COPY FOR ROY

CRUISE REPORT

CRUISE	North Sea Survey Cruise 51/89
VESSEL	RRS *Challenger*
PERIOD	27 April to 9 May, 1989

PERSONNEL		
	A Morris	PML - Principal Scientist
	M Althaus	Southampton U
	A Banaszek	POL
	J Baretta	NIOZ, The Netherlands
	D Beasley	RVS
	C Fileman	MAFF
	D Flatt	POL
	D Harper	MAFF
	R Howland	PML
	G Malin	UEA
	D Mills	UCNW
	P Nightingale	UEA
	A Tappin	Southampton U
	J Wynar	RVS

ACKNOWLEDGRMENT

The excellent services afforded by Capt. P Moore and his officers and crew throughout this cruise are most gratefully acknowledged.

OBJECTIVES

(1) To make underway measurements of surface-sampled variables (salinity, temperature, transmittance, fluorescence, irradiance) and acoustic Doppler current profiles around a set track covering the southern North Sea.
(2) To carry out CTD profiling recording temperature, conductivity for salinity, transmittance, fluorescence, dissolved oxygen, up- and downwelling irradiance at 120 nominated stations along the track. To take associated water samples for calibration and for measurements of nutrients, dissolved and particulate metals, chlorophyll, primary production (once daily), phytoplankton species (alternate stations) and suspended solids load.
(3) To collect zooplankton samples at approximately 60 of the stations.
(4) To recover and redeploy moorings at four sites and to deploy moorings at six sites.
(5) To carry out an intercalibration exercise with the German vessels *Gauss* and *Valdivia* participating in their ZISCH Programme.

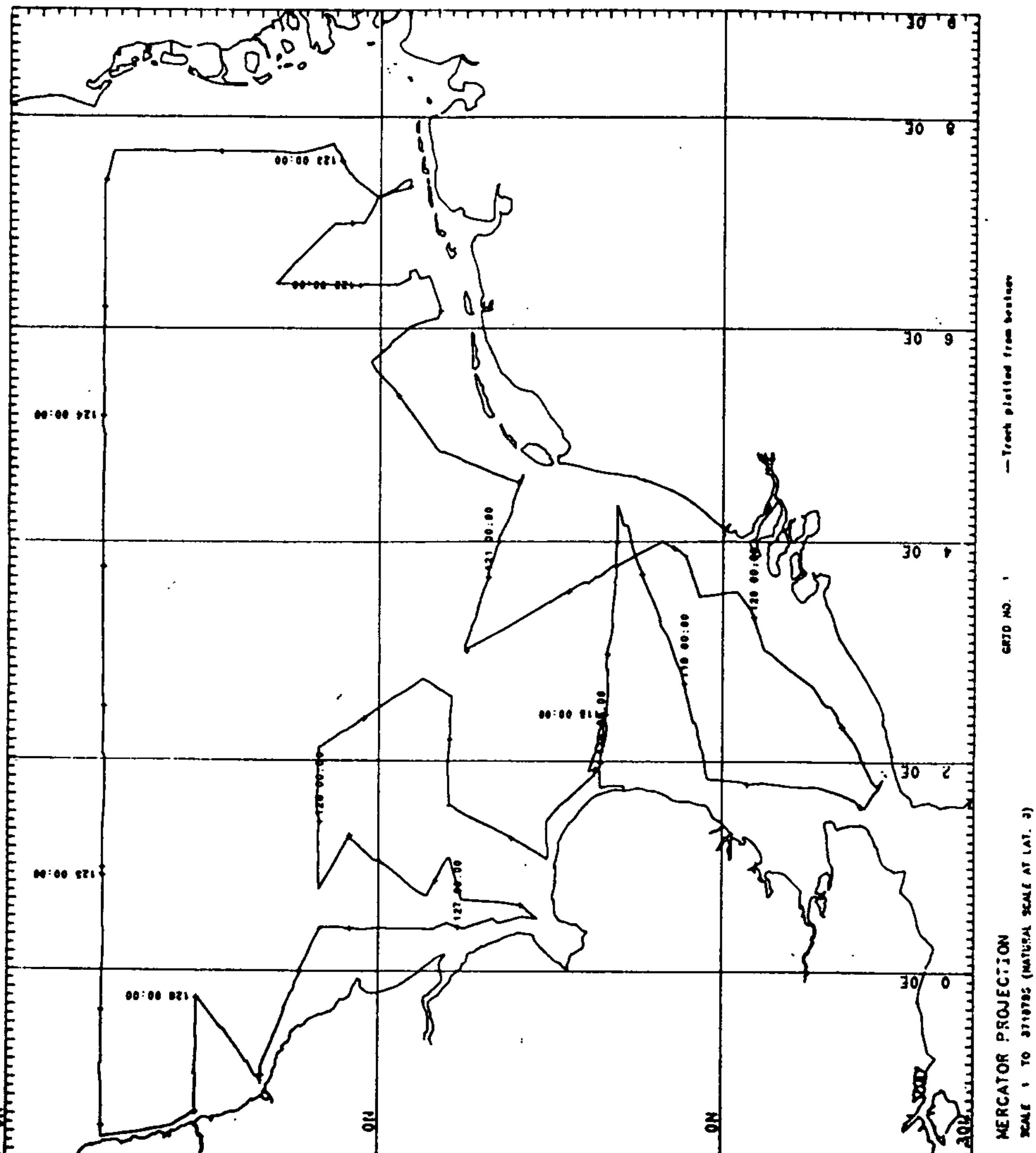

Figure 1. Track followed on Cruise 51/89.

