CHALLENGER 61

Plymouth Marine Laboratory
United Kingdom

61

NERC NORTH SEA PROJECT

NORTH SEA SURVEY

CRUISE REPORT

RRS CHALLENGER

Cruise 61/89

21 September - 3 October 1989

Principal Scientist

I. R. Joint

1989

NATURAL ENVIRONMENT RESEARCH COUNCIL

SCIENTIFIC PERSONNEL

Dr I R Joint	Plymouth Marine Laboratory, Principal Scientist
Mr M Althaus	University of Southampton, Oceanography
Dr A J Bale	Plymouth Marine Laboratory
Mr A Banaszek	Proudman Oceanographic Laboratory
Mr L Jackson	University of East Anglia, Environmental Sciences
Mr A Jones	Research Vessel Services
Ms S Jones	Research Vessel Services
Mr M B Jordan	Plymouth Marine Laboratory
Ms H Kitts	Polytechnic South West, Marine Sciences
Ms J Merrett	Liverpool University, Oceanography
Mr P Nightingale	University of East Anglia, Environmental Sciences
Mr C Ottley	University of Essex, Chemistry
Dr A Tappin	University of Southampton, Oceanography

ACKNOWLEDGEMENTS

We thank the master, officers and crew of *RRS Challenger* for all their assistance, which contributed to a very successful cruise.

CRUISE OBJECTIVES

1. To follow a set track around the southern North Sea (Figure 1) making continuous measurements of:-

   a) Sea surface temperature, conductivity, transmittance, fluorescence, dissolved oxygen and incident irradiance.

   b) Air/sea fluxes.

   c) Current profiles.

2. AT 120 sites along the track (Figure 2):-

   a) To record CTD profiles of temperature, conductivity, transmittance, fluorescence, dissolved oxygen and up- and down-welling irradiance.

   b) to obtain water samples with a rosette sampler for calibration of the CTD sensors, for nutrient and trace metal measurements and (once per day) for the estimation of primary productivity.

3. To recover moorings for:-

   a) Current meters at sites B, E and F.

   b) Acoustic doppler current profilers at sites A, C and D.

   c) Thermistor chains at sites A, B, C and D.

NARRATIVE

RRS Challenger sailed from Great Yarmouth on mid-day on 21 September 1989 and the first CTD profile was done at station AA at 15.57. The ship then steamed round the standard survey track, sampling at every site for CTD measurements. At each station, 10 litre Go-Flo bottles on the rosette sampler were used to collect water samples for the following analysis;

nutrients (nitrate, nitrite, ammonia, phosphate and silicate), trace metal, chlorophyll concentration, suspended solids concentration and dissolved gases.

The first mooring was recovered successfully at mooring E (station AB) at 18.50 GMT on 21 September; details of all other mooring recoveries can be found later in this report. All moorings were recovered, except that at site D (station BB). At this site, the ADCP was recovered successfully, but there was no sign of the surface buoy of the Thermistor chain. We made a brief attempt to grapple for the Thermistor chain, and spent two hours dragging in the vicinity of the deployed rig. However, nothing was recovered by this exercise and the ship continued on to the next CTD station. Later that day we received a Telex informing us that a Lowestoft trawler had recovered the Thermistor chain, free floating several miles from the deployment position. The trawler took the Thermistor chain back to Lowestoft and it was subsequently recovered.

On Monday 25 September, *Challenger* visited the Netherlands Institute for Sea Research (NIOZ) at Texel. *Challenger* berthed at the port of Den Helder, and the NIOZ research ship, Navicula, transported the scientific party and crew of *Challenger* across to the island of Texel and we spent the morning touring the laboratories. After lunch we returned to *Challenger* and about 80 - 100 people from the NIOZ Laboratory then visited the ship. The NIOZ personnel were particularly impressed by the computing facilities on *Challenger* and showed a keen interest in all of the measurements being taken as part of the North Sea Survey. At 17.30 hours, *Challenger* sailed from Den Helder and returned to the standard survey track. The next CTD profile was taken at station 2781 (BK) at 02.20.

