THE UNIVERSITY OF SOUTHAMPTON

DEPARTMENT OF OCEANOGRAPHY

RRS Challenger Cruise 50/89
(NERC North Sea Project)

CRUISE REPORT

Report No. SUDO/TEC/90/4/NC

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1. PERIOD 12 to 25 April, 1989

2. PERSONNEL

A.J. Bale (PML)
J.D. Burton (Southampton University) (Principal Scientist)
E. Cooper (RVS)
G. Daneri (Southampton University)
G. Glegg (Polytechnic Southwest)
D.J. Hydes (IOSDL)
I.R. Joint (PML)
G. Malin (UEA)
K. McShane (UEA)
F. Ormaza-Gonzalez (Southampton University)
D. Phillips (RVS)
D.A. Purdie (Southampton University)
P.J. Statham (Southampton University) (Co-Principal Scientist)
S. Turner (UEA)

3. OBJECTIVES

The scientific objectives of the cruise, undertaken as part of the NERC North Sea Project, were to investigate gross and net primary production during bloom conditions and to examine the relationships between primary productivity and the biogeochemical cycling of certain trace metals and biogenic trace gases. In order to be able to relate changes in water chemistry to primary productivity it was intended to make time series measurements of chemical, biological and hydrographic parameters within a tracked body of water in which production was occurring. Measurements on transects were also to be made (1) to enable the characteristics of the tracked water body to be related to those of the surrounding waters, and (2) to enable comparisons to be made of biological and chemical characteristics of waters within contrasting productivity regimes, affording additional information and an alternative strategy should the required changes in biological activity not occur during the time series experiments.

4. NARRATIVE

The cruise track is shown in Fig. 1. Details of CTD stations are listed in Appendix 1.

Sailed from Great Yarmouth at 13.55* on 12 April (Day 102) and proceeded north to investigate an area centred on 54°20'N, 00°45'E. This was chosen on the basis of available information, particularly measurements on RRS Challenger Cruise 49/89 which indicated a chlorophyll front associated with a diatom bloom in that area. The non-toxic seawater supply, which was used for most underway measurements, was switched on once clear of the rivermouth. The PES fish was deployed at 14.45 and the Simrad pole immediately following. Continuous surface recording equipment was commissioned; scientific watch keeping commenced at 19.00. By 23.00, had reached waters with abundant diatoms (mainly Rhizoselenia), virtually undetectable concentrations of nitrate and high fluorescence values.

Course changed at 03.30 on Day 103. Headed west along 53°55'N, observing marked decrease in fluorescence between 01°01.3' and 00°35.3'E. Changed course to NE at 04.50. Shakedown CTD stations (1703 & 1704) at 09.12 and 10.15, respectively. Grid survey about the NE course commenced at 14.30 and continued to 22.30. Deployment position for time series experiment (Site N) chosen on basis of underway observations and proceeded towards station into Day 104, continuing underway observations of fluorescence and nitrate concentrations. CTDs at deployment position at 04.32 (1705) and 05.12 (1706). Combined in situ incubation rig and sediment trap deployed at 06.15 and drogue deployed at 07.36. Remained in sight of drogue carrying out CTD casts at drogue position at 10.40 (1707), 14.30 (1708), 18.37 (1709) and 23.33 (1710). The cruise track during the drogue experiment at Site N is shown in Fig. 2.

CTD station at drogue at 04.23 (1711) on Day 105. CTD was down following this cast. Incubation/sediment trap rig recovered at 06.04. Water samples for the rig obtained by hydrowire cast at 07.05 using five 7-litre NIO water bottles. Incubation/sediment trap rig redeployed at drogue position at 07.50. CTD casts at drogue at 10.14 (1712), 13.09 (1713) and 18.02 (1714). Between stations 1713 and 1714 underway measurements of fluorescence and nutrients made on grid to map variability in area of drogue. Following station 1714 larger grid commenced, to include return to drogue to maintain sampling intervals. Trace metal samples taken on this section using clean sampling tube with intake forward of PES fish. PES fish brought inboard at 20.08 and redeployed at 20.38 to adjust sampling system. During Day 105 conditions of solar insolation were the most favourable encountered to date leading to surface water warming and development of significant stratification.

Grid continued until 03.50 on Day 106. Drogue could not be located before daybreak because of failure of Argos buoy light. CTD stations at 00.42 (1715), 04.43 (1716) and 05.43 (1717) made at the position of the incubation/sediment trap rig. Rig recovered at 06.27, water samples for

*All times are GMT

incubation experiment obtained by hydrowire cast as previously, and rig redeployed at 07.05 at drogue. Drogue recovered at 07.32, light fault rectified, and redeployed at 07.46. CTD stations at drogue at 08.19 (1718), 13.02 (1719), 18.31 (1720) and 23.30 (1721). Underway measurements on grids made following all stations with clean pumping system operated for trace metal sampling between station 1719 and 1720.

CTD station 1722 at 04.55 on Day 107. Incubation/sediment trap rig recovered at 06.15. Spar on Dahn buoy broken. CTD station 1723 at 08.01. Underway grid measurements between this station and station 1724 at 13.11'. Drogue recovered at 13.55 terminating experiment at Site N (78 hour). Commenced sailing for Broad Fourteens area of Southern Bight, following track (Fig. 1) designed to cross nutrient fronts. Underway trace metal sampling commenced at 15.20. CTD station 1725 at 23.46.