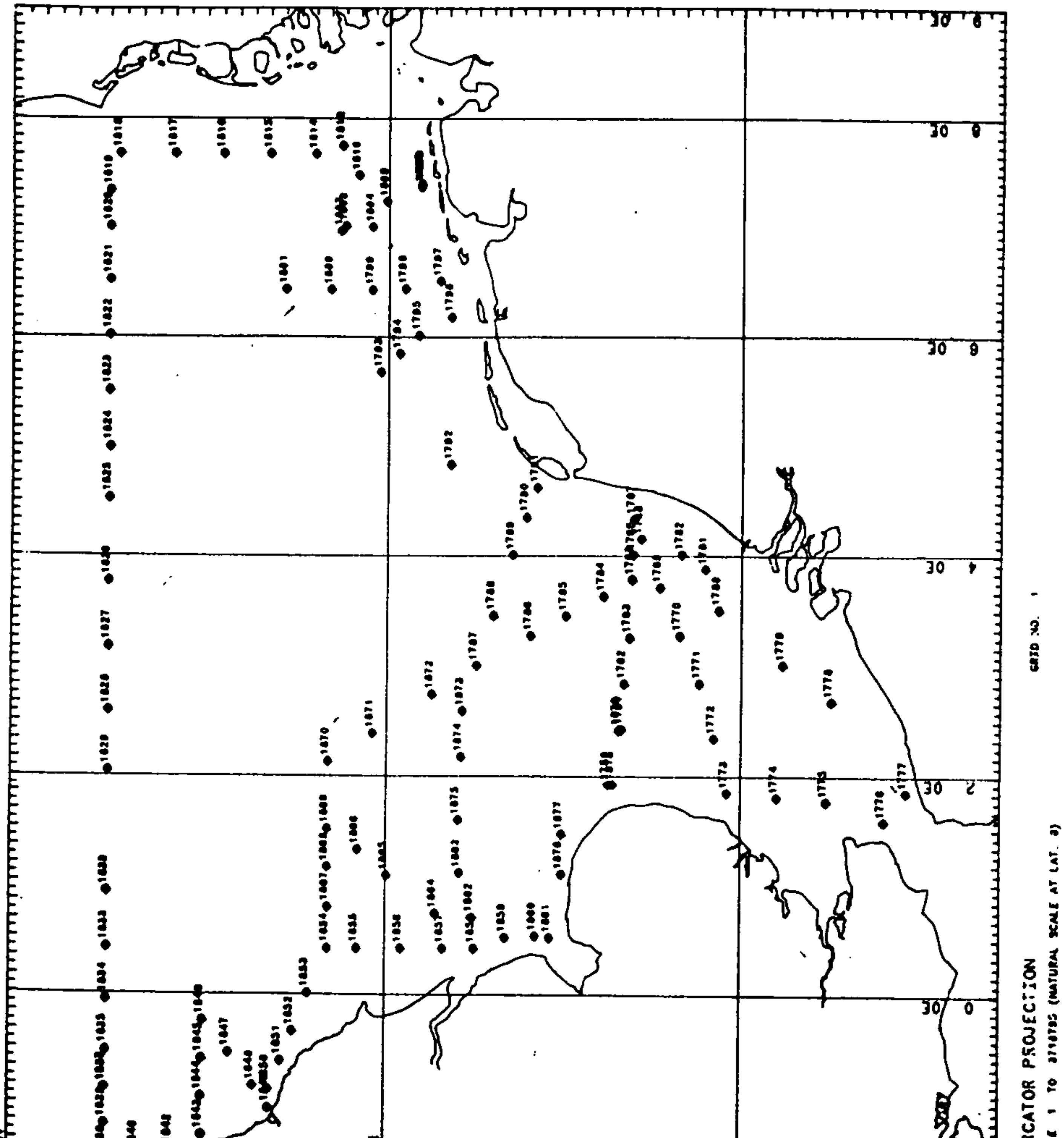

Figure 2. CTD stations worked on Cruise 51/89.

SUMMARY

The weather throughout this trip was extremely clement with winds mostly around force 3 and never exceeding force 5. We were hampered only by occasional fog, which was particularly dense in the German Bight region at the time of the intercalibration exercise with the German ZISCH vessels. Dense blooms of *Phaeocystis* were encountered adjacent to most of the continental coastline. Morale was continuously high and all the scientists are commended for their efforts in ensuring the success of this cruise.

The objectives of the cruise were achieved with the exceptions of an incomplete suite of planned CTD stations and the lack of surface recorded fluorescence trace due to instrument failure. Figure 1 shows the cruise track which was followed and Figure 2 shows the sites of worked CTD stations according to their serial number. These are listed in the Appendix, together with water depths, positions and timings.

109 out of a possible 125 stations CTD were worked on this cruise. The reasons for not completing the full suite of stations were various:
(1) initial problems with CTD operations, accounting for missing BH, BI, BJ and BK in order to ensure intercalibration rendezvous;
(2) aiming to ensure mooring operations in daylight (CR omitted);
(3) human error (AT);
(4) alterred track (EO);
(5) corner cutting to save time (repeat visits to BB, CS and DM);
(7) retarded progress through CTD problems, especially bottle misfires, and the intercalibration exercise; priority accorded to mooring operations at site E at end of cruise (EA, EB, EC, ED, EE, and EF).

The following problems were encountered with the CTD system:
(1) A major breakdown at the beginning of the cruise attributable to cable damage probably occurring during the pre-cruise wire tests. This was cured by cutting off about 20ft of cable adjacent to the instrument and reconnecting,
(2) A similar fault occurred in mid cruise. It was found that the cable connections has been torn away and required to be remade.
(3) Intermittent breakdowns of BBC unit which prevented data recording occurred throughout the cruise. Overcome but not cured by rebooting the system.
(4) Occasional automatic data transfer in mid cast without any apparent reason. Problem overcome but not cured by using a separate file to complete casts.
(5) Bottle misfires were a particular nuisance on this cruise because of the inclusion of trace metal work using the clean bottle system. Numerous recasts were required which continuously ate into the available cruise time.
(6) Breakdown of the fluorimeter on the CTD system neccesitated its replacement with the surface recording instrument.

INTERCALIBRATION EXERCISE

The plan to rendezvous with the German vessels *Valdivia* and *Gauss* was duly carried out. The intention was to synchronoise work at a number of CTD stations in the German Bight for intercalibration purposes. Cruise logistics dictated the meeting point - which turned out to be station BX. This station was worked commencing at 1430. Within the available time, only three common

stations could be worked, BX, BY and BZ. This was partly due to the long time spent at BX by *Gauss* (cause unreported) and partly due to problems with our CTD system at BY. Calm conditions were prevalent but dense fog reduced visibility to about 100m or less at stations BX and BY. Thus close approach of the vessels was not safe and they stood off at a half-mile distance on stations. Safety considerations also prohibited the exchange of samples by small boat.
Interchange of information on samplings and measurements and synchronising the station operations was achieved by radio contact. No data were exchanged except that salinities, temperatures and nutrient concentrations measured at stations BX and BY on *Valdivia* were reported. This information is listed in Table 1.

Table 1. Data reported by *Valdivia* on 2/5/89 during intercalibration exercise. Nutrient concentrations in umoles/l.