The rest of the survey track was completed without incident; all moorings were recovered and CTD profiles were done at all of the high and medium priority stations. In total, six low priority stations were omitted from the sampling track. The final CTD station at site AA was CTD number 2862 and this was completed at 03.07 on 3 October 1989.

Challenger berthed at Great Yarmouth just after mid-day on Tuesday 3 October. The cruise had been very successful with all objectives attained. All moorings had been recovered (although one was recovered by a trawler rather than *Challenger*) and 116 out a planned 120 sites were profiled with the CTD. Very little time was lost because of bad weather.

INDIVIDUAL PROJECT REPORTS

RECOVERY OF MOORINGS: A. BANASZEK (POL)

CTD STATION	POSITION LAT.	LONG	INSTRUMENTS	TIME/DATE RECOVERED	TIME/DATE DEPLOYED
A(CS)	55 30.1N	00 55.2E	THERMISTOR S/N 8	0703 GMT	1605 GMT
			STRING 1683	29.9.89	30.8.89
A(CS)	55 30.16N	00 54.8e	ADCP POLDOP 9	0620 GMT	1641 GMT
			RCM8-6443	29.9.89	30.8.89
B(CK)	55 30.1N	05 30.6E	S4 05451264 T	0620 GMT	1750 GMT
			S4 05111113 M	28.9.89	29.8.89
			S4051111118 B		
			RCM8-9347		
B(CK)	55 31.1N	05 29.8E	THERMISTOR S/N11	0540 GMT	1856 GMT
			STRING 1682	28.9.89	29.8.89
C(DM)	54 20.3N	00 23.8E	THERMISTOR S/N 10	1640 GMT	0550 GMT
			STRING 1612	30.9.89	1.9.89
C(DM)	54 20.4N	00 23.9E	ADCP POLDOP 2	1600 GMT	0659 GMT
			RCM8-9633	30.9.89	1.9.89
D(BB)	53 29.6N	03 00.6E	THERMISTOR S/N 9	Rig recovered	0945 GMT
			STRING 561	by trawler	28.8.89
D(BB)	53 29.8N	03 00.4E	ADCP POLDOP 3	0603 GMT	1014 GMT
			RCM8-9632	23.9.89	26.8.89
E(AB)	52 41.0N	02 24.6E	S4 05451263 T	1850 GMT	2017 GMT
			S4 05111112 M	21.9.89	23.8.89
			RCM8-9378 B		
F(AE)	52 36.9N	03 46.1E	S4 05451261 T	0755 GMT	2335 GMT
			RCM8-9419 B	22.9.89	25.8.89

CURRENT METER RIGS

All three mooring stations ie B E and F were recovered successfully. However the rig at Station E had been damaged since the surface buoy had been badly split. The flashing light on the buoy still worked despite the fact that the buoy was almost submerged. This enabled us to locate the rig and drag for it using the Gifford grapnel. Damage to the current meters was minimal with only a bent spindle on the Aanderaa current meter.

ADCPs

The Doppler at Station D C and A were all recovered successfully aided by the fact that each mooring incorporated a Benthos transporter.

THERMISTOR RIGS

Thermistor moorings at sites A B C were recovered but the rig at Station D was recovered by a Lowestoft trawler on the day that we visited the site. The thermistor at Station A showed signs that it has been damaged,

the thermistor string having been torn completely away from the chain.

SHIPBOARD ADCP

This performed faultlessly throughout the cruise.

Start and stop times for P.O.L. Instruments recovered during CH61/89

Instrument	Station	Time of 1st scan	Time of last scan
POLDOP 9	A	1153 GMT 30.8.89	1200 GMT 29.9.89
POLDOP 2	C	2130 GMT 31.8.89	1725 GMT 30.9.89
POLDOP 3	D	0700 GMT 26.8.89	0657 GMT 24.9.89
RCM 6443	A	0215 GMT 30.8.89	0113 GMT 30.9.89
RCM 9632	C	1415 GMT 31.8.89	0335 GMT 2.10.89
RCM 9632	D	0920 GMT 25.8.89	1340 GMT 24.9.89
Thermistors			
SN 8 CHAIN 1683	A	1345 GMT 30.8.89	0141 GMT 30.9.89
SN 11 CHAIN 1682	B	1702 GMT 29.8.89	2309 GMT 29.9.89
SN 10 CHAIN 1612	C	0550 GMT 1.9.89	0257 GMT 30.9.89
SN 9 CHAIN 5611	D	0545 GMT 26.8.89	rig recovered by trawler