Proceeded on track during Day 108, with underway measurements. Hove to at 03.53 for sampling by water bottle. PES fish recovered at 04.49 and redeployed at 05.41 to repair sampling tube. CTD stations were made to sample for biological measurements and measurements of biogenic trace gases (1726, 00.15; 1727, 09.10; 1728, 15.37; 1729, 19.55) and for trace metals also at station 1730 at 23.41. Underway trace metal sampling stopped at 23.21.

Section completed with CTD station 1731 at 02.00 on Day 109. Proceeded to Great Yarmouth to drop the Master. PES fish brought inboard at 10.04. Simrad pole brought inboard at 13.42 and redeployed at 14.30. Returned to Broad Fourteens, making underway measurements of nutrients and taking bucket samples to examine condition of Phaeocystis.

Grid survey commenced at 00.36 on Day 110 with underway measurements and bucket samples. CTD station 1732 at 04.25. Continued grid survey. Water for in situ incubation experiment obtained by hydrocast at 07.13. Incubation/sediment trap rig deployed at 07.45. CTD stations 1733 at 08.21, 1734 at 11.19 and 1735 at 15.08 made at rig position, with grid survey between. Rig recovered at 18.15 followed by CTD station 1736 at 18.19. Continued grid survey.

On Day 111 continued grid survey until 03.56 when hove to at position for second drogue experiment (Site S). CTD station 1737 at this position at 04.41. Hydrocast at 04.55 to collect water for in situ incubation experiment. Incubator/sediment trap rig deployed at 05.30. Drogue deployed at 05.40. CTD stations 1738 at drogue at 08.04 and 1739 at 13.02. Remained within sight of drogue until station 1739. Commenced grid survey in drogue deployment area, including return to drogue for CTD station 1740 at 17.49. Ship's track during Experiment S is shown in Fig. 3. CTD station 1741 at 23.03 was ostensibly at drogue but it was subsequently discovered that because of light failure on Argos buoy and consequent confusion concerning lights on the drogue and incubation/sediment trap rig buoys this station was actually at the rig.

Continued grid survey on Day 112, repeating western section of Day 111 track. CTD station 1742 at drogue at 04.54. Hydrocast to collect water for in situ incubation experiment at 05.10. Incubation/sediment trap rig recovered at 06.00 and redeployed at 06.35 at drogue. CTD station 1743 at 07.57 at drogue position. PES fish deployed at 08.09,

with clean sampling tube for trace metal analysis rigged. Proceeded with underway sampling for trace metals and nutrients on grid around drogue, with CTD stations 1744 at 13.09 and 1745 at 18.08 at the drogue position. During grid transit it was necessary to recover the PES fish at 13.22 to rectify sampling line fault; redeployed at 13.33. Following CTD station 1745, grid repeated without trace metal sampling. CTD station 1746 at 23.15 was inadvertently at the position of the incubation/sediment trap rig because of the same problem which arose on Day 111.

Completed grid at 03.55 on Day 113. CTD station 1747 at 04.46 at drogue. Hydrocast for water sampling for incubation experiment at 05.01. PES fish brought inboard at 05.06. Incubation/sediment trap rig recovered at 06.04 and redeployed at drogue at 06.48. CTD stations 1748 at 07.19 and 1749 at 07.59. Pumped sampling system re-rigged and fish redeployed at 08.45. Hove to close to drogue between CTD stations 1749 and 1750 (at 13.08), while Autoanalyzer run for discrete samples and thus unavailable for continuous measurements. Between 13.20 and 23.00 proceeded along two transects covering gradients in nutrient concentrations. Because of failure of the pump on the trace metal sampling system nutrient measurements only could be made on these transects. CTD stations 1751 (at 15.31) and 1752 (at 18.02) made at the drogue position. For station 1753 (at 23.50) drogue could not be precisely located because of failure of the light on the Argos buoy. The station was made at the closest position that could be determined using radio location. Hove to following station.

CTD station 1754 at 04.50 on Day 114, at drogue. Hydrocast for water sampling for incubation experiment at 05.05. Incubation/sediment trap rig recovered at 06.06 and redeployed at 06.46. Drogue recovered at 07.40, light replaced, and redeployed at 07.56. Proceeded to repeat the 330° section of the transects of Day 113, which showed a marked and regular gradient of nitrate. Samples for trace metal analysis were taken, using a Go-Flo bottle deployed on Kevlar line, to give samples at 1 nautical mile intervals over the 12 nautical mile section. Continuous analysis operated for nutrients. CTD station 1755 at 15.13 at drogue. Drogue recovered at 16.01 terminating experiment at Site S (82 hr) because sea state was making sighting difficult. Recovered incubation/sediment trap rig at 18.22. CTD stations 1756 (19.04) and 1757 (21.45) at last position of drogue. Work over the side terminated to allow completion of experimental work and clearing of laboratories by following noon. Proceeded to Great Yarmouth arriving at 06.18 on Day 115.

5. SCIENTIFIC PROGRAMME

General comments

The intended shipboard programme was achieved. Progress was facilitated by fair to good weather conditions throughout; no time was lost to bad weather but 24 hr were taken to drop the Master. The drogue experiments appeared, from preliminary examination of the data, to have worked well. The location of the Dahn and Argos buoys was generally achieved rapidly under the reasonable sea conditions encountered; the only exceptions were due to light failures on the Argos buoy which made location in darkness impossible on certain occasions. Pre-tripping of water bottles on the rosette was more frequent than normal. There were, however, no major problems with the ship or with RVS equipment.

