/05/95 23:48	19/05/95 00:10	56.604	8.941	135
N150	CTD82	19/05/95 01:05	19/05/95 01:25	56.618	8.992	162
N200	CTD83	19/05/95 02:00	19/05/95 02:23	56.619	9.011	220
N300	CTD84	19/05/95 02:55	19/05/95 03:29	56.629	9.028	338
N500	CTD85	19/05/95 04:21	19/05/95 04:52	56.632	9.073	501
N700	CTD86	19/05/95 05:36	19/05/95 06:15	56.645	9.113	699
N850	CTD87	19/05/95 07:00	19/05/95 07:45	56.656	9.151	836
N1000	CTD88	19/05/95 08:32	19/05/95 09:30	56.676	9.197	1024
N1300	CTD89	19/05/95 10:25	19/05/95 11:29	56.699	9.328	1296
N1500	CTD90	19/05/95 12:13	19/05/95 13:24	56.735	9.406	1512
P1500	CTD91	19/05/95 14:45	19/05/95 16:00	56.651	9.615	1533
P1300	CTD92	19/05/95 17:53	19/05/95 19:00	56.631	9.463	1310
P1000	CTD93	19/05/95 20:11	19/05/95 21:07	56.604	9.285	1000
P850	CTD94	19/05/95 22:18	19/05/95 23:06	56.598	9.226	844
P700	CTD95	20/05/95 01:13	20/05/95 01:58	56.590	9.183	709
P500	CTD96	20/05/95 02:49	20/05/95 03:24	56.578	9.114	501
P300	CTD97	20/05/95 04:12	20/05/95 04:32	56.568	9.052	290
P200	CTD98	20/05/95 05:21	20/05/95 05:37	56.566	9.031	202
P150	CTD99	20/05/95 06:21	20/05/95 06:36	56.563	9.003	158
P140	CTD100	20/05/95 07:27	20/05/95 07:42	56.551	8.935	140
R140	CTD101	20/05/95 08:28	20/05/95 08:47	56.500	8.931	143
R150	CTD102	20/05/95 09:51	20/05/95 10:05	56.503	8.991	148
R200	CTD103	20/05/95 11:05	20/05/95 11:25	56.506	9.038	207
R300	CTD104	20/05/95 12:59	20/05/95 13:30	56.505	9.060	305
R500	CTD105	20/05/95 14:37	20/05/95 15:12	56.507	9.106	468
R700	CTD106	20/05/95 15:55	20/05/95 16:35	56.515	9.172	671
R850	CTD107	20/05/95 17:11	20/05/95 17:51	56.514	9.231	852
R1000	CTD108	20/05/95 18:37	20/05/95 19:30	56.515	9.297	1007
R1300	CTD109	20/05/95 20:50	20/05/95 21:55	56.530	9.488	1297
R1500	CTD110	20/05/95 23:02	21/05/95 00:19	56.537	9.677	1523
S1500	CTD111	21/05/95 01:35	21/05/95 02:47	56.460	9.636	1507
S1300	CTD112	21/05/95 03:43	21/05/95 04:42	56.463	9.504	1281
S1150	CTD113	21/05/95 05:27	21/05/95 06:22	56.466	9.395	1133
S1000	CTD114	21/05/95 07:21	21/05/95 08:08	56.464	9.295	991
S850	CTD115	21/05/95 09:25	21/05/95 10:08	56.470	9.219	848
S700	CTD116	21/05/95 11:14	21/05/95 11:50	56.470	9.157	673
S500	CTD117	21/05/95 13:06	21/05/95 13:34	56.457	9.094	474
S300	CTD118	21/05/95 14:15	21/05/95 14:38	56.465	9.053	248
S200	CTD119	21/05/95 15:26	21/05/95 15:46	56.463	9.040	188
S160	CTD120	21/05/95 16:40	21/05/95 16:53	56.462	9.011	149
S140	CTD121	21/05/95 17:41	21/05/95 18:03	56.400	8.955	145

CD93B Slow stations - pelagic sampling						
Station	Event	Start date&time	End date&time	Lat N	Lon W	Comments
S140	CTD63	17/05/95 14:36	17/05/95 14:51	56.469	8.963	
	CTD64	17/05/95 15:41	17/05/95 15:53	56.470	8.955	
	CTD65	17/05/95 16:41		56.468	8.953	
	OPT1/CS4/1	17/05/95 16:55	17/05/95 17:05	56.467	8.954	CS4
	OPT1/PRR/1	17/05/95 17:10	17/05/95 17:20	56.467	8.952	PRR600
	OPT1/SAT/1	17/05/95 17:25	17/05/95 17:40	56.468	8.956	SATLANTIC
	CTD66	17/05/95 19:04	17/05/95 19:25	56.462	8.959	Geochemistry
	CTD67	17/05/95 21:01	17/05/95 21:16	56.461	8.958	Geochemistry
	CTD68	17/05/95 22:55	17/05/95 23:14	56.462	8.963	Go-flo
	CTD69	18/05/95 00:37	18/05/95 00:50	56.463	8.957	
	CTD70	18/05/95 02:58	18/05/95 03:13	56.462	8.959	
	CTD71	18/05/95 04:39	18/05/95 04:48	56.465	8.958	
	CTD72	18/05/95 04:50	18/05/95 05:02	56.465	8.958	
	CTD73	18/05/95 06:46	18/05/95 06:55	56.463	8.954	
	CTD74	18/05/95 06:56	18/05/95 07:04	56.462	8.953	
	CTD75	18/05/95 07:06	18/05/95 07:16	56.462	8.952	
	CTD76	18/05/95 09:15	18/05/95 09:27	56.463	8.955	
	OPT1/PRR/2	18/05/95 09:40	18/05/95 09:52	56.462	8.956	PRR600
	OPT1/CS4/2	18/05/95 09:55	18/05/95 10:10	56.460	8.956	CS4
	OPT1/SAT/2	18/05/95 10:20	18/05/95 10:27	56.459	8.958	SATLANTIC
	CTD77	18/05/95 10:20	18/05/95 10:30	56.458	8.959	
	CTD78	18/05/95 11:10	18/05/95 11:26	56.459	8.968	
	SVT1	18/05/95 11:58		56.463	8.966	2 settling tubes (5m)
	SVT2	18/05/95 12:08		56.463	8.967	2 settling tubes (5m)
R1000	CTD122	21/05/95 23:52	22/05/95 00:44	56.520	9.283	Go-flo
	CTD123	22/05/95 02:20	22/05/95 03:11	56.516	9.289	Geochemistry
	CTD124	22/05/95 04:01	22/05/95 04:52	56.517	9.289	
	CTD125	22/05/95 06:08	22/05/95 06:58	56.518	9.296	
	SVT3	22/05/95 07:36		56.518	9.284	2 settling tubes (2m)
	SVT4	22/05/95 07:52		56.520	9.280	2 settling tubes (2m)
	CTD126	22/05/95 08:41	22/05/95 09:50	56.517	9.292	Go-flo
	CTD127	22/05/95 10:32	22/05/95 11:18	56.519	9.290	For deep water
N2000	CTD134	24/05/95 01:16	24/05/95 01:39	56.999	9.999	Production cast
	CTD135	24/05/95 02:15	24/05/95 03:47	57.003	10.000	
	OPT3/INF	24/05/95 08:30	24/05/95 08:40	57.002	10.013	INF 300
	OPT3/CS4	24/05/95 08:45	24/05/95 09:00	57.003	10.017	CS4
	OPT3/PRR	24/05/95 09:05	24/05/95 09:10	57.004	10.017	PRR600
	OPT3/SAT	24/05/95 09:11	24/05/95 09:20	57.007	10.020	SATLANTIC
	CTD136	24/05/95 09:33	24/05/95 09:59	57.008	10.019	Optical dip
S200	CTD143	25/05/95 03:04	25/05/95 03:28	56.465	9.044	Production
	CTD144	25/05/95 04:12	25/05/95 04:32	56.463	9.046	
	CTD145	25/05/95 06:06	25/05/95 06:25	56.462	9.044	
	CTD146	25/05/95 08:10	25/05/95 08:30	56.464	9.046	Go-flo
	CTD147	25/05/95 09:20	25/05/95 09:45	56.463	9.042	Optical/drifters
	OPT5/PRR	25/05/95 09:25	25/05/95 09:34	56.462	9.043	PRR600
	OPT5/SAT	25/05/95 09:37	25/05/95 09:45	56.464	9.042	SATLANTIC
	OPT5/CS4	25/05/95 09:50	25/05/95 10:15	56.464	9.042	CS4
	OPT5/INF	25/05/95 10:20	25/05/95 10:30	56.462	9.043	INF 300
	CTD148	25/05/95 10:44	25/05/95 10:54	56.466	9.043	DO cast
	CTD149	25/05/95 10:57	25/05/95 11:12	56.467	9.042	DO cast/drifters
	CTD150	25/05/95 12:43	25/05/95 13:08	56.465	9.046	Geochemistry
	SVT5	25/05/95 13:34		56.462	9.044	2 settling tubes (2m)

N1500	CTD151	25/05/95 19:19	25/05/95 20:21	56.736	9.392	Go-flo
	CTD152	25/05/95 21:08	25/05/95 22:09	56.733	9.390	For deep water
	CTD153	26/05/95 07:13	26/05/95 08:24	56.734	9.388	
	CTD154	26/05/95 09:12	26/05/95 10:28	56.731	9.396	
	SVT6	26/05/95 11:00		56.734	9.399	2 settling tubes (5m)
	OPT6/PRR	26/05/95 11:08	26/05/95 11:19	56.734	9.398	PRR600
	OPT6/SAT	26/05/95 11:24	26/05/95 11:35	56.733	9.398	SATLANTIC
	OPT6/CS4	26/05/95 11:40	26/05/95 11:55	56.733	9.398	CS4
	OPT6/INF	26/05/95 12:00	26/05/95 12:05	56.732	9.398	INF 300
	CTD155	26/05/95 12:06	26/05/95 12:28	56.733	9.393	Optical
	CTD156	26/05/95 13:29	26/05/95 14:45	56.735	9.386	Go-flo
S300	CTD166	27/05/95 15:41	27/05/95 16:07	56.465	9.056	
	CTD167	27/05/95 16:57	27/05/95 17:15	56.462	9.055	Go-flo
	SVT7	27/05/95 17:35		56.462	9.061	2 settling tubes (3-5m)
	CTD168	27/05/95 17:57	27/05/95 18:18	56.464	9.059	
	CTD169	27/05/95 19:28	27/05/95 19:53	56.462	9.062	Geochemistry
	CTD170	27/05/95 20:59	27/05/95 21:24	56.465	9.068	
	CTD171	27/05/95 22:08	27/05/95 22:20	56.464	9.070	
	CTD172	27/05/95 23:00	27/05/95 23:23	56.468	9.059	
	CTD173	28/05/95 00:02	28/05/95 00:22	56.469	9.060	
	CTD174	28/05/95 01:08	28/05/95 01:31	56.467	9.060	
	CTD175	28/05/95 02:06	28/05/95 02:25	56.466	9.061	
	CTD176	28/05/95 03:09	28/05/95 03:31	56.465	9.059	
	CTD177	28/05/95 04:10	28/05/95 04:26	56.464	9.058	
	CTD178	28/05/95 05:06	28/05/95 05:23	56.466	9.053	
	CTD179	28/05/95 06:16	28/05/95 06:32	56.464	9.061	
	CTD180	28/05/95 07:11	28/05/95 07:31	56.463	9.064	
	OPT8/PRR	28/05/95 08:09	28/05/95 08:21	56.463	9.058	PRR600
	OPT8/SAT	28/05/95 08:23	28/05/95 08:36	56.463	9.059	SATLANTIC
	OPT8/CS4	28/05/95 08:40	28/05/95 08:56	56.462	9.057	CS4
	OPT8/INF	28/05/95 08:58	28/05/95 09:06	56.462	9.058	INF 300
	CTD181	28/05/95 09:26	28/05/95 09:47	56.462	9.057	Optical cast
S700	CTD183	28/05/95 21:50	28/05/95 22:29	56.464	9.151	
	SVT8	28/05/95 22:47		56.465	9.159	2 settling tubes (2m)
	CTD184	28/05/95 23:27	29/05/95 00:08	56.468	9.163	Go-flo
	CTD185	29/05/95 00:41	29/05/95 01:24	56.469	9.161	Geochemistry
	CTD186	29/05/95 02:02	29/05/95 02:40	56.468	9.162	
	CTD187	29/05/95 03:06	29/05/95 03:33	56.468	9.164	
	CTD188	29/05/95 04:06	29/05/95 04:37	56.467	9.161	

CD93B Coring stations						
Multicores						
Stn	**Core**	**Date & Time**	**Lat N**	**Lon W**	**Depth**	**Comments**
S700	MC1	18/05/95 19:16	56.473	9.156	NPA	8 cores
S700	MC2	18/05/95 20:55	56.480	9.158	NPA	7 cores
S700	MC3	18/05/95 21:53	56.478	9.162	NPA	8 cores
R1000	MC4	22/05/95 13:20	56.517	9.289	989	8 cores
R1000	MC5	23/05/95 01:21	56.517	9.285	979	6 cores
R1000	MC6	23/05/95 02:42	56.515	9.292	995	8 cores
N1500	MC7	25/05/95 23:49	56.734	9.393	1497	5 cores
N1500	MC8	26/05/95 02:14	56.735	9.385	1485	4 cores
N1500	MC9	26/05/95 04:00	56.733	9.391	1490	4 cores
N1500	MC10	26/05/95 22:46	56.736	9.405	1513	4 cores
Sholkovitz Gravity Cores						
Stn	**Core**	**Date & Time**	**Lat N**	**Lon W**	**Depth**	**Comments**
R1000		21/05/95 21:12	56.524	9.285	982	Unsuccessful
R1000		21/05/95 22:42	56.520	9.289	1002	Unsuccessful
RVS Gravity Cores						
Stn	**Core**	**Date & Time**	**Lat N**	**Lon W**	**Depth**	**Comments**
R1000	GC1	23/05/95 04:55	56.514	9.288	981	Successful
N2000	GC2	24/05/95 04:52	56.010	10.004	2072	Successful
N1500	GC3	27/05/95 00:25	56.737	9.390	1501	Successful

CD93B Drifting buoy experiments								
Event	Drifter	PTT	Release details			Recovery details		
ID	Name/No	no	Date & time	Lat N	Lon W	Date & time	Lat N	Lon W
BDRF2/1	UWB 2 "Karen"	3798	22/05/95 16:51	56.254	9.337	24/05/95 19:12	56.442	9.737
BDRF1/1	UWB 1 "Ray"	3797	22/05/95 17:13	56.247	9.343	24/05/95 18:52	56.445	9.742
DDRF1	DML 1	24263	22/05/95 19:44	56.250	9.062			
DDRF2	DML 2	24262	22/05/95 20:08	56.254	9.098			
DDRF3	DML 3	24264	22/05/95 20:57	56.254	9.133			
DDRF4	DML 4	24261	22/05/95 21:15	56.255	9.163			
DDRF5	DML 5	24260	22/05/95 22:36	56.256	9.318			
DDRF6	DML 6	24259	22/05/95 22:50	56.253	9.349			
BDRF1/2	UWB 1 "Ray"	3797	25/05/95 11:46	56.518	9.044	26/05/95 17:32	56.570	8.945
BDRF2/2	UWB 2 "Karen"	3798	25/05/95 12:01	56.514	9.042	26/05/95 18:30	56.697	8.924
	Notes:							
	The UWB drifters are equipped with thermistor chain, colour sensor and a							
	DML sediment trap.							