Start and stop times for R.V.S. current Meters

Onstrument	Station	Time of 1st scan	Time of last scan
S4 05451264T	B	1745 GMT 29.8.89	0825 GMT 28.9.89
S4 05111113M	B	1740 GMT 29.8.89	0800 GMT 28.9.89
RCM 9347 B	B	1640 GMT 29.8.89	0800 GMT 29.8.89
S4 05451263T	E	1740 GMT 23.8.89	0909 GMT 22.9.89
S4 05111112M	E	1933 GMT 23.8.89	0853 GMT 22.9.89
RCM 9378 B	E	1710 GMT 23.8.89	1430 GMT 22.9.89
S4 05451261T	F	1534 GMT 25.8.89	1034 GMT 22.9.89
RCM 9419 B	F	1505 GMT 25.8.89	1455 GMT 22.9.89

Position of current meters. T = top M = middle B = bottom

NUTRIENT ANALYSIS:- A.J. Bale (PML)

Five nutrients: nitrate, nitrite, ammonia, phoshate and silicate were determined on water bottle samples from all depths at all the occupied stations except EL using the on-board auto analyser. There were no problems and all the results were fully processed and stored on the main computer during the cruise.

A qualitative assessment of the data indicates that the results were compatible with the hydrographic conditions prevailing after a long stable summer. There was little indication of the mixing of bottom waters into the stratified, nutrient depleted, upper waters. Ammonia was very high at DH off Hartlepool, high phosphates were detected near the bed at DQ and DR off Humber Mouth (possibly related to the dump site in that region) and high nitrites at AN, AO and AL, and to a lesser extent

at AM and AP in the mouth of the Thames.

PHYTOPLANKTON BIOMASS AND PRODUCTIVITY:- I.R. Joint, M.B. Jordan (PML)

Chlorophyll: Samples were taken for chlorophyll analysis at every CTD station from the surface mid-depth and bottom water samples. In addition, samples were taken from each water bottle used in the primary productivity experiments.

Primary Productivity: On deck incubations were done at 10 stations; 2752,2763, 2774, 2782, 2794, 2807, 2815, 2828, 2840, 2851. Triplicate samples were incubated for 24h at 6 levels of ambient light to simulate the light profile in the water column.

Phytoplankton samples were taken from alternate stations; one sample was fixed with Lugol's iodine and a replicate was fixed with neutral formalin.

Dissolved oxygen:- The ENDECO pulsed dissolved oxygen sensor was run continuously, sampling water from the non-toxic sea water supply. One of the duplicate sensors was not functioning correctly but good data were obtained throughout the cruise from the other sensor. Winkler titrations were done at intervals on samples from CTD bottles and from the non-toxic supply.

SUSPENDED SEDIMENTS:- I.R. Joint and M.B. Jordan

Continuous measurements of surface transmittance were obtained along the survey track using two deck-mounted transmissometers, which sampled the non-toxic sea water supply. Vertical profiles were obtained from the transmissometer mounted on the CTD. Water samples were filtered from three depths at every CTD station; the filters were dried and stored for subsequent gravimetric determinations.

DISSOLVED AND PARTICULATE TRACE METALS:- M. Althaus (SUDO), H, Kitts (PSW), A.D. Tappin (SUDO)

Samples for the determination of a range of dissolved and particulate trace metals were collected at 117 CTD stations (generally at one depth per station unless vertical gradients were present) using procedures described previously for survey cruises (Ch. 33, 43 and 51 (ie modified 101. Go-Flo bottles mounted on a CTD-rosette, with initial sample handling carried out in the RVS Chemistry container). The equipment operated satisfactorily.