The main components of the scientific programme are summarized below. In addition four samples of rainwater were collected and sent to University of East Anglia for analysis as part of the programme to determine atmospheric inputs of constituents in wet deposition.

Primary productivity and dissolved oxygen (D.A. Purdie and G. Daneri)

Studies of phytoplankton productivity were undertaken in each of the areas of drogue deployment. Primary productivity was measured using a combination of the radiotracer carbon-14 technique and measurements of oxygen flux in bottles incubated at several screened light levels, using natural light. Regular sampling was undertaken over 3 to 4 days in each region. In all, 9 on-deck incubations were conducted. Very different levels of phytoplankton productivity were found, with relatively low carbon fixation at the northern site (<50 mg C m^{-3} d^{-1}) and exceptionally high values (maximum ca. 1500 mg C m^{-3} d^{-1}) in a dense bloom of Phaeocystis in the Southern Bight.

Concentrations of dissolved oxygen were measured at five-minute invervals on water from the non-toxic supply and calibrations were carried out at all CTD stations using water bottle samples. The percentage saturation reached a maximum of 125 % in the Southern Bight during the developing bloom of Phaeocystis. During the drogue experiment at this site the rapid development of the bloom was followed with increase of productivity over three days accompanied by increase in concentration of dissolved oxygen and removal of nitrate. A comparison between bottle production measurements and changes in situ will enable the rate of air-sea exchange of oxygen to be estimated.

At all CTD stations, water bottle samples were taken for measurements of chlorophyll a, ATP and particulate organic carbon, in addition to those for dissolved oxygen; samples were also preserved for examination of phytoplankton.

Ten experiments were undertaken to investigate the effects of light intensity on the phytoplankton, allowing an evaluation of the changing physiological response to light intensity of the populations over the period.

Primary productivity: calibration of on-deck incubator and sub-population measurements (I.R. Joint)

Measurements were made using an in situ incubation rig to calibrate the on-deck (simulated in situ) incubator which is used on every North Sea Project survey cruise. At dawn each day on station, water samples were taken for both in situ and on-deck incubations. At the same time as the on-deck incubations were done, in situ measurements of primary productivity were made using a free-floating toroid buoy to support the incubation bottles. Eight comparative experiments were completed during the cruise. In addition, experiments were done to measure the productivity of pico-, nano- and microphytoplankton. Completion of the measurements at PML will enable a direct calibration of the on-deck incubations to be made.

Other samples were taken for the determination of bacterial and phytoplankton abundance and biomass; bacterial productivity was measured on 9 occasions using the tritium-thymidine incorporation technique.

Nutrients (D.J. Hydes)

Measurements of nitrate, phosphate and dissolved silicon were made using segmented flow automated analysis. Samples were analyzed from all depths sampled at CTD stations 1703-56 inclusive. Concentrations of nutrients were also measured at 2.5 min intervals on 22 separate continuous runs, using the ship's non-toxic seawater supply. For the continuous operation, only the data for nitrate are regarded as reliable.

Phosphorus and alkaline phosphatase activity (F. Ormaza-Gonzalez)

A newly developed sensitive detector system, using flow injection analysis with long capillary cells, was evaluated for measurement of dissolved inorganic phosphate by shipboard measurements for comparison with the results obtained by the routine automated segmented-flow method. Samples (120) for analysis for dissolved inorganic phosphate, dissolved organic phosphorus and dissolved polyphosphates were collected and 240 samples of suspended particulate matter were taken on membrance filters for analysis of particulate phosphorus; these samples were returned for analysis ashore.

Alkaline phosphatase activity was measured on board. It was undetectable at the northern site but in the area of Phaeocystis bloom measurable activities were found, varying from about 10 to 350 pmol min^{-1} . These higher rates were generally associated with low concentrations (less than 0.1 µmol l^{-1}) of dissolved inorganic phosphorus.

In addition, 26 samples from CTD casts were filtered and frozen for subsequent analysis of dissolved organic carbon.

Trace gases (S. Turner and G. Malin)

Surface water samples were taken using the CTD rosette and ship's non-toxic supply and were analysed for trace gases. The dissolved trace

gases were extracted and concentrated using a cryogenic purge and trap technique and analysed using three gas chromatographs (2 FPD and 1 ECD).

Concentrations of dimethyl sulphide (DMS) and its precursor dimethylsulphoniopropionate (DMSP) were determined, including intra- and extracellular DMSP fractions. About 16 halocarbon compounds were detected, including methyl iodide, bromoform, methylchloroform and carbon tetrachloride. Chlorophyll samples were frozen for laboratory analysis and phytoplankton samples were preserved using Lugol's iodine and formalin.

DMS concentrations in the "parcel" of water, tracked by drogue at the northern site, were about 20 ng S l^{-1}. Diatom and dinoflagellate species were observed in net-concentrated samples. In contrast, in the Phaeocystis dominated waters of the Broad Fourteens, DMS concentrations were at least an order of magnitude higher. During the experiment at the northern site a comparison was made between samples taken from the CTD rosette and from the ship's non-toxic supply. The average concentration of DMS measured in rosette samples was 21 ng S l^{-1} compared to 39 ng S l^{-1} for the non-toxic supply seawater. The most likely cause for such an increase in DMS concentration is that phytoplankton cells sustain considerable damage during passage through the pumping system. Further support for this was observed where Phaeocystis was present in the water; samples taken from the CTD rosette contained visible colonies of this species, whereas those from the non-toxic supply appeared to contain none. Our conclusion is that the present non-toxic supply is unsuitable for the analysis of volatile trace gases and by implication for certain studies of phytoplankton.