RRS Charles Darwin

Cruise 93

Leg A: Fairlie to Fairlie, May 7 to 16, 1995

Leg B: Fairlie to Fairlie, May 16 to 30, 1995

LOIS Shelf Edge Study (SES) Cruise 2

Principal Scientist: Dr Paul Tett
(University of Wales, Bangor)

CRUISE REPORT CONTENTS

Summary and Scientific Overview

The LOIS Shelf Edge Study (SES) region lies between 7 and 10 °W, 56 and 57 °N, extending from the outer edge of the Malin shelf across the continental slope of the Rockall Trough. The main aims of cruise CD93 were to service moorings and carry out CTD surveys in the SES region, and to study selected sites in detail during the anticipated period of the spring phytoplankton bloom. In addition, marine optical measurements would be made with the hope of relating to aircraft remote sensing, Argos-tracked drifters were to be released, and benthic sampling was to be carried out. Both legs of the cruise are described in this report.

Cruise organisation

Charles Darwin sailed from Fairlie on 7 May and returned on 30 May. Figure 1 is a track plot. The cruise was divided into 2 legs by a port call at Fairlie on 16 May. The main aim during leg A was the servicing, during daylight hours, of moorings. This was carried out by Alan Harrison's team and the ship's officers and crew. Night-time was used for CTD stations and repositioning. Leg 'B' combined "survey" and "process" studies, involving biologists, chemists and sedimentologists. "Fast" CTD surveys were found easy to organise; the schedule for "slow" stations (used for process studies) and aircraft liason was harder to arrange. A steering group, consisting of the PSO and 1 member of each discipline (specifically, Paul Tett, Sarah Jones (SPM), Martyn Harvey (benthos), Linda Gilpin (production) and Jane Foster (geochemistry)) met at 1720 each day, the navigator of the NERC aircraft was contacted at 1740, and a programme for the next 24-48 hours published soon afterwards. A formal scientific discusion was held during the final passage.

Moorings

All mooring sites were serviced during leg A. In particular, the partial sediment trap mooring laid at N1500 in March was recovered and fully redeployed. South line mooring sites S140, S200, S300 and S700 were fully instrumented. Because of equipment losses between March and May, North line mooring sites N140, N200 and N300 were only partly instrumented, and, because of lack of time, the subsurface mooring at N700 was not laid. The Meteorological Buoy at S140 was recovered at the end of leg A and relaid early in leg B.

Losses began almost immediately, probably as a result of midwater trawling by large fishing boats. By the end of the cruise the position was:

- Waverider, Met. Buoy, and toroids at S140, S200, S300 and S700 confirmed in place visually and by Argos on 28 May: instruments removed from S200 on May 29;
- N1500 sediment trap mooring, and S300 and S700 subsurface moorings confirmed in place acoustically during leg B;
- N140 marker spar and U-mooring, and N700 spar, confirmed visually on 27 May;
- N200 spar and U-mooring lost (subsurface float, RCM and thermisor logger/chain recovered on May 28 after Argos alert);
- N300 marker spar missing on 27 May, status of subsurface mooring unknown;
- 140 U-mooring lost (subsurface float and S4 recovered after chance sighting on 14 May);
- S200 U-mooring lost without trace;
- The status of the RDI ADCP and the Bottom Pressure Recorder (BPR) at S140, and the BPRs at N140 and N1500, could not be investigated during leg B.

It was concluded that (i) toroids survive well, being easy to see and without invisible subsurface parts; (ii) especial care in laying U-moorings and marker spars in a tight line is repaid; (iii) Dutch and German, as well as French and Spanish, fishing communities should be notified of current mooring positions, and every effort should be made to restore moorings to these positions after servicing; (iv) intermediate buoyancy and Argus beacons are worthwhile.

Coring

Despite problems that developed with the Multicorer during the later part of the cruise, multicores were obtained (and some incubated for oxygen demand) at S700, R1000 and N1500; gravity cores were taken at R1000, N1500 and N2000.

CTD surveys

A total of 196 CTD casts were made during the cruise. In addition to the predefined "fast" survey of lines N, P, R and S carried out during leg B, CTD stations from lines N and S were worked whenever possible, allowing a time-series of contoured sections to be constructed. Table 1 lists and comments on these sections. In addition CTD stations were worked near Islay during each passage, at 2 sites in the deepest part of the Rockall Trough, and during drifter deployment and recovery.

The CTD system, including "tone-fire" water-bottle closing, worked well. Considerable effort was put into sensor calibration: frozen chlorophyll samples have been returned to DML to aid fluorometer calibration; SPM and POC samples were taken for transmissometer calibration, and dissolved oxygen concentrations determined chemically for calibration of the oxygen sensor, which had been reconfigured with a SeaBird pump.

"Slow" stations

During leg B, seven sites (S140, S200, S300, S700, R1000, N1500 and N2000) were worked in detail, including multiple CTD casts, and special water-sampling for geochemical measurements. Rates of photosynthesis, primary production, microplankton respiration, and particulate sinking, and optical properties were measured at most of these stations. The go-flo bottles, used for clean sampling, sometimes malfunctioned.

Drifters

Two kinds of Argos-tracked drifter experiment were carried out during leg B. Six drogued drifters were released at shelf and slope stations on the V-line, on behalf of DML and Southampton University. Two UWB instrumented drifters, each with a DML sedimentation trap at 75 m, were each released twice, and recovered 30-50 hours later. The traps mainly took copepods. In general, releases near the shelf-break tended to move northwards, parallel to the shelf-break; those in deeper water moved north-west.

Optics and remote sensing

The NERC aircraft, equipped with CASI and ATM, made a number of attempts to fly to the SES study area, but weather (mainly, the amount of cloud) prevented any effective overflights. Despite much effort by the aircraft's crew, short periods of (relatively) clear sky could not be used because of the delay involved in flying the plane from Coventry, with refueling stop at Caernarfon or Londonderry.

In-water optical measurements were made at about a dozen stations according to the SeaWiFs-compatable protocols developed by the UWB Marine Optics Group. These included measurements of radiance and irradiance made with four specialised sensors, and detailed measurements of light absorbers, especially phytoplankton pigments.

The spring bloom and its decline

The cruise was fortunate in coinciding with the increase and decline of the spring phytoplankton bloom. In the surface waters, phytoplankton were the main absorbers of light, and data from the CTD fluorometer and transmissometer well indicated the distribution of biomass. This information was supplemented by measurements of chlorophyll concentration made at optical stations during the cruise itself (most chlorophyll samples were not processed during the cruise itself, and data from moored instruments was not available until later). These data show that the bloom peaked during the first 2 weeks of May (certainly by May 15), and declined thereafter. By about 20 May there were indications of phytoplankton sinking to 200 m at some sites, and on May 24 large quantities of phytoplankton pigments (mainly pheopigments, but with about 20% chlorophyll or similar) were seen near the bed at N1500. There was no evidence for sinking phytoplankton in midwater in any CTD profile, and no mid-water bottle samples contained sinking phytoplankton. It is possible that the downwards transport was largely mediated by mesozooplankton.

Early in May, thermal layering was weak near the sea-surface, and the most obvious physical feature was a reduced salinity superficial layer extending across the slope waters from the outer shelf. The penetration of this layer weakened later in May, as thermal layer intensified. The shelf water may have had phytoplankton dominated by flagellates and small dinoflagellates, at least during the later stages of the bloom, whereas the oceanic bloom was clearly dominated by chain forming diatoms, especially *Chaetoceros*.

SPM

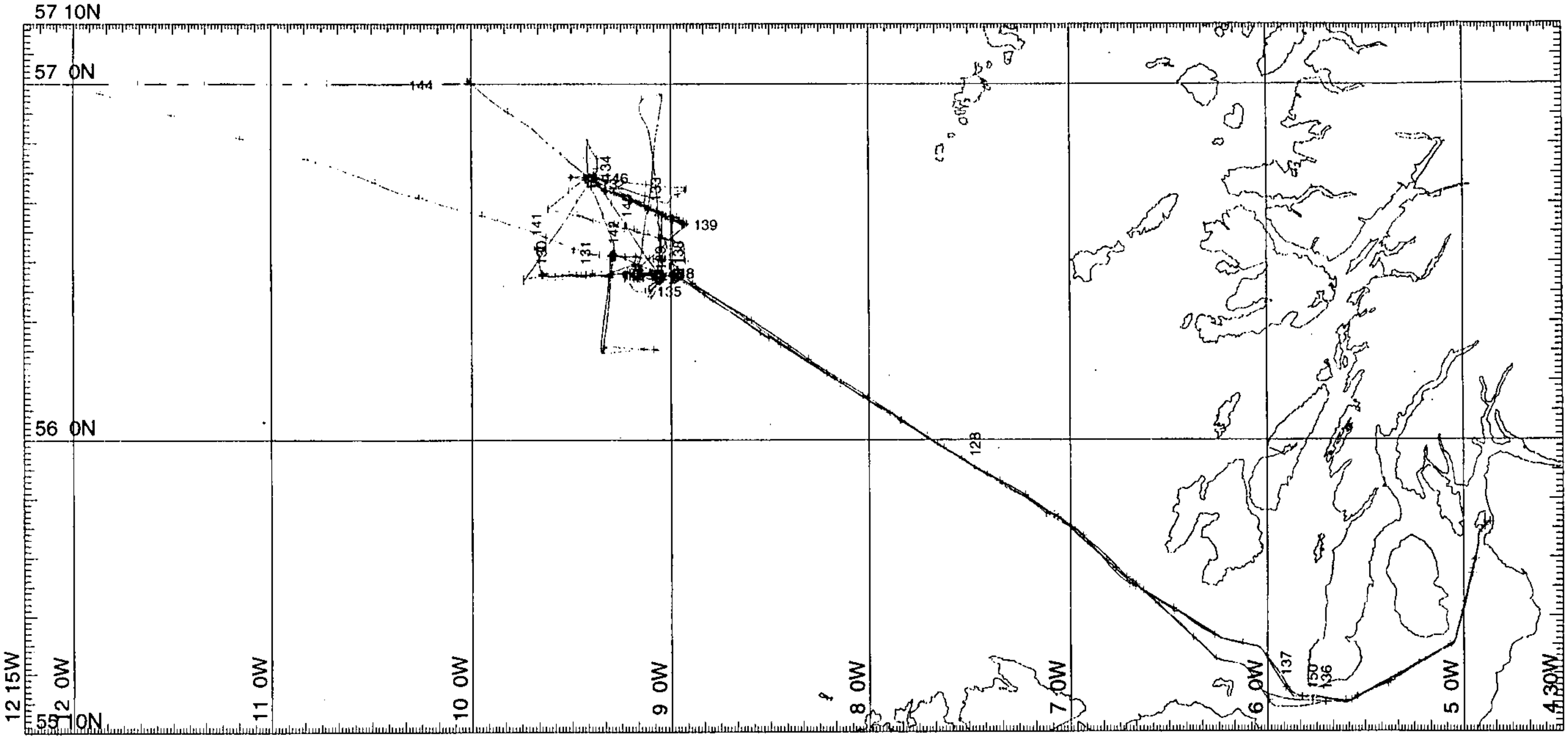
SPM was characterised using a Galai laser sizer at most CTD stations. In superficial waters, and in some near-bed samples, it was dominated by phytoplankton. Preliminary estimates gave 1 m d^{-1}, or slower, for the sinking rates of most near-surface phytoplankton. Midwater regions of enhanced turbidity were seen frequently at slope sites, typically at depths of 300 - 700 m. The transmissometer signal was not usually accompanied by a fluorescence signal, implying that the turbid material did not contain chlorophyll-like pigments.

Conclusions

With the exception of aircraft overflights, all objectives were acheived. Losses of moored instruments were of concern. We were fortunate to be able to observe the spring phytoplankton bloom and its decline.

Figure 1. Track plot. The heavily worked lines are the S and N lines in the SES region.

Table 1. List of sections. See also station lists.



MERCATOR PROJECTION

SCALE 1 TO 3000000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

GRID NO. 1

--- Track plotted from bestnav

RRS Charles Darwin 93 Leg B whole track

CD93: Summary of contoured sections across the slope.

Three methods were used:

F. "Fast survey", starting at one end and proceeding from site to site directly to other end, visiting all (or almost all) sites;
spF. Sparse "fast" survey: only some sites visited;
A. Assembled from sites visited over several days, including some occupied for "slow" stations or mooring servicing/calibration.

Contoured sections (to 800m) have been plotted for: T:temperature, S:salinity, Fv:fluorescence voltage (also to 200m), Trv:transmissometer voltage, and DO:(uncalibrated, upcast only) oxygen.

Line	Dates (May)	Site range	Method	Comments
S	9-11	140-1500	A	T - downwelling on slope; S - lower salinity surface water on shelf; Fv - maximum greater, and extends deeper, over deep water; Trv - minima on shelf and over deep water; midwater and near-bed turbid regions at S200-S400.; DO - downwelling on slope.
N	12-14	140-1600	A	T - downwelling on slope; S - lower salinity surface water on shelf; Fv - maxima lower than previous S-line, but some plumes to 200 m; Trv - minima over shelf and upper slope; midwater and near-bed turbid regions S300-S500;
N	18-19	140-1500	F	T - ocean SML warmer than shelf, some downwelling on slope; S - lower salinity surface layer extends to N1300; Fv - highest over shelf and slope, plumes to 100 m; TrV - minima over shelf and slope; midwater turbid plume N500-N1300; DO - highest where Fv maximum. *Nutrient sections also available.*
P	19-20	1500-140	F	T - ocean SML warmest, downwelling on slope; S - low salinity shelf water only to P700; Fv - greatest fluorescence near shelf; plumes to 200 m; TrV - minima over shelf, sinking plumes?.
R	20	140-1500	F	T - ocean SML warmest; downwelling on slope; S - lower salinities mostly on shelf; Fv - greatest fluorescence over shelf, large sinking? plume to 150 m at R700-R100; Trv - minimum transmission over shelf, plume coincides with Fv. *Fv, Trv and DO also contoured on y-T section.*
S	21	1500-140	F	T - warmest SML now over slope, downwelling on slope; S - weak low-salinity layer extending to S850; Fv - maxima now lower than before, sinking plume at S1350-S1500; TrV - matches Fv, some near-bed turbid water on slope; DO - maxima less marked.
S	24-25	1500,1000 ,500,200	spF	T - SML warmer over shelf and slope, weak downwelling; Fv - maxima weak; TrV - turbid plume extending offshore from S500?; DO - maxima weak.
N	27	140-1500	spF	T - SML temperature layering strengthening everywhere, downwelling on slope; S - low-salinity water conifned to shelf; Fv - maxima weak, greatest on shelf; TrV - midwater turbidity at N500, extending in plume?; DO - structure weak.
S	(28-)29	1000-130	spF/A	T - SML temperature layering strengthening, downwelling on slope; S - low salinity water penetrates only to S300; Fv - fluorescence maxima strongest on shelf; TrV - transmission minima strongest on shelf/inner slope, turbid midwater at S500/S700; DO - mindwater minimum at S700.

Objectives

LOIS - SES objectives

The objectives of the LOIS Shelf Edge Study are:

(a) to identify the time and space scales of ocean-shelf momentum transmission and to quantify the contributions to ocean-shelf water exchange by physical processes;

(b) to estimate fluxes of water, heat and certain dissolved and suspended constituents across a section from the shelf edge with special emphasis on net organic export from, and nutrient import to, the shelf;

(c) to relate sediment properties and fluxes to the physical context;

(d) to incorporate process understanding into models which will be tested by comparison with observations and provide a basis for estimation of fluxes integrated over time and the length of the shelf edge.

Seven SES cruises are planned during 1995-96, to study the shelf edge west of Scotland. The first cruise, Charles Darwin 91, took place in March 1995, and involved bathymetric, sea-bed and sediment survey, and the placing of a skeleton array of moorings.

Study region and survey strategy for Charles Darwin 93

SES mooring lines. The SES south mooring line (S) (which carries the majority of the sensors, including all those for chemistry and biology) runs E-W from 150S at about 56°24'N, 9°00'W to 700S, and the north mooring line (N) runs WNW from 130N at about 56°37'N, 8°55'W to the 1500N sediment trap mooring. The shelf break is at about 9°05'W on S and about 9°00'W on N. The **detailed study region** is bounded by these lines. A **"slow" survey**, with detailed pelagic and benthic sampling, will be carried out along S, with additional sampling near 1000R, 1500N, and 2000N.