Depth	S	T	Nitrate	Ammonia	Silicate	Phosphate	Nitrite
Station 38							
1	33.444	7.96	0.37	1.39	2.83	0.10	0.03
10	33.456	7.88	0.31	1.09	2.14	0.05	0,04
25	33.706	7.64	0.28	1.02	1.37	0.03	0.02
Station 39							
1	32.626	8.16	1.28	0.90	0.87	0.02	0.03
10	32.679	7.78	1.60	1.22	-	0.07	0.05
17.5	32.694	7.77	1.59	1.18	2.61	0.06	0.05

NARRATIVE

Thur 27 April.

Depart Great Yarmouth 1330, reaching the first CTD station at 1730. Continuous surface recording equipment commissioned and logging commenced. ACDP swiched on. CTD system not operated successfully at first station (AA) although deck tested before sailing. Faulty power supply diagnosed. Repair and rerun CTD dip 1759. Operated satisfactorily except for fluorimeter. Faulty CTD fluorimeter subsequently replaced by surface recording instrument, John Howarth informed by Telex. Second station AB reached at 2040 - too dark to carry out Mooring E operations at AB. CTD again faulty. Bottles not firing and no logging so main termination repaired. (1 station).

Fri 28 April.

Satisfactory CTD at station AB completed at 0205, except for further bottle firing problems. Proceed to station AC. Tests and repair attempts until successful CTD cast at 0356 except for bottle misfiring. CTD faults cured by cutting off a 6m length of cable, indicating damage during brake tests on winch prior to sailing. Check and adjust bottle lanyards. Successful bottle cast 0449. Proceed through station AD to AE at 0946. CTD casts successful. RIg F deployed successfully at AE (1027-1041). Proceed to AF. Required 2 casts before sucessful bottle firings. Routine progress to station AK at 2252. (10 stations; running total 11).

Sat 29 April.

Routine progress from station AL to station AS, except for occasional bottle firing problems. Station AT passed through without CTD dip due to communication error (intended message was to omit core site close to AS). (8 stations; running total 19).

Sun 30 April.

Proceed routinely from station AU to BC. Wire test of acoustic unit 263C at 0520, repeated at 0646. Mooring site D at station BB reached at 1750. ACDP rig and thermistor chain recovered and replacements deployed successfully by 2005. (9 stations;running total 28).

Mon 1 May.

Stations BD to BG completed. It was deemed necessary to omit stations BH to BK to catch up time lost during earliest part of the cruise in order to ensure rendezvous with German vessels *Valdivia* and *Gauss* in the German Bight for intercalibrations. Even with this saving, it is necessary to rearrange the common stations - Telexed Hamburg with proposal to rendezvous at BV or BW on Tuesday 2 May at 1500 to 1600 (BST). Proposal accepted in telexed reply. Proceed routinely from Station BL to Station BR with progress hampered by fog. (11 stations; running total 39).

Tues 2 May.

Continuing fog. Progress from Station BS to BV. Problems with CTD at BU. No input to BBC - cured by switching CTD PSU off then on again. CTD not logged. General fault on Level B not noticed. Ship stationary at BV for approx. 3 hours for repairs to ship's foghorn. Radio contact with *Valdivia* and *Gauss* established. Discussions between scientists regarding procedures. Arranged to carry out common stations at BX, BY and BZ commencing at the same time but maintaining standard procedures used on each vessel. *Challenger* to make two CTD casts, the initial one without water bottle operations, and two zooplankton net casts. Complete station BW and proceed to first intercalibration station BX. *Gauss* and *Valdivia* waiting on site, vessels stationed in line with half-mile spacing. Not visible in fog. Agreed no sample exchanges possible due to fog. Commenced first intercalibration station at 1430. Two CTD dips, two plankton net casts completed by 1515. *Valdivia* completed earlier and left for Station BY. Rendezvous with *Valdivia* at Station BY 1640. Hove to awaiting *Gauss*. Commence second intercalibration station BY at 1800. Problems with CTD operations. First dip gave no data. Rebooted. On the second attempt, data was written to file for no apparent reason at mid-depth on the upcast. Third cast carried out for completing the data. The water bottle cast gave trouble with bottle triggering. Repeated cast before successful bottle sampling. Meanwhile, *Valdivia* and *Gauss* left for Station BZ. Rejoined two German vessels awaiting our arrival at BZ by 2230 and commenced final intercalibration station. Station completed successfully by 2320 except for one bottle misfire. *Valdivia* already departed; *Gauss* completing operations as *Challenger* returned to standard transect. *Valdivia* reported salinity, temperature and nutrient results for first two intercalibration stations over radio. (8 stations; running total 47).

Wed 3 May.

At Station CA, BBC computer crashed on upcast. Reboot and continued data on new file. Continue routinely reaching Station CK at 2110. *Phaeocystis* which had been highly abundant at most of the stations off the continental coast now much less prominent. Ship's safety committee meeting 1030. Scientists reported three points: (1) inoperative alarm in clean container; (2) insecure and unsafe gas bottle piping: (3) problems with scientist's emergency muster point with respect to cramped conditions, overwhelming fan noise. Completed standard station operations at CK and then deployed thermistor chain by 2206, Mooring B by 2253. Fortunately no recoveries required at this site reached in darkness. Telex from Met Office requesting positional data. Replied informing no air-sea measurements this cruise. (11 stations; running total 58).

Thur 4 May.

Continue routinely from Station CL, reaching CQ at 1340. Successful operations except for occasional bottle misfires. Omitted station operations at CR in order to ensure adequate daylight period at Mooring A (Station CS) for rig recovery operations. CTD cast at Station CS failed with symptoms of cable failure. Faulty connections to cable found and repaired. Winch depth slave unit in laboratory faulty. CTD for fluorometer calibration at mooring site; BBC again required rebooting. ADCP recovered without difficulty at mooring station A (CS) despite fog (100yd visibility), replacements deployed by 2330 (7 stations; running total 65).

Fri 5 May.

Worked stations from CT to DE without major problems. Some bottle misfiring as usual; Level B failed to log all of CTD cast at CV and gave problems at DC; delay for loss of power to winch and A-frame. Muster and boat drill at 1615. Changed muster station for scientists - on deck adjacent to ship's hospital - this is a considerable improvement. (12 stations; running total 77).

Sat 6 May.

Routine operations from DF to DP. Thermistor chain and ACDP deployed successfully at Station DM (Mooring C). (11 stations; running total 88).