In addition experiments were carried out to investigate the effects of light intensity and nutrient concentration on DMS and DMSP production and to examine the distribution of DMSP according to size fraction, and the rate of bacterial breakdown of extracellular DMSP.

Trace gases: methane (K. McShane)

The determination of methane by gas-liquid chromatography was carried out on-board ship.

Measurements of methane were made on surface water at 107 locations. Samples were obtained from rosette deployments and from the ship's non-toxic seawater supply. Concentrations ranged from 67 to 109 nl l^{-1} (volume of methane given at STP). Vertical profiles were measured at 19 stations; no systematic variations with depth were found. Shipboard incubation experiments were carried out with water from four locations, covering contrasting conditions of biological activity and phytoplankton composition, to measure rates of bacterial methane oxidation using methane labelled with carbon-14. Following incubation, carbon-14 labelled carbon dioxide produced by oxidation was stripped and trapped on a phenethylamine soaked filter. The filters were returned for analysis ashore.

Trace metals (P.J. Statham, G. Glegg, D.J. Hydes, J.D. Burton)

Samples were taken using modified Teflon-lined Go-Flo bottles deployed on the CTD rosette; sampling by deployment on Kevlar-line was used on certain transect samples. Pumped samples were collected underway using a clean pumping system, with an intake forward of the PES fish. Water was filtered under pressure through Nuclepore filters (0.4 μm pore size). Large volumes were filtered to collect amounts of suspended particulate matter adequate for analysis from 29 samples. Sub-samples of filtrates (88) were analyzed for aluminium by spectrofluorimetry on board and unfiltered samples were also analyzed for this element.

Further aliquots were acidified to pH ca. 2 and returned ashore for analysis for cadmium, cobalt, copper, manganese, nickel, iron and zinc by chelation/solvent extraction, followed by graphite furnace atomic absorption spectrophotometry. In all, 123 samples were collected. Aliquots from 41 samples were taken for analysis for arsenic species at Polytechnic South-West. For 29 samples, replicates were taken for intercomparison with measurements using cathodic stripping voltammetry to be made at Liverpool University.

All filtration and sample handling procedures were carried out using the RVS Clean Chemistry Container.

Radiochemical measurements of uptake of trace metals (A.J. Bale)

At each drogue deployment site a 20-litre water sample was taken and incubated for 4-5 days in a clear Nalgene bottle under artificial light, at a temperature of 8°C. Nutrients were measured at 8-12 hour intervals and samples were taken for determination of chlorophyll and cell numbers. Nitrate utilisation by the culture taken at the northern site indicated that the population (predominantly diatoms) continued to thrive. Visual observation of the Phaeocystis taken at the southern site showed that this culture was also growing. At daily intervals, duplicate subsamples from the culture were labelled with a "cocktail" containing manganese-54, zinc-65, cadmium-109 and caesium-137 and incubated on deck at ambient seawater temperatures. Dark and sterilised controls were incubated in parallel. The separated particulate and dissolved phases of these labelled samples will be analysed by gamma spectrometry at PML to determine the extent to which the metals were taken up during photosynthesis. Parallel measurements of the stable metal behaviour were made by P.J. Statham.

Suspended particulate material (A.J. Bale)

Sediment traps of the DAFS single-cone type were deployed, free drifting, in conjunction with the in situ incubation rig, generally for 24 hour periods (dawn to dawn). Three deployments were achieved at the northern site and four at the southern site with the traps set at 28 m and 17 m from the surface, respectively. Visual examination of the samples indicated that the material collected at both sites was predominantly of biological origin. Considerably more material was collected, per unit time, at the southern site where the phytoplankton population was dominated by Phaeocystis. Aliquots of each sample were taken in order to determine the overall mass of material caught and its

carbon and nitrogen content; the remainder was frozen for subsequent analysis of trace metals. Samples of water were collected for gravimetric determination of the suspended solids concentration at each CTD station occupied while the traps were deployed.

6. ACKNOWLEDGEMENT

The excellent support received throughout the cruise from Capt. G. Long, Capt. D. Coverdale, and their officers and crew, is most gratefully acknowledged.