The **Sea-soar survey** covers a somewhat larger area, with 4 cross-slope sections (S, R, P and N; each about 50 km long, 140-1600 m water depth) and 3 along-slope sections (50 km long) S-N from 56°18'N to 56°44'N, in water depths 170 (repeated), 500 and 1000m. The vehicle will be equipped with CTD and fluorometer.

The **"fast" (CTD) survey** will include stations on S, R, P and N. Stations outside the detailed study region may include W, stations on the DML **WOCE** line from the shelf break at 57°00'N, 9°00'W (DML station R1, 155m) and then to 57°09'N, 9°42'W (DML station O, 1900m). The **CTD system** will include transmissometer, fluorometer, oxygen sensor and PAR sensors, and a rosette equipped with twelve 10-litre Niskin bottles. The non-toxic supply will go to thermosalinograph, transmissometer, fluorometer, and these, together with a pyrrheliometer, will be logged continuously.

Objectives of CD93

Climate-forced numerical simulations suggest that thermal stratification should be commencing during the cruise, and the spring bloom of phytoplankton should take place in late May. Although moored instruments will monitor the time-course of the bloom, CD93 will also collect time-series of samples from "slow" survey stations. The NERC aircraft, with CASI and ATM, will overfly the detailed study region about once a week..

<u>Leg A</u>

(a) Service all moorings and add full suite of instruments.

(b) CTD profiles: to calibrate moored instruments; and at some other "fast" stations.

(c) Specialised optical measurements: for calibration of moored optical sensors; and to relate to CASI measurements during overflights by NERC aircraft.

(d) Opportunistic CTD stations during passage to and from study region.

Leg B

(a)* Sea-Soar survey, with 13 hrs of repeated runs along 170 m contour (near either Neap or Spring tides). Repeat about 7 days later.

(b) Slow survey. Four stations occupied for 24 hours each. Detailed optical measurements (during daytime), and repeated CTD-waterbottle casts at all mooring sites, penetrating to within 5 m (ideally 2 m) of the bed, providing: water for all required analyses, including chemistry, photosynthesis, respiration; and near-bottom water for core incubation. Special sampling for SPM. Benthic sampling with multi-corer and box corer.

(c) Drifter experiments. Release of 12 Argos-tracked drifters; release and recovery of 2 (optically instrumented) Argos-tracked drifters and in-situ productivity incubations.

(d) Fast CTD survey.

(e) Remote sensing. Darwin will sample close to an optically-instrumented (S) mooring with the aircraft overhead.

(f) Water sampling at dawn whenever possible for deck productivity incubation.

(g) Service surface optical and nutrient sensors from one mooring;

(h) Opportunistic CTD stations during passage to and from study region.

*Unavailability of Sea-Soar meant that objective (a) was not attempted.

Personnel

Officers and Crew (both legs)

Name	Position
Bourne, R.A.	Master
Noden, J.D.	C/O
Oldfield, P.T.	2/O
Crofts, M.L.	3/0
Baker, J.G.	R/O
Adams, A.P.	C/E
McDonald, B.J.	2/E
Slater, I.M.	3/E
Parker, P.G.	E/E
Trevaskis, M.	CPO(D)
Vettos, C.	SG1A
Luckhurst, K.R.	SG1A
Dean, P.H.	SG1A
Dickinson, R.	SG1A
Maclean, A.	SG1A
Healy, A.	MM1A
Bell, R.	SCM
Perry, C.K.	Chef
Kenny, C.J.	M/Stwd
Link, W.J.	Stwd
Shields, S.	Stwd

Scientists, leg A (7-16 May)

Name	Cabin	Main Task	From
Alan Harrison	9	Moorings	POL
Anne Hammerstein	4	Moorings/ optical instruments	UWB
Bill Miller	15	Instruments/RVS technical liason	RVS
Brian Grantham	2	Moored nitrate analysers and fluorometers	DML
Fernando Perez-Castillo	6	Sediment traps/transmissometer calibration	UWB
Graham Ballard	11	Moorings	POL
Hilary Wilson	3	CTD oxygen sensor calibration	UWB
Ivan Ezzi	1	Moored nitrate analysers and fluorometers	DML
Jake Loncar	17	Data	BODC
Jeff Jones	13	Mechanical	RVS
Kev Smith	14	Mechanical	RVS
Neil MacDougall	8	Moorings	DML
Paul Duncan	5	Computing	RVS
Paul Tett	CS	Chief Scientist	UWB
Phil Taylor	16	Instruments/moorings	RVS
Ru Morrison	7	Remote sensing sea-truth	UWB
Suse Kratzer	12	Colour sensor cal./phytoplankton/pigments	UWB
Tony Banaczek	10	Moorings	POL

Scientists, leg B (16 - 30 May)

Name	Cabin	Main task	From
Anne-Christine Le Gall	1	Geochemistry	Soton
Bill Miller	15	Instruments/RVS technical liason	RVS
Brian Grantham	2	Nutrients	DML
Hilary Wilson	4	Respiration, oxygen	UWB
Jane Foster	10	Geochemistry	Edin
Jeff Jones	13	Mechanical	RVS
John Hughes	9	Data	BODC
John Wynar	16	Instruments	RVS
Kev Smith	14	Mechanical	RVS
Linda Gilpin	3	Primary production	QUB
Lynda Mitchell	12	Benthos	DML
Martyn Harvey	11	Benthos	DML
Paul Duncan	5	Computing	RVS
Paul Smith	7	Remote sensing sea-truth	UWB
Paul Tett	CS	Chief Scientist	UWB
Ray Wilton	8	Drifters, optical instruments	UWB
Sarah Jones	17	SPM	UWB
Stuart Lowe	6	SPM	UWB

Leg A

SUNDAY MAY 7 (JULIAN DAY 127): Ship left Fairlie at 09 hr BST and made passage out of Firth of Clyde and then in direction of SES detailed study region. Conditions generally good; sky overcast with low cloud; swell increased towards Atlantic. Scientists engaged in preparing equipment and moorings. Flow-through system not running, and doubts about its logging software. CTD oxygen sensor not yet connected to pump. Two CTD stations in evening near Islay, the first including optical measurements.

MONDAY MAY 8 (DAY 128): Clocks to GMT. Continued passage. Forecast weather unsuitable for aircraft/CASI. Most work concerned preparation or deployment of S-line moorings. Arrived S140 at 08 hr and deployed bottom-mounted ADCP. Deployed surface-toroid mooring at S300. The S300 pop-up mooring apparently responded to distant interrogation but not when close. Recovered S140 U-mooring. Attempted optical station in afternoon: in order to get sun on starboard (hydrographic winch) ship lay broadside to NW wind: conditions impossible for moorings assembly on rear deck, so optical station aborted. Discussions about safety and reliability of anchor-first deployment of deep moorings, starting with replacement S300 pop-up. Conclusion: safety considerations preclude anchor-first except in calm conditions. CTD casts from 003 to 005 included some for moored instrument calibration. Two minutes silence observed at 1938. Remained at S300 for mooring gear tests and to interrogate existing S300 pop-up mooring.

TUESDAY MAY 9 (DAY 129): CTD stations overnight between S700 and S120 (casts 006 to 010). CTD DO sensor ducted through Seabird pump from cast 008 onwards: spikes in DO downcast caused concern, but upcast looked good. Weather at 0600 good, but forecast noon cloud cover too great for aircraft remote sensing. After breakfast, deploy S140 U-mooring. Continue acoustic search for S300 pop-up mooring, now thought to have moved from original location. Optical station at S300, using port side hydraulic crane to lower sensors. Concluded that S300 pop-up mooring has gone from area; a new pop-up mooring was deployed. During deployment it was discovered that nominal co-ordinates for site were at 340 m depth, so the mooring was finally deployed to the north of the S300 toroid, in 300 m depth. Recovered S200 U-mooring with toroid and deployed Waverider buoy at S140. CTD casts from 011 to 014, mainly for mooring calibration. Weather fine and conditions generally good during day.

WEDNESDAY MAY 10 (DAY 130): CTD stations overnight between S1500 and S1000 (casts 015 to 018). Aircraft overflight requested at 0600 with prospect of clear sky. Overcast by 0900; however, agreed that aircraft would come for reconnaissance; flew by 1123-1140. Weather in afternoon improved: much clear sky; bright sun; NE wind. Deployed S200 U-mooring and toroid mooring, with optical station. Deployed S700 toroid mooring. S700 pop-up mooring interrogated and located. CTD casts 019 to 023 for calibration and optics.

THURSDAY MAY 11 (DAY 131): CTD stations overnight between S1300 and S850 (casts 024 to 026). At 0600 arranged for aircraft to fly to Londonderry. Forecast wind N/NE, 4/5; squally showers and sunny intervals. Drifted S700 pop-up mooring recovered, with some difficulty: only bottom 20 m remained, with 1 RCM and acoustic release. It was about 2 n.m. north of its deployed position. Aircraft cancelled at 1000 due to increased cloud. Deployed replacement S700 pop-up mooring, and then recovered BPR at S140. Optical stations at S700 and S140. CTD casts 027 to 029 for calibration and optics. Then passage towards

N1500, with CTD stations at S170 and R1000 (casts 030, 031), and search for missing original S300 pop-up mooring.

Losses of instruments with old S300 and S700 pop-up moorings made it impossible to deploy a full suite on the North line. Advice was sought overnight from T.Sherwin (UWB), who on Friday suggested deployment of sparsely implemented physics moorings at all N-line sites (N140, N200, N300, N700).

FRIDAY MAY 12 (DAY 132). CTD station and overnight in vicinity of N1500. Acoustic contact with partial sediment trap mooring. At 0800, wind (25+ knots) and swell from north too strong for safe recovery of pop-up mooring. Commenced CTD stations at N1600 (including optics), then decided to deploy U-mooring at N140, which was successfully achieved. CTD stations N170 to N500. CTD casts during day from 032 to 040.

SATURDAY MAY 13 (DAY 133). Overnight CTD stations continued from N700 to N1000 (casts 041 to 043). Early morning weather good (wind 10 kn. N, cloud 2/8). Agreed at 06 hr that aircraft would overfly; confirmed at 8hr and 10hr. N1500 sediment trap partial mooring successfully popped-up soon after 6 hr, and recovered using rubber boat. Trap had taken samples. RCM had data, but associated transmissometer was bent, perhaps at time of deployment. By noon wind had shifted to 15 knot from NW, cloud had increased, and there were squally showers. Aircraft radioed that had reached S line, but thick cloud prevented remote sensing. It returned to Coventry. Complete N1500 mooring (2 traps) deployed in afternoon, preceded by deployment of Bottom Pressure Recorder. In evening, deployed N200 mooring, and spooler test rig at 400m. Casts 044 to 047 for mooring calibration.

SUNDAY MAY 14 (DAY 134). Overnight CTD stations from N1400 to N1150, and N500, N300 (casts 048 - 052). Deployed N300 pop-up mooring with reduced instrumentation, and recovered spooler test. It had been planned to deploy N700 pop-up with sparse instrumentation. However, spar marker had gone. There was insufficient time to replace marker and deploy pop-up mooring; it was thought that instruments would be dangerously exposed without marker, so only new marker was deployed. Calibration CTD casts 053 - 054. On passage to S140 a drifting buoy was encountered and recovered: it was the subsurface float (with 1 S4 current meter) of the U-mooring deployed at S140 on 9 May). After placing a spar marker buoy near the S140 Met Buoy (ready for removal of the Met Buoy tomorrow), Darwin started at 20 hr to search acoustically to N and W of S140 site for the rest of the S140 U-mooring, and the old S300 mooring.

Day had commenced overcast and raining, with forecast of winds NW to NE, 3/4, and showers; aircraft was told no flight needed. By afternoon weather was fine, with periods of largely clear skies, and sea was becoming increasingly calm. Suggests need for aircraft to be temporarily based in Londonderry, able to respond to conditions in SES area at 2 hours notice, as opposed to 6 hours at present.

Results analysed by Sunday suggest that the Spring Bloom was underway on the outer shelf, with some S-line surface layer chlorophyll concentrations exceeding 3 mg/cubic metre.

MONDAY MAY 15 (DAY 135). Search for missing moorings ended at 03 hr without success. Full moon, weather fine, occasional showers, sea conditions good. CTD at S300 and S140 for DON and POC samples (casts 055,056). Recovered Met. Buoy and deployed toroid mooring at S140, followed by optical station for sensor calibration (cast 057). DGPS turned off at 1100. Weather and sea good, sky increasingly clear. Passage to Islay stations D and C (CTD casts 058, 059), after which Non-toxic supply was turned off. Continued passage to Mull of Kintyre.

TUESDAY MAY 16 (DAY 136). Clocks to BST. Passage through Firth of Clyde, arriving Fairlie 0830 BST. Disembark leg A personnel and gear, especially remaining moorings gear. Embark leg B personnel and gear, including Clean Chemistry Container (Radio-Isotope Container already aboard). Service Met. Buoy. Take on Argos drifters, delayed in transit from U.S. Sail Fairlie 2000 BST.

Leg B

WEDNESDAY MAY 17 (DAY 137). Clocks to GMT. Watches began 0300 as Islay C station was approached; non-toxic supply had been running for some hours. Acoustic fish not out; depths from hull transducer. Positions from ordinary GPS unless stated. Stations Islay C, Islay D and S130 worked (CTD casts 060-062) on passage to S140. Weather improving from overcast and rainy to mostly clear sky, low wind and good sea. Reached S140 at 1330. All surface moorings in place. Deployed Met. Buoy. Began CTD time series with cast 063 to provide water for variety of needs, including SPM (Jones, Lowe), chemistry (Foster, Le Gall, sometimes using Go-Flo bottles) and productivity (Gilpin). Optical measurements in afternoon (Smith). A new watch system was organised during the day, and to was agreed to have daily meetings of a small co-ordinating group (Foster, Gilpin, Harvey, Jones, Tett) to plan scientific schedule. Agreed no aircraft flight on Thursday.

THURSDAY MAY 18 (DAY 138). Continued CTD time series at S140 up to 1230 (cast 78), with productivity, optical and SPM settling tube measurements. After some further experiments with the plumbing of the DO sensor, it was decided to revert (cast 073) to the leg A configuration for the rest of the cruise. Successful coring (MC1 - MC3) at S700, and CTD cast 080, between 15hr and 22hr. S700 toroid and subsurface moorings in place: the subsurface mooring was confirmed acoustically after pellets were seen at the surface. Commence "Fast" CTD survey at N140 just before midnight (cast 081), including Go-Flo bottles. Conditions generally good during day, with showers and sunny intervals.

FRIDAY MAY 19 (DAY 139). Continue "Fast" CTD stations from N150 on N line (casts 082-090), reaching N1500 at noon. The stations were defined in advance, in relation to mooring position and the detailed map of bottom topography made by CD91. Commence P line at P1500, completing P850 before midnight (casts 091-094). Darwin made a course from P1500 to P140, identifying station positions by water depth as displayed on the Simrad echo sounder in the Main Laboratory. The station positions marked as a result are available for subsequent surveys. Wind increased during the day, and it was generally overcast, with showers. A problem in logging CTD bottle fire events to the level A computing system error (not all events were recorded) was identified for some earlier casts, but could not be repeated during tests. It was agreed that the NERC aircraft would attempt 2 overflights on Saturday, if the weather proved suitable.

SATURDAY MAY 20 (DAY 140). Continue "Fast" CTD stations on P line from P700 to P140 (casts 095-100), completing P140 by 08 hr. Sky overcast, and forecast of increasing winds and rain as depression approached, so overflights cancelled at 0725. "Fast" CTD stations on R line, from R140 to R1500 (casts 101-110). The procedure for identifying station positions according to water depth was the same as that used on the P line. In retrospect, however, it might have been faster to survey the course from R140 to R1500 without stopping, marking station positions as appropriate depth contours were passed, and then returning to known station positions. An analysis of cast 081 salinity data, with samples taken from alternating Niskin and Go-Flo bottles and compared with CTD salinity, gave some causes for concern, although routine salinity samples taken from a lower-water-column bottle on each cast have generally been in good agreement with the CTD. For example, 9 samples from casts 091-099 were on average 0.028 (s.d. 0.002) psu greater than the corresponding CTD value.

