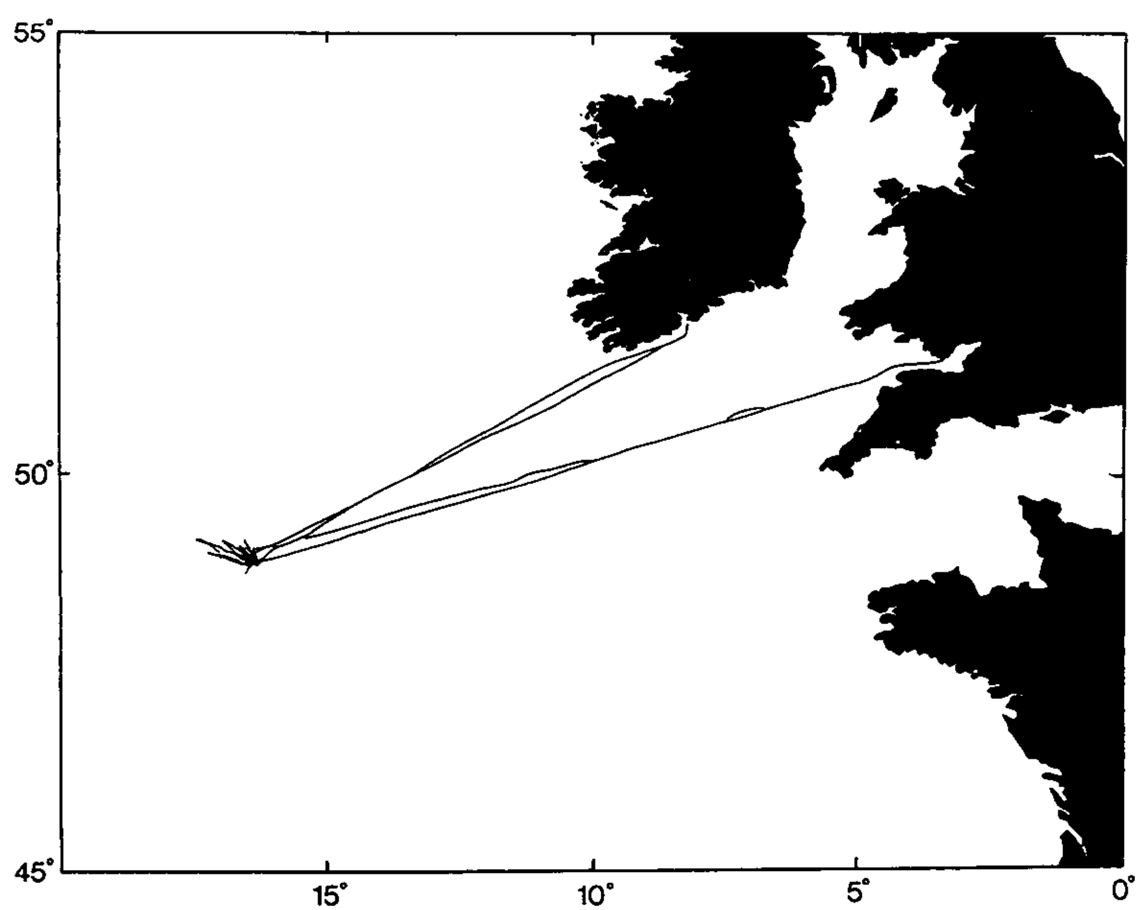
Institute of
Oceanographic Sciences
Deacon Laboratory

RRS *Charles Darwin* Cruise 72

24 Aug - 11 Sep 1992

Particle flux and biology in the northeast Atlantic (49°N 16.5°W)

Cruise Report No 235 1993



INSTITUTE OF OCEANOGRAPHIC SCIENCES

DEACON LABORATORY

Wormley, Godalming,
Surrey, GU8 5UB, U.K.

Telephone: 0428 79 4141
Telex: 858833 OCEANS G
Telefax: 0428 79 3066

Director: Dr. C.P. Summerhayes

Natural Environment Research Council

INSTITUTE OF OCEANOGRAPHIC SCIENCES

DEACON LABORATORY

CRUISE REPORT NO. 235

RRS *CHARLES DARWIN* CRUISE 72
24 AUG - 11 SEP 1992

Particle flux and biology in the northeast Atlantic (49°N 16.5°W)

Principal Scientist
R S Lampitt

1993

DOCUMENT DATA SHEET

AUTHOR LAMPITT, R S et al	*PUBLICATION DATE* 1993

TITLE

RRS *Charles Darwin* Cruise 72, 24 Aug-11 Sep 1992. Particle flux and biology in the northeast Atlantic (49°N 16.5°W).

REFERENCE

Institute of Oceanographic Sciences Deacon Laboratory, Cruise Report, No. 235, 35pp.

ABSTRACT

This report presents a summary of the scientific activities carried out during Cruise 72 of RRS *Charles Darwin*. The main aim of the cruise was to examine some of the questions highlighted by the NERC Biogeochemical Ocean Flux Study (BOFS) in particular those concerning the influence of biological processes on vertical particle flux. Due to circumstances outside the influence of the scientific personnel, several of the objectives could not be addressed. Nevertheless success was achieved in several areas: 1) A sediment trap mooring was successfully turned round, 2) various aspects of oceanic microbiology were examined focussing especially on the distinction between free living and attached bacteria. 3) Additional observations were made on these bacteria using novel molecular biological techniques. 4) The distribution of large particles (marine snow) was determined using a camera system attached to the CTD. 5) Zooplankton and micronekton were well sampled and their distribution related to a significant quantity of new data on acoustic backscatter derived from the ADCP.

KEYWORDS

ACOUSTIC DOPPLER CURRENT PROFILER
ADCP
BACKSCATTER
BACTERIA
BOFS
"*CHARLES DARWIN*" - cruise(1992)(72)
PARTICULATE FLUX

ISSUING ORGANISATION

Institute of Oceanographic Sciences
Deacon Laboratory
Wormley, Godalming
Surrey GU8 5UB. UK.

Director: Colin Summerhayes DSc

Telephone Wormley (0428) 684141
Telex 858833 OCEANS G.
Facsimile (0428) 683066

Copies of this report are available from: **The Library,** *PRICE* *£8.00*

SCIENTIFIC PERSONNEL

Martin V. Angel	IOSDL
Tracy Anning	PML
Ben Boorman	IOSDL
Carl Davies	IOS-JRC
David Edge	IOSDL
Peter J. Herring	IOSDL
Diane Hughes	PML
Andrew Jones	RVS
Richard S. Lampitt	IOSDL (Principal Scientist)
Derek Lewis	RVS
Michael Sampson	RVS
Howard S.J. Roe	IOSDL
Moragh W. Stirling	UEA
Carol Turley	PML
Clive Washington	RVS
Jackie A.K. Will	Univ Wales Cardiff
Michael Wyman	PML

SHIP'S PERSONNEL

P.J. MacDermott	Master
R.C. Plumley	Chief Officer
P.W. Newton	2nd Officer
R.A. Warner	Extra 2nd Officer
I.G. McGill	Chief Engineer
D.E. Anderson	2nd Engineer
V.E.D. Lovell	3rd Engineer
R.M. Keys	3rd Engineer
J.G.L. Baker	Radio Officer
M.J. Drayton	CPO Deck
C.J. Perry	Cook Steward

ITINERARY

Depart Barry, South Wales 25 August 1992

Arrive Barry, South Wales 11 September 1992

INTRODUCTION

The BOFS programme addressed a wide range of key questions in collaboration with other JGOFS nations. As might be expected, a number of specific additional questions were thrown into relief during this exercise and cruise 72 sought to address some of these.

The cruise suffered from a number of financial problems during the final few months of planning and there was a distinct possibility that it would be cancelled. Without additional support from RVS above that which is normal or expected, no cruise would have been possible. Even so station time was cut from 27 days to 13 days and the objectives had to be modified accordingly. The most serious decision was to drop plans to use the Seasoar to provide the framework for the various biological and chemical observations we were to make. A final pre-cruise misfortune was that Dr Karen Heywood had to withdraw from the cruise 2 days before sailing due to ill health. In spite of these changes and unexpectedly poor weather conditions, a number of our original objectives were achieved successfully.

OBJECTIVES

The site of study during this cruise was 49°N 16°20W (Figure 1). The main objectives were:

1: To recover and deploy moorings as part of a long term study of particle flux at this site.

2: To collect various classes of particle for on board study and experimentation with particular emphasis on their microbiology and molecular biology.

3: To obtain acoustic information using the on board and bottom mounted ADCP and to relate these data to the physical structure of the water column and to the net collected plankton.

4: To examine the diel variability of one particular class of particle.