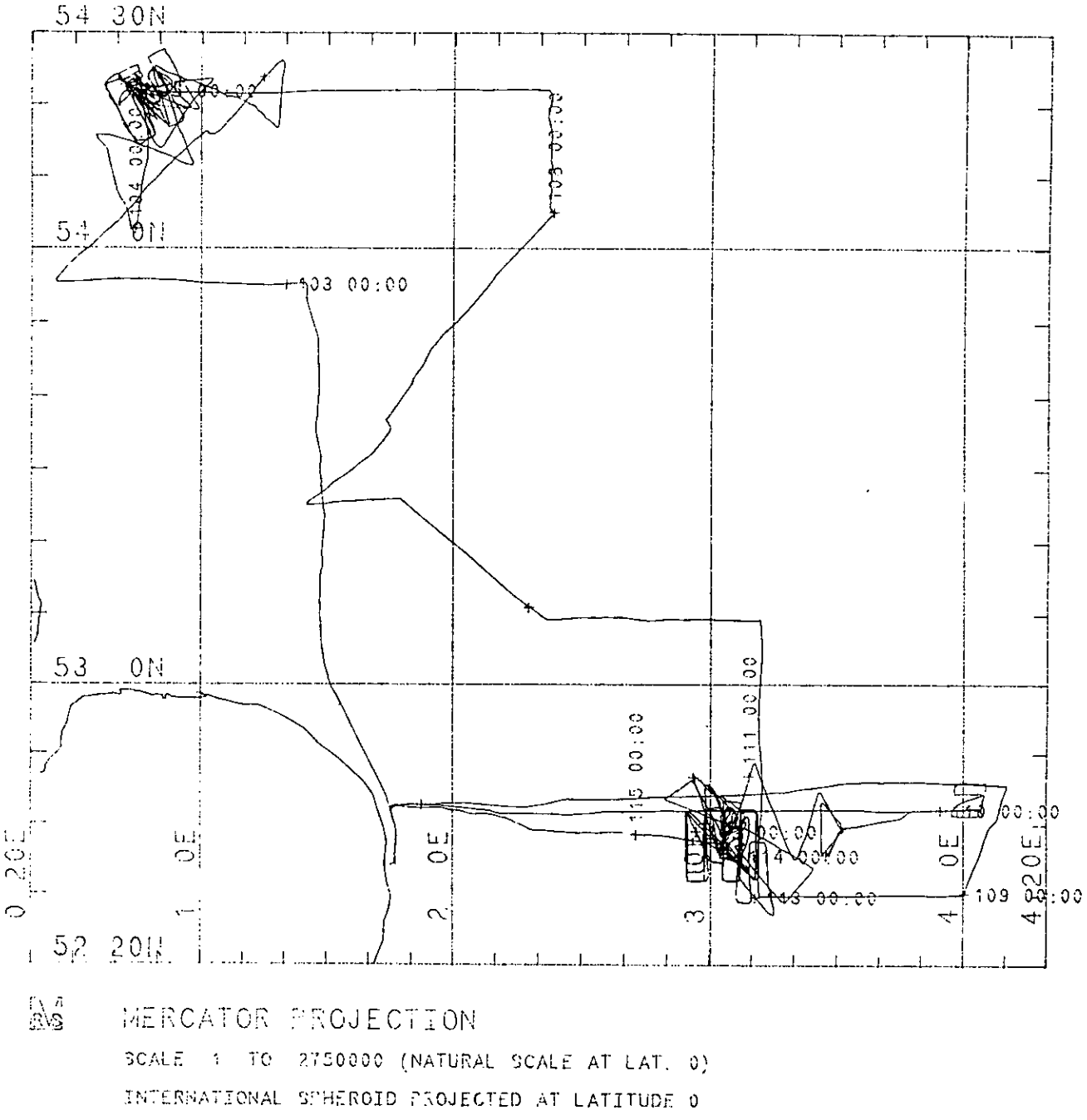

Fig. 1 Cruise track.