SUNDAY MAY 21 (DAY 141). "Fast" CTD stations (at pre-determined positions) on S line, starting at S1500 at 02 hr. Weather worsening: at 0630, low cloud, drizzle, wind 25 knots, 160°. 24-hr forecast for Malin includes winds to 6-7, turning to south. In conversation with fisheries protection vessel "Vigilante" soon after 10 hr, it was learnt that the large fishing vessels seen last week were probably Dutch or German, catching pelagic blue whiting. If they follow last year's behaviour, they will by now have followed the fish northwards, and their stay in the SES region may not have lasted more than a fortnight. Smaller Spanish (long-liner) and French (trawlers) continue in the SES area. "Vigilante" reports that some boats have complained that our moorings are not in the exact positions given by the preliminary notices.

Completed S-line at station S140 (casts 111 to 121). Swell increasing. Toroids at S700, S300, S200, S140, and Met Buoy and WaveRider at S140 all seen from bridge. The spar buoy marking S200 subsurface mooring was not seen, however, and could not be found between S200 and R200 on passage from S140 to R1000. Reached R1000 at 20 hr. Two failed Gravity Corer drops.

MONDAY MAY 22 (DAY 142). Continue overnight station at R1000. Weather and sea considered unsuitable for multicoring. Go-flo (122) and Niskin (123) CTD casts, followed by standard CTD casts (124-125) at 04 and 06 hr, then a mixed Niskin/Go-flo cast (126) and cast 127 for deep water. Settling velocity tubes taken. After this there was a successful Multicorer drop, ending 14 hr. Coring was interrupted to go to the drifter release line, V (at 56°15'N), reached at 16 hr. An optical station was carried out at V1000 (cast 128), and two UWB drifters were deployed over the stern. Each carried a colour sensors, a 70 m thermistor chain, and a DML sediment trap. They will be tracked by Argos and, at close quarters, by a VHF beacon. Between 19 hr and 23 hr, Darwin deployed 6 Argos-tracked drifters for DML/Southampton University, between V150 and V1000, with associated 100m CTD casts 129-131. Sky overcast, and some rain, but wind strength fell gradually during the day.

TUESDAY MAY 23 (DAY 143). Returned to R1000 to complete coring: 2 more successful drops of the Multicorer, and 1 successful drop of the Gravity corer. At 0540 commenced passage for station NR, at 57°N, 12°W for CTD station at 15 hr; then to N2300 (11°W) at 20 hr (casts 132, 133).

WEDNESDAY MAY 24 (DAY 144). Arrived N2000 (10°W) at 01 hr. CTD cast for simulated *in situ* production measurement, followed by standard CTD, successful Gravity Corer drop , and optical/CTD station (casts 134-136), ending at 10 hr. Passage to N1500 for standard (137) and geochemical (138) CTD casts, ending 16 hr. N1500 Sediment trap mooring release successfully acoustically interrogated; intermittent response from BPR. During day contour plots from the "Fast" surveys along N,P,R and S lines were examined, and thought to show evidence of sinking of fluorescent and light-absorbing material to 200m at some stations. Today's casts at N1500 showed increasing fluorescence, and decreasing transmission, in the 100 m above the sea-bed. Samples from this layer were rich in particulates and the remains of diatom chains, and it was tentatively concluded that this was recently sedimented material from the spring bloom, which had thus reached the bottom (1500 m) in a few days. There was no evidence of large particles in mid-water, so the downwards route was not clear.

Meanwhile, reports received from the Argos system, via the RVS computer and a twice-daily link from Darwin, showed that the UWB drifters were moving WNW. The ship headed for an estimated position SW of S1500, and homed in on the drifters using the signal from their VHF beacons. At 1830 they were seen in the water, and by 1912 both had been successfully and speedily recovered, sea conditions being good. The traps proved to have caught large numbers of *Calanus*-sized copepods and some other zooplankton and nekton. A single optical profile was made at the recovery site, followed by CTD cast 139 with Go-flo bottles for geochemical work (to test cleanliness of these bottles).

Darwin then moved to S1500 and S1000 for CTD casts (140,141). This was a successful and eventful day, the only disappointment being that cloud cover prevented remote sensing overflights.

THURSDAY MAY 25 (DAY 145). CTD cast (143) at S500. Arrived at "Slow" station S200 for CTD cast at 03 hr for simulated *in situ* production, followed by casts (144-150) for purposes including optics, geochemistry and dissolved oxygen. The S300 mooring acoustic release was successfully interrogated; there may have been a response from the acoustic release on missing S200 U-mooring at about 4 km. The 2 UWB drifters were re-launched about 3 n.m. north of S200, avoiding the nets of a large (Irish) trawler working nearby.

At about noon a message was received, via POL and Clyde Coastguard, that a POL buoy had been seen at 57°06'N, 009°15'W by the French fishing vessel "Heliotrope". Work at S200 was thus terminated early with the initiation of a Settling Velocity Tube experiment, and "Charles Darwin" proceeded at 14 hr to check the moorings at S140, since it was thought that the buoy might be the POL Meteorological Buoy. The Met. Buoy was however in place at S140, as were all other surface moorings. The next hypothesis was that the out-of-position buoy was a spar from the U-mooring at N200. This site was checked: there were no surface signs of either the U-mooring with spar, or the marker spar. Acoustic search at first gave confusing results, but finally suggested that the U-mooring acoustic release was not present. Another message from POL stated that the only POL spar was the marker at N140. This was checked and found in place, together with the DML spar and pellets of the N140 U-mooring. It was finally concluded that the out-of-position buoy was probably the original N700 marker spar, deployed in March and found missing during leg A.

"Charles Darwin" then proceeded to N1500, arriving at 19 hr, and commencing the "slow" station with CTD casts for geochemistry and for deep water samples (151-152). Multicorer sampling was commenced at 23 hr. During the day the sky was mostly completely cloudy, and the wind strength increased during the afternoon.

FRIDAY MAY 26 (DAY 146). Multicore sampling continued at N1500 to 05 hr. Three drops were carried out, each returning only 4 or 5 out of 8 cores; the coring mechanism may have been damaged during a recent fall on deck. A new termination was made for the CTD cable. Standard, go-flo and optical protocol casts (153-156) were made, an optical station worked, and Settling Velocity Tubes filled, before leaving the site at 15 hr to recover the UWB drifters. Both had moved northwards and into slightly shallower water on the shelf. They were encountered about 6 n.m north of N140, and both recovered, in worsening weather, between 1708 and 1830; during recovery of the second drifter, its sediment trap caught on the rudder, but was brought inboard safely. An short optical station was worked, and a double CTD cast (157-158) carried out for precise oxygen measurement and optical protocol samples, at the drifter recovery site.

Thereafter the ship returned to N1500, commencing a Multicorer drop at 22 hr. This was recovered successfully, but only 4 cores were obtained, due to continuing problems with the mechanism.

Some of the casts at N1500 showed increased chlorophyll fluorescence, and decreased transmission, in a layer exceeding 100 m thick above the sea-bed, as had been observed on Wednesday.

SATURDAY MAY 27 (DAY 147). Work at N1500 concluded with a gravity core. An abbreviated "fast" survey of the N-line was begun at N140 at 03 hr, and concluding at N1500 at 13 hr (casts 159-165). Although there were sunny periods during the morning, the general tendency of the weather was to stronger winds (up to 25 knots) and more cloud, and so the planned overflight was cancelled once the plane had reached Caernarfon. A "slow" station was commenced at S300 at 16 hr, with SVTs and CTD casts (166-172) for a variety of purposes, including a Go-flo cast for geochemistry.

SUNDAY MAY 28 (DAY 148). CTD casts continued at S300, including water for respiration measurement, and ending with an optical station at 10 hr (casts 173-181). The P/S came on watch at 0400 to find the lab. decorated with balloons for his birthday. The S200 toroid was recovered by the crew, Bill Miller supervising, and all instruments safely removed before the mooring itself was returned to its original position. An optical station was worked here (cast 182). At 14 hr, just as the ship was about to proceed to S700, Phil Taylor telephoned from RVS to notify an Argos alert. Beacon 24574 had been reported at 56°55'N, 9°06'W. Darwin proceeded to this position in good weather, and directly detected the beacon's transmissions to find it at 56°58', 09°03'W at 17 hr. Thus the subsurface buoy, 1 current meter and 1 thermistor chain/logger from the N200 U-mooring were recovered.

Darwin then returned to S700 to start the "slow" station at 22 hr. Settling Velocity Tubes were filled, and water taken for geochemistry and standard purposes.

Early in the morning the sky had been relatively clear of cloud. By 09 hr, however, when the NERC aircraft telephoned from Caernarfon, cloud cover had increased to 5/8 and it seemed likely to increase further. The overflight was therefore cancelled, and the aircraft returned to Coventry. In the afternoon there was a long period of sunshine; however, small, transitory clouds and humid haze probably rendered conditions unsuitable for remote sensing. Nevertheless, a flight might have been asked for had the aircraft been at Londonderry. This conclusion emphasises the need for flights to be able to occur at relatively short (i.e. 1-2 hrs) notice: probably impossible in the SES region because of lack of a suitable airport with overnight hanger facilities for the aircraft.

MONDAY MAY 29 (JULIAN DAY 149). Continued "slow" station at S700 until 04 hr (casts 183-188).An abbreviated "fast" survey of the S-line was then carried out, starting at S1000 and concluding at S140 (including optical measurements) at 11 hr (casts 189-193); the resulting contour plots, which included some data from the "slow" stations at S700 and S300, showed a midwinter maximum of turbidity, and minimum of oxygen, at S700. During the return passage to Fairlie, CTD stations were worked at S130 (8°30'W) and Islay D and C (casts 194-196). After Islay C, at 21 hr the thermosalinograph was turned off and the echo-sounding 'fish' brought inboard.

At dawn the sky was largely clear, although it began to cloud over soon afterwards. However, in the expectation of variable weather, Air Atlantic was contacted at Coventry airport at 8 hr to request continuation of the day's flight beyond Caernarfon. At 0930 the aircraft contacted 'Charles Darwin' on VHF radio, reporting its approach from the south-east over largely continuous and multi-layered cloud. With no prospect of a suitable break in the cloud, this final mission was terminated at 0945, and the aircraft returned to Coventry.

Following the CTD cast at S130, a scientific de-briefing meeting was held in the Chief Scientist's cabin. The cruise had been fortunate in coinciding with the Spring Phytoplankton Bloom and its decline, as shown by measurements of fluorescence, extracted chlorophyll and surface-layer nutrients. At some stations (mostly on or near the shelf, according to first impressions), phytoplankton dominated by diatoms (especially *Chaetoceros* and *Rhizosolenia*) has been succeeded by one dominated by small flagellates and dinoflagellates (such as *Prorocentrum*). The cruise had, perhaps, even more luckily, seen features that suggested the sinking of surface-layer phytoplankton to depths of 100-200 m, and the sudden appearance of the remains of phytoplankton in near-bed water at, especially, N1500, where cores showed increased benthic oxygen demand. Two major questions were raised. Why had the bloom developed a higher biomass at the shelf edge that in oceanic waters? And how had phytoplankton reached the sea-bed so rapidly once the bloom had ended?

The bedwards transport was discussed at some length. No evidence of sinking phytoplankton had been found at depths between 200 and the near-bed at stations such as N1500. The turbid regions found in midwater on the upper slope were low in fluorescence and contained few obvious phytoplankton remains. With the support of the evidence of mesozoooplankton caught by the drifting traps, the maximum of ammonium at about 100 m depth, and the lack of respiration in the size fraction < 2 µm, it was hypothesised that zooplankton were the primary agents of the downwards transport, through some combination of vertical migration and defecation.

It was agreed that a most interesting data set had been collected, and that it would be desirable to have a follow-up meeting in about three months, after completion of processing of samples taken during the cruise.

TUESDAY MAY 30 (JULIAN DAY 150): Clocks were returned to BST. Following the end-of-cruise party, some of the scientists remained on deck overnight, reporting phosphorescence in the water once the ship had entered the Firth of Clyde. "Charles Darwin" docked at Fairlie soon after 08 hr. Demobilisation was completed by 16 hr.

Technical Reports

Moorings (A.Harrison, leg A)

At the 10 sites on the two sections visited during the cruise, mooring operations took place at all except site S1500 where the BP recorder could not be found. A total of 7 mooring recoveries were made, of which 2 were damaged by trawling, with 17 deployments/ redeployments and 3 moorings lost without trace.

The mooring team comprised staff from RVS, DML and POL, providing specialists for each type of mooring and instrumentation, except for the Met. Buoy which was returned to Fairlie for servicing. The emphasis of the work was on preparation of new equipment rather than turning round recovered items, allowing longer lead-in time to each mooring deployment. Future cruises will not, however, have this benefit. The use of 2 winches was a big improvements over cruise CD91 when there was only one, allowing two moorings to be prepared independently thus saving time and sharing the work load of the team.

The weather was good throughout CD93A cruise period with only half a day when mooring work could not take place, otherwise there was no restriction to deck work.

Planning for Challenger cruises and the mooring strategy will need to address these points when the emphasis will be on re-cycling moorings and instruments, and searching for missing/damaged moorings expected from the heavy trawling activity in the area. The use of marker buoys and ARGOS beacons suggest that this risk can be reduced for surface moorings, but sub-surface moorings are more vulnerable.

DML moored instruments and water-column measurements (I Ezzi, leg A).

Two W.S.Ocean NAS2 nitrate analysers (deployed on CD92, 17/4/95) were recovered from S200 (surface and 192m). Instruments were deployed at S200 (surface and 192m), S700 (surface and 209m) and S140 (142m only). One instrument malfunctioned and was not deployed (S140 surface). Preliminary analysis of data from the two recoveries shows a continuing problemsof variability of the on board standard and in cadmium column performance. These problems were also evident during bench testing and calibration of instruments to be deployed.

One Chelsea Instruments Aquatracka logging fluorometer was recovered from S200 (surface) and calibrated using a *Skeletonema* culture from CCAP before and after cleaning of window. Four other instruments were calibrated and deployed at S200 (surface and 51m), S700 (surface and 40m) and S140 (surface).

At almost all CTD stations, water from 5m, 30m and 60m was filtered, and filters frozen for chlorophyll determination at DML, to provide for calibration of the CTD fluorometer. The non-toxic sea water supply was sampled at each CTD station for chlorophyll determination for calibration of deck tank fluorometer.

At stations N1500, S150 and S300 water from a range of was filtered and frozen for subsequent analysis for DON at DML by Fa Chen (POL)

Particulates and Sediment Traps (F. Perez-Castillo, leg A)

The partial (and perhaps damaged) sediment trap mooring laid at N1500 by CD91 was sucessfully recovered on 13 May, with 1 trap, current-meter/transmissometer and acoustic release. The mooring was redeployed later the same day, with two Parflux mark 7G-21 sediment traps at 1000m and 1400m (100m above sea-bed), and an RCM+Transmissometer.

The traps have a turret containing 22 bottles. Each bottle was marked by engraving as: XIII A No. bottle (1000m trap) and XIII B No. bottle (1400m trap). The bottles were then washed with Decon-90 detergent and rinsed with distilled water. On May 10, three days before deployment, a preservative was prepared from GF/C filtered deep seawater from 700m at N700, 5% formaldehyde, NaCl and Borax. Bottles were filled with the preservative and fitted in each trap. Finally, traps were programed for 22 events at seven day intervals starting on May 14, at mid day and ending on October 8, 1995.

In order to calibrate the CTD-Transmissometer, 2 l water samples were taken from several CTD casts, and filtered through GF/C fiber-glass pre-weighted filters. Filters were rinsed with 50 ml of distilled water, frozen and returned to UWB forgravimetric analysis of SPM. Transmissometer air and and blanked voltages were regularly noted.

Seawater samples were taken at several depths from CTD Casts at S140, S300, S700 and N1500. 500 ml were filtered through pre-combusted GF/F filters. The filters were frozen and brought back to DML for analysis of particulate organic carbon and nitrogen.