5: To use some of the collected biological specimens for experimentation on their behaviour.

NARRATIVE

Within a few hours of sailing at 1530h on 25th August, the adverse weather which was to plague the cruise was felt for the first time. With a forward speed between zero and 5Kts, passage to the station took considerably longer than expected only reaching the site at 0930h on 28th.

Although the weather adversely affected much of our work, XBT's could still be deployed every 4 hours (Table 6), the Acoustic Doppler Current Profiler (ADCP) continued to record backscattering strength, a measure of planktonic biomass and a variety of meteorological and underway surface water analyses were carried out throughout.

The weather abated sufficiently on the 28th for us to deploy a couple of CTD's and then the IOS Rectangular Midwater Trawl (RMT). This was the first time the RMT had been used on RRS Darwin demanding a fundamentally different method of deployment from that which had been used previously. Some teething problems were experienced but a satisfactory method was derived subsequently although it was very demanding in terms of manpower. The weather window was brief and no further work was possible till 30th when water samples were taken and a drifting mooring of IOS sediment traps was deployed. Another RMT was also possible before the weather again closed in and we hove to until late on 31st when various vertical nets and the marine snow catcher were deployed followed by the CTD carrying, this time, the Marine Snow Profiler (a camera system which photographs marine snow aggregates *in situ*). Little work was possible on 1st September again due to high winds but later in the day, the drifting mooring was successfully retrieved with samples of sedimenting material for microbiological analyses. Work was again not possible until late on 2nd when the Longhurst Hardy Plankton Recorder (LHPR) was deployed for the first time.

Late on the 2nd we proceeded to a fixed sediment trap mooring which had been deployed in April of this year by the German research vessel Meteor. Considerable difficulty was experienced releasing the mooring from the seabed and by the time it reached the surface, dusk was too far advanced to undertake a safe recovery because some loose ropes were feared to be near the surface. Acoustic contact was maintained with the mooring overnight and in the morning an inflatable was dispatched to the surface float. The loose ropes proved to be an unfounded fear and the mooring was successfully recovered in good sea conditions. Two of the three traps had worked perfectly providing a clear visual impression of the flux rates which had occurred during the previous five months. A marine snow camera system was also attached to this mooring; after processing its film will provide data on the abundance of this important particle class 40 times per week for 19 weeks.

The weather forecast was, at last, very encouraging during the sediment trap recovery on the 3rd September but unfortunately a sick steward required an immediate medical examination on shore. We experienced the best weather of the cruise during our passage to and from Cork. By the time we returned to station early on the 6th, conditions had deteriorated and, although they were adequate to deploy an LHPR, further deterioration to storm force 10 prevented us recovering the gear until late in the afternoon.

After a successful CTD deployment with the Marine Snow Profiler, we proceeded in the small hours of the 7th to the site at which a Bathysnap had been deployed in April also by Meteor. Some successful water bottle casts and vertical nets preceded a very smooth recovery of the Bathysnap. This paved the way for a successful LHPR haul followed by deployment of a fixed sediment trap mooring to be recovered at the end of next year.

In the early hours of 8th, after the usual water bottle collections and a CTD deployment, we carried out another LHPR haul. A Bathysnap was then deployed close to the fixed sediment trap mooring to be recovered at the same time as the traps next year. Later in the day particulate material was collected using a Stand Alone Pump (SAP) for the first and only time during the cruise. A final LHPR rounded off a successful end to the cruise.

On most mornings during the cruise, water samples were taken with a GOFLO sampler for primary productivity measurements and as this was a robust instrument and only deployed to 10m depth, this activity was influenced less by the poor weather than others.

Apart from the obvious problems imposed on us by poor weather conditions, it must also be noted that on some occasions, the weather was satisfactory but insufficient technical support was available to operate the ship.

A final irony concerning the poor weather conditions experienced (Figure 2) was that the on board wave recorder, measured but failed to record the sea conditions due to a software fault. This was only discovered after docking.

After a very encouraging and enthusiastic period of initial proposition and planning, this cruise was faced with a sequence of problems which had a serious impact on the scientific objectives. Although the effects were substantial and a proportion of the objectives had to be abandoned, those which were addressed successfully served to make it a worthwhile effort..

SCIENTIFIC AND TECHNICAL REPORTS

Free-living and attached oceanic bacteria

(a) Influence of pressure on growth and reproduction of mesopelagic communities

The influence of pressure on bacterial DNA and protein synthesis was examined on a free-living bacterial community and on a community of bacteria attached to sedimenting material from approximately 2200 m, collected by Goflo bottles and drifting, unpoisoned, IOS sediment traps deployed for 48 h, respectively. Subsamples were incubated with 3H-thymidine and 3H-leucine for 4-5 h at a range of pressures (table 2) from 1-400 atm (equivalent to 1-4000 m water depth) and in situ temperature, to examine the ability of the communities of bacteria to synthesis DNA and protein under a range of pressures encountered in oceanic waters. Other subsamples were taken to follow changes in cell numbers and biomass.

We were unable to carry out similar experiments planned at 1000, 500 and 200 m due to weather conditions and other circumstances limiting our working time on station.

(b) Examination of the relationship between bacterial DNA and protein synthesis through the oceanic water column

Using GoFlo water bottles attached to the CTD samples were taken from 5 - 4000 m (Table 1) and the bacterial incorporation of 3H-thymidine and 3H-leucine determined in 1-3-4h incubations at *in situ* temperature. Samples were extracted on board and radioactivity incorporated into DNA and protein will be determined on land using a liquid scintillation counter.

The distribution of bacterial numbers and biomass were also examined by the Acridine Orange DNA fluorochrome method of direct counting. Samples were prepared on board and stored frozen for analysis on land.

(c) Examination of loss of bacterial cells in preserved seawater samples

We have previously found dramatic loss of bacteria in preserved seawater samples which can result in a highly significant underestimation of bacterial cell numbers and biomass. In the experiment carried out on seawater from 10 m (Table 1) the influence of temperature on bacterial numbers in stored samples will be examined over a period of 100 d.

(d) Collection of marine bacterial samples for 16S ribosomal RNA analysis

Oceanic surface water samples were collected for isolation of mixed populations of marine bacteria for 16s rRNA sequencing. Comparative analysis of these 16s rRNA sequences with other known bacterial 16s rRNA sequences allows the construction of phylogenetic trees. It is hoped that this information will assist in culturing some of the previously unculturable bacteria present in the marine environment.

Seawater samples collected in Go-Flo bottles were filtered through a 0.2 um Nuclepore filter and total DNA extracted. The 16s rRNA genes will be amplified through the polymerase chain reaction (PCR) using eubacterial-specific primers back on land. The mixed population of 16s rRNA genes can then be cloned in *E. coli* using a plasmid vector, and the DNA sequence determined.

Seawater samples throughout the water column from 4000 m to 5 m (Table 1) were filtered for future 16s rRNA sequence analysis. Bacterial cells were also fixed in paraformaldehyde for in situ hybridization analysis using eubacterial and archaebacterial-specific probes. This will allow estimation of the relative proportions of bacteria in these two kingdoms present in oceanic waters through the water column. Sediment trap material collected from 2200 m (Table 2) will also be analysed in this way.

TABLE 1

Study of free-living oceanic bacteria

Station	Cast	Date	Time	Depth	AODC	Tdr	Leuc	16s rRNA	Comments
52901#2	2	28 Aug	1412	2199	*	*	*	*	Pressure expts
				500				*	
				4000				*	
52904#6	3	31 Aug		5	*	*	*	*	
				15	*	*	*	*	
				30	*	*	*	*	
				40	*	*	*	*	
				50	*	*	*	*	
				60	*	*	*	*	
				80	*	*	*	*	
				100	*	*	*	*	
				150	*	*	*	*	
				200				*	
				250					
				300					
52901#1	6	6 Sep		5					O_2 determination
				200	*	*	*	*	
				300	*	*	*	*	
				400	*	*	*	*	
				500	*	*	*	*	
				700	*	*	*	*	O_2 determination
				900	*	*	*	*	
				1500	*	*	*	*	O_2 determin + RNA sample (Wyman)
				2200	*	*	*	*	
				3000	*	*	*	*	
				4000	*	*	*	*	
52915#3	7	8 Sep		10	*				Cell loss expt

TABLE 2

Study of the pressure tolerance of free-living mesopelagic bacteria and bacteria attached to descending mesopelagic particles

Station	Cast	Date	Time	Depth	Incubn pressure	AODC	TDR	Leuc	16s RNA	Comments
52901#2	2	28 Aug	1412	2199	1	*	*	*	*	Sea water
					50	*	*	*		
					100	*	*	*		
					150	*	*	*		
					200	*	*	*		
					300	*	*	*		
					400	*	*	*		
52902#5	deploy	30 Aug	1431)	2175	1	*	*	*	*	Drifting sediment trap RNA (Wyman)
	recov	1 Sep	2020)	2205	50	*	*	*		
					100	*	*	*		
					150	*	*	*		
					200	*	*	*		
					300	*	*	*		
					400	*	*	*		

CMT, DJH, JAKW

Molecular biology and community production

Many of our original objectives were not achieved owing to the combination of bad weather, logistical problems associated with the restricted availability of technicians and crew and an interruption of three days in mid-cruise for the passage to Cork. Since the only uninterrupted source of seawater during the cruise was the ships non-toxic supply, a modified sampling program was built around this source.