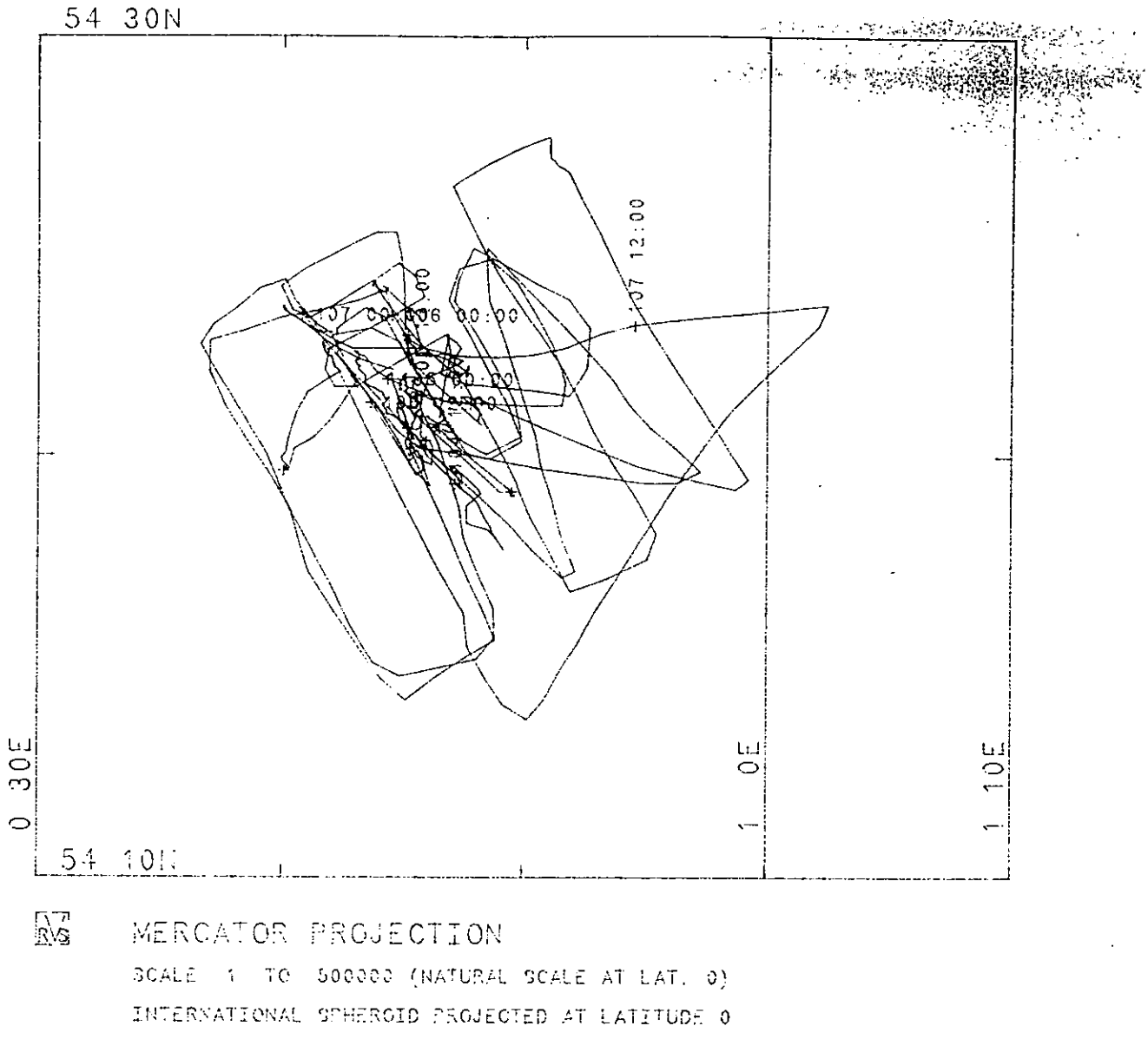

Fig. 2 Cruise track during drogue experiment at northern site (Site N).

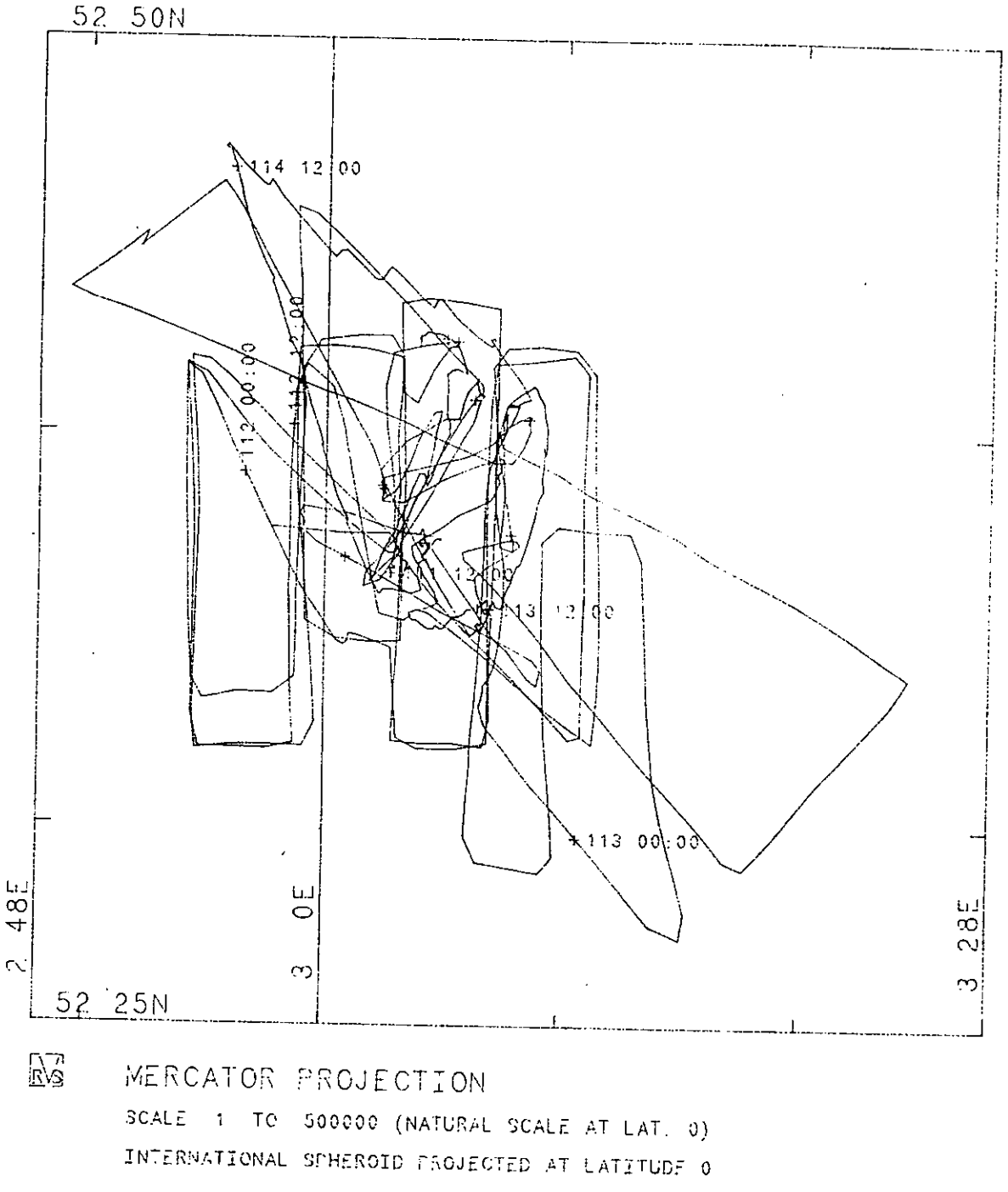

Fig. 3 Cruise track during drogue experiment at southern site (Site S).

Appendix 1

Data for CTD Stations

The listings are of calibrated data supplied by BODC. Position is the mean during the cast. Depth (m) is fully corrected and represents the mid-point of the Go-Flo bottle length. Time (GMT) is for the end of the down cast. Temperature (°C) is calibrated by the results of measurements made by reversing thermometers. Salinity is calibrated by salinometer measurements on water bottle samples and is given in practical salinity units.