Sea water collected for subsequent dissolved trace metal analysis was filtered (Nuclepore, 0.4 μm) and then stored acidified (Cd, Co, Cu, Mn, Ni, Pb, Zn, Fe), at 4°C in the dark (As) or frozen (Al). In total 134 acidified samples were taken, together with 40 and 53 samples for As and Al determination, respectively.

The samples will be analysed ashore using chelation - solvent extraction - GFAAS (Cd etc) hydride generation - GFAAS (As) or by chelation - fluorimetry (Al).

In addition, 69 large volume filtration samples (up to 20 l) were taken

for subsequent determination of a range of particulate trace metals (Cd, Co, Cu, Mn, Ni, Pb, Zn, Fe). The membranes were stored frozen prior to shore-based analysis employing a 1M HCl leach and measurement of the leachate using FAAS.GFAAS. Information generated from these samples will aid in the interpretation of the dissolved phase data.

During all stages of collection and initial sample processing, extreme care was taken to avoid contaminating the samples.

AIR/SEA FLUXES: Jane Merrett and G E D Bradshaw (Liverpool University)

This has been a successful cruise for air/sea flux sampling. During the cruise 7 high volume filter pairs were collected both for organic and trace metal analysis on return to Liverpool. These samples were of approximately 16 hours duration.

Two cascade impactor samples were also collected. However due to electrical and other problems the sampling time was reduced to approximately 30 hours each.

This work was completed in conjunction with Chris Ottley, Essex, Andy Rondell, UEA.

COLLECTION OF 'LARGE MARINE AEROSOL' USING ISOKINETIC SAMPLING TECHNIQUES:- Chris Ottley (University of Essex)

Equipment has operated successfully throughout cruise 61. The predominance of northerly winds has limited sampling time somewhat, as has the relatively rough weather on several days. However 60 hours worth of cascade impactor (size differential sample) has been obtained with 14 bulk aerosol samples of ~ $10m^3$ for trace metal work. 14 filter pack samples for the determination of NH_4^+, NH_3, HCl, HNO_3, NO_3^-, SO_4^{2-}, SO_2 and C^-.

Rain sampling was carried out in conjunction with Jane Merrett (LUDO) for Andrew Rendell (UEA). However only 3 showers of short duration were observed on the cruise resulting in only one poor sample.

TRACE GASES: Philip Nightingale and Luke Jackson, (School of Environmental Sciences, University of East Anglia)

Surface water samples were taken from 112 stations using the CTD rosette and analysed for trace gases. The dissolved trace gases were extracted and concentrated using a purge and cryogenic-trap technique and then analysed using three Gas Chromatographs (2 FPD and 1 ECD).

Concentrations of dimethyl sulphide (DMS) and its precursor dimethylsulphoniopropionate (DMSP) were determined. Water samples were also analysed for low molecular weight halocarbon compounds. approximately 20 halocarbon gases were regularly detected including methyliodide, bromoform, methylchloroform and carbon tetrachloride. Chlorophyll samples were frozen for laboratory analysis and phytoplankton samples were preserved using Lugol's iodine and formalin.

Overall, this was a successful cruise, no major problems were encountered

with the analytical apparatus or the sampling equipment. However, the levels of DMS and DMSP had dropped to such an extent that a bleed gas had to be used to improve the sensitivity of the detector. this was found to make one of the detectors very noisy and also resulted in a lot of baseline drift on the DMS detection system.