Four diel sampling periods were completed on station. In addition samples were also taken during the transect to Cork. Samples of 10-20 litres were filtered onto GFC filters at the times indicated in the appended station list for the extraction of total RNA from eukaryotic phytoplankton. In parallel, 10-12 litres of seawater were filter-fractionated through 2.0 and 0.6μm filters for the selective isolation of *Synechococcus* RNA. Both sample types will be processed on shore for the analysis of temporal and spatial variability in transcription activity. Subsamples of *Synechococcus* cells were taken at each sampling time for the determination of cell RNA content by in situ hybridization. It was possible to estimate community production by oxygen titration on only eight days. Consistent with the low chlorophyll concentration in the mixed layer (~0.2 μg/litre), net production was low. Gross production on most days was of the order of 2-4 μmol/kg. Net production varied from 1-2 μmol/kg at light saturation. One sediment trap sample was obtained from 2200m for the determination of bacterial cell RNA content on aggregated material. A comparison will be made between this material and the planktonic bacteria collected from the same depth.

Four net tows for *Trichodesmium* were completed. *Trichodesmium* colonies were obtained from each tow but insufficient material was available for experimentation. Bad weather and restrictions on sampling time prevented the planned diel tows in our original programme from going ahead.

TABLE 3

DATE/TIME	POSITION	DEPTH	STATION #	SAMPLE	ANALYSIS
28/8 1050	48.55,16.18	10	52901#1	CTD	rRNA in situ
28/8 1050	48.55,16.18	20	52901#1	CTD	rRNA in situ
28/8 1050	48.55,16.18	35	52901#1	CTD	rRNA in situ
28/8 1050	48.55,16.18	45	52901#1	CTD	rRNS in situ
29/8 1500		5	CS1	NT	DNA
29/8 1990		5	CS2	NT	DNA
30/8 0515	49.10,17.12	5	LS1,BS1	NT	RNA, Chl
30/8 0630	49.11,17.16	5	LS2,BS2	NT	RNA, Chl
30/8 0820		5	52902#1	GOFLO	PROD,Chl
30.8 0840			52902#2	WP2	TRICHO
30/8 1020	49.10,17.16	5	LS3,BS3	NT	RNA,Chl
30/8 1100	49.10,17.16	5	BS4	NT	RNA,Chl
30/8 1330	48.58,16.33	5	BS5	NT	RNA,Chl
30/8 1450	48.57,16.26	5	LS4	NT	RNA,Chl
30/8 1530	48.57,16.27	5	BS6	NT	RNA,Chl
30/8 1715	48.58,16.28	5	LS5,BS7	NT	RNA,Chl
30/8 2010	48.58,16.23	5	LS6,BS8	NT	RNA,Chl
31/8 0540	48.55,16.19	5	LS7,BS9	NT	RNA,Chl
31/8 0745	48.01,16.22	5	LS8,BS10	NT	RNA,Chl
31/8 0935	49.04,16.25	5	LS9,BS11	NT	RNA,Chl
31/8 1215	49.01,16.23	5	LS10,BS12	NT	RNA,Chl

DATE/TIME	POSITION	DEPTH	STATION #	SAMPLE	ANALYSIS
31/8 1515	48.56,16.19	5	LS11,BS13	NT	RNA,Chl
31/8 1600		30	52904#4	WP2	TRICHO
31/8 1715	48.57,16.22	5	LS12,BS14	NT	RNA,Chl
31/8 1915	48.58,16.23	5	LS13,BS15	NT	RNA,Chl
31/8 2055	49.00,16.26	5	LS14,BS16	NT	RNA,Chl
31/8 2325	49.01,16.21	5	LS15,BS17	NT	RNA,Chl
01/9 O230	49.01,16.21	5	LS16,BS18	NT	RNA,Chl
01/9 0623	48.56,16.20	5	52905#1,2	GOFLO	PROD,Chl
01/9 2300		2200	CMT1	SED	RNA in situ
02/9 0450	48.56,16.20	5	52906#1,2	GOFLO	PROD.Chl
02/9 1400		5		NT	Chl
03/9 0445	48.55,16.21	5	52907#1-3	GOFLO	PROD,Chl
03/9 0545	48.55,16.22	50	52907#4,5	WP2	TRICHO
03/9 1515	49.15,15.32	5	T1	NT	RNA,Chl
03/9 1600	49.22,15.21	5	T2	NT	RNA,Chl
03/9 1930	49.40,14.24	5	T3	NT	RNA,Chl
03/9 1955	49.42,14.19	5	T4	NT	RNA,Chl
03/9 2315	49.58,13.26	5	T5	NT	RNA,Chl
04/9 0411	50.23,12.10	5	T6	NT	RNA,Chl
04/9 0518	50.29,11.52	5	T7	NT	RNA,Chl
04/9 0835	50.46,10.57	5	T8	NT	RNA,Chl
04/9 0949	50.23,10.34	5	T9	NT	RNA,Chl
04/9 1138	51.02,1003	5	T10	NT	RNA,Chl
04/9 1235	51.07,0947	5	T11	NT	RNA,Chl
04/9 2343	51.22,09.23	5	T12	NT	RNA,Chl
05/9 0610	50.47,11.08	5	T13	NT	RNA,Chl
05/9 0820	50.34,11.31	5	T14	NT	RNA,Chl
05/9 1227	50.13,12.47	5	T15	NT	RNA,Chl
05/9 1635	49.51,13.47	5	T16	NT	RNA,Chl
05/9 1715	49.48,13.57	5	T17	NT	RNA,Chl
05/9 2044	49.31,14.45	5	T18	NT	RNA,Chl
05/9 2133	49.28,14.51	5	T19	NT	RNA,Chl
06/9 0400	48.53,16.23	5	52909#1-3	GOFLO	PROD,Chl
06/9 0845	48.53,16.32	5	LS17,BS19	NT	RNA,Chl
06/9 1205	48.58,16.48	5	LS18,BS20	NT	RNA,Chl
06/9 1635	48.03,17.10	5	LS19,BS21	NT	RNA,Chl
06/9 2030		2200	CMT2	CTD	RNA in situ
07/9 0430	48.57,16.19	5	52911#1,2	GOFLO	PROD,Chl
07/9 0430	48.57,16.19	5	52911#3-5	GOFLO	RNA in situ
07/9 0630		5	52911#6	WP2	TRICHO
08/9 0430	49.02,16.23	5	52915#1,2	GOFLO	PROD,Chl
08/9 0554	49.02,16.23	300	52915#3	CTD	Chl
08/9 0600	49.02,16.23	5	BS19	NT	RNA,Chl
08/9 0800	49.02,16.23	5	BS20	NT	RNA,Chl
08/9 1000	49.08,16.27	5	BS21	"	RNA,Chl"
08/9 1325	48.54,16.20	5	BS22	"	RNA,Chl
08/9 1530	48.55,16.22	5	BS23	"	RNA.Chl
08/9 1645		15	52917#1	SAP	DNA
08/9 1930	48.57,16.32	5	BS24	NT	RNA,Chl
08/9 2325	49.01,16.37	5	BS25	"	RNA,Chl
09/9 0415	49.07,16.02	5	52919#1,2	GOFLO	PROD,Chl
09/9 0506	49.08,15.56	5	BS26	NT	RNA,Chl

MW,TA

Particle Flux Measurements

A mooring carrying 3 sediment traps was deployed off the German research vessel *Meteor* on 6.4.92. Traps were set at depths of 1000m and 3000m and 100m off the seabed a sampling time of 2 weeks and a cup solution of 4% formalin with a salinity excess of 2PPT above ambient. After a very prolonged recovery due firstly to a sticky release and then to failing light, the mooring was eventually taken on board on 3rd September and good sets of samples were found in the two lower trap. Unfortunately the international depth trap at 1000m had failed to operate. This was particularly disappointing as a marine snow camera system and current meter were also at that depth. The carousel had only moved part of the way towards cup number 1 and then jammed. No reason for this was apparent after interrogating the data logger. In contrast to previous years, only one sedimentation pulse occurred during the year, this being at the end of May with much lower fluxes at other times than had been found previously (Figure 3). A variety of gravimetric, chemical, radiological and microscopical analyses will be carried out on the collected material by several groups within the UK.