Sun 7 May.

Station DQ completed and then routed through stations EL,EM and EN before heading for DR. This change was implemented to ensure reaching these high priority stations with available time running short. Route DR, DS, EK, EJ, EI, EG and EH. (11 stations; running total 99).

Mon 8 May.

Available time will now only allow a track through EF, EB and EA of the Dogger Bank sites. However, these stations were not worked, together with Stations EC, ED, CS and EE, priority being given to revisiting AB in order to work mooring E. Proceeded through stations DZ, DY, DX, DW, DV, DU and DT. Then to EP, EQ and AA missing out EO for lack of time. (10 stations; final total 109).

Tues 9 May.

Complete station AA and proceed to AB at approx 0245 to await first light. Mooring E operations completed successfully and proceeded to wait off Great Yarmouth for pilotage. Voyage completed 1430.

INDIVIDUAL PROJECT REPORTS

Moorings (D Flatt and A Banaszek).

Details of mooring recoveries and deployments are listed in Table 2.

(1)ACDPs.
All three ACDPs, At mooring stations A,C and D, were successfully recovered and redeployed. The acoustic units fitted to the rigs were all of a modified type to give an uninterrupted transmit pulse. This modification improved the performance of the units; the recovery time for each was connsiderably less than that in earlier cruises. The Mufax in the plot was again unusable and the acoustic work had to be done from the main deck.

(2) Thermistor chains.
The three thermistor moorings at A,C and D were all recovered successfully and relaid along with a fourth at B. The fluorimeter on A was redeployed.

(3) Current meters.
Station E was the only current meter rig deployed on the previous survey. Three current meter rigs were deployed at stations B,E and F. A full complement of S4 and Aanderaa current meters was fitted to the moorings. The fluorimeter at E was redeployed.

(4) Shipboard APDC.
This worked faultlessly throughout the cruise.

Table 2. Mooring operations on Cruise 51/89.

Mooring (CTD station)	Position Lat. N	Position Long. E	Instruments	Recovery Time/date	Deployment Time/date
A (CS)	55 29.99	00 54.25	Thermistor SN08-chain 1612 Fluorimeter	1845/04May	
A (CS)	55 29.88	00 54.64	Thermistor SN11-chain 1612 Fluorimeter		2318/04May
A (CS)	55 29.96	00 55.13	ADCP POLDOP3 RCM7 9631	1821/04May	

/contd.

A (CS)	55 29.99	00 55.20	ADCP POLDOP1 RCM4 6443		2328/04May
B (CK)	55 30.19	05 27.96	S4 05451265 T S4 05451261 M S4 05451264 B RCM8 9069		2253/03May
B (CK)	55 29.92	05 30.02	Thermistor SN09-chain 1609		2150/03May
C (DM)	54 20.26	00 24.16	Thermistor SN10-chain 1610	1439/06May	
C (DM)	54 19.71	00 24.26	Thermistor SN08-chain 1610		1616/06May
C (DM)	54 19.77	00 23.95	ADCP POLDOP4 RCM7 9632	1458/06May	
C (DM)	54 19.86	00 24.21	ADCP POLDOP3 RCM7 9632		1641/06May
D (BB)	53 29.84	02 59.70	Thermistor SN09-chain 1608	1911/30Apr	
D (BB)	53 29.91	02 59.60	Thermistor SN11-chain 1608		2003/30Apr
D (BB)	53 29.34	03 00.00	ADCP POLDOP1 RCM4 6443	1938/30Apr	
D (BB)	53 29.31	02 59.29	ADCP POLDOP2 RCM7 9633		1839/30May
E (AB)	52 41.37	02 24.78	RCM8 9347 Fluorimeter S4 05451262 T	0400/09Apr	
E (AB)	52 41.17	02 25.13	RCM8 9414 Fluorimeter S4 05111117 B		0554/09Apr
F (AE)	52 37.02	03 35.99	S4 05451263 RCM8 9347		1041/28Apr

CTD operation (J Wynar).

The CTD caused a lot of down-time during the first few days of the survey. The final termination from the armoured cable to the connector on the CTD broke twice. Although static checks had been made in Gt Yarmouth, it would appear that the wire test made in port had damaged the termination with the result that it failed on the first station. The second failure may have been the

result of less than delicate lifting of the CTD from the deck. If the cable had become caught momentarily while the CTD was being snatched in this way, the termination may have broken again.
Initially, the rosette also proved troublesome although we were expecting pre-triggering from experience of the previous cruise. However, we gradually learned by trial-and-error which were the worst positions on the rosette, *viz*. 1,10,11 and 12, and avoided these when possible.
The fluorimeter on the CTD failed but was replaced by the surface fluorimeter. The original may be sent back to Barry for repair.

Computing (D Beasley).

The computing for this cruise followed the now well established pattern for North Sea Project survey cruises. On a cruise of this complexity, some problems can always be expected, but those that did occur were dealt with quickly. Data were logged from a variety of sources, and very little was lost due to equipment failure. The loss of power to all equipment on day 120 gave rise to a loss of 11 minutes of data.
The usual plots were produced: CTD profiles, daily time-series stack plots, daily ship's track and transects. At the end of the cruise, surface contour plots were produced for attenuation, oxygen, salinity and temperature as well as a complete list of all stations, final ship's track plot and CTD station positions. GF3 format data tapes have been produced for all the required parameters.
Unfortunately, it has still not been possible to produce surface contour plots with the land blanked out (although the land outline is shown). The current version of our graphics software (Uniras) has a number of bugs, but I understand that most of these have now been resolved, and the new version should be installed very soon.

Technical report.
This describes the important non-routine aspects of the computing support during the cruise.

Hardware.
Master clock synchronisation. All power was lost for a couple of minutes on day 120. When power came back, both the master clock and the RVS clock started up at 70 001 000000. The master clock was reset, but the RVS clock saw the sudden jump in time as a fault, and carried on with 70 001 00XXXX. There appears to be no obvious way of resynchronising the RVS clock with the master. I decided to switch it off and back on again - but discovered that its mains lead was not identified anywhere. I had to guess which plug to pull out. Fortunately, I guessed right first time! I have now labelled the lead.

