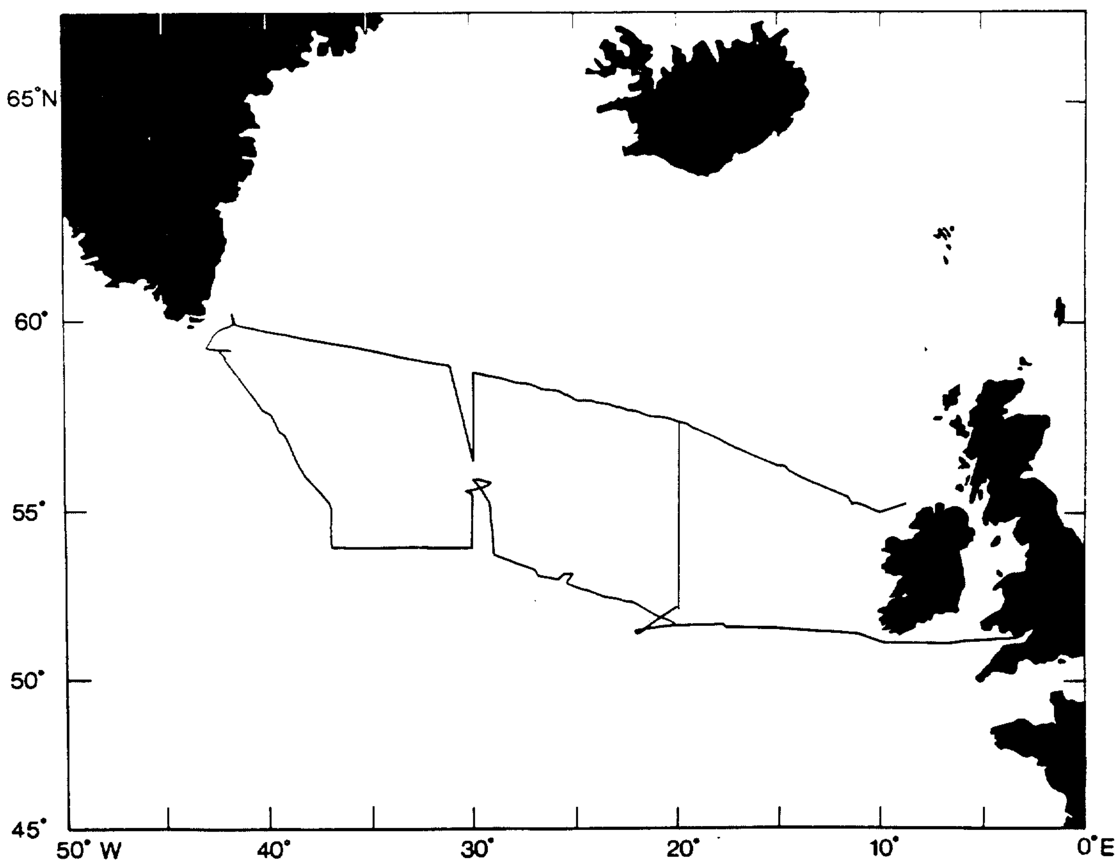
Institute of
Oceanographic Sciences
Deacon Laboratory

RRS Charles Darwin Cruise 62

01 Aug - 04 Sep 1991

CONVEX-WOCE Control Volume AR12

Cruise Report No 230 1992



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CRUISE REPORT NO. 230

RRS CHARLES DARWIN CRUISE 62
01 AUG-04 SEP 1991

CONVEX-WOCE Control Volume AR12

Principal Scientist
W J Gould

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ABSTRACT

The cruise on RRS *Charles Darwin* was the first occupation of the WOCE Control Volume AR12. 96 stations were worked with a NBIS Mk III or Mk V CTD, and a 24 bottle multisampler measuring salinity, dissolved oxygen, silicate, nitrate and CFC 11 and 12. Station spacing was typically 30 - 40 nm but closer over topography. XBT drops (mostly T-7) were made between the CTD stations. There were additional measurements with a hull-mounted 150 KHz RDI ADCP and high quality meteorological observations were made with the UK Multimet system. Some biological sampling was carried out with vertical nets in order to calibrate ADCP backscatter measurements. Wide beam bathymetry (10 KHz) was carried out throughout. All data were recorded by the ship's PSTAR computer system.

KEYWORDS

ACOUSTIC DOPPLER CURRENT PROFILER(ADCP)
AR12
CFC 11,12
"CHARLES DARWIN"/RRS - cruise(1991)(62)
CORE PROJECT 3
CTD OBSERVATIONS
MULTIMET
NUTRIENTS
WOCE

ISSUING ORGANISATION

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GOULD W John	(WJG)	IOSDL	(Principal Scientist)
BACON Sheldon	(SB)	IOSDL	
BOSWELL Steve	(SMB)	JRC	
BRANDON Mark	(MB)	JRC	
GWILLIAM Pat	(TPJG)	IOSDL	
HARTMAN Mark	(MH)	JRC	
HEYWOOD Karen	(KJH)	UEA	
HILL Andy	(AH)	RVS	
HOLLEY Sue	(SH)	JRC	
JONES Doriel	(DJ)	RVS	
PAULSON Chris	(CP)	RVS	
PAYLOR Rodger	(RP)	JRC	
POVEY Lara	(LP)	IOSDL/Univ Surrey	
READ Jane	(JR)	IOSDL	
SAUNDERS Peter	(PMS)	IOSDL	
SMYTHE WRIGHT Denise	(DSW)	JRC	
TIDDY Raoul	(RT)	JRC/Coventry Polytechnic	
WOODLEY Colin	(CW)	RVS	