The schedule set for all these traps was:

Event	Date	Time
1	12.4.92	0001h
2	26.4.92	"
3	10.5.92	"
4	24.5.92	"
5	7.6.92	"
6	21.6.92	"
7	5.7.92	"
8	19.7.92	"
9	2.8.92	"
10	16.8.92	"
11	30.8.92	"

Carousel voltage ranges during their deployments were found to have been satisfactory for all traps:

Trap	Serial No.	Main Battery Voltage	Auxiliary Battery Voltage
A	543	21.0-21.5	8.1-8.0
B	520	20.4-18.4	8.0-7.8
C	526	21.4-19.8	8.0-7.9

An identical mooring was deployed at the same site for recovery at the end of 1993. Trap times were set to obtain the highest temporal resolution during the spring and summer when changes in flux are expected to be greatest. The schedule programmed for all three traps was:

Event	Date	Time
1	13.9.92	1200h
2	11.10.92	"
3	6.12.92	"
4	31.1.93	"
5	28.3.93	"
6	11.4.93	"
7	25.4.93	"
8	9.5.93	"
9	23.5.93	"
10	6.6.93	"
11	20.6.93	"
12	18.7.93	"
13	15.8.93	"
14	12.9.93	"

RSL

Marine Snow Distribution

The Marine Snow Profiler (MSP) photographs *in situ* 40 L of water under orthogonal collimated illumination. This is provided by a flash light directed through a bank of 3 fresnel lenses. The system can be used on a mooring to provide information on temporal variability at one locus or attached to a CTD frame to give a vertical profile at the same time as a suite of other parameters are recorded (eg C, T, D, O_2, Fluor, Trans, Light.).

During this cruise 3 deployments were made on the CTD using a new high speed flash gun (Mecablitz 45CL1) to reduce the particle smear experienced on D191 and using side baffles to prevent light spillage around the sides of the fresnels. These should give details of the distribution in the upper water column and on one occasion a full depth profile.

One mooring mode camera system was recovered from the sediment trap mooring which had been deployed on April 6th. This was at a depth of about 1200m with a frame interval of 4hrs 16mins. Film had passed through the gate and the flash was still firing on time; encouraging observations. An identical instrument was deployed during the cruise at the same height on the sediment trap mooring with a frame interval of 4hrs 16mins for recovery in 1993. As with all the marine snow profiles Tmax 100 film was used focussed at 80cm. The initial CTD deployment was with an aperture of f11 but as this appeared to give inadequate illumination this was opened to f5.6 for the subsequent two deployments. The vertical profiles were obtained with a frame interval of 15sec.

RSL

Bioacoustics

A programme of complementary LHPR and RMT 1+8M sampling was planned to validate biologically acoustic backscatter data from the ADCP. Bad weather severely curtailed the biological sampling and only 5

LHPR tows were achieved, one of which failed due to faulty electronics. Sampling was aimed at depths according to a) significant positive backscatter intensity anomalies produced by continuous plots of the ADCP data and b) the depth profile of the automatic gain control of the ADCP continuously displayed in the main lab. The limited sampling indicated that the strong positive anomalies below the thermocline (60m) and at depths of ca. 110m and 250m were due to amphipods (*Themisto compressa*) and euphausiids (*Meganyctiphanes norvegica* and *Nematobrachion boopis*). Future analysis will hopefully a) produce meaningful calibration of biomass v. acoustic backscatter and b) relate biological patchiness both horizontally and vertically to acoustic variability.

The ADCP operated throughout the cruise (Tables 4 & 5). Data were continuously logged and plotted and records kept of ambient temperature in the laboratory and concurrent water temperature to enable future calibration of the transducer. Depth penetration by the ADCP was disappointing - due partly to the poor weather, and partly - as shown by a number of calculations of absolute target strength - to the paucity of scatterers. However, it is clear that using the ADCP as a biological indicator offers immense promise (Figure 4) - clear synoptic pictures of biological patchiness in time and space are readily obtained and it is possible to target net sampling according to acoustic records.

HSJR, MVA

Nets and Bathysnap

Although this cruise was not very successful in the size or quantity of catches from the fishing gears, it has shown us how to fish these gears on ships with 'A'-frames. The RMT 1+8M has been modified to allow a folded net to be deployed and recovered, without the use of a crane, through the 'A'-frame. Launch is very simple, using the main warp and two small auxiliary winches to lift the net over the rail and into the water. The first recovery was troubled by being unable to pull the weight-bar inboard and so the net was launched face down to allow time for a rethink. The second recovery went very smoothly, using a deck-mounted winch to pull the weight bar in. No problems occurred with the release gear or electronics and this net appears now to be ready for use on all NERC ships, as long as winch or capstan is fitted forward of the aft deck. It should be noted that on this ship, without a traction winch, fishing the top two hundred metres may prove very difficult. To prevent slack turns appearing on the drum the ship's speed was held at four knots until about four hundred metres of wire had been paid out. This speed is twice that which the net should be fished at.

The LHPR was fished on five occasions, three very good hauls, one reasonable haul and one very suspect one. The second haul was left in the water for an extended period due to inclement weather and on recovery was found not to have wound on properly, and the battery pack to have al but discharged itself. However, no fault was found in the lab. and with a new battery pack in place it worked perfectly until it was on deck. A further test revealed an intermittent fault on the motor logic board. This board was replaced and a third successful haul was carried out. The fourth haul stopped winding on about two-thirds of the way through the haul, but worked perfectly on deck, while the fifth had worked perfectly. This suggests that there is another minor fault in the system which lack of familiarity with the gear prevented us from finding. Real time depth records were provided by an IOS monitor mounted on the frame.

Two Bathysnaps featured in the cruise, one recovery and one deployment, with less than ideal weather conditions contributing to problems with both. During the recovery the rope rode up the block and became trapped stopping hauling. The line was stopped off, cut, and brought in through another block. Hardly textbook but recovery was accomplished without further incident. Bad weather also hindered deployment. The amount of movement from the ship meant that steadying lines were needed for the frame. Unfortunately, one became trapped and the gear had to be brought back in, freed, and redeployed. The second attempt used only one stay, which was not ideal, but was successful and the Bathysnap was successfully launched.

BB

IOSDL 10kHz monitoring

An IBM compatible equipped with IOSDL waterfall display software and interface was used for all 10kHz monitoring. It was driven from the Simrad echo sounder analogue output and provided a user-friendly interface for displaying the towed net operations. The acoustic monitor attached to the RMT net system performed without fault. The LHPR operation benefited from the attachment of an IOSDL monitor to relay accurate, real time depth, information.

DE

Moorings

The sediment trap mooring deployed earlier in the year was equipped with two IOSDL CR200s each firing a single pyro on the same release mechanism. Both units responded to beacon command. CR2527 was activated through its firing cycle three times but the mooring did not rise. CR2530 was reluctant to respond to the firing command but eventually fired after altering the ship's position. Due to these problems and the anticipated near dusk recovery the mooring was acoustically monitored overnight and recovered the following morning. On inspection only one pyro had fired. The other was kept for inspection back at the lab.

The MSP camera had run through all film and was kept for processing back at the lab. This mooring was eventually redeployed with new film and batteries in the MSP and using RVS releases.

The Bathysnap mooring equipped with CR2436 was recovered without any problems. Again this was redeployed with a new camera and flash with a wire tested IOSDL release CR2443 310-329hz, 349-368hz, p 1.06 sec.

DE

Camera operations

A MSP was attached to the CTD frame and used three times. Film for the first deployment was developed onboard. The other two were kept for processing back at the lab.