Level B performance. The monitor in the plot (M2080) is now completely unusable. It needs repairing or throwing away. I am currently using the M2250 at the end of the bench as the Level B monitor.
The Level B goes through periods of working perfectly and periods when it crashes 7 or 8 times in three hours (as on day 127). It also seems reluctant to restart - needing several attempts with the key before it gets going again. On two occasions, the Level B 'half' failed. It refused to accept most data from most Level As, although in other respects it was running OK, hence there was no alarm. The first time this occurred was at 0346 on day 122, and it wasn't noticed until 0745. Most of the Level As were shown on the monitor as

being dead. I tried resetting one or two. Although the TX LED flashed to show that reset messages were being sent to the Level B, the RX LED remained off - so the Level B was ignoring the messages. I could enter commands at the Level B console, but none did any good. I restarted the Level B and things went back to normal.
During this period (0346 to 0750; day 122) no Decca was logged. Instruments such as tsgl03, flute and gyro have lots of gaps in their data yet no em log data was lost at all.
The same thing occurred on day 127, but fortunately I noticed after 10 minutes and reset the Level B.

Disc errors. A number of disc errors have been appearing in the console windows on Sidney. I think the disc needs reformatting.

Software.
Titsil. I have updated titsil so that it will now accept files with or without a blank line at the start.
Nutsin. I have updated nutsin on the PS/2 so that it now correctly reads the information in the header of the input file and writes it to the output file. Previously it just assumed that the input data file was always in the same fixed format. In fact, I found that the order of variables in the program was different to the order of variables in the data files. If left uncorrected, this would cause titsil to store data under the wrong variable names. I can only presume that on previous cruises people have been manually rearranging the order of variables in the header of the titsil-format file before sending it to titsil. In any case, nutsin now outputs the correct header for the input file, and there is no need to alter anything. (It can still only cope with a fixed number of variables (5), so there are still miprovements to be made. On the PS/2, the source code is in: /nutri/nutsin3.c. The executable is in /work/nutri/nutsin.exe /nutri/nutsin3.exe/exec/nutsin.exe /exec/nutsin.v3e .

Shell scripts. I have updated a number of the existing shell scripts for doing routine jobs to make them easier and simpler to use. I have also written several new utilities. All these are described in the revised operator's guide (see below). Future computer staff on the *Challenger* would be well advised to read this to avoid any confusion about the way the shell scripts now work.

Operator's guide. I have gone through the *Challenger* Operator's Guide, originally written by Doriel, and brought it up to date with current practice. Details of all the revised and new utilities are included.

Zooplankton (J Beretta).

On this cruise, in generally very good weather, zooplankton samples were taken at around 50 stations. One vertical haul with a 300um mesh net, having a mouth area of $0.382m^2$ was taken at all sampled stations. Additionally, when time permitted, a vertical haul with a 50um mesh net was taken. The plankton biovolume on this cruise ranged from a minimum of $1.3cm^3m^{-2}$ off the Dutch coast in a dense *Phaeocystis* bloom to a maximum of $70cm^3m^{-2}$ at station CO on the northern transect midway between the English and Danish coasts. The bulk of this sample consisted of Ctenophores, however. The highest concentrations of zooplankton generally were found in thw western part of the surveyed area, where *Phaeocystis* was absent. The expected mass outburst of the Ctenophore *Pleurobrachia pileus* was not found. Judging from the size distribution of the individuals of this species (few large ones, higher numbers of very small ones) the outburst will occur later in May.

Trace gases (G Malin and P Nightingale).

Surface water samples were taken using the CTD rosette and 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, 1 ECD).
Concentrations of dimethyl sulphide (DMS) and its precursor dimethylsulphoniopropionate (DMSP) were determined at all of the CTD stations. Due to the longer analysis time required for halocarbon measurements, slightly fewer stations were sampled for 9 halocarbon compounds, with at least a further 10 gases being regularly detected. Those compounds being determined included 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.
The highest DMS and DMSP concentrations were observed in the *Phaeocystis* dominated waters off the Dutch, Belgian and German coasts. Methyl iodide concentrations were also found to be greatest in these waters. Elevated levels of bromoform and dibromomethane were found off the UK coast. The distributions of the other halocarbons were more complex and no immediate conclusions can be drawn.
One cause for concern was that on too many occasions the surface bottle was fired to collect a water sample with the top of the bottle above the sea surface. Obviously this is undesirable when trying to determine levels of dissolved gases not only for the measurement of the gases mentioned in this report but also for the determination of dissolved oxygen.

Nutrients (R Howland).

The five channel nutrient analyser was used on all CTD station samples throughout the cruise, with few problems. Most of the problems encountered were centred on the nitrate channel which at the start of the cruise gave a noisy response with excessive baseline drift and jumps. This settled down after a few days by which time we were in the vicinity of the German Bight where, due to a bloom, nutrient concentrations were very low. Peak shapes for nitrate, nitrite and ammonia at these low concentrations were poor and the computer had difficulty in resolving them. Checks on the efficiency of the nitrate column were carried out every few days. This varied randomly between 72 and 96%. On the whole, the instrument functioned well, and any problems were overcome without loss of data.

Trace metals (C Fileman, D Harper, M Althaus and A Tappin).

Samples for subsequent trace metal analysis were taken using modified teflon-lined 10l Go-Flo bottles mounted on the CTD rosette. Samples for Hg analysis were taken using an unmodified 5l Go-Flo bottle, although during the cruise the 10l bottles were also shown to suitable for collecting sea water for this purpose. as in previous cruises involving trace metal work, the modified Go-Flo bottles frequently did not function properly (*e.g.* pressure trip valves not working, end valves sticking).
Approximately 35 1l samples were collected for on-shore analysis of trace

metals and filtered through a 0.4um membrane using 10psi overpressure. Cd, Co, Cu, Mn, Ni, Fe, Zn and possibly Fe will be determined by chelation/solvent extraction followed by graphite furnace AAS. Generally, one sample was taken for each CTD cast at *ca.* 10m depth and additional samples were taken where the water column was not vertically homogeneous with respect to salinity or light transmittance (suspended particle loading). 70 samples of suspended particles were collected at 50 stations by large volume filtration (up to 25l) for subsequent trace metal analysis (at Poly SW). Replicate samples were taken at the three intercalibration stations with the intention of suppling these for analysis by our German colleagues.

MAFF scientists preserved 130 samples of filtered water and 84 samples of suspended particulate material during the cruise. 80 of the samples were analysed on board for Cd, Pb and 'labile' Cu before equipment failure. These covered the German Bight, the Danish coast and the transect at 55^{o} 30'N. The remainder of the samples will be analysred at Burnham-on-Crouch. All the water samples will be reanalysed after UV irradiation to determine total dissolved Cu. The suspended sediments will be leached with nitric acid for determination of Cd, Pb and Cu.