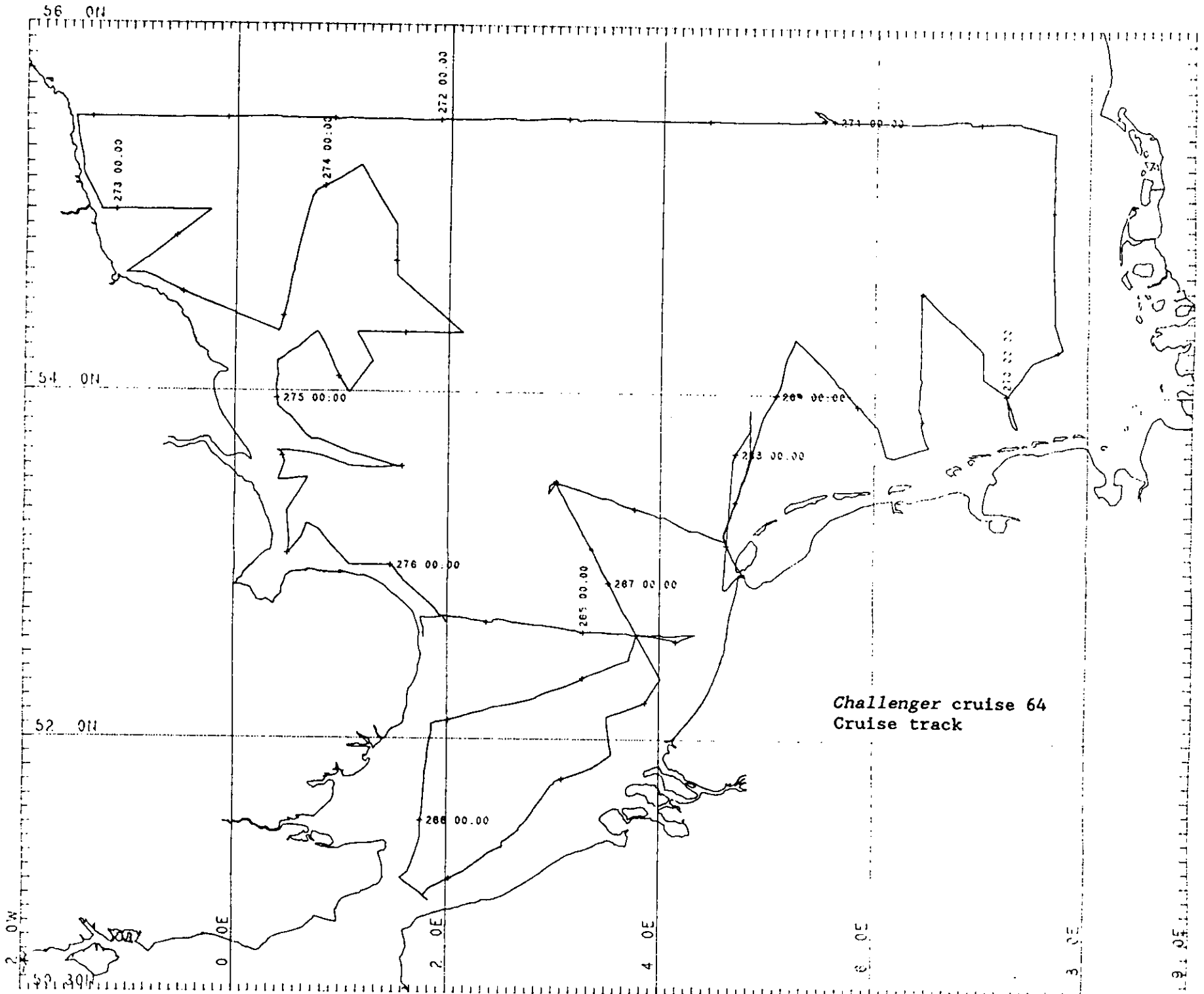
Table 1: CTD Station List

Date	Station number	Site	Start time yr day hr min	Start Position Lat Long	Depth (m)
SEPT 21	2747	AA	89 264 15.57	52 43.1N 1 56.0E	25
	2748	AB	89 264 19.30	52 41.4N 2 25.2E	52
	2749	AC	89 264 21.47	52 40.1N 2 50.0E	45
	2750	AD	89 264 23.40	52 38.0N 3 14.9E	34
SEPT 22	2751	AF	89 265 02.58	52 37.0N 3 60.0E	27
	2752	AG	89 265 04.51	52 37.0N 4 19.9E	21
	2753	AH	89 265 06.01	52 34.6N 4 8.9E	26
	2754	AE	89 265 08.19	52 37.2N 3 46.0E	30
	2755	AI	89 265 09.56	52 28.2N 3 42.1E	27
	2756	AJ	89 265 12.05	52 21.4N 3 15.9E	39
	2757	AK	89 265 14.05	52 14.8N 2 49.7E	41
	2758	AL	89 265 16.18	52 10.0N 2 20.2E	51
	2759	AM	89 265 18.53	52 5.2N 1 50.6E	30
	2760	AN	89 265 21.51	51 47.2N 1 47.2E	26
SEPT 23	2761	AO	89 266 00.12	51 29.9N 1 45.0E	36
	2762	AP	89 266 02.30	51 10.9N 1.33.7E	48
	2763	AQ	89 266 04.25	61 3.0N 1 49.8E	32
	2764	AR	89 266 09.03	51 28.2N 2 40.2E	31
	2865	AS	89 266 11.30	51 45.0N 3 0.1E	32
	2766	AT	89 266 13.17	51 50.0N 3 22.0E	27
	2767	AU	89 266 16.03	52 7.9N 3 29.9E	32
	2768	AV	89 266 17.54	52 13.0N 3 52.0E	26
	2769	AW	89 266 19.13	52 21.0N 4 0.1E	24
	2770	AX	89 266 21.23	52 37.1N 3 46.2E	30