RVS Computing (P.Duncan, leg A)

During this cruise navigational, CTD, and surface variables were logged with varying degrees of success. The Ship's ADCP, normally logged direct to the Level C was not logged during leg A due to the failure of an RS-232 buffer box. The logged packages were:

GPS_4000, a new Trimble GPS receiver with differential capability which was used in conjunction with the Racal *Skyfix* differential correction service. Differential GPS results in position fixes accurate to 7-10 metres. *Skyfix* was used between 10:26 GMT on 8th May (Julian day 128) and 11:00 GMT on 15th May (Julian day 135). The receiver also had a Rubidium time standard connected, allowing it to give position fixes when only two satellites are available - normally at least three satellites are required.

DECMK53G, the Decca Mk53G navigation receiver was mounted on the bridge and normally operated in GPS mode, giving positions accurate to within 100m.

LOG_CHF, the Chernikeeff log with fore/aft and port/starboard ship's speed through the water.

GPS_TRIM, a Trimble 4000AX GPS Surveyor receiver, approximately five years old, with no differential capability.

RVS_CTDR. This version of the Level A CTD software sent unfiltered data to the Level B, and suffered from problems of serial data overrun. As a result, some bottle data from the first twenty CTD casts has missing samples. After this the RVS_CTDF software was used.

RVS_CTDF, filtered the data, and sent it to the Level B at one second intervals.

EA500D1. The Simrad EA500 echo sounder gave the depth of water underneath either the Ship's hull or the PES Fish. This software occasionally sent two records with the same time stamp, upsetting the *prodep* software used to correct depth for Carter area.

BIN_GYRO. This Level A was connected to the Ship's gyro compass and gave the true heading. The data was combined with the data from the Chernikeeff log to give relative motion, which was in turn fed to the *bestnav* program for linking with GPS.

SURFLOG1, a PC based Level A giving thermosalinograph, fluorometer, transmissometer and light records, but providing data of suspect status for the fluorometer, transmissometer and light sensors during leg A.

MX1107. The Magnavox MX-1107 satellite navigation receiver received fixes much less frequently than GPS, typically once every four hours. Between fixes the receiver used log and gyro inputs for dead reckoning, and was only on board as a backup system in case the three GPS receivers failed.

BOTTLES. The Level A took data from the bottle firing system, typically giving a one or zero value when a bottle was fired. The associated time stamp was used during the generation of bottle data.

The level B disk drive had been replaced during the handover period for this cruise, and the level B software was re-installed. It was then discovered that the Level B would not send data to the Level C over the Ethernet, despite being able to use *telnet*, *ftp* and *ping* successfully. Eventually it was decided to use a serial link. This worked but the link sometimes failed, causing a backlog which took a long time to recover. On the 10th May the link speed was uprated from 9600 to 19200, reducing the time any backlog took to transfer. The Level C system worked well. All CTD casts were recorded in real units. Plots and bottle data were output for each CTD cast, and some contour plots were produced for temperature, salinity, fluorescence, transmission and oxygen.

CTD oxygen sensor (H.Wilson, legs A & B)

The objective was to calibrate the Beckman Polarographic Oxygen Sensor mounted on the CTD and coupled to a SeaBird pump, using dissolved oxygen (DO) determined by microWinkler titration of water-bottle samples..

The first CTD cast with the sensor and pump both operating was 008. The downcast profile showed two unexpected high spikes in the top 100m, but the upcast appeared normal. Oxygen current was observed whilst the CTD was held just below the surface. It showed no great or rapid changes, confirming that the sensor was performing stably. On the next cast, the CTD was sent to 100m then brought up near to the surface and sent down again. On this second downcast (010), the spikes were no longer present, and the profile looked as expected. It appears that air became trapped when the sensor inlet pipe penetrated the water. The air was pushed through by pressure causing a rapid and high oxygen current change. Once this had taken place, the readings became normal and stable. It was decided only to consider the upcast data for calibration of the sensor.

The first water samples for DO were taken on the 11th May, on cast 026, followed by samples from five other casts, giving a good range of oxygen values. These were matched with the corresponding measurements of oxygen concentration calculated from the sensor data. There was a fair correlation between the values of oxygen obtained by micro-Winkler titration and calculated sensor values ($n=31$, $r^2=0.87$). Some of the values from the sensor seemed high, suggesting the error was not due to the titration method, and need further investigation.

The sampling strategy initiated during CD93A was continued during leg B, namely trying to obtain as wide a range as possible of values of dissolved oxygen. Discrete samples were taken over the whole profile at five stations. Replicate samples were also taken at several depths at other stations to estimate the error of the micro-Winkler titrations.

The leg B results showed an improved correlation between the oxygen values calculated from the sensor and those measured by micro-Winkler titration ($r^2=0.99$, $df=26$), with a residual standard deviation of 0.203 μM. This should allow results from the oxygen sensor to be used with some confidence.

Bio-optical measurements (S. Kratzer, J Morrison, leg A)

Some or all of the following four optical instruments were deployed at optical stations. The first two fulfil SeaWiFS requirements.

(1) Biospherical Instruments PRR-600 submarine reflectance radiometer and PRR-610 surface reference sensor, measuring upwelling radiance at 412, 443, 490, 510, 555, 665 and 683 nm, downwelling irradiance at 412, 443, 490, 510, 555 and 665 nm and PAR, and depth, temperature, pitch and roll. On loan to UWB for evaluation purposes from Biospherical Instruments..

(2) Satlantic submarine reflectance radiometer, measuring depth and upwelling radiance and downwelling irradiance at the same wavelengths as the PRR-600 but without the 683 nm upwelling and PAR. There is no surface reference unit. The instrument is NERC owned, based at PML, and was purchased as part of the SeaWiFs Exploitation Initiative.

(3) Biospherical Instruments INF-300 submarine natural fluorometer and QSR-240 surface reference unit, measuring upwelling radiance at 683 nm (the peak wavlength of the solar-induced fluorescence of chlorophyll a in living phytoplankton), downwelling scalar PAR irradiance and reference surface scalar PAR irradiance. On loan to UWB from MAFF.

(4) UWB-SOS self-logging submarine 4-Colour Sensor, measuring either downwelling or upwelling irradiance (depending on orientation) at 440, 490, 570 and 670 nm. The instrument's depth measuring capability was not working, probably because of software problems, during leg A.

The main problem in optical oceanography is avoidance of ship shadow. On station the ship was kept head to wind and the position of deployment, on the sunny side of the ship, was dependant on the position of the sun. Three possible sights for deployment were used, the hydro wire, located mid ships on the starboard side, and the two cranes at the sides of the aft deck. The aft deployments required partial or total manual lifting, which was particularly difficult with the relatively heavy Satlantic instrument.

At each optical station, the CTD-rosette was used to take water samples from the following optical depths: 0.2, 0.5, 0.8 1.3, 1.8, 2.3 and 2.8, which were estimated from an initial Secchi depth measurement. Chlorophyll a and phaeopigment concentrations were measured for all these optical depths, using GF/F filtration, extraction into 90% acetone measurement on board the ship with a Turner Fluorometer.

For optical depths 0.5 and 2.3, water was filtered for a range of measurements: (a) 2 l were filtered onto GF/F filters for the absorption spectra of the total particulate material, measured from 350-750 nm, using a Shimadzu 1201 spectrophotometer and then extracted in 90% acetone; (b) the extracts were scanned the next day by the same spectrophotometer, allowing the calculation of chlorophyll a, b and c, the phaeopigment and the total carotenoid concentrations; the chlorophyll a concentrations of the extracts were also measured by the Turner Fluorometer; (c) for the determination of SPM (suspended particulate matter) 2 l of sample were filtered through pre-weighed 47 mm GF/F filters, which were then rinsed with distilled water, dried, and returned to Menai Bridge for further weighing; (d) 0.5 l of sample was filtered onto 25 mm GF/F filters which were immediately frozen in liquid nitrogen, for subsequent HPLC abalysis of pigment composition at PML.

Yellow substances at o.d. 0.5 were measured by spectrophotometrically scanning sea water filtered through 0.2 µm membrane filter, using distilled water as a blank and a 10 cm pathlength. Water from the same depth was passed through 2 µm and 0.2 µm Nucleopore filters in order to measure the chlorophyll and phaeopigment concentrations of the >2 µm and 0.2-2 µM size fractions by acetone extraction and fluorometric measurement. Finally, subsamples from the same depth were preserved with acidified Lugol's Iodine or alkaline Formaldehyde, for subsequent microscopic analysis of phytoplankton species composition at UWB.

Seven optical stations were worked during leg A, and a further 7 during leg B.

UWB Drifter Deployment and Recovery (R.Wilton, leg B)

Two UWB drifters, equipped with Argos PTT, VHF beacon, 4 colour irradiance sensor, hull thermistor, 70m thermistor chain, sediment trap and data logger were deployed on two occasions during CD93B as outlined below. The DML sediment traps attached to the end of the thermistor chain required some buoyancy in the form of two 15kg floats to support them without sinking the drifters. The damping effect of the of this arrangement meant that the drifters were occasionally submersed under wave crests. However, this did not appear to have degraded the number or quality of fixes by the Argos satellite, with updates between 3-4 hours being typical. A pellet line attached to the lifting eye of the buoy aided recovery.

PTT No.	Release Details			Recovery Details		
	Date/Time	Lat N	Lon W	Date/Time	Lat N	Lon W
3798	22/05/95 16:51	56.254	9.337	24/05/95 19:12	56.442	9.737
3797	22/05/95 17:13	56.247	9.343	24/05/95 18:52	56.445	9.742
3797	25/05/95 11:46	56.518	9.044	26/05/95 17:32	56.570	8.945
3798	25/05/95 12:01	56.514	9.042	26/05/95 18:30	56.697	8.924

SPM measurements (S.Jones, S.Lowe, leg B)

The main objectives were: to analyse spm concentration by gravimetric filtration of water samples, primarily for transmissometer calibration; to determine particle size distribution using a Galai laser sizer ; and, to use settling velocity tubes to estimate particle sinking rates. Some samples were also taken from water and "fluff" overlying Multicorer samples.

During both fast and slow CTD surveys, water samples were taken from as many casts as possible. In general, samples were taken from surface and near-bed Niskin bottles and at depths corresponding to maximum transmittance. Samples were filtered immediately on arrival at the surface through Whatman GF/C filters, rinsed with distilled water, air dried and then frozen. As much as 9 l was filtered in the case of maximum transmittance and between 4 and 6 l for surface samples. Frozen samples were returned to UWB for gravimetric analysis for SPM.

Voltages output from the 25 cm transmissometer on the CTD were corrected using the following equation:

$$V = (A / B).(X - Z)$$

where V = corrected output voltage.

A = Air calibration value = 4.82 volts (3-7-89).

B = Present air calibration value = 4.79 volts.

X = Raw data value.

Z = Zero offset with ligth path blocked = 0.002 volts.

The corrected voltages were converted to beam attenuance coefficients, c, using :

$$c = - 4 \ln(20.V)$$

where T = T(z)/100. A transmissometer calibration will be obtained by regressing beam attenuance on SPM concentration.

Particle size distributions (2 - 600 μm) were measured with a Galai CIS100 laser sizer which detects the time of intersection of a moving laser beam with a suspended particle. Samples, generally from surface and near bed, were taken immediately from the CTD. The laser unit also houses a video microscope camera to both directly monitor particles and capture images for 2-D shape analysis. After some initial difficulties, images of selected samples were video-recorded for subsequent particle shape determinations.

To determine particulate sinking rates, settling velocity tubes were used to sample water at 5 m depth at each of the slow stations. The apparatus allows capture of a virtually undisturbed parcel of water, and was used in fours. After sampling, the tubes were placed upright on deck and enclosed in water-jackets fed with surface seawater. One pair was sampled for total SPM (determined gravimetrically on 0.4 μm Cyclopore filters), the third tube was sampled for particulate organic carbon (POC) (and nitrogen), and the fourth for chlorophyll (and pheopigments). The procedure involved drawing subsamples at times of 2, 8, 20, 40, 80, 160, 360, 450, 600 minutes after erection. Problems were encountered as the membrane filters used for SPM clogged rapidly due to the phytoplankton present. As a result, settling velocity determinations restricted to chlorophyll and POC at most stations. Chlorophyll was analysed fluorometrically on board ship, whereas POC (and SPM) samples were returned to shore laboratories for analysis.

At the beginning of the fast CTD survey, SPM was dominated by the surface phytoplankton bloom. Video images identified diatoms (*Chaetoceros* and *Rhizoselenia*) and small flagellates. Particles were generally individual specimens with the occasional aggregate comprising linked, clumped diatom chains. Transmission readings indicated that the highest SPM concentrations were present in the upper 100 m of the water column. SPM decreased in this layer during the leg. Strongly-attenuating near-bed layers were observed in deeper waters later in the leg. Video images showed that particles were made up of aggregated surface phytoplankton species, benthic diatoms and what appeared to be small inorganic flocculated particles. Some mystery surrounds the formation of these deep layers, as mid-water SPM concentrations remained very low and particle size very small.

Preliminary analysis of chlorophyll data indicates that settling rates in the near surface were low (c. 85% less than 0.2m/day, 97% less than 10m/day, 99% less than 100m/day). Over several days, settling at these rates may be capable of producing the localised 'plumes' of high fluorescence observed extending down to 150m during the fast CTD survey. However, the fact that aggregation and rapid settling of chlorophyll-rich material were not directly observed between this depth and the near-bed nepheloid layer suggests that an additional process was occuring. Significant numbers of grazing zooplankton (copepods) were observed on filters from samples throughout the water column, and in drifting sediment traps at 80m. It is possible that these migrating organisms could be responsible for clearing upper ocean layers of spm by feeding on surface phytoplankton and defecating deeper in the water column.

One Multicorer sample was analysed during the cruise. This involved siphoning off the supra-surface 'fluff' layer and the water retained above the core. The particle size distribution was bimodal, ranging from 5-500um, and might have comprised an unaltered 'surface' sub-population and a sub-population characteristic of aggregation products.

During the cruise the performance of the laser sizer was assessed by running replicate samples. These tests suggested that the sizer performed consistantly, with good agreement between repleciates, but perhaps some flocculation occuring whilst samples wait for analysis.

Some filters processed in the wet lab were contaminated by fibrous fluff, usually blue (but sometimes purple). This has not been observed during identical processing on RRS Challenger. It is a particular problem for spm determination, which requires accurate measurement of dry weight of filters.

Nutrients (B.Grantham, leg B)

Nutrient analysis during leg A was aimed at providing calibrations for the moored NAS2 nitrate analysers. Calibrations were taken from CTD profiles at the time of deployment and from samples of the on-board standards carried by the analysers. A full transect of the N line was also acheived during leg A. Most analyses were carried out during leg B, when concentrations of ammonium, phosphate, silicate and nitrate+nitrite were measured in water samples taken at representative depths (including near-bed) throughout the water column from most CTD casts.

Nutrient concentrations were also measured during leg B in water overlying sediment cores taken with the Multicorer, and in Geochemical water samples (to relate to metal concentrations and to provide further information on the depth of sampling when bottle misfires were suspected). During both legs, silicate was measured in sediment trap water samples (the preservatives used in the traps interefered with other nutrient analyses).

The Autoanalyser, a Lachat Quikchem 8000 flow-injection analyser performed well and >1200 samples were analysed. The only serious problem arose early in leg B when the ammonium channel began giving sharp double-spiked peaks for samples exceeding 35 psu. This effect was not apparent with less saline samples or the standards made up in distilled water. Evidently the buffering effect of the EDTA reagent was insufficient at high salinities to prevent the formation of calcium and magnesium hydroxide precipitates which were causing the spiking. The problem was overcome by increasing the concentration of the EDTA buffer.