Dissolved Cd in the analysed samples varied between <3 and 70ng l^{-1}. Lowest levels occurred in the central North Sea and the highest off the Rhine and Elbe estuaries. Pb concentrations were in the range 20 to 35 ng l^{-1} except in the vicinity of major estuaries where they reached up to 170ng l^{-1}. 'Labile' Cu as measured by ASV is only semi-quantitative; concentrations ranged from 70ng l^{-1} in the central North Sea to greater than 400ng l^{-1} off some major estuaries.

A total of 108 stations were sampled for Hg analysis. At each station, samples of unfiltered water, filtered water (glass fibre, GF/F grade) and suspended particulate material were preserved. Nearly all the samples were analysed at sea for total Hg in unfiltered samples and for reactive and total dissolved Hg in filtered samples by cold vapour AAS following preconcentration oa a gold trap. Due to an intermittent contamination problem during filtration, reliable dissolved Hg data are only available for approximately half the sampled stations.

The concentration ranges found were 0.15 to 1.1ng l^{-1} of dissolved reactive Hg, 0.24 to 1.3ng l^{-1} of dissolved total Hg and 0.21 to 2.4ng l^{-1} of total (dissolved plus reactive particulate) Hg. The highest concentrations of all forms were found in coastal areas, notably off the Elbe, Humber and Thames estuaries (no data are available for off the Rhine). In these areas, less than half the Hg was in the dissolved phase. Lowest concentrations were observed in the western central North Sea where the Hg was predominantly in the dissolved phase.

Biology (D Mills).

The biologist was responsible for the following measurements:

(1) Chlorophyll. Samples from three depths (surface, mid and bottom) at all CTD stations were filtered and stored frozen for subsequent determination of extracted chlorophyll.

(2) Phytoplankton. Surface samples from alternate CTD stations were preserved for analysis of phytoplankton species composition.

(3) Dissolved oxygen. Water was collected from surface, mid and bottom bottles at selected stations for the determination of dissolved oxygen on board using a semi-automatic micro Winkler technique. Surface dissolved oxygen was monitored using a pulsed oxygen electrode system.

(4) Moored fluorimeter. Submersible fluorimeters and associated battery loggers were recovered and redeployed at moorings A and E. Samples were collected on site for chlorophyll and phytoplankton species analysis. The logged data were downloaded onto disc for subsequent analysis.
(5) Primary production. Water was collected each day at the nearest to dawn CTD station and used for the determination of carbon-14 uptake as a measure of primary production. Samples were incubated for 24h in a deckboard incubator.
(6) Suspended sediments. Recorded volumes of water were collected at three depths from most CTD stations and filtered for particle weight measurement. Surface transmission was recorded underway and the instruments checked periodically for zero readings in air. Only relatively low volumes of water could be filtered, occasionally as low as 500ml, in waters off the continental coasts where *Phaeocystis* was abundant.

REPORT PREPARED BY: A W Morris, 16 May 1989

REPORT AUTHORISED BY: B L Bayne, 16 May 1989

INTERNAL CIRCULATION: PML cruise personnel
Notice board
File VES 11.1

EXTERNAL CIRCULATION: North Sea Steering Group (M Blackley) - 3 copies
NERC HQ
RVS (C Fay) - 2 copies
MIAS (M T Jones)
MAFF(D Harper) - 3 copies
Polytechnic SW (G Millward)
Southampton U (A Tappin) - 3 copies