	2771	AY	89 266 22.56	52 46.9N 3 37.2E	31
SEPT 24	2772	AZ	89 267 00.42	53 0.1N 3 25.9E	27
	2773	BA	89 267 02.29	53 11.8N 3 16.0E	27
	2774	BB	89 267 05.09	53 29.9N 3 0.0E	32
	2775	BC	89 267 10.29	53 24.7N 3 27.1E	29
	2776	BD	89 267 13.05	53 18.1N 4 0.2E	28
	2777	BE	89 267 14.54	53 13.5N 4 20.1E	30
	2778	BF	89 267 16.15	53 9.9N 4 36.9E	22
	2779	BG	89 267 19.50	53 39.0N 4 49.9E	30
	2780	BH	89 267 22.03	53 55.1N 4 49.9E	40
SEPT 26	2781	BK	89 269 02.18	54 19.0N 5 14.7E	44
	2782	BL	89 269 04.51	54 3.0N 5 40.4E	38
	2783	BM	89 269 06.03	53 56.5N 5 50.2E	34
	2784	BN	89 269 07.18	63 50.0N 6 0.3E	30
	2785	BO	89 269 09.03	53 39.0N 6 10.3E	26
	2786	BP	89 269 10.50	53 43.1N 6 29.8E	22
	2787	BQ	89 269 12.27	53 55.0N 6 24.5E	26
	2788	BR	89 269 13.56	54 5.9N 6 24.9E	33
	2789	BS	89 269 15.45	54 20.1N 6 24.9E	38
	2790	BT	89 269 17.43	54 34.9N 6 25.0E	39
	2791	BU	89 269 19.24	54 25.0N 6 42.7E	37
	2792	BV	89 269 21.08	54 15.0N 7 00.0E	37
	2793	BW	89 269 22.28	54 5.9N 7 0.0E	34
	2794	BX	89 269 23.53	54 0.5N 7 13.8E	30
SEPT 27	2795	BY	89 270 01.40	53 49.5N 7 19.6E	23
	2796	BZ	89 270 04.51	54 11.5N 7 28.0E	38
	2797	CA	89 270 06.13	54 16.0N 7 45.2E	27