STN	DATE	TIME	LAT	LONG	DEPTH	S	T
1703	13/04/89	09:16	54.2718	1.0215	3.9	34.69	6.903
					22.6	34.69	6.841
					45.4	34.70	6.846
1704	13/04/89	10:19	54.2635	1.0389	42.8	34.71	6.866
1705	14/04/89	04:37	54.3566	0.7607	7.4	34.81	7.030
1706	14/04/89	05:17	54.3560	0.7561	1.9	34.80	7.010
					3.8	34.80	7.010
					5.8	34.80	7.004
					8.9	34.80	6.996
					10.8	34.79	6.993
					15.7	34.80	6.974
					20.8	34.80	6.960
					25.8	34.80	6.951
					30.7	34.80	6.948
1707	14/04/89	10:47	54.3400	0.7556	4.4	34.69	7.015
					8.4	34.76	7.012
					16.4	34.77	7.015
					26.4	34.79	6.949
					51.2	34.79	6.941
1708	14/04/89	14:34	54.3262	0.7843	4.3	34.68	6.987
					8.3	34.69	6.985
					16.2	34.77	6.991
					26	34.78	6.947
					50.6	34.78	6.944
1709	14/04/89	18:45	54.3497	0.7385	4.4	34.73	6.987
					8.6	34.73	6.988
					16.5	34.74	6.983
					26.3	34.76	6.967
					55.9	34.78	6.943
1710	14/04/89	23:43	54.3685	0.7274	5.0	34.73	6.974
					8.9	34.74	6.977
					27.1	34.77	6.955
					41.5	34.78	6.950
1711	15/04/89	04:29	54.3436	0.7730	3.6	34.72	6.954
					7.3	34.73	6.954
					15.3	34.74	6.959
					25.3	34.75	6.957
					48.0	34.77	6.956
1712	15/04/89	10:17	54.3621	0.7514	4.6	34.76	7.054
					8.8	34.76	7.006
					16.7	34.78	6.971
					26.7	34.78	6.960
					40.6	34.79	6.957

STN	DATE	TIME	LAT	LONG	DEPTH	S	T
1713	15/04/89	13:11	54.3437	0.7717	4.6	34.73	7.256
					8.7	34.73	7.235
					16.3	34.74	6.986
					26.4	34.75	6.976
					49.7	34.77	6.960
1714	15/04/89	18:05	54.3547	0.7940	4.2	34.76	7.378
					8.1	34.75	7.297
					16.1	34.78	6.972
					26.1	34.78	6.964
					33.1	34.78	6.962
1715	16/04/89	00:47	54.3993	0.7375	4.0	34.75	7.247
					7.9	34.75	7.137
					15.8	34.76	7.030
					25.8	34.77	6.984
					40.6	34.77	6.973
1716	16/04/89	04:47	54.3735	0.7594	4.3	34.76	7.208
					8.4	34.76	7.201
					16.3	34.78	6.979
					26.2	34.78	6.974
					45.9	34.78	6.972
1717	16/04/89	05:45	54.3791	0.7514	4.0	34.76	7.146
					6.0	34.77	7.144
					8.2	34.77	7.144
					11.1	34.77	7.146
					16.3	34.77	7.048
					21.1	34.78	6.988
					26.1	34.79	6.975
					30.8	34.79	6.973
1718	16/04/89	08:23	54.3766	0.7887	4.4	34.76	7.116
					8.5	34.76	7.098
					16.6	34.76	7.049
					26.6	34.78	6.971
					56.1	34.78	6.967
1719	16/04/89	13:04	54.3644	0.7383	2.2	34.75	7.095
					8.4	34.75	7.087
					16.5	34.76	7.029
					26.2	34.77	6.959
					44.1	34.77	6.960
1720	16/04/89	18:38	54.3447	0.7517	4.1	34.76	7.144
					8.1	34.76	7.146
					16.0	34.76	7.148
					25.8	34.78	6.952
					50.4	34.78	6.943
1721	16/04/89	23:34	54.3914	0.6805	4.2	34.76	7.068
					8.2	34.76	7.069

STN	DATE	TIME	LAT	LONG	DEPTH	S	T
					16.9	34.76	7.064
					25.0	34.77	7.011
					57.2	34.78	6.943
1722	17/04/89	05:02	54.3604	0.7171	4.0	34.75	7.024
					8.0	34.75	7.024
					15.6	34.76	7.026
					25.8	34.76	7.016
					30.6	34.77	6.984
					60.5	34.78	6.956
1723	17/04/89	08:05	54.3741	0.6953	5.5	34.77	7.012
					9.3	34.77	7.012
					17.1	34.77	7.012
					27.4	34.77	7.011
					55.4	34.80	6.944
1724	17/04/89	13:14	54.3927	0.6666	4.8	34.76	7.042
					8.4	34.76	7.028
					16.3	34.76	7.026
					26.4	34.78	6.962
					60.8	34.79	6.950
1725	17/04/89	23:51	54.0804	2.3957	8.1	34.68	6.971
					26.1	34.68	6.973
					45.9	34.68	6.846
					62.8	34.68	6.819
1726	18/04/89	00:17	54.0798	2.3772	1.6	34.69	6.947
1727	18/04/89	09:13	53.4290	1.7918	4.0	34.60	7.251
1728	18/04/89	15:41	53.1544	3.2002	5.0	35.05	8.123
					8.9	35.05	8.121
					16.8	35.05	8.116
					26.8	35.05	8.120
1729	18/04/89	19:58	52.4990	3.1971	4.6	35.06	8.601
					8.6	35.06	8.604
					16.5	35.06	8.606
					26.3	35.06	8.609
1730	18/04/89	23:46	52.5027	4.0025	3.3	33.04	8.085
					7.3	33.06	8.092
					15.2	33.48	8.143
					16.8	33.52	8.150
1731	19/04/89	02:02	52.7539	4.1708	3.5	33.60	8.008
					7.4	33.60	8.006
					10.4	33.60	8.011
					15.4	33.66	8.027
1732	20/04/89	04:30	52.7023	4.0702	4.3	33.65	8.058