APPENDIX

Challenger 51 CTD Locations

Station	Start time	Position	Depth	End time	Position	Depth
1759 AAB 89	117 18.24	52 45.4N 1 54.6E	31	117 18.53	52 46.5N 1 54.2E	20
1760 ABB 89	117 22.00	52 41.3N 2 25.3E	52	117 22.03	52 41.4N 2 25.3E	53
1761 ABA 89	118 01.08	52 40.7N 2 25.0E	54	118 01.23	52 40.5N 2 24.9E	53
1762 ACB 89	118 04.02	52 40.0N 2 50.1E	44	118 04.34	52 40.2N 2 50.0E	45
1763 ADA 89	118 07.15	52 38.2N 3 14.9E	34	118 07.31	52 38.4N 3 15.0E	35
1764 AEA 89	118 09.49	52 37.2N 3 46.2E	27	118 10.03	52 37.2N 3 46.3E	31
1765 AFA 89	118 11.51	52 36.9N 4 0.1E	28	118 12.03	52 36.7N 4 0.0E	28
1766 AFB 89	118 12.21	52 37.0N 3 59.9E	27	118 12.31	52 36.9N 3 59.7E	27
1767 AGA 89	118 14.18	52 36.8N 4 19.8E	20	118 14.30	52 36.6N 4 19.5E	21
1768 AHA 89	118 15.43	52 34.3N 4 8.9E	25	118 15.54	52 34.2N 4 8.8E	26
1769 AIA 89	118 18.00	52 28.1N 3 41.9E	26	118 18.11	52 28.2N 3 42.1E	28
1770 AJB 89	118 20.21	52 21.6N 3 16.0E	39	118 20.33	52 21.9N 3 16.2E	34
1771 AKB 89	118 23.06	52 14.7N 2 50.2E	40	118 23.23	52 14.7N 2 50.2E	41
1772 ALA 89	119 01.44	52 9.6N 2 20.2E	49	119 02.00	52 9.2N 2 20.0E	48
1773 AMA 89	119 04.13	52 4.9N 1 49.9E	29	119 04.25	52 4.8N 1 49.8E	28
1774 ANA 89	119 06.46	51 47.2N 1 47.1E	27	119 06.59	51 47.4N 1 47.3E	27
1775 AOB 89	119 09.22	51 29.9N 1 45.0E	37	119 09.34	51 30.1N 1 45.1E	37
1776 APB 89	119 12.45	51 9.9N 1 33.6E	52	119 13.03	51 10.0N 1 33.7E	52
1777 AQA 89	119 14.53	51 3.0N 1 50.1E	30	119 15.03	51 2.9N 1 50.1E	31
1778 ARB 89	119 19.48	51 28.5N 2 40.6E	34	119 19.59	51 28.6N 2 40.8E	32
1779 ASB 89	119 22.35	51 45.4N 3 0.2E	32	119 22.46	51 45.5N 3 0.3E	36
1780 AUA 89	120 02.46	52 7.9N 3 29.7E	29	120 02.57	52 7.8N 3 29.4E	31
1781 AVA 89	120 04.54	52 12.7N 3 52.0E	24	120 05.05	52 12.6N 3 51.9E	26
1782 AWA 89	120 06.35	52 21.0N 4 0.1E	25	120 06.46	52 21.0N 4 0.2E	25
1783 AXA 89	120 09.16	52 37.5N 3 46.2E	29	120 09.27	52 37.8N 3 46.5E	30
1784 AYB 89	120 10.46	52 47.1N 3 37.2E	30	120 10.59	52 47.4N 3 37.4E	30
1785 AZB 89	120 13.16	52 59.8N 3 26.7E	28	120 13.30	52 59.9N 3 26.9E	28
1786 BAA 89	120 15.17	53 11.9N 3 16.1E	28	120 15.30	53 11.9N 3 16.0E	28
1787 BBB 89	120 20.14	53 30.0N 2 59.9E	31	120 20.25	53 30.1N 2 59.9E	31
1788 BCA 89	120 22.46	53 24.4N 3 27.0E	29	120 22.57	53 24.7N 3 27.2E	29
1789 BDB 89	121 01.26	53 18.1N 4 0.0E	28	121 01.37	53 18.2N 4 0.4E	28
1790 BEB 89	121 03.49	53 13.4N 4 20.9E	31	121 04.04	53 13.3N 4 21.9E	31
1791 BFB 89	121 05.13	53 9.9N 4 37.0E	22	121 05.25	53 9.8N 4 36.9E	21
1792 BGA 89	121 09.18	53 38.9N 4 49.8E	30	121 09.30	53 39.0N 4 49.7E	30
1793 BLB 89	121 13.30	54 2.9N 5 40.1E	38	121 13.43	54 2.8N 5 40.6E	37
1794 BMA 89	121 15.06	53 56.5N 5 50.3E	34	121 15.18	53 56.6N 5 50.8E	34
1795 BNA 89	121 16.21	53 50.1N 6 0.2E	30	121 16.31	53 50.1N 6 0.6E	30
1796 BOB 89	121 18.06	53 38.9N 6 10.0E	26	121 18.16	53 38.9N 6 10.2E	26
1797 BPA 89	121 19.55	53 42.9N 6 29.8E	22	121 20.05	53 43.0N 6 29.8E	22
1798 BQA 89	121 22.09	53 54.8N 6 25.3E	26	121 22.18	53 54.9N 6 24.9E	26
1799 BRA 89	121 23.40	54 6.0N 6 24.7E	34	121 23.51	54 6.1N 6 24.5E	34
1800 BSA 89	122 01.32	54 20.0N 6 24.9E	38	122 01.46	54 20.1N 6 24.9E	38
1802 BUB 89	122 05.41	54 16.6N 6 57.4E	38	122 05.41	54 16.6N 6 57.4E	38
1801 BTB 89	122 03.28	54 34.9N 6 25.0E	39	122 03.42	54 34.9N 6 25.2E	39
1803 BVB 89	122 08.19	54 15.0N 7 0.1E	38	122 08.33	54 15.1N 7 0.1E	38
1804 BWB 89	122 12.48	54 5.9N 6 59.6E	34	122 13.03	54 5.8N 6 59.4E	34
1805 BXA 89	122 14.32	54 1.1N 7 13.8E	31	122 14.38	54 1.1N 7 13.8E	31
1806 BXB 89	122 14.43	54 1.1N 7 13.8E	31	122 14.54	54 1.1N 7 13.9E	31
1807 BYB 89	122 18.22	53 49.4N 7 21.7E	26	122 18.48	53 49.4N 7 22.8E	26
1808 BYA 89	122 19.00	53 49.4N 7 23.2E	26	122 19.05	53 49.3N 7 23.3E	26
1809 BYA 89	122 19.11	53 49.3N 7 23.6E	26	122 19.21	53 49.3N 7 24.0E	25
1810 BZA 89	122 22.24	54 10.5N 7 28.4E	40	122 22.36	54 10.5N 7 28.2E	39
1811 BZB 89	122 22.37	54 10.5N 7 28.2E	39	122 22.48	54 10.5N 7 28.0E	39
1812 CAA 89	123 00.56	54 16.1N 7 44.6E	27	123 01.01	54 16.1N 7 44.5E	27