Table 1: (CONTINUED) CTD Station List

Date	Station number	Site	Start time yr day hr min	Start Position Lat	Long	Depth (m)
	2798	CB	89 270 07.35	54 24.9N	7 40.2E	27
	2799	CC	89 270 09.27	54 40.1N	7 40.0E	23
	2800	CD	89 270 11.12	54 55.0N	7 39.9E	22
	2801	CE	89 270 12.54	55 10.1N	7 40.0E	22
	2802	CF	89 270 14.51	55 27.0N	7 40.0E	24
	2803	CG	89 270 16.15	55 30.0N	7 19.9E	29
	2804	CH	89 270 17.40	55 30.1N	7 0.1E	28
	2805	CI	89 270 19.55	55 30.1N	6 30.0E	42
	2806	CJ	89 270 22.12	55 30.0N	6 0.1E	50
SEPT 28	2807	CK	89 271 04.38	55 32.3N	5 26.5E	52
	2808	CL	89 271 09.00	55 29.8N	4 59.2E	43
	2809	CM	89 271 11.09	55 30.0N	4 30.9E	32
	2810	CN	89 271 14.37	55 30.0N	3 44.8E	34
	2811	CO	89 271 17.17	55 30.1N	3 10.1E	36
	2812	CP	89 271 20.10	55 30.1N	2 35.1E	47
	2813	CQ	89 271 22.46	55 29.8N	2 1.5E	66
SEPT 29	2814	CR	89 272 01.46	55 30.0N	1 24.9E	76
	2815	CS	89 272 04.40	55 29.9N	0 54.3E	86
	2816	CT	89 272 09.20	55 30.2N	0 24.0E	73
	2817	CU	89 272 11.33	55 30.0N	0 3.9W	74
	2818	CV	89 272 13.34	55 30.0N	0 32.1W	65
	2819	CW	89 272 15.24	55 29.9N	0 52.0W	95
	2820	CX	89 272 16.59	55 29.9N	1 11.9W	89
	2821	CY	89 272 18.37	55 30.0N	1 32.9W	31
	2822	CZ	89 272 20.03	55 20.2N	1 29.9W	40
	2823	DA	89 272 21.34	55 10.2N	1 27.0W	36
	2824	DB	89 272 23.09	54 59.8N	1 18.3W	40
SEPT 30	2825	DC	89 273 00.44	55 0.0N	0 57.0W	84
	2826	DD	89 273 02.19	54 59.9N	0 36.1W	72
	2827	DE	89 273 03.53	54 59.9N	0 15.0W	93
	2828	DF	89 273 05.36	54 52.0N	0 32.9W	65
	2829	DG	89 273 07.21	54 44.0N	0 51.2W	55
	2830	DH	89 273 08.34	54 39.2N	1 3.3W	24
	2831	DI	89 273 09.35	54 39.2N	0 53.3W	42
	2832	DJ	89 273 11.15	54 35.0N	0 37.2W	51
	2833	DK	89 273 12.43	54 30.9N	0 21.0W	58
	2834	DL	89 273 14.22	54 25.9n	0 0.1E	61
	2835	DM	89 273 17.01	54 20.1N	0.24.1E	60
	2836	EF	89 273 20.05	54 40.9N	0 32.6E	75
	2837	EE	89 273 23.18	55 6.1N	0.44.1E	75
OCT 1	2838	ED	89 274 01.39	55 15.0N	1 10.0E	68
	2839	EC	89 274 03.07	55 4.9N	1 19.1E	36
	2840	EB	89 274 04.37	54 55.4N	1 29.8E	32
	2841	EA	89 274 06.35	54 39.0N	1 30.0E	35
	2842	DY	89 274 09.51	54 20.1N	2 7.5E	36
	2843	DZ	89 274 12.19	54 20.0N	1 30.0E	48
	2844	EH	89 274 13.49	54 20.1N	1 8.0E	57
	2845	EI	89 274 15.20	54 10.0N	1 16.8E	63
	2846	EJ	89 274 16.55	53 59.8N	1 3.6E	43
	2847	EG	89 274 20.07	54 20.0N	0 45.7E	62
	2848	DN	89 274 22.16	54 10.2N	0 23.7E	57