DE

TABLE 4

Darwin 72 ADCP computer files

Day No.	Start Time	End Time	File No.	Comments
238-9	2000	0400	1	On shelf
239	0400	1200	2	On shelf
239	1200	2000	3	On shelf
239-40	2000	0400	4	Crossed break at 0130, scattering at lip, eddy structure in deep water offshore
240	0400	1200	5	
240	1200	2000	6	
240-1	2000	0400	7	DSL rise 2000-2100 250-50m
241	0400	1200	8	Hove to 0930
241	1200	2000	9	Trawling at 2kts from 1600
241-2	2000	0400	10	DSL 300-50m 2000-2115, Rich 0030-0215
242	0400	1200	11	DSL sink 0548-0600 100-250m
242	1200	2000	12	
242-3	2000	0400	13	Clear rise 1930-2100 from 300+, 250 and 150m V. patchy during night
243	0400	1200	14	1015 underway
243	1200	2000	15	
243-4	2000	0400	16	
244	0400	1200	17	
244	1200	2000	18	Waves in thermocline 1600-1800h
244-5	2000	0400	19	2 layers 300 & 150 rising to 75-150m 2000-2030
245	0400	1200	20	
245	1200	2000	21	
245-6	2000	0400	22	Two surface layers at 40 +80-100m
246	0400	1200	23	
246	1200	2000	24	See stn 52906/3
246-7	2000	0400	25	Calm conditions multiple layers 200,110,60,wml
247	0400	1200	26	
247	1200	2000	27	
247-8	2000	0400	28	
248	0400	1200	29	Crossed shelf break 0830h
248	1200	2000	30	Shelf waters
248-9	2000	0400	31	Shelf waters
249	0400	1200	32	Crossed shelf break 0600h
249	1200	2000	33	
249-50	2000	0400	34	
250	0400	1200	35	See LHPR 52909, Heavy gale
250	1200	2000	36	
250-1	2000	0400	37	
251	0400	1200	38	
251	1200	2000	39	See LHPR 52913
251-2	2000	0400	40	See LHPR 52915
252	0400	1200	41	

252	1200	2000	42	See LHPR 52918
252-3	2000	0400	43	
253	0400	1200	44	
253	1200	2000	45	
253-4	2000	0400	46	Crossed shelf break 2230h
254	0400	1200	47	

TABLE 5

ADCP temperature log

Day	Ships time	ADCP time	Deck temp	Water temp
238	1750 06	1749 58	32.8	17.6
239	0748 00	0747 57	33.3	16.8
239	1306 07	1305 58	33.4	16.8
239	1807 11	1805 57	34.2	15.3
240	0653 54	0653 58	33.8	16.1
240	0836 24	0835 57	34.2	16.0
240	1628 00	1627 58	28.4	15.8
240	2012 23	2011 58	26.9	15.8
241	0837 05	0835 57	23.6	16.6
241	1149 49	1149 58	24.9	16.6
241	1335 37	1333 58	24.9	16.7
241	1955 50	1955 57	24.9	16.7
241	2305 49	2305 57	24.6	16.6
242	0946 32	0945 57	25.5	16.7
242	1507 32	1505 58	26.0	17.0
242	1859 22	1857 57	25.8	16.9
243	0619 44	0619 58	23.2	16.5
243	0910 32	0909 57	23.3	16.4
243	1357 42	1357 57	24.9	16.8
243	1957 43	1957 57	25.1	16.4
243	2214 33	2213 57	25.2	16.2
244	0849 50	0849 58	30.5	16.0
244	1016 21	1015 58	31.3	16.1
244	1231 55	1231 57	32.1	16.4
244	1536 07	1535 58	33.1	16.5
244	1804 26	1803 58	28.2	16.5
245	0449 39	0449 57	24.9	16.3
245	0813 03	0811 57	25.7	16.4
245	1320 10	1320 00	27.0	16.3
245	1530 Interruption of record for bleeding			
245	1758 08	1757 58	28.2	16.5
246	0821 36	0821 58	31.9	16.3
246	1209 35	1209 57	28.6	16.3
246	1541 36	1541 59	29.4	16.5
246	1656 40	1655 58	30.0	16.5
246	1935 04	1933 58	31.4	16.0
247	0003 34	0003 50	26.6	15.9
247	0749 34	0749 58	24.3	15.9
247	1145 33	1145 58	25.7	15.9
247	1355 27	1353 58	25.9	15.8
247	1603 33	1603 58	26.5	15.8
247	1955 32	1955 58	29.3	15.1
248	0709 32	0709 59	22.9	14.7
248	1308 23	1307 58	25.4	13.7
248	1545 07	1543 57	26.0	14.8
248	1909 52	1909 58	25.5	13.2
249	0805 28	0805 50	24.4	14.7
249	1149 40	1149 58	25.3	15.5

Table 5 contd

Day	Ships time	ADCP time	Deck temp	Water temp
249	1533 27	1531 37	27.1	15.4
249	1831 32	1831 58	27.0	15.1
249	2251 26	2251 58	27.0	15.7
250	0635 26	0635 58	29.8	16.0
250	1107 26	1107 59	32.8	16.2
250	1333 25	1333 59	33.2	16.1
250	1706 12	1705 56	32.9	16.2
250	1931 24	1931 57	27.3	15.9
251	0655 22	0655 58	24.0	15.8
251	0831 56	0831 58	24.1	15.7
251	1029 22	1029 58	23.4	15.6
251	1509 21	1509 57	23.5	15.8
251	1851 21	1851 58	23.2	15.6
252	0513 20	0513 58	23.1	15.6
252	0919 20	0919 59	25.1	15.6
252	1541 17	1541 57	28.1	15.7
252	1909 16	1909 57	26.8	15.6
253	0705 17	0705 59	24.0	14.9
253	1136 28	1135 58	23.8	14.9
253	1155 16	1155 58	23.7	14.9
253	ca 1430 Interrupt; "disk full"			
253	1453 16	1453 58	24.4	14.8
253	1535 58	1535 49	25.4	14.8
253	1645-1845 No recording during disk copying			
253	1924 46	1921 53	27.2	14.6
254	0752 49	0751 54	24.7	15.0

TABLE 6

XBT Log

Date	Day	Time	File No.	Drop No.	Position N	W	
29/8	242	1055	701a	1	48°53.41	16°20.18	
	242	1510	702a	2	48°53.44	16°30.05	
	242	1904	703a	3	48°56.40	16°43.00	
30/8	243	0614	704a	4	49°11.58	17°16.25	
	243	0948	705a	5	49°13.76	17°26.10	
	243	1035	706a	6	49°12.53	17°22.53	
	243	1355	707a	7	48°58.73	16°32.22	
	243	1950	708a	8	48°56.95	16°19.11	
31/8	244	0844	709a	9	49°02.70	16°23.80	
	244	1241	710b	10	48°55.57	16°18.59	
	244	1805	711a	11	48°58.00	16°23.00	
1/9	245	0544	712a	12	48°55.63	16°19.21	
	245	0820	713a	13	48°56.00	16°22.61	
	245	1529	714a	14	48°46.26	16°30.18	
	245	1801	715a	15	49°07.13	16°34.49	
2/9	246	0813	716a	16	48°57.03	16°21.53	
	246	1159	717a	17	49°00.58	16°35.60	
	246	1530	718a	18	49°10.80	16°52.94	
	246	2031	719a	19	48°55.33	16°17.92	
	246	2350	720a	20	48°54.84	16°16.48	
3/9	247	0742	748a	21	48°57.05	16°19.60	
	247	1136	722a	22	49°00.80	16°21.89	
	247	1555	723a	23	49°21.44	15°22.84	
	247	1946	724a	24	49°41.82	14°22.18	
4/9	248	0659	725a	25	50°38.03	11°24.09	
	248	0806	726a	26	50°44.19	11°05.40	On slope
5/9	249	0755	727a	27	50°37.08	11°36.23	
	249	1153	728a	28	50°17.00	12°38.20	
	249	1537	729a	29	49°56.60	13°32.49	
	249	1835	70e	30	49°41.94	14°16.44	
	249	2242	71b	31	49°21.23	15°09.23	
6/9	250	0642	732a	32	48°53.87	16°23.21	only to 220m"
	250	1708	733a	33	49°03.13	17°08.71	
	250	1934	74a	34	48°53.40	16°33.21	
7/9	251	0648	735a	35	48°58.17	16°19.98	
	251	1015	736a	36	48°54.65	16°15.84	
	251	1459	737a	37	49°06.60	16°21.55	
	251	1842	738a	38	48°56.87	16°17.73	
8/9	252	0502	739a	39	49°01.84	16°23.19	
	252	0907	740a	40	49°04.69	16°24.57	only to 100m"
	252	0909	741a	41	49°05.32	16°25.00	to ca 500m
	252	1531	742a	42	48°55.90	16°22.42	
	252	1859	743a	43	48°56.65	16°25.85	
9/9	253	0654	744a	44	49°13.58	15°24.30	
	253	1154	745a	45	49°29.14	14°01.10"	
	253	1443	746a	46	49°37.19	13°12.60	