Geochemistry (J.Foster, A.-C. Le Gall, leg B)

Edinburgh aims were to investigate the magnitude of chemical scavenging using natural radioisotopes of ^{210}Pb and ^{210}Po, and to determine spatial and temporal characteristics of particle removal processes. In the case of the radio-isotopes, 20 litre water samples at 6 depths, plus a non-toxic sample, were collected from S140, S200, S300,S700, R1000, N1500. The water was filtered for particulate (>0.45µm) and dissolved (<0.45µm) material, subsequent analysis to be carried out in Edinburgh. Water samples were also collected, using Go-Flo bottles at up to 6 dephs at S140, N140, R300, R1000, N1500. About 3 litres of water were filtered, the filter papers being destined for thin-film XRF analysis of major elements.

Southampton objectives were: to collect water and particulate samples from the water column above the shelf hedge for metal analysis; and to measure Aluminium concentrations in the water column. Water was collected at up to 6 depths from S140, N140, R300, R1000, 56.449°N 9.739°W, S200, N1500, S300 and S700 using Go-Flo bottles on the CTD rosette. At most stations, the content of each Go-Flo was filtered through 0.4 µm Nucleopore filters; .some of the filtered water was saved for laboratory analysis of dissolved trace metals, and the filter was saved for the analysis of particulate trace metals. Filtered and unfiltered water were also fluorometrically analysed on board for dissolved and total aluminium.

Previous use had shown lack of reliability in the closing mechanisms of the GoFlo bottles. A salinity samples was therefore drawn from each Go-Flo and compared with CTD salinity at the same nominal depth. Go-flo samples were discarded when their salinity differed significantly from that of the CTD. After cast 122, it was apparent that there was also a contamination problem, and the top and bottom valves of each Go-Flo were cleaned. Samples of cast 139 taken only for aluminium suggested that the contamination had disappeared.

Microplankton respiration (H.Wilson, leg B)

Respiration work concentrated on the slow stations, at S140, S300 and N1500. At S140, samples were taken from the surface mixed layer, from mid-depths and bottom water as a trial run. At N1500, samples were taken from the surface layer and from a bottom sample, and water from 80m was taken at V1000. Samples from S300 were taken from 15m in the surface mixed layer. Samples were incubated for 24 hours in darkness, at temperatures close to ambient, to estimate microplankton and (after filter-fractionation) bacterial respiration rates. Samples were also taken for further estimation of chlorophyll *a* concentration in the <200 µm and <2 µm fractions, and for enumeration of bacteria and protozoa.

Many of the changes in oxygen concentration were small or insignificant in both fractions. Early on in the cruise at S140, microplankton respiration rate was significant in surface waters, and bacterial respiration rate was high at a depth of 80m. Towards the end of the cruise at S300, there was significant oxygen uptake by both microplankton and bacteria at 15m. Measurements at V1000 showed no significant uptake of oxygen in the bottom mixed layer. At N1500 measurements were made at 5 and 1480 m. The <200μm fraction was respiring at a rate of 0.055 μM hr^{-1}; the small (<2 μm) fraction showed no significant oxygen uptake in the case of samples from either 5 or 1480 m. This was surprising as there seemed to be an accumulation of chlorophyll and pheopigments in this deep part of the water column.

Primary production (L.Gilpin, leg B)

The object of this work was to determine the species composition, size distribution and photosynthetic characteristics of the phytoplankton in the SES region during the cruise. Stations were sampled to provide examples of shelf, shelf break and oceanic regions:

Cast	Stn	P:I	S.I.S.	Size Fractionated Chl	Phytoplankton
63	S140	5m		5,15,30,60,100, 132m	5,15,30,60,100, 132m
76	S140	5m		5m	5m
78	S140	20m		1,6,11,20,30,60m	1,6,11,20,30,60m
90	N1500	5m		5m	5m
91	P1500			5m	5m
92	P1300	5m		5m	5m
100	P140	5m		5m	5m
103	R200	5m		5m	5m
105	R500	5m		5m	5m
108	R1000			5m	5m
114	S1000	5m		5m	5m
117	S500			5m	5m
118	S300	5m		5m	5m
121	S140	5m		5m	5m
134	N2000	7m x4	yes	1,7,12,18,22,29,33,38,42,50m	1,7,18,29,50m
143	S200		yes	1,4,7,11,12,17,20,23,25,30m	1,11,20,30m
147	S200	14m		14m	14m
153	N1500	5m		5m	5m
160	N150	4m x3	yes	2.5,4,7,11,13,17,20,23,25,30m	2.5,4,11,20,30m

The photosynthetic characteristics of the planktonic assemblages were determined for 20 samples from a photosynthesis versus irradiance (P:I) curve produced following sample inoculation with ^{14}C sodium bicarbonate and incubation in a range of irradiances (1.5 - 1500 μE m^{-2} s^{-1}) using a photosynthetron. Following the incubation, any remaining inorganic ^{14}C was displaced by acidification and the incorporation of ^{14}C in the particulate component was measured onboard with a LKB Scintillation Counter.

Primary production in the euphotic zone was determined in three 24-hr incubations under simulated *in situ* (SIS) conditions. Water samples were collected from a pre-dawn CTD cast at 10 depths selected to represent 97, 55, 32.6, 19.9, 13.8, 6.9, 4.6, 3, 2.1 and 1% surface incident irradiance. Samples were treated in accordance with JGOFS Level 1 protocols, and triplicate 60ml samples, and one dark bottle, from each depth were inoculated with ^{14}C bicarbonate and placed in an on-deck incubator used to simulate *in situ* light level and approximate spectral quality at each depth. Following incubation, samples were fractionated using 18, 2 and 0.25 μm polycarbonate membrane filters and the particulate incorporation of labelled bicarbonate was measured by scintillatiom.

Size-fractionated chlorophyll was determined by acetone extraction of 18, 2, and 0.25 µm filters, followed by fluometric measurement, at 19 stations including all those where P:I or on-deck incubations were carried out. Duplicate plankton samples from each station were preserved in 50ml amber bottles using Lugol's iodine and Glutaraldehyde solutions.

The GP container provided ample working space, but leaked. Two on-deck incubators were plumbed into the non-toxic supply which also fed two container labs and the transmissometer tank. With only one non-toxic supply to the aft deck area this required much ancillary plumbing. During the fast CTD survey sampling at several stations was missed when these were occupied during darkness; requirements for sampling for diel processes should be carefully considered during cruise planning.

Benthic coring (M.Harvey, L.Mitchell, leg B)

Cores were obtained from three stations. Prior to the third (N1500) the corer head became inexplicably detached from the frame and fell to the deck, damaging to the firing mechanism. A a result, four deployments of the corer were necessary to obtain a sufficient number of cores. At the first two stations visited (S700 and R1000) the multicoring was preceded by a CTD cast to obtain 120 litres of water from within 10 metres of the sea bed, to be used for core incubations. The constant temperature room was used for these incubations so that in situ temperatures could be maintained. The multicorer was deployed three times.
Two cores from each deployment were taken for measurement of sediment oxygen uptake rate and nutrient fluxes. Oxygen uptake rates showed a 2.5x increase at the deepest station for which data are available (N1500) compared with values obtained on CD92A in early April.

One core from each deployment was sectioned into 5cm depth horizons and subcores taken from these to determine the sediment sulphate reduction rate and porosity. One core was taken, sectioned similarly, and the sediment in each horizon was centrifuged and the resultant pore water filtered and frozen for subsequent determination of its sulphate content. One core from each deployment was saved for subsequent carbon isotope analysis, one core for ^{210}Pb, and one core for meiofauna characterization. One core was saved for determination of trace organics at Liverpool University.

The Sholkovitz gravity corer was deployed at R1000 but failed to penetrate the sediment. The RVS gravity corer was therefore used instead, and proved highly successful. The cores obtained from it were in excess of one metre in length and will be used for measurement of ^{210}Pb.

BODC data logging (J.Loncar, leg A; J.Hughes, leg B)

The following tables summarise sampling events recorded by BODC.

<u>Leg A</u>
CD93AMR.XLS : Moorings - deployments, recoveries, losses.
CD93ACTD.XLS : All CTD casts.

<u>Leg B</u>
CD93BMR.XLS : Moorings - deployments, recoveries.
CD93BCTD.XLS : All CTD casts.
CD93FAST.XLS : CTD casts during main "Fast" survey of 18 - 21 May.
CD93SLOW.XLS : All events at "Slow" stations.
CD93BCOR.XLS : All coring events, succesful or not.
CD93BDRF.XLS : UWB and DML/Soton drifter experiments.

Cruise CD93 Leg A Moorings									
TBEGNS	SITE	LAT	LAT	LAT	LON	LON	LON	WDEPTH	TYPE
DEPLOYMENTS									
8/5/95 8:42	S140	56	27.63	56.46	8	57.91	-8.97	150	RDI ADCP and PRESSURE RECORDER
8/5/95 12:20	S300	56	27.28	56.45	9	3.91	-9.07	300.5	TOROID BUOY
9/5/95 9:31	S140	56	28	56.47	8	57.55	-8.96	148.5	'U' SHAPE CURRENT METER MOORING
9/5/95 16:21	S300	56	27.49	56.46	9	3.78	-9.06	262	SUBSURFACE CURRENT METER MOORING
9/5/95 20:10	S140	56	27.88	56.46	8	58.54	-8.98	151	WAVERIDER
10/5/95 13:48	S200	56	27.3	56.46	9	2.8	-9.05	203	'U' SHAPE CURRENT METER MOORING
10/5/95 16:39	S200	56	26.86	56.45	9	2.88	-9.05	196	TOROID BUOY
10/5/95 20:24	S700	56	27.2	56.45	9	9.45	-9.16	698	TOROID BUOY
11/5/95 13:22	S700	56	27.63	56.46	9	9.86	-9.16	711	SUBSURFACE CURRENT METER MOORING
12/5/95 18:26	N140	56	36.59	56.61	8	56.06	-8.93	139	'U' SHAPE CURRENT METER MOORING
13/5/95 11:35	N1500	56	42.56	56.71	9	24.45	-9.41	1486	BOTTOM PRESSURE RECORDER
13/5/95 16:48	N1500	56	43.1	56.72	9	24.5	-9.41	1496.5	SEDIMENT TRAP MOORING
13/5/95 21:12	N200	56	37.69	56.63	8	59.74	-9	200	'U' SHAPE CURRENT METER MOORING
14/5/95 11:26	N140	56	36.52	56.61	8	56.35	-8.94	136	BOTTOM PRESSURE RECORDER
14/5/95 13:34	N300	56	37.59	56.63	9	1.15	-9.02	304	SUBSURFACE CURRENT METER MOORING
14/5/95 17:11	N700	56	38.96	56.65	9	6.51	-9.11	699	SPAR MARKING BUOY
14/5/95 19:45	S140	56	27.1	56.45	8	58.09	-8.97	150	SPAR MARKING BUOY
15/5/95 10:25	S140	56	27.98	56.47	8	57.71	-8.96	148	TOROID BUOY
RECOVERIES									
8/5/95 15:07	S140	56	28.7	56.48	8	57.87	-8.96	150	'U' SHAPE CURRENT METER MOORING
9/5/95 18:00	S200	56	27.24	56.45	9	3.21	-9.05	230	'U' SHAPE CURRENT METER MOORING
11/5/95 6:22	S700	56	29.49	56.49	9	10.84	-9.18	711	SUBSURFACE CURRENT METER MOORING
11/5/95 14:30	S140	56	27.49	56.46	8	58.23	-8.97	140	BOTTOM PRESSURE RECORDER
13/5/95 6:15	N1500	56	44.14	56.74	9	26.07	-9.43	1559	SEDIMENT TRAP MOORING
LOSSES									
27/3/95 13:50	N700	56	38.83	56.65	9	6.75	-9.11	702	SPAR MARKING BUOY
28/3/95 15:30	S300	56	27.3	56.46	9	4.63	-9.08	296	SUBSURFACE CURRENT METER MOORING
29/3/95 10:40	S700	56	27.73	56.46	9	9.68	-9.16	695	SUBSURFACE CURRENT METER MOORING
31/3/95 10:08	S1500	56	27.08	56.45	9	38.48	-9.64	1500	BOTTOM PRESSURE RECORDER
9/5/95 9:31	S140	56	28	56.47	8	57.55	-8.96	148.5	'U' SHAPE CURRENT METER MOORING

CD93A CTD Casts				
Cast	Start Date/Time	End Date/Time	Site	Comments
CTD1	7/5/95 18:55	7/5/95 19:18	Islay 'C'	118 m, not logged
CTD2	7/5/95 21:10	7/5/95 21:22	Islay 'D'	
CTD3	8/5/95 9:16	8/5/95 9:48	S140	transmissometer calibration
CTD4	8/5/95 12:39	8/5/95 13:10	S300	
CTD5	8/5/95 17:07	8/5/95 18:06	S300	transmissometer&RCM calibration
CTD6	9/5/95 1:12	9/5/95 2:11	S700	
CTD7	9/5/95 3:05	9/5/95 3:34	S500	
CTD8	9/5/95 4:22	9/5/95 4:43	S300	
CTD9	9/5/95 5:15	9/5/95 5:49	S200	DO sensor running
CTD10	9/5/95 6:38	9/5/95 7:07	S140	
CTD11	9/5/95 9:59	9/5/95 10:40	S140	transmissometer&RCM calibration
CTD12	9/5/95 13:00	9/5/95 13:46	S300	
CTD13	9/5/95 18:33	9/5/95 19:10	S200	
CTD14	9/5/95 21:20	9/5/95 21:42	S300	
CTD15	10/5/95 0:22	10/5/95 1:38	S1500	
CTD16	10/5/95 2:22	10/5/95 3:36	S1400	
CTD17	10/5/95 5:10	10/5/95 5:18	S1000	100 m cast to purge oxygen plumbing
CTD18	10/5/95 5:20	10/5/95 6:15	S1000	
CTD19	10/5/95 7:24	10/5/95 7:46	S200	
CTD20	10/5/95 10:12	10/5/95 10:49	S200	transmissometer calibration
CTD21	10/5/95 15:00	10/5/95 15:27	S200	
CTD22	10/5/95 16:56	10/5/95 17:19	S200	
CTD23	10/5/95 21:04	10/5/95 21:44	S700	no light meters
CTD24	11/5/95 0:25	11/5/95 1:34	S1300	
CTD25	11/5/95 2:27	11/5/95 3:46	S1150	
CTD26	11/5/95 4:54	11/5/95 5:46	S850	
CTD27	11/5/95 8:50	11/5/95 9:15	S700	transmissometer calibration
CTD28	11/5/95 10:18	11/5/95 11:14	S700	
CTD29	11/5/95 16:14	11/5/95 16:40	S140	
CTD30	11/5/95 17:34	11/5/95 17:55	S170	
CTD31	11/5/95 20:41	11/5/95 21:32	R1000	
CTD32	12/5/95 0:01	12/5/95 1:15	N1500	
CTD33	12/5/95 9:55	12/5/95 11:40	N1600	
CTD34	12/5/95 12:38	12/5/95 13:11	N1600	shallow PAR meter cast for OPTICS
CTD35	12/5/95 16:00	12/5/95 16:46	N140	RCM&transmissometer calibration
CTD36	12/5/95 19:30	12/5/95 19:45	N140	
CTD37	12/5/95 20:44	12/5/95 20:55	N170	
CTD38	12/5/95 21:35	12/5/95 21:50	N200	
CTD39	12/5/95 22:29	12/5/95 22:53	N300	
CTD40	12/5/95 23:31	13/5/95 0:08	N500	
CTD41	13/5/95 0:59	13/5/95 1:44	N700	
CTD42	13/5/95 2:33	13/5/95 3:20	N800	
CTD43	13/5/95 4:00	13/5/95 4:57	N1000	
CTD44	13/5/95 9:51	13/5/95 11:11	N1500	1500-200 m bottles
CTD45	13/5/95 12:15	13/5/95 12:30	N1500	100-surface bottles
CTD46	13/5/95 19:27	13/5/95 19:54	N200	RCM&transmissometer calibration
CTD47	13/5/95 21:49	13/5/95 22:10	N200	
CTD48	14/5/95 0:22	14/5/95 1:35	N1400	
CTD49	14/5/95 2:31	14/5/95 3:31	N1300	
CTD50	14/5/95 4:29	14/5/95 5:20	N1150	
CTD51	14/5/95 6:32	14/5/95 7:03	N500	
CTD52	14/5/95 7:46	14/5/95 8:03	N300	
CTD53	14/5/95 9:05		N300	RCM&transmissometer calibration
CTD54	14/5/95 13:48	14/5/95 14:28	N300	
CTD55	15/5/95 4:26	15/5/95 4:55	S300	
CTD56	15/5/95 5:54	15/5/95 6:17	S140	transmissometer calibration
CTD57	15/5/95 11:18	15/5/95 11:35	S140	
CTD58	15/5/95 18:33	15/5/95 18:43	Islay 'D'	
CTD59	15/5/95 20:15	15/5/95 20:30	Islay 'C'	