STN	DATE	TIME	LAT	LONG	DEPTH	S	T
					8.4	33.73	8.077
					11.2	33.74	8.082
					14.3	33.79	8.096
					17.3	33.80	8.102
1733	20/04/89	08:24	52.6601	3.5307	4.9	35.04	8.373
					9.1	35.04	8.369
					13.9	35.04	8.374
					17.9	35.04	8.375
1734	20/04/89	11:23	52.5977	3.4676	4.2	35.04	8.427
					8.2	35.04	8.397
					16.1	35.04	8.394
					26.1	35.04	8.395
1735	20/04/89	15:13	52.6326	3.4947	4.4	35.04	8.496
					8.5	35.03	8.458
					16.6	35.03	8.443
					26.4	35.04	8.445
1736	20/04/89	18:23	52.6614	3.5220	4.5	35.05	8.465
					8.5	35.05	8.466
					16.4	35.05	8.467
					25.1	35.05	8.468
1737	21/04/89	04:45	52.6994	3.0623	4.5	35.12	8.674
					8.4	35.12	8.674
					16.5	35.12	8.675
					26.0	35.12	8.676
1738	21/04/89	08:10	52.6691	3.0868	4.8	35.11	8.659
					8.8	35.12	8.660
					16.9	35.11	8.672
					26.7	35.11	8.674
1739	21/04/89	13:07	52.6161	3.0523	4.4	35.11	8.733
					8.4	35.11	8.718
					16.2	35.11	8.708
					26.6	35.11	8.700
1740	21/04/89	17:52	52.7039	3.0925	4.2	35.12	8.735
					8.1	35.12	8.735
					16.2	35.11	8.737
					26.2	35.12	8.738
1741	21/04/89	23:06	52.5797	3.0167	4.8	35.13	8.717
					8.7	35.13	8.722
					16.8	35.13	8.724
					31.4	35.13	8.725
1742	22/04/89	04:56	52.6713	3.0796	3.9	35.12	8.684
					7.5	35.12	8.687
					15.9	35.12	8.691

STN	DATE	TIME	LAT	LONG	DEPTH	S	T
					25.7	35.12	8.695
1743	22/04/89	08:01	52.6792	3.1079	4.5	35.12	8.692
					8.5	35.12	8.691
					16.5	35.12	8.689
					26.3	35.12	8.690
1744	22/04/89	13:13	52.5899	3.0617	4.5	35.12	8.757
					8.6	35.11	8.735
					16.6	35.11	8.737
					31.3	35.11	8.719
1745	22/04/89	18:12	52.6824	3.1095	4.2	35.13	8.734
					8.0	35.13	8.735
					15.9	35.13	8.736
					25.9	35.13	8.738
1746	22/04/89	23:18	52.5564	3.1128	4.0	35.10	8.737
					7.7	35.10	8.738
					15.8	35.10	8.740
					25.4	35.10	8.744
1747	23/04/89	04:50	52.6656	3.1248	5.0	35.10	8.710
					9.0	35.10	8.709
					16.9	35.11	8.711
					25.5	35.11	8.712
1748	23/04/89	07:22	52.6847	3.1485	9.3	35.11	8.706
1749	23/04/89	08:03	52.6782	3.1531	4.7	35.12	8.708
					8.5	35.12	8.706
					16.5	35.11	8.706
					26.2	35.12	8.707
1750	23/04/89	13:10	52.5819	3.1060	5.1	35.11	8.737
					9.1	35.10	8.736
					17.3	35.11	8.736
					27.0	35.10	8.738
1751	23/04/89	15:34	52.7471	2.8715	4.4	35.07	8.565
					8.4	35.07	8.566
					25.9	35.08	8.567
1752	23/04/89	18:05	52.6732	3.1438	4.2	35.10	8.717
					8.0	35.10	8.721
					16.0	35.10	8.724
					25.8	35.11	8.726
1753	23/04/89	23:59	52.5932	3.1090	4.1	35.10	8.699
					7.8	35.10	8.699
					15.8	35.10	8.704
					20.4	35.09	8.707

STN	DATE	TIME	LAT	LONG	DEPTH	S	T
1754	24/04/89	04:54	52.6498	3.1217	3.8	35.10	8.670
					7.8	35.10	8.677
					15.6	35.10	8.674
					25.6	35.10	8.677
1755	24/04/89	15:17	52.6096	3.0655	4.1	35.10	8.656
					8.2	35.10	8.656
					16.2	35.10	8.660
					25.8	35.10	8.661
1756	24/04/89	19:09	52.6252	3.0687	4.1	35.10	8.669
					8.2	35.10	8.679
					16.1	35.10	8.681
					30.8	35.10	8.682
1757	24/04/89	21:50	52.6163	3.0707	5.0	35.10	8.664
					9.2	35.10	8.664
					17.1	35.10	8.668
					27.0	35.10	8.675

END