GEAR CODES USED IN STATION LIST

APSTEIN	40cm diameter closing plankton net with 20µm mesh
BSNAP	Bathysnap - Benthic deployed camera system
CTD	Conductivity - Temperature - Depth probe
GOFLO	General Oceanics Water Bottle
LHS2	PML Longhurst-Hardy Plankton Recorder
MS	Multi-sampler. 12 x 1.7 litre water bottles attached to CTD
MSC	Marine snow catcher (100 litre clear water bottle)
MSP	Marine snow profiler (on CTD frame)
MSP(M)	Marine snow profiler (on mooring)
RMT1M	Multiple 1m^2 rectangular midwater trawl (330µm mesh)
RMT8M	Multiple 8m^2 rectangular midwater trawl (4.5mm mesh)
SAP	Stand alone pump - for *in situ* particle filtration
SED TRAP	Moored sediment traps
SED FLOAT	Free-floating sediment traps
WP2	Working Party 2 net

STN.	DATE 1992	POSITION LAT.	LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
52901	28/ 8	48 55.7N	16 18.8W	CTD	0- 105	1055-1115	W/B at 45,35,20,10m	
# 1		48 56.0N	16 18.9W	MS				
52901	28/ 8	48 56.7N	16 19.6W	CTD	0-4079	1212-1500	2xW/B's at 4079,4074,3047,1010,505m	4089
# 2		48 57.8N	16 21.0W	MS				
52901	28/ 8	49 0.8N	16 23.9W	RMT1M/1	400- 495	1733-1833	Materials haul	
# 3		49 2.6N	16 26.5W	RMT8M/1		Day	Flow Dist. 3.595 km.	
52901	28/ 8	49 2.6N	16 26.5W	RMT1M/2	295- 400	1833-1933	Materials haul	
# 4		49 4.2N	16 30.0W	RMT8M/2		Dusk	Flow Dist. 4.450 km.	
52901	28/ 8	49 4.2N	16 30.0W	RMT1M/3	295- 305	1933-2033	Materials haul	
# 5		49 5.7N	16 33.8W	RMT8M/3		Dusk	Flow Dist. 4.540 km.	
52902	30/ 8	49 13.6N	17 24.0W	GOFLO	0- 5	0817-0836		
# 1		49 13.7N	17 24.5W			Day		
52902	30/ 8	49 13.7N	17 25.1W	MSC	0- 50	0855-0907	Leaked	
# 2		49 13.6N	17 25.3W			Day		
52902	30/ 8	49 13.7N	17 25.8W	MSC	0- 50	0930-0945		
# 3		49 13.8N	17 26.2W			Day		
52902	30/ 8	49 13.8N	17 26.3W	WP2	0- 50	0948-0955	Materials haul	
# 4		49 13.8N	17 26.4W			Day		
52902	30/ 8	48 57.8N	16 29.3W	SED.FLOAT	0-2200	1623-1623	Two traps at 2175 & 2205 m.	
# 5	1/ 9	48 54.1N	16 27.6W					
52903	30/ 8	48 58.6N	16 20.9W	RMT1M/1	1000- 895	2026-2127	No flow, materials haul	
# 1		49 0.5N	16 23.3W	RMT8M/1		Night		

STN.	DATE 1992	POSITION LAT.	POSITION LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
52903	30/ 8	49 0.5N	16 23.3W	RMT1M/2	895- 750	2127-2227	No flow, materials haul	
# 2		49 2.3N	16 25.9W	RMT8M/2		Night		
52903	30/ 8	49 2.3N	16 25.9W	RMT1M/3	750- 690	2227-2327	No flow, materials haul	
# 3		49 3.8N	16 29.0W	RMT8M/3		Night		
52904	31/ 8	48 56.1N	16 18.9W	WP2	0- 50	1336-1343	Vertical tow, Materials haul	
# 1		48 56.1N	16 18.8W			Day		
52904	31/ 8	48 56.1N	16 18.9W	WP2	0- 50	1348-1401	Oblique; materials haul	
# 2		48 56.2N	16 19.3W			Day		
52904	31/ 8	48 56.2N	16 19.4W	MSC	0- 60	1418-1434		
# 3		48 56.1N	16 19.4W			Day		
52904	31/ 8	48 56.2N	16 19.6W	MSC	0- 40	1446-1456		
# 4		48 56.2N	16 19.6W			Day		
52904	31/ 8	48 56.4N	16 20.2W	APSTEIN	0- 50	1612-1622	Materials haul	
# 5		48 56.6N	16 20.3W			Day		
52904	31/ 8	49 0.1N	16 26.6W	CTD	0- 300	2022-2123	WB @ Standard Depths.	
# 6		49 0.3N	16 27.1W	MS				
				MSP				
52904	31/ 8	49 0.5N	16 27.6W	APSTEIN	0- 50	2145-2153	Materials haul	
# 7		49 0.6N	16 27.7W			Night		
52905	1/ 9	48 55.8N	16 20.1W	GOFLO	0- 5	0626-0632		
# 1		48 55.9N	16 20.1W			Dawn		
52905	1/ 9	48 55.9N	16 20.3W	GOFLO	0- 5	0638-0640		
# 2		48 55.9N	16 20.3W			Dawn		

STN.	DATE 1992	POSITION LAT.	POSITION LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
52906	2/ 9	48 56.2N	16 18.4W	GOFLO	0- 5	0440-0446		
# 1		48 56.3N	16 18.5W			Night		
52906	2/ 9	48 56.3N	16 18.5W	GOFLO	0- 5	0450-0453		
# 2		48 56.3N	16 18.5W			Night		
52906	2/ 9	49 3.6N	16 42.5W	LHPR2	0- 350	1325-1620	Oblique; pauses @ 350, 180 and 65m.	
# 3		49 13.8N	16 56.9W			Day		
52907	3/ 9	48 55.4N	16 20.6W	GOFLO	0- 5	0437-0440	NBG	
# 1		48 55.4N	16 20.7W			Night		
52907	3/ 9	48 55.5N	16 20.7W	GOFLO	0- 5	0443-0444		
# 2		48 55.5N	16 20.7W			Night		
52907	3/ 9	48 55.5N	16 20.8W	GOFLO	0- 5	0447-0448		
# 3		48 55.5N	16 20.9W			Night		
52907	3/ 9	48 55.6N	16 20.8W	WP2	0- 50	0545-0555	Materials haul	
# 4		48 55.6N	16 20.8W			Dawn		
52907	3/ 9	48 55.6N	16 20.9W	WP2	0- 50	0604-0615	Materials haul	
# 5		48 55.6N	16 20.9W			Dawn		
52908	3/ 9	48 56.6N	16 19.6W	SED TRAP	1171-4500	0700-1200	Recovery; Dep. Apr. 1171, 3000m(100mab)	
# 1		49 1.2N	16 22.1W	CM				
				MSP(M)				
52909	6/ 9	48 53.8N	16 23.3W	GOFLO	0- 5	0631-0632	Failure	
# 1		48 53.8N	16 23.3W			Dawn		
52909	6/ 9	48 53.8N	16 23.3W	GOFLO	0- 5	0634-0635		
# 2		48 53.9N	16 23.2W			Dawn		

STN.	DATE 1992	POSITION LAT.	POSITION LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
52909 # 3	6/ 9	48 53.9N 48 53.9N	16 23.2W 16 23.2W	GOFLO	0- 5	0637-0638 Dawn		
52909 # 4	6/ 9	48 52.6N 48 52.6N	16 26.3W 16 26.2W	GOFLO	0- 5	0716-0717 Dawn		
52909 # 5	6/ 9	48 52.7N 48 52.7N	16 26.2W 16 26.1W	GOFLO	0- 5	0727-0728 Day		
52910 # 1	6/ 9	48 53.1N 49 3.7N	16 29.8W 17 10.8W	LHPR2	0- 360	0828-1645 Day	Bad weather delayed recovery.	
52911 # 1	6/ 9	48 52.7N 48 52.9N	16 28.8W 16 29.6W	CTD MS MSP	0-4200	2030-2353	WB @ Standard Depths	
52911 # 2	7/ 9	48 57.7N 48 57.7N	16 19.8W 16 19.8W	GOFLO	0- 5	0421-0423 Night		
52911 # 3	7/ 9	48 57.7N 48 57.7N	16 19.8W 16 19.8W	GOFLO	0- 5	0425-0426 Night		
52911 # 4	7/ 9	48 57.8N 48 57.9N	16 19.8W 16 19.8W	GOFLO	0- 10	0441-0443 Night		
52911 # 5	7/ 9	48 57.9N 48 57.9N	16 19.8W 16 19.8W	GOFLO	0- 10	0452-0453 Night		
52911 # 6	7/ 9	48 58.2N 48 58.1N	16 19.6W 16 20.0W	WP2	0- 5	0636-0652 Dawn	Towed @ 1 knot, Depth approximate	
52912 # 1	7/ 9	48 56.7N 48 56.9N	16 19.3W 16 19.5W	BSNAP	0-4810	0900-0925	Recovery; deployed by Meteor in April.	4810