CD93B Moorings					
Stn	Buoy Description	Event type	Date & Time	Lat N	Lon W
S140	POL Met Buoy	Deployment	17/05/95 14:08	56.455	8.972
S200	Toroid (with ARGOS beacon 22184,	Recovery	28/05/05 11:22	56.447	9.049
	thermistor,transmissometer,				
	fluorometer,colour sensor &				
	nitrate analyer)				
S200	Toroid (with ARGOS beacon 22184)	Deployment	28/05/95 14:11	56.448	9.047
N200	Sub-surface sphere (with ARGOS	Recovery	28/05/95 17:44	56.968	9.051
	beacon 24574)				

CD93B CTD casts							
Cruise	Cast	Start date&time	End date&time	Stn	Lat N	Lon W	Comments
CD93B	CTD60	17/05/95 03:27	17/05/95 03:42	Islay C	55.588	6.676	
CD93B	CTD61	17/05/95 05:15	17/05/95 05:25	Islay D	55.756	6.998	
CD93B	CTD62	17/05/95 11:30	17/05/95 11:44	S130	55.285	8.502	
CD93B	CTD63	17/05/95 14:36	17/05/95 14:51	S140	56.469	8.963	
CD93B	CTD64	17/05/95 15:41	17/05/95 15:53	S140	56.470	8.955	
CD93B	CTD65	17/05/95 16:41		S140	56.468	8.953	
CD93B	CTD66	17/05/95 19:04	17/05/95 19:25	S140	56.462	8.959	Geochemistry
CD93B	CTD67	17/05/95 21:01	17/05/95 21:16	S140	56.461	8.958	Geochemistry
CD93B	CTD68	17/05/95 22:55	17/05/95 23:14	S140	56.462	8.963	Go-flo
CD93B	CTD69	18/05/95 00:37	18/05/95 00:50	S140	56.463	8.957	
CD93B	CTD70	18/05/95 02:58	18/05/95 03:13	S140	56.462	8.959	
CD93B	CTD71	18/05/95 04:39	18/05/95 04:48	S140	56.465	8.958	
CD93B	CTD72	18/05/95 04:50	18/05/95 05:02	S140	56.465	8.958	
CD93B	CTD73	18/05/95 06:46	18/05/95 06:55	S140	56.463	8.954	
CD93B	CTD74	18/05/95 06:56	18/05/95 07:04	S140	56.462	8.953	
CD93B	CTD75	18/05/95 07:06	18/05/95 07:16	S140	56.462	8.952	
CD93B	CTD76	18/05/95 09:15	18/05/95 09:27	S140	56.463	8.955	
CD93B	CTD77	18/05/95 10:20	18/05/95 10:30	S140	56.458	8.959	
CD93B	CTD78	18/05/95 11:10	18/05/95 11:26	S140	56.459	8.968	
CD93B	CTD79	18/05/95 14:40	18/05/95 14:48	S700	56.462	9.163	Aborted at 30m (buoy!)
CD93B	CTD80	18/05/95 15:18	18/05/95 15:58	S700	56.476	9.166	
CD93B	CTD81	18/05/95 23:48	19/05/95 00:10	N140	56.604	8.941	Go-flo/Geochemistry
CD93B	CTD82	19/05/95 01:05	19/05/95 01:25	N150	56.618	8.992	
CD93B	CTD83	19/05/95 02:00	19/05/95 02:23	N200	56.619	9.011	
CD93B	CTD84	19/05/95 02:55	19/05/95 03:29	N300	56.629	9.028	
CD93B	CTD85	19/05/95 04:21	19/05/95 04:52	N500	56.632	9.073	
CD93B	CTD86	19/05/95 05:36	19/05/95 06:15	N700	56.645	9.113	
CD93B	CTD87	19/05/95 07:00	19/05/95 07:45	N850	56.656	9.151	
CD93B	CTD88	19/05/95 08:32	19/05/95 09:30	N1000	56.676	9.197	
CD93B	CTD89	19/05/95 10:25	19/05/95 11:29	N1300	56.699	9.328	
CD93B	CTD90	19/05/95 12:13	19/05/95 13:24	N1500	56.735	9.406	
CD93B	CTD91	19/05/95 14:45	19/05/95 16:00	P1500	56.651	9.615	
CD93B	CTD92	19/05/95 17:53	19/05/95 19:00	P1300	56.631	9.463	
CD93B	CTD93	19/05/95 20:11	19/05/95 21:07	P1000	56.604	9.285	
CD93B	CTD94	19/05/95 22:18	19/05/95 23:06	P850	56.598	9.226	
CD93B	CTD95	20/05/95 01:13	20/05/95 01:58	P700	56.590	9.183	
CD93B	CTD96	20/05/95 02:49	20/05/95 03:24	P500	56.578	9.114	
CD93B	CTD97	20/05/95 04:12	20/05/95 04:32	P300	56.568	9.052	
CD93B	CTD98	20/05/95 05:21	20/05/95 05:37	P200	56.566	9.031	
CD93B	CTD99	20/05/95 06:21	20/05/95 06:36	P150	56.563	9.003	
CD93B	CTD100	20/05/95 07:27	20/05/95 07:42	P140	56.551	8.935	
CD93B	CTD101	20/05/95 08:28	20/05/95 08:47	R140	56.500	8.931	
CD93B	CTD102	20/05/95 09:51	20/05/95 10:05	R150	56.503	8.991	
CD93B	CTD103	20/05/95 11:05	20/05/95 11:25	R200	56.506	9.038	
CD93B	CTD104	20/05/95 12:59	20/05/95 13:30	R300	56.505	9.060	Go-flo/Geochemistry
CD93B	CTD105	20/05/95 14:37	20/05/95 15:12	R500	56.507	9.106	
CD93B	CTD106	20/05/95 15:55	20/05/95 16:35	R700	56.515	9.172	
CD93B	CTD107	20/05/95 17:11	20/05/95 17:51	R850	56.514	9.231	
CD93B	CTD108	20/05/95 18:37	20/05/95 19:30	R1000	56.515	9.297	
CD93B	CTD109	20/05/95 20:50	20/05/95 21:55	R1300	56.530	9.488	
CD93B	CTD110	20/05/95 23:02	21/05/95 00:19	R1500	56.537	9.677	
CD93B	CTD111	21/05/95 01:35	21/05/95 02:47	S1500	56.460	9.636	
CD93B	CTD112	21/05/95 03:43	21/05/95 04:42	S1300	56.463	9.504	
CD93B	CTD113	21/05/95 05:27	21/05/95 06:22	S1150	56.466	9.395	

CD93B CTD casts							
Cruise	Cast	Start date&time	End date&time	Stn	Lat N	Lon W	Comments
CD93B	CTD114	21/05/95 07:21	21/05/95 08:08	S1000	56.464	9.295	
CD93B	CTD115	21/05/95 09:25	21/05/95 10:08	S850	56.470	9.219	
CD93B	CTD116	21/05/95 11:14	21/05/95 11:50	S700	56.470	9.157	
CD93B	CTD117	21/05/95 13:06	21/05/95 13:34	S500	56.457	9.094	
CD93B	CTD118	21/05/95 14:15	21/05/95 14:38	S300	56.465	9.053	
CD93B	CTD119	21/05/95 15:26	21/05/95 15:46	S200	56.463	9.040	
CD93B	CTD120	21/05/95 16:40	21/05/95 16:53	S160	56.462	9.011	
CD93B	CTD121	21/05/95 17:41	21/05/95 18:03	S140	56.400	8.955	
CD93B	CTD122	21/05/95 23:52	22/05/95 00:44	R1000	56.520	9.283	Go-flo
CD93B	CTD123	22/05/95 02:20	22/05/95 03:11	R1000	56.516	9.289	Geochemistry
CD93B	CTD124	22/05/95 04:01	22/05/95 04:52	R1000	56.517	9.289	
CD93B	CTD125	22/05/95 06:08	22/05/95 06:58	R1000	56.518	9.296	
CD93B	CTD126	22/05/95 08:41	22/05/95 09:50	R1000	56.517	9.292	Go-flo
CD93B	CTD127	22/05/95 10:32	22/05/95 11:18	R1000	56.519	9.290	For deep water
CD93B	CTD128	22/05/95 17:27	22/05/95 17:51		56.244	9.346	Optical dip (nr V1000)
CD93B	CTD129	22/05/95 19:26	22/05/95 19:36	V150	56.251	9.062	
CD93B	CTD130	22/05/95 20:34	22/05/95 20:42	V200	56.257	9.146	
CD93B	CTD131	22/05/95 22:05	22/05/95 22:15	V1000	56.258	9.334	
CD93B	CTD132	23/05/95 14:44	23/05/95 16:31	NR	56.999	12.025	
CD93B	CTD133	23/05/95 20:15	23/05/95 21:52	N2300	56.999	11.000	
CD93B	CTD134	24/05/95 01:16	24/05/95 01:39	N2000	56.999	9.999	Production cast
CD93B	CTD135	24/05/95 02:15	24/05/95 03:47	N2000	57.003	10.000	
CD93B	CTD136	24/05/95 09:33	24/05/95 09:59	N2000	57.008	10.019	Optical dip
CD93B	CTD137	24/05/95 13:06	24/05/95 14:19	N1500	57.734	9.400	
CD93B	CTD138	24/05/95 15:13	24/05/95 16:29	N1500	56.740	9.391	Geochemistry
CD93B	CTD139	24/05/95 19:46	24/05/95 20:02		56.449	9.739	Go-flo
CD93B	CTD140	24/05/95 20:56	24/05/95 22:09	S1500	56.463	9.646	
CD93B	CTD141	24/05/95 23:40	25/05/95 00:32	S1000	56.462	9.309	
CD93B	CTD142	25/05/95 01:29	25/05/95 01:58	S500	56.468	9.101	
CD93B	CTD143	25/05/95 03:04	25/05/95 03:28	S200	56.465	9.044	Production
CD93B	CTD144	25/05/95 04:12	25/05/95 04:32	S200	56.463	9.046	
CD93B	CTD145	25/05/95 06:06	25/05/95 06:25	S200	56.462	9.044	
CD93B	CTD146	25/05/95 08:10	25/05/95 08:30	S200	56.464	9.046	Go-flo
CD93B	CTD147	25/05/95 09:20	25/05/95 09:45	S200	56.463	9.042	Optical
CD93B	CTD148	25/05/95 10:44	25/05/95 10:54	S200	56.466	9.043	DO cast
CD93B	CTD149	25/05/95 10:57	25/05/95 11:12	S200	56.467	9.042	DO cast
CD93B	CTD150	25/05/95 12:43	25/05/95 13:08	S200	56.465	9.046	Geochemistry
CD93B	CTD151	25/05/95 19:19	25/05/95 20:21	N1500	56.736	9.392	Go-flo
CD93B	CTD152	25/05/95 21:08	25/05/95 22:09	N1500	56.733	9.390	
CD93B	CTD153	26/05/95 07:13	26/05/95 08:24	N1500	56.734	9.388	
CD93B	CTD154	26/05/95 09:12	26/05/95 10:28	N1500	56.731	9.396	
CD93B	CTD155	26/05/95 12:06	26/05/95 12:28	N1500	56.733	9.393	Optical
CD93B	CTD156	26/05/95 13:29	26/05/95 14:45	N1500	56.735	9.386	Go-flo
CD93B	CTD157	26/05/95 19:09	26/05/95 19:22		56.702	8.926	
CD93B	CTD158	26/05/95 19:23	26/05/95 19:41		56.702	8.927	
CD93B	CTD159	27/05/95 03:06	27/05/95 03:25	N140	56.604	8.928	
CD93B	CTD160	27/05/95 03:52	27/05/95 04:09	N200	56.617	8.991	
CD93B	CTD161	27/05/95 04:59	27/05/95 05:23	N300	56.629	9.023	
CD93B	CTD162	27/05/95 06:08	27/05/95 06:47	N700	56.644	9.108	
CD93B	CTD163	27/05/95 07:36	27/05/95 08:24	N1000	56.671	9.199	
CD93B	CTD164	27/05/95 09:48	27/05/95 10:54	N1300	56.697	9.332	
CD93B	CTD165	27/05/95 12:01	27/05/95 13:11	N1500	56.736	9.396	
CD93B	CTD166	27/05/95 15:41	27/05/95 16:07	S300	56.465	9.056	
CD93B	CTD167	27/05/95 16:57	27/05/95 17:15	S300	56.462	9.055	Go-flo

CD93B CTD casts							
Cruise	Cast	Start date&time	End date&time	Stn	Lat N	Lon W	Comments
CD93B	CTD168	27/05/95 17:57	27/05/95 18:18	S300	56.464	9.059	
CD93B	CTD169	27/05/95 19:28	27/05/95 19:53	S300	56.462	9.062	Geochemistry
CD93B	CTD170	27/05/95 20:59	27/05/95 21:24	S300	56.465	9.068	
CD93B	CTD171	27/05/95 22:08	27/05/95 22:20	S300	56.464	9.070	
CD93B	CTD172	27/05/95 23:00	27/05/95 23:23	S300	56.468	9.059	
CD93B	CTD173	28/05/95 00:02	28/05/95 00:22	S300	56.469	9.060	
CD93B	CTD174	28/05/95 01:08	28/05/95 01:31	S300	56.467	9.060	
CD93B	CTD175	28/05/95 02:06	28/05/95 02:25	S300	56.466	9.061	
CD93B	CTD176	28/05/95 03:09	28/05/95 03:31	S300	56.465	9.059	
CD93B	CTD177	28/05/95 04:10	28/05/95 04:26	S300	56.464	9.058	
CD93B	CTD178	28/05/95 05:06	28/05/95 05:23	S300	56.466	9.053	
CD93B	CTD179	28/05/95 06:16	28/05/95 06:32	S300	56.464	9.061	
CD93B	CTD180	28/05/95 07:11	28/05/95 07:31	S300	56.463	9.064	
CD93B	CTD181	28/05/95 09:26	28/05/95 09:47		56.462	9.057	Optical cast
CD93B	CTD182	28/05/95 13:16	28/05/95 13:43	S200	56.455	9.052	Optical cast
CD93B	CTD183	28/05/95 21:50	28/05/95 22:29	S700	56.464	9.151	
CD93B	CTD184	28/05/95 23:27	29/05/95 00:08	S700	56.468	9.163	Go-flo
CD93B	CTD185	29/05/95 00:41	29/05/95 01:24	S700	56.469	9.161	Geochemistry
CD93B	CTD186	29/05/95 02:02	29/05/95 02:40	S700	56.468	9.162	
CD93B	CTD187	29/05/95 03:06	29/05/95 03:33	S700	56.468	9.164	
CD93B	CTD188	29/05/95 04:06	29/05/95 04:37	S700	56.467	9.161	
CD93B	CTD189	29/05/95 05:38	29/05/95 06:24	S1000	56.464	9.302	
CD93B	CTD190	29/05/95 06:59	29/05/95 07:37	S850	56.461	9.225	
CD93B	CTD191	29/05/95 08:17	29/05/95 08:45	S500	56.467	9.102	
CD93B	CTD192	29/05/95 09:22	29/05/95 09:42	S200	56.462	9.046	
CD93B	CTD193	29/05/95 10:59	29/05/95 11:15	S140	56.462	8.969	
CD93B	CTD194	29/05/95 13:27	29/05/95 13:41	S130	56.288	8.503	
CD93B	CTD195	29/05/95 18:58	29/05/95 19:11	Islay D	55.741	6.986	
CD93B	CTD196	29/05/95 20:31	29/05/95 20:44	Islay C	55.575	6.648	