OCT 1	2849	DO	89 275 02.30	53 54.9N 0 24.0E	48
	2850	EK	89 275 02.30	53 43.9N 0 43.0E	31
	2851	DT	89 275 06.04	53 35.0N 1 33.9E	50
	2852	DS	89 275 08.27	53 35.0N 1 5.2E	24
	2853	DP	89 275 11.28	53 39.9N 0 24.0E	20
	2854	DQ	89 275 13.10	53 30.0N 0 24.1E	15
	2855	DR	89 275 14.32	53 31.0N 0 41.1E	97
	2856	EL	89 275 16.09	53 19.9N 0 29.8E	17
	2857	EM	89 275 17.21	53 9.8N 0 30.8E	21
	2858	EN	89 275 18.02	53 4.9N 0 29.6E	37
	2859	EO	89 275 20.21	53 13.0N 0 47.6E	26
	2860	EP	89 275 22.07	53 0.9N 1 4.1E	18
	2861	EQ	89 275 23.48	53 1.0N 1 27.1E	28
OCT 3	2862	AA	89 276 03.07	52 43.3N 1 55.7E	25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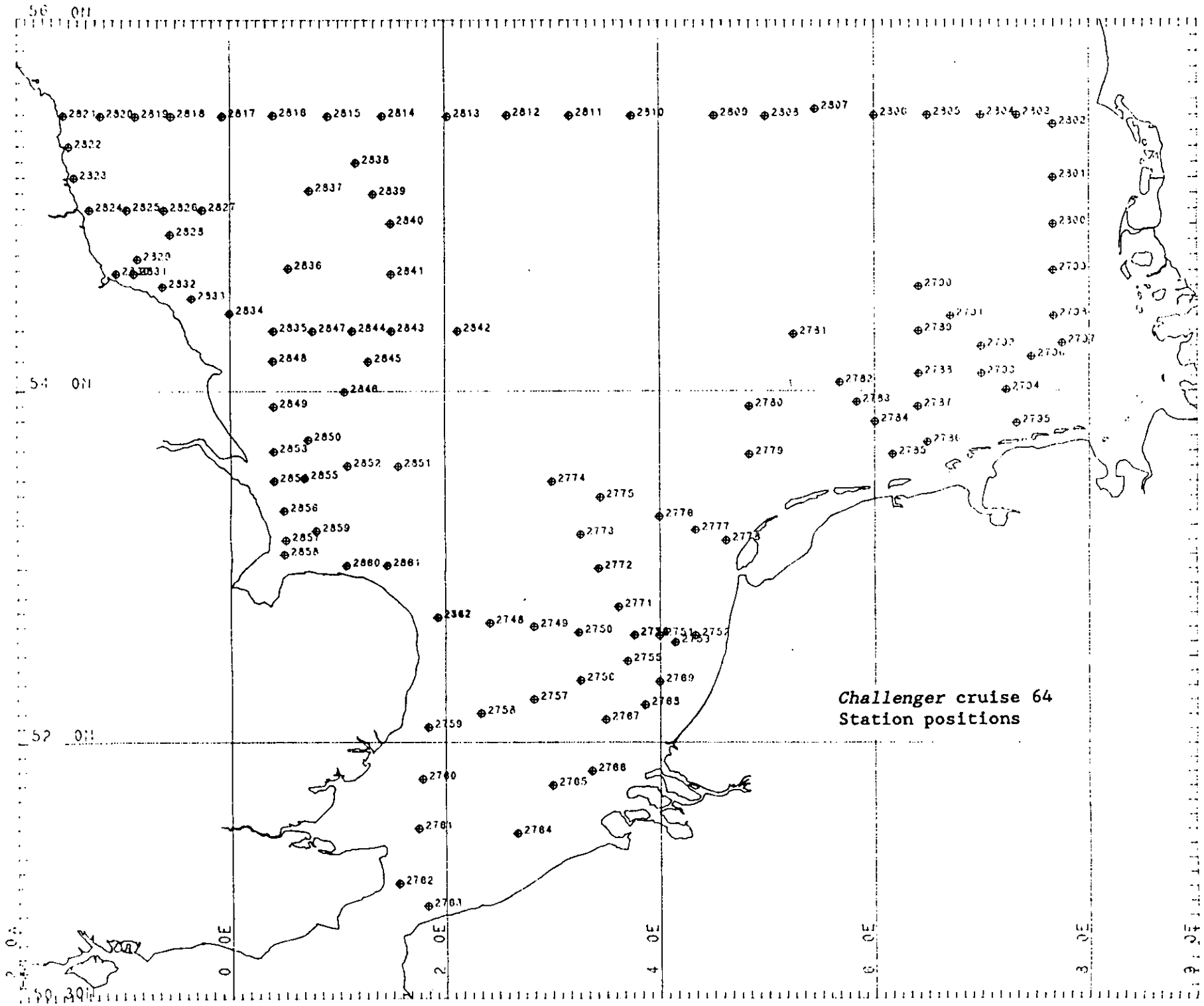
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Station positions