STN.	DATE 1992	POSITION LAT.	LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
52913	7/ 9	48 56.6N	16 18.8W	LHPR2	0- 250	1204-1430	Oblique, pauses at 190, 160, 60m.	
# 1		49 7.8N	16 22.2W			Day		
52914	7/ 9	48 55.2N	16 15.4W	SED TRAP	1040-4710	1700-2115	Parflux traps @ 1090, 3110, 4710m	4810
# 1		48 59.5N	16 22.8W	CM				
				MSP(M)				
52915	8/ 9	49 1.2N	16 22.8W	GOFLO	0- 5	0431-0432		
# 1		49 1.2N	16 22.8W			Night		
52915	8/ 9	49 1.3N	16 22.9W	GOFLO	0- 5	0436-0437		
# 2		49 1.3N	16 22.9W			Night		
52915	8/ 9	49 2.8N	16 23.5W	CTD	0- 300	0555-0725	WB @ 300,100,60,40,20,10m	
# 3		49 4.3N	16 24.3W	MS				
				MSP				
52915	8/ 9	49 2.1N	16 22.7W	LHPR2	0- 350	0815-1114	Oblique; pauses @ 190, 160, and 60m	
# 4		49 13.3N	16 30.9W			Day		
52916	8/ 9	48 55.6N	16 22.3W	BSNAP	0-4810	1500-1546	Deploy. 8h frame interval; on 2231 6/9	4810
# 1		48 56.1N	16 22.6W					
52917	8/ 9	48 57.0N	16 23.5W	SAP	0- 15	1644-1746	30 minutes pumping	
# 1		48 57.6N	16 24.7W					
52918	8/ 9	48 56.2N	16 23.4W	LHPR2	0- 75	1832-2110	Fished in thermocline @ about 65m	
# 1		48 59.4N	16 40.7W			Dusk		
52919	9/ 9	49 6.9N	16 2.5W	GOFLO	0- 5	0420-0422		
# 1		49 6.9N	16 2.5W			Night		
52919	9/ 9	49 6.8N	16 2.5W	GOFLO	0- 5	0425-0427		
# 2		49 6.8N	16 2.5W			Night		

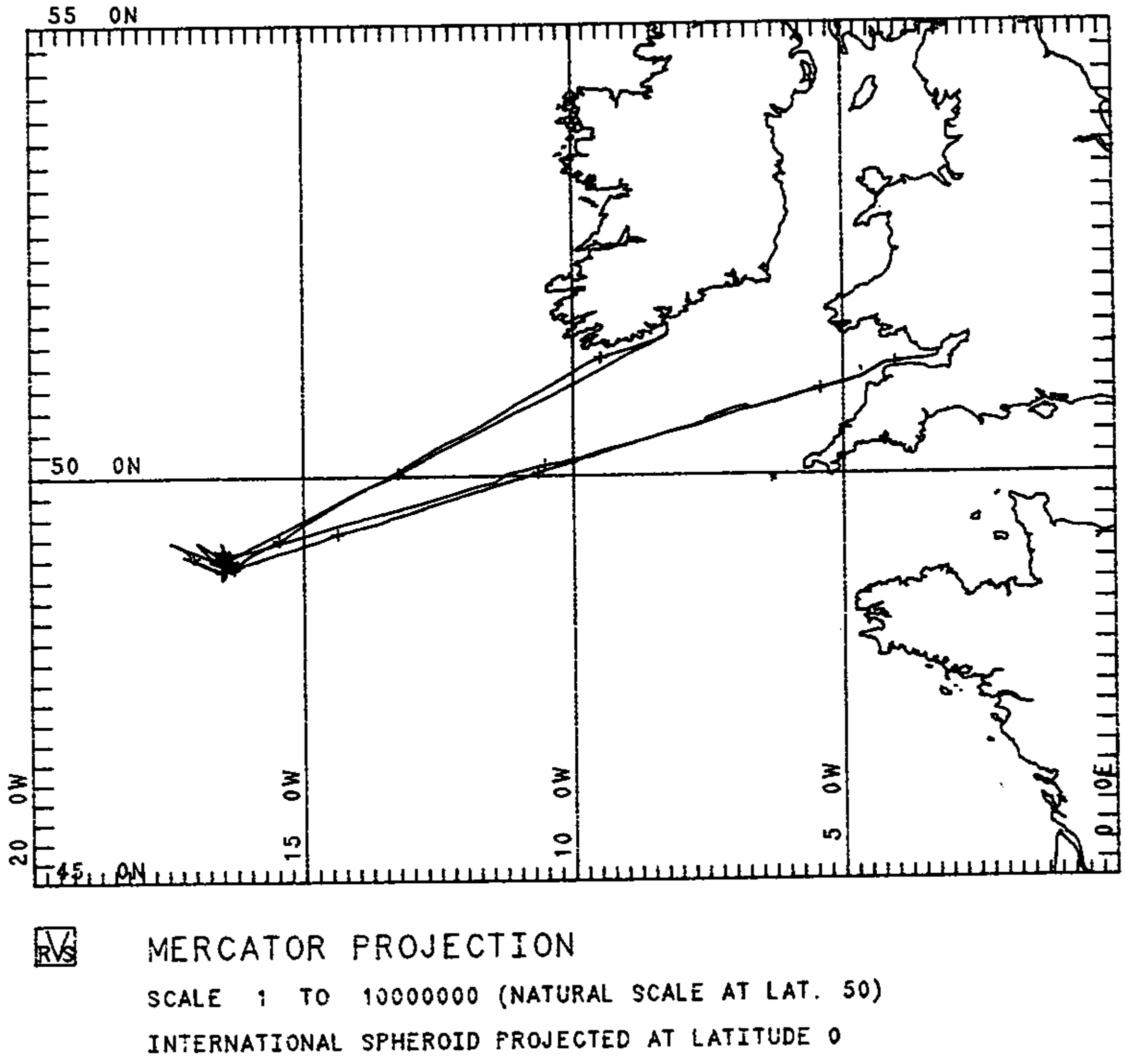
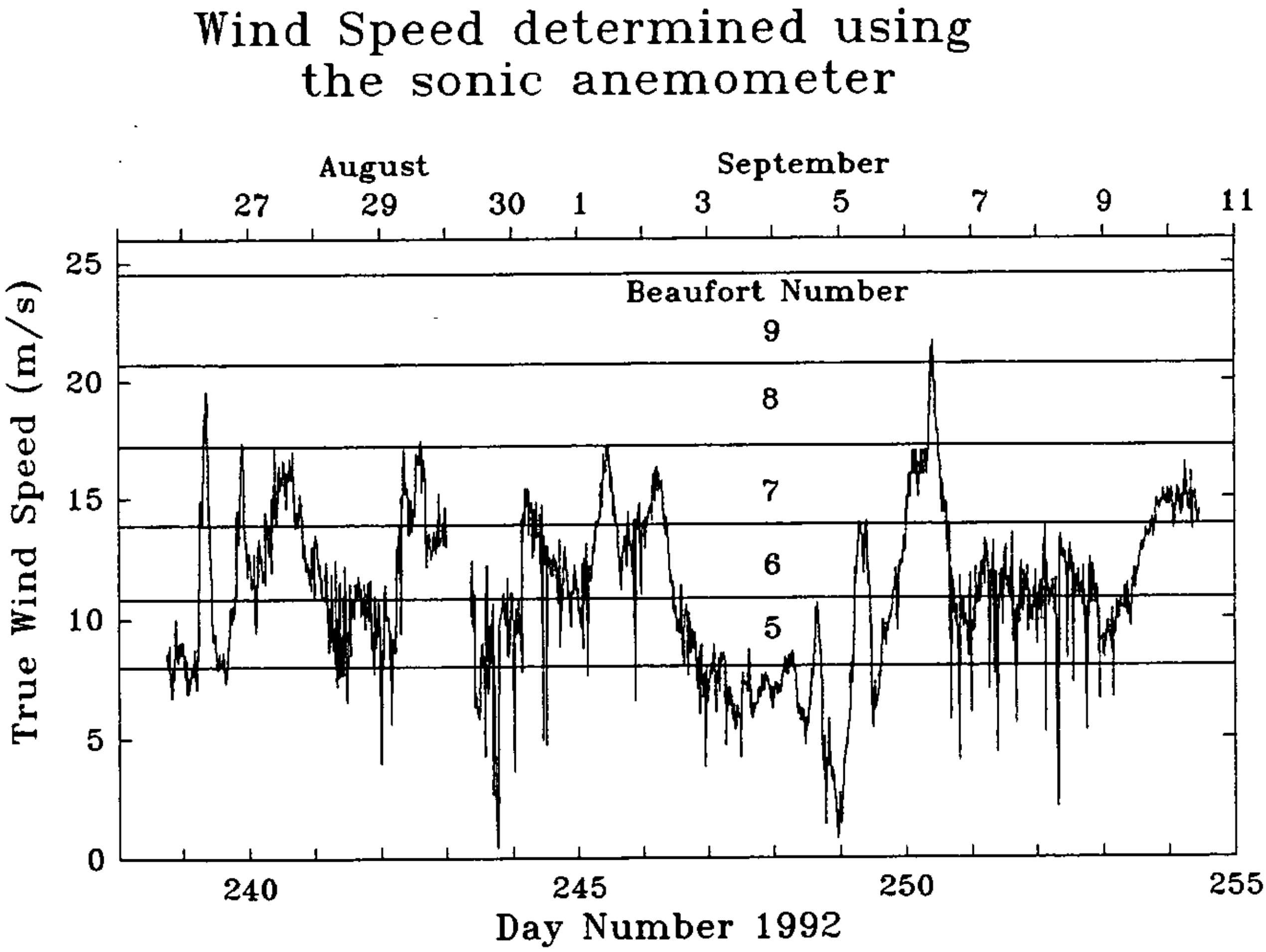