1813	CAA	89	123	01.05	54 16.2N	7 44.4E	27	123	01.08	54 16.2N	7 44.3E	27
1814	CBA	89	123	02.18	54 25.1N	7 39.8E	24	123	02.31	54 25.2N	7 39.6E	24
1815	CCA	89	123	04.21	54 39.9N	7 40.0E	21	123	04.33	54 39.9N	7 40.1E	21
1816	CDA	89	123	06.26	54 54.9N	7 40.0E	21	123	06.38	54 54.8N	7 40.2E	21
1817	CEB	89	123	08.25	55 9.9N	7 40.0E	22	123	08.33	55 9.9N	7 40.2E	22
1818	CFA	89	123	10.43	55 27.0N	7 40.1E	25	123	10.56	55 27.0N	7 40.2E	25
1821	CIB	89	123	16.16	55 30.0N	6 30.2E	43	123	16.30	55 29.9N	6 30.3E	43
1822	CJA	89	123	18.52	55 30.0N	6 0.0E	50	123	19.09	55 30.1N	6 0.0E	50
1823	CKB	89	123	21.14	55 30.1N	5 29.6E	52	123	21.28	55 30.1N	5 29.8E	52
1824	CLA	89	124	00.52	55 29.8N	4 59.1E	44	124	01.08	55 29.6N	4 58.9E	44
1826	CNA	89	124	06.10	55 30.0N	3 45.1E	34	124	06.21	55 30.1N	3 45.3E	34
1827	COB	89	124	08.38	55 29.9N	3 9.9E	36	124	08.57	55 29.9N	3 10.0E	36
1828	CPA	89	124	11.20	55 30.0N	2 34.9E	47	124	11.36	55 29.8N	2 34.8E	48
1829	CQB	89	124	13.41	55 29.8N	2 1.9E	68	124	13.56	55 29.7N	2 1.8E	68
1830	CSA	89	124	21.16	55 30.1N	0 54.2E	84	124	21.36	55 30.2N	0 53.9E	84
1831	CSA	89	124	21.48	55 30.1N	0 54.1E	84	124	22.18	55 30.2N	0 53.8E	83
1832	CSA	89	124	23.48	55 30.0N	0 53.9E	85	125	00.15	55 29.9N	0 53.6E	83
1833	CTA	89	125	02.15	55 29.9N	0 24.0E	76	125	02.31	55 29.7N	0 23.8E	75
1834	CUA	89	125	04.22	55 30.0N	0 4.0W	76	125	04.43	55 30.0N	0 3.9W	76
1835	CVA	89	125	06.41	55 30.0N	0 31.9W	63	125	07.02	55 30.2N	0 31.8W	65
1836	CWA	89	125	08.18	55 30.1N	0 52.2W	93	125	08.26	55 30.2N	0 52.3W	92
1837	CWB	89	125	08.49	55 30.4N	0 52.6W	94	125	09.10	55 30.6N	0 52.8W	94
1838	CXA	89	125	10.48	55 30.1N	1 12.2W	87	125	11.06	55 30.0N	1 12.6W	87
1839	CYA	89	125	12.31	55 29.9N	1 33.0W	33	125	12.43	55 29.6N	1 33.0W	33
1842	DAA	89	125	16.14	55 9.4N	1 26.6W	40	125	16.28	55 9.2N	1 26.5W	39
1840	CZB	89	125	13.45	55 20.0N	1 30.1W	43	125	14.00	55 19.7N	1 30.3W	43
1841	DAA	89	125	16.08	55 9.5N	1 26.5W	40	125	16.11	55 9.5N	1 26.6W	40
1843	DBA	89	125	17.47	55 0.1N	1 7.0W	42	125	18.02	55 0.1N	1 7.0W	42
1844	DCB	89	125	19.50	55 0.3N	0 56.9W	82	125	20.10	55 0.6N	0 57.0W	78
1845	DDA	89	125	22.02	55 0.1N	0 36.0W	69	125	22.19	55 0.2N	0 36.1W	69
1846	DEB	89	125	23.42	54 59.9N	0 15.1W	91	126	00.03	54 59.9N	0 15.0W	92
1847	DFA	89	126	01.54	54 51.8N	0 32.9W	65	126	02.10	54 51.4N	0 32.7W	66
1848	DGA	89	126	03.50	54 43.9N	0 50.9W	59	126	04.06	54 43.5N	0 50.5W	57
1849	DHA	89	126	05.27	54 38.9N	1 3.2W	27	126	05.37	54 38.9N	1 3.0W	27
1850	DIA	89	126	06.26	54 38.9N	0 53.0W	45	126	06.39	54 38.8N	0 52.8W	45
1851	DJA	89	126	07.56	54 35.1N	0 37.2W	52	126	08.10	54 35.3N	0 37.3W	51
1852	DKB	89	126	09.36	54 31.3N	0 21.1W	57	126	09.50	54 31.5N	0 21.5W	57
1853	DLA	89	126	11.57	54 26.3N	0 0.1W	59	126	12.13	54 26.4N	0 0.6W	59
1854	DMB	89	126	15.13	54 19.9N	0 24.0E	62	126	15.33	54 19.4N	0 24.2E	70
1855	DNA	89	126	17.53	54 9.9N	0 24.0E	59	126	18.12	54 9.5N	0 24.3E	60
1856	DOB	89	126	19.48	53 54.9N	0 24.0E	50	126	20.03	53 54.9N	0 24.0E	50
1857	DPA	89	126	22.24	53 40.7N	0 24.0E	19	126	22.36	53 40.7N	0 23.9E	19
1858	DQB	89	127	00.35	53 30.2N	0 24.0E	13	127	00.41	53 30.3N	0 24.0E	13
1859	ELA	89	127	02.26	53 20.0N	0 29.9E	14	127	02.33	53 19.9N	0 29.8E	15
1860	EMA	89	127	03.47	53 9.7N	0 30.9E	19	127	03.58	53 5.7N	0 31.5E	19
1861	ENA	89	127	04.31	53 5.7N	0 31.5E	34	127	04.46	53 5.7N	0 31.5E	35
1862	DRA	89	127	08.31	53 30.9N	0 40.8E	102	127	08.51	53 31.0N	0 40.8E	101
1863	DSB	89	127	10.38	53 35.2N	1 5.0E	23	127	10.46	53 35.3N	1 4.9E	22
1864	EKA	89	127	12.38	53 43.3N	0 42.9E	29	127	12.48	53 43.6N	0 42.9E	29
1865	EJB	89	127	15.05	53 59.9N	1 3.5E	44	127	15.20	53 59.8N	1 3.4E	44
1866	EIB	89	127	17.52	54 9.8N	1 17.7E	65	127	18.07	54 9.7N	1 17.7E	66
1867	EGB	89	127	20.38	54 19.9N	0 46.3E	61	127	20.52	54 20.0N	0 46.6E	63
1868	EHB	89	127	22.39	54 20.2N	1 8.2E	58	127	22.53	54 20.3N	1 8.2E	61
1869	DZA	89	128	00.23	54 20.1N	1 29.3E	48	128	00.40	54 20.4N	1 28.5E	45
1870	DYA	89	128	03.26	54 20.0N	2 7.2E	37	128	03.39	54 20.1N	2 6.8E	35
1871	DXA	89	128	05.45	54 4.9N	2 22.9E	70	128	06.06	54 4.4N	2 23.3E	68
1872	DWB	89	128	08.28	53 44.9N	2 44.4E	37	128	08.39	53 44.9N	2 44.5E	38
1873	DVB	89	128	10.18	53 34.5N	2 35.1E	28	128	10.28	53 34.3N	2 35.1E	29
1874	DUB	89	128	12.11	53 34.9N	2 9.9E	22	128	12.20	53 35.0N	2 9.8E	22
1875	DTB	89	128	14.59	53 35.6N	1 34.4E	77	128	15.14	53 35.9N	1 34.4E	81

1876 EPB 89	128 19.37	53 0.6N	1 7.9E	20	128 19.50	53 0.6N	1 7.9E	20
1877 EQA 89	128 21.08	52 56.1N	1 35.2E	30	128 21.18	52 56.1N	1 35.2E	29
1878 AAA 89	128 23.29	52 40.4N	2 14.0E	35	128 23.42	52 40.4N	2 14.0E	34
1879 ABA 89	129 05.06	52 41.8N	2 24.6E	52	129 05.19	52 42.3N	2 24.6E	51