CD93B - main FAST CTD SURVEY (lines N,P,R,S)						
Stn	Cast	Start date&time	End date&time	Lat N	Lon W	Depth
N140	CTD81	18/05/95 23:48	19/05/95 00:10	56.604	8.941	135
N150	CTD82	19/05/95 01:05	19/05/95 01:25	56.618	8.992	162
N200	CTD83	19/05/95 02:00	19/05/95 02:23	56.619	9.011	220
N300	CTD84	19/05/95 02:55	19/05/95 03:29	56.629	9.028	338
N500	CTD85	19/05/95 04:21	19/05/95 04:52	56.632	9.073	501
N700	CTD86	19/05/95 05:36	19/05/95 06:15	56.645	9.113	699
N850	CTD87	19/05/95 07:00	19/05/95 07:45	56.656	9.151	836
N1000	CTD88	19/05/95 08:32	19/05/95 09:30	56.676	9.197	1024
N1300	CTD89	19/05/95 10:25	19/05/95 11:29	56.699	9.328	1296
N1500	CTD90	19/05/95 12:13	19/05/95 13:24	56.735	9.406	1512
P1500	CTD91	19/05/95 14:45	19/05/95 16:00	56.651	9.615	1533
P1300	CTD92	19/05/95 17:53	19/05/95 19:00	56.631	9.463	1310
P1000	CTD93	19/05/95 20:11	19/05/95 21:07	56.604	9.285	1000
P850	CTD94	19/05/95 22:18	19/05/95 23:06	56.598	9.226	844
P700	CTD95	20/05/95 01:13	20/05/95 01:58	56.590	9.183	709
P500	CTD96	20/05/95 02:49	20/05/95 03:24	56.578	9.114	501
P300	CTD97	20/05/95 04:12	20/05/95 04:32	56.568	9.052	290
P200	CTD98	20/05/95 05:21	20/05/95 05:37	56.566	9.031	202
P150	CTD99	20/05/95 06:21	20/05/95 06:36	56.563	9.003	158
P140	CTD100	20/05/95 07:27	20/05/95 07:42	56.551	8.935	140
R140	CTD101	20/05/95 08:28	20/05/95 08:47	56.500	8.931	143
R150	CTD102	20/05/95 09:51	20/05/95 10:05	56.503	8.991	148
R200	CTD103	20/05/95 11:05	20/05/95 11:25	56.506	9.038	207
R300	CTD104	20/05/95 12:59	20/05/95 13:30	56.505	9.060	305
R500	CTD105	20/05/95 14:37	20/05/95 15:12	56.507	9.106	468
R700	CTD106	20/05/95 15:55	20/05/95 16:35	56.515	9.172	671
R850	CTD107	20/05/95 17:11	20/05/95 17:51	56.514	9.231	852
R1000	CTD108	20/05/95 18:37	20/05/95 19:30	56.515	9.297	1007
R1300	CTD109	20/05/95 20:50	20/05/95 21:55	56.530	9.488	1297
R1500	CTD110	20/05/95 23:02	21/05/95 00:19	56.537	9.677	1523
S1500	CTD111	21/05/95 01:35	21/05/95 02:47	56.460	9.636	1507
S1300	CTD112	21/05/95 03:43	21/05/95 04:42	56.463	9.504	1281
S1150	CTD113	21/05/95 05:27	21/05/95 06:22	56.466	9.395	1133
S1000	CTD114	21/05/95 07:21	21/05/95 08:08	56.464	9.295	991
S850	CTD115	21/05/95 09:25	21/05/95 10:08	56.470	9.219	848
S700	CTD116	21/05/95 11:14	21/05/95 11:50	56.470	9.157	673
S500	CTD117	21/05/95 13:06	21/05/95 13:34	56.457	9.094	474
S300	CTD118	21/05/95 14:15	21/05/95 14:38	56.465	9.053	248
S200	CTD119	21/05/95 15:26	21/05/95 15:46	56.463	9.040	188
S160	CTD120	21/05/95 16:40	21/05/95 16:53	56.462	9.011	149
S140	CTD121	21/05/95 17:41	21/05/95 18:03	56.400	8.955	145

CD93B Slow stations - pelagic sampling						
Station	Event	Start date&time	End date&time	Lat N	Lon W	Comments
S140	CTD63	17/05/95 14:36	17/05/95 14:51	56.469	8.963	
	CTD64	17/05/95 15:41	17/05/95 15:53	56.470	8.955	
	CTD65	17/05/95 16:41		56.468	8.953	
	OPT1/CS4/1	17/05/95 16:55	17/05/95 17:05	56.467	8.954	CS4
	OPT1/PRR/1	17/05/95 17:10	17/05/95 17:20	56.467	8.952	PRR600
	OPT1/SAT/1	17/05/95 17:25	17/05/95 17:40	56.468	8.956	SATLANTIC
	CTD66	17/05/95 19:04	17/05/95 19:25	56.462	8.959	Geochemistry
	CTD67	17/05/95 21:01	17/05/95 21:16	56.461	8.958	Geochemistry
	CTD68	17/05/95 22:55	17/05/95 23:14	56.462	8.963	Go-flo
	CTD69	18/05/95 00:37	18/05/95 00:50	56.463	8.957	
	CTD70	18/05/95 02:58	18/05/95 03:13	56.462	8.959	
	CTD71	18/05/95 04:39	18/05/95 04:48	56.465	8.958	
	CTD72	18/05/95 04:50	18/05/95 05:02	56.465	8.958	
	CTD73	18/05/95 06:46	18/05/95 06:55	56.463	8.954	
	CTD74	18/05/95 06:56	18/05/95 07:04	56.462	8.953	
	CTD75	18/05/95 07:06	18/05/95 07:16	56.462	8.952	
	CTD76	18/05/95 09:15	18/05/95 09:27	56.463	8.955	
	OPT1/PRR/2	18/05/95 09:40	18/05/95 09:52	56.462	8.956	PRR600
	OPT1/CS4/2	18/05/95 09:55	18/05/95 10:10	56.460	8.956	CS4
	OPT1/SAT/2	18/05/95 10:20	18/05/95 10:27	56.459	8.958	SATLANTIC
	CTD77	18/05/95 10:20	18/05/95 10:30	56.458	8.959	
	CTD78	18/05/95 11:10	18/05/95 11:26	56.459	8.968	
	SVT1	18/05/95 11:58		56.463	8.966	2 settling tubes (5m)
	SVT2	18/05/95 12:08		56.463	8.967	2 settling tubes (5m)
R1000	CTD122	21/05/95 23:52	22/05/95 00:44	56.520	9.283	Go-flo
	CTD123	22/05/95 02:20	22/05/95 03:11	56.516	9.289	Geochemistry
	CTD124	22/05/95 04:01	22/05/95 04:52	56.517	9.289	
	CTD125	22/05/95 06:08	22/05/95 06:58	56.518	9.296	
	SVT3	22/05/95 07:36		56.518	9.284	2 settling tubes (2m)
	SVT4	22/05/95 07:52		56.520	9.280	2 settling tubes (2m)
	CTD126	22/05/95 08:41	22/05/95 09:50	56.517	9.292	Go-flo
	CTD127	22/05/95 10:32	22/05/95 11:18	56.519	9.290	For deep water
N2000	CTD134	24/05/95 01:16	24/05/95 01:39	56.999	9.999	Production cast
	CTD135	24/05/95 02:15	24/05/95 03:47	57.003	10.000	
	OPT3/INF	24/05/95 08:30	24/05/95 08:40	57.002	10.013	INF 300
	OPT3/CS4	24/05/95 08:45	24/05/95 09:00	57.003	10.017	CS4
	OPT3/PRR	24/05/95 09:05	24/05/95 09:10	57.004	10.017	PRR600
	OPT3/SAT	24/05/95 09:11	24/05/95 09:20	57.007	10.020	SATLANTIC
	CTD136	24/05/95 09:33	24/05/95 09:59	57.008	10.019	Optical dip
S200	CTD143	25/05/95 03:04	25/05/95 03:28	56.465	9.044	Production
	CTD144	25/05/95 04:12	25/05/95 04:32	56.463	9.046	
	CTD145	25/05/95 06:06	25/05/95 06:25	56.462	9.044	
	CTD146	25/05/95 08:10	25/05/95 08:30	56.464	9.046	Go-flo
	CTD147	25/05/95 09:20	25/05/95 09:45	56.463	9.042	Optical/drifters
	OPT5/PRR	25/05/95 09:25	25/05/95 09:34	56.462	9.043	PRR600
	OPT5/SAT	25/05/95 09:37	25/05/95 09:45	56.464	9.042	SATLANTIC
	OPT5/CS4	25/05/95 09:50	25/05/95 10:15	56.464	9.042	CS4
	OPT5/INF	25/05/95 10:20	25/05/95 10:30	56.462	9.043	INF 300
	CTD148	25/05/95 10:44	25/05/95 10:54	56.466	9.043	DO cast
	CTD149	25/05/95 10:57	25/05/95 11:12	56.467	9.042	DO cast/drifters
	CTD150	25/05/95 12:43	25/05/95 13:08	56.465	9.046	Geochemistry
	SVT5	25/05/95 13:34		56.462	9.044	2 settling tubes (2m)

N1500	CTD151	25/05/95 19:19	25/05/95 20:21	56.736	9.392	Go-flo
	CTD152	25/05/95 21:08	25/05/95 22:09	56.733	9.390	For deep water
	CTD153	26/05/95 07:13	26/05/95 08:24	56.734	9.388	
	CTD154	26/05/95 09:12	26/05/95 10:28	56.731	9.396	
	SVT6	26/05/95 11:00		56.734	9.399	2 settling tubes (5m)
	OPT6/PRR	26/05/95 11:08	26/05/95 11:19	56.734	9.398	PRR600
	OPT6/SAT	26/05/95 11:24	26/05/95 11:35	56.733	9.398	SATLANTIC
	OPT6/CS4	26/05/95 11:40	26/05/95 11:55	56.733	9.398	CS4
	OPT6/INF	26/05/95 12:00	26/05/95 12:05	56.732	9.398	INF 300
	CTD155	26/05/95 12:06	26/05/95 12:28	56.733	9.393	Optical
	CTD156	26/05/95 13:29	26/05/95 14:45	56.735	9.386	Go-flo
S300	CTD166	27/05/95 15:41	27/05/95 16:07	56.465	9.056	
	CTD167	27/05/95 16:57	27/05/95 17:15	56.462	9.055	Go-flo
	SVT7	27/05/95 17:35		56.462	9.061	2 settling tubes (3-5m)
	CTD168	27/05/95 17:57	27/05/95 18:18	56.464	9.059	
	CTD169	27/05/95 19:28	27/05/95 19:53	56.462	9.062	Geochemistry
	CTD170	27/05/95 20:59	27/05/95 21:24	56.465	9.068	
	CTD171	27/05/95 22:08	27/05/95 22:20	56.464	9.070	
	CTD172	27/05/95 23:00	27/05/95 23:23	56.468	9.059	
	CTD173	28/05/95 00:02	28/05/95 00:22	56.469	9.060	
	CTD174	28/05/95 01:08	28/05/95 01:31	56.467	9.060	
	CTD175	28/05/95 02:06	28/05/95 02:25	56.466	9.061	
	CTD176	28/05/95 03:09	28/05/95 03:31	56.465	9.059	
	CTD177	28/05/95 04:10	28/05/95 04:26	56.464	9.058	
	CTD178	28/05/95 05:06	28/05/95 05:23	56.466	9.053	
	CTD179	28/05/95 06:16	28/05/95 06:32	56.464	9.061	
	CTD180	28/05/95 07:11	28/05/95 07:31	56.463	9.064	
	OPT8/PRR	28/05/95 08:09	28/05/95 08:21	56.463	9.058	PRR600
	OPT8/SAT	28/05/95 08:23	28/05/95 08:36	56.463	9.059	SATLANTIC
	OPT8/CS4	28/05/95 08:40	28/05/95 08:56	56.462	9.057	CS4
	OPT8/INF	28/05/95 08:58	28/05/95 09:06	56.462	9.058	INF 300
	CTD181	28/05/95 09:26	28/05/95 09:47	56.462	9.057	Optical cast
S700	CTD183	28/05/95 21:50	28/05/95 22:29	56.464	9.151	
	SVT8	28/05/95 22:47		56.465	9.159	2 settling tubes (2m)
	CTD184	28/05/95 23:27	29/05/95 00:08	56.468	9.163	Go-flo
	CTD185	29/05/95 00:41	29/05/95 01:24	56.469	9.161	Geochemistry
	CTD186	29/05/95 02:02	29/05/95 02:40	56.468	9.162	
	CTD187	29/05/95 03:06	29/05/95 03:33	56.468	9.164	
	CTD188	29/05/95 04:06	29/05/95 04:37	56.467	9.161	

CD93B Coring stations						
Multicores						
Stn	**Core**	**Date & Time**	**Lat N**	**Lon W**	**Depth**	**Comments**
S700	MC1	18/05/95 19:16	56.473	9.156	NPA	8 cores
S700	MC2	18/05/95 20:55	56.480	9.158	NPA	7 cores
S700	MC3	18/05/95 21:53	56.478	9.162	NPA	8 cores
R1000	MC4	22/05/95 13:20	56.517	9.289	989	8 cores
R1000	MC5	23/05/95 01:21	56.517	9.285	979	6 cores
R1000	MC6	23/05/95 02:42	56.515	9.292	995	8 cores
N1500	MC7	25/05/95 23:49	56.734	9.393	1497	5 cores
N1500	MC8	26/05/95 02:14	56.735	9.385	1485	4 cores
N1500	MC9	26/05/95 04:00	56.733	9.391	1490	4 cores
N1500	MC10	26/05/95 22:46	56.736	9.405	1513	4 cores
Sholkovitz Gravity Cores						
Stn	**Core**	**Date & Time**	**Lat N**	**Lon W**	**Depth**	**Comments**
R1000		21/05/95 21:12	56.524	9.285	982	Unsuccessful
R1000		21/05/95 22:42	56.520	9.289	1002	Unsuccessful
RVS Gravity Cores						
Stn	**Core**	**Date & Time**	**Lat N**	**Lon W**	**Depth**	**Comments**
R1000	GC1	23/05/95 04:55	56.514	9.288	981	Successful
N2000	GC2	24/05/95 04:52	56.010	10.004	2072	Successful
N1500	GC3	27/05/95 00:25	56.737	9.390	1501	Successful

CD93B Drifting buoy experiments								
Event	**Drifter**	**PTT**	**Release details**			**Recovery details**		
ID	**Name/No**	**no**	**Date & time**	**Lat N**	**Lon W**	**Date & time**	**Lat N**	**Lon W**
BDRF2/1	UWB 2 "Karen"	3798	22/05/95 16:51	56.254	9.337	24/05/95 19:12	56.442	9.737
BDRF1/1	UWB 1 "Ray"	3797	22/05/95 17:13	56.247	9.343	24/05/95 18:52	56.445	9.742
DDRF1	DML 1	24263	22/05/95 19:44	56.250	9.062			
DDRF2	DML 2	24262	22/05/95 20:08	56.254	9.098			
DDRF3	DML 3	24264	22/05/95 20:57	56.254	9.133			
DDRF4	DML 4	24261	22/05/95 21:15	56.255	9.163			
DDRF5	DML 5	24260	22/05/95 22:36	56.256	9.318			
DDRF6	DML 6	24259	22/05/95 22:50	56.253	9.349			
BDRF1/2	UWB 1 "Ray"	3797	25/05/95 11:46	56.518	9.044	26/05/95 17:32	56.570	8.945
BDRF2/2	UWB 2 "Karen"	3798	25/05/95 12:01	56.514	9.042	26/05/95 18:30	56.697	8.924
	Notes:							
	The UWB drifters are equipped with thermistor chain, colour sensor and a							
	DML sediment trap.							