Figure 1. Track chart for RRS *Charles Darwin* cruise 72 (24 Aug - 11 Sep 1992)



NB: Wind speeds recorded on the bridge log are significantly higher than these data obtained from the acoustic anemometer. eg Storm force 10 was recorded on the bridge for much of the morning of day 250.

Figure 2. Wind speeds recorded using the on board sonic anemometer. Tick marks indicate midnight.

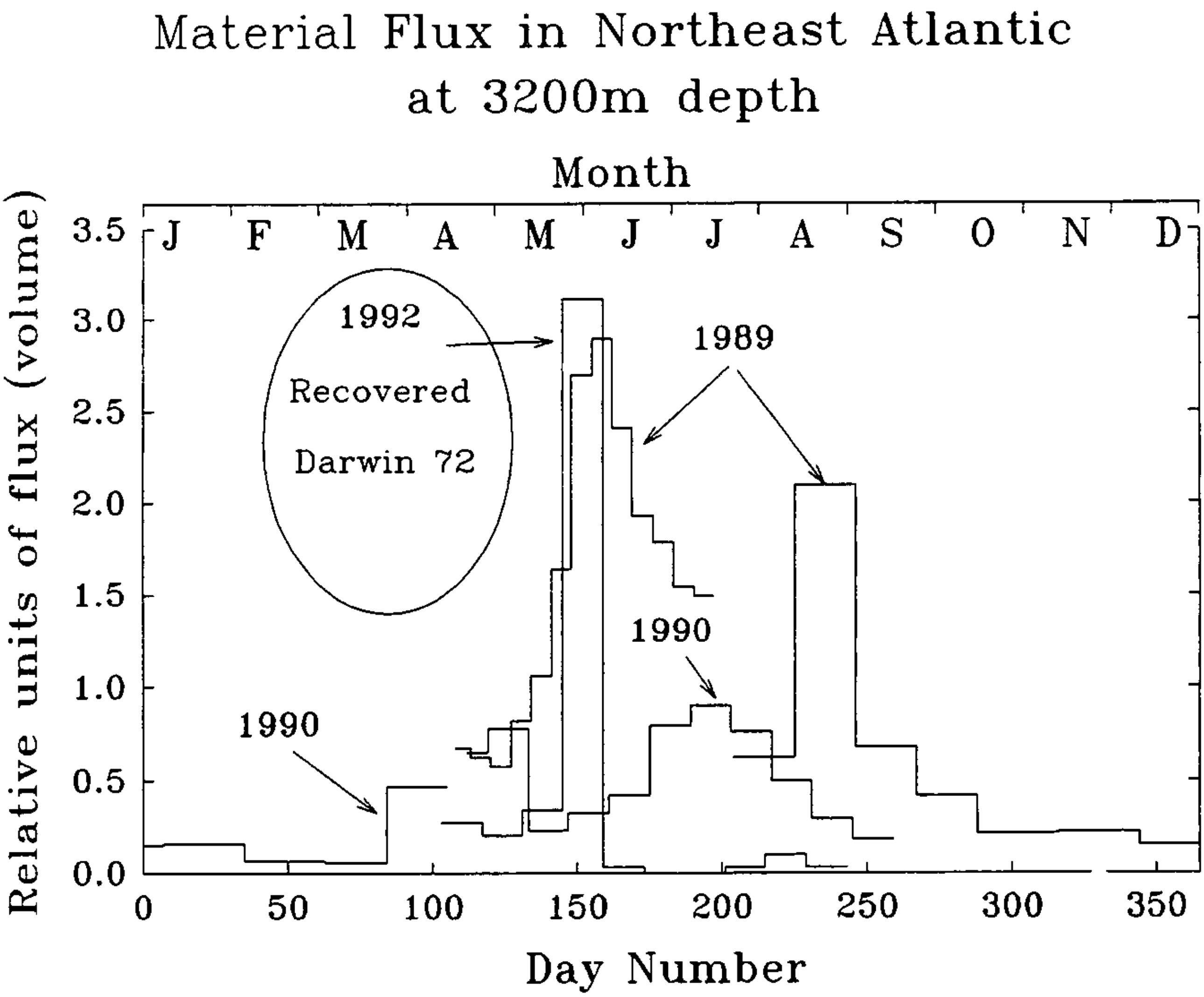


Figure 3. Particle flux at 3200m depth estimated from the volume of material collected in sediment traps. This is compared with data from previous years at a nearby site (48°N 20°W).

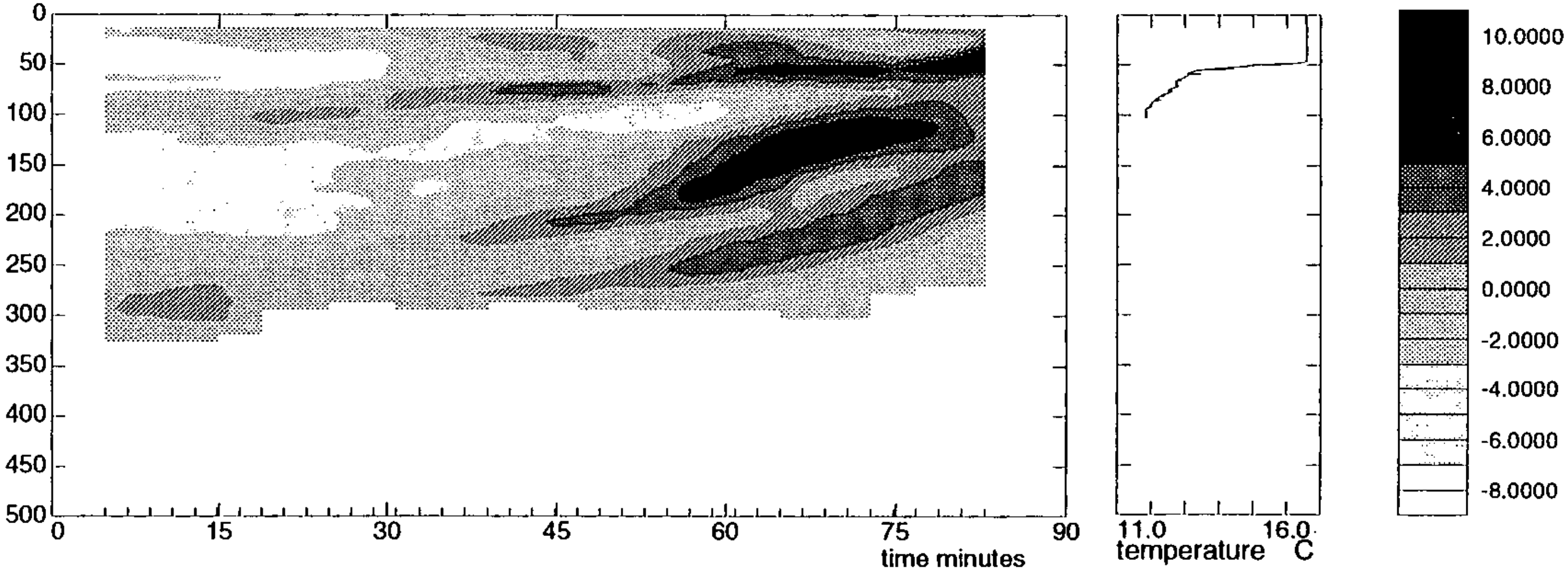


Figure 4. RRS *Charles Darwin* cruise 72: relative acoustic backscatter from the ADCP showing layers of diel migration in the vicinity of the thermocline.