SHIPS PERSONNEL

MACDERMOTT P. J.	Master
BOURNE R.A.	Chief Officer
SYKES S.	Second Officer
WARNER R.A.	Third Officer
DONALDSON B.	Radio Officer
MOSS S.A.	Chief Engineer
ANDERSON J.E.	Second Engineer
HOLT J.M.	Third Engineer
PERRIAM R.J.	Electrical Engineer
MACDONALD R.	CPO(D)
BOWEN A.M.	S1A
HARRISON M.A.	S1A
LEWIS T.G.	S1A
OLDS A.E.	S1A
DEAN P.H.	S1A
PETERS K.	CPO(C)
BISHOP P.J.	Cook
ORSBORN J.A.	Second Steward
ELLIOT C.J.	Steward
LINK W.J.	Steward
HILL V.	Motorman

OBJECTIVES

The WOCE Implementation Plan (World Climate Research Programme, WCRP-11 and 12, WMO/ICSU 1988) calls for the observation of the gyre scale circulation of the N Atlantic by means of the occupation of a series of CTD station grids that have come to be known as Control Volumes. The rationale for this observational strategy has its origins in the observations of Armi and Stommel, 1977 (Journal of Physical Oceanography **13**, 828-857) who observed changes in the shape and strength of the eastern Atlantic subtropical gyre over a period of several months.

The cruise described here is the first occupation of one such Control Volume. The data set collected will be used to

a) determine the changes in distribution and physical and chemical characteristics of water masses in the area from previous surveys, notably TTO.

b) to determine the "ages" of the water masses by the measurement of CFC concentrations.

c) to collect a data set that would enable the absolute transport of water masses through the area to be determined together with the fluxes of heat and salt, across the area between the UK and Greenland.

d) to make high quality meteorological measurements from the vessel using the IOSDL Multimet package.

e) to carry out biological sampling in order to determine the relationship between ADCP backscatter strengths and biomass distribution.

ACKNOWLEDGEMENTS

This was a long and hard cruise and all the ship's personnel should be praised for the cheerful and efficient way that did their work. Of special mention are the Master and deck officers who handled the vessel so efficiently in marginal (and worse) conditions. The Darwin is a demanding ship and a 3 or 4 hour station in high winds and seas gives no room for even the briefest relaxation of alertness; in the most severe conditions it needed both the Master and the Officer of the watch to keep the ship on station .

The watchkeepers Arthur Olds, Paul Dean and Greg Lewis ably assisted with the CTD handling in difficult conditions.

Finally but certainly not least the catering staff fed and looked after us extremely well. The catering was a very great improvement over some previous cruises (particularly Darwin 43).

NARRATIVE

RRS Charles Darwin sailed from Barry on Cruise 62 at 2030A on Thursday August 1st (day 213). Sailing had been delayed from the planned midday tide by the failure of a ballast pump during refuelling that morning. Clocks were retarded by 1 hour to GMT overnight. (All times hereafter in this report will be GMT). Course was set for the first CTD station west of Ireland.

Passage was made in slight sea and swell and between 0520 and 0800/2nd (214) an ADCP calibration run was carried out during a period with a stable GPS satellite constellation. At 0915 the vessel stopped to deploy the PES fish and the non-toxic seawater supply system was turned on. Unfortunately an outlet in the constant temperature lab had not been closed properly at the end of the previous cruise and this resulted in flooding of the autoanalyser. A test XBT drop on the continental shelf at 1850 was successful but revealed that the launcher cable was too short. It was later lengthened.

The first CTD station (A1) at the shelf edge was reached at 2345 and completed by 0100/3rd (215). The station revealed that several lanyards had not been threaded properly and few samples were collected. The ADCP was changed to a deep water configuration at the end of the station. Passage continued westwards with CTD stations CD62001 to 004 across the north end of the Porcupine seabight and onto Porcupine Bank with XBT drops taken midway between stations, by 1600/3rd. ADCP data logging had failed at 0400 but data were recovered from the backup disk.

The section then continued westwards into deep water. The weather worsened overnight until it was blowing 40 kts by the time CTD CD62007 was reached at 0730/4th (216). A number of vertical net hauls were made and by 1015 the weather had abated and the CTD station went ahead and was completed by 1415.

The CTD oxygen sensor had shown low sensitivity on previous stations and was replaced before the next station. On arrival at the station a net haul was carried out to 200 m while the CTD modifications were completed. On deployment of the CTD at 1924 the conductivity sensor was found to be inoperative. The CTD unit was opened up and a broken wire found. The CTD was redeployed by 2122 but was still found to have an erroneous conductivity output. Since the CTD technicians now needed rest the station CD62008 was abandoned and an XBT dropped instead.

Between 2330/4th (216) and 0430/5th (217) a further ADCP calibration run was carried out. CTD CD62009 was started at 0611/5th (217) but the data stream was found to be noisy. A second drop was made with only the CTD connected which improved the situation and the station was finally completed with all sensors connected by 1346/5th (217).

The final CTD of section A (CD62010) was completed by 2110/5th and course set for a position 5 miles north of the Pingree East Thulean Rise mooring, with two hourly XBT drops en route. On arrival at the mooring position at 0447/6th (218) a series of net hauls was carried out until 0550 when an acoustic search for the mooring was commenced. This continued until 0930 when the search was abandoned with no acoustic contact made and no visual sign of the mooring being on the surface.

Course was set for the next CTD station with two hourly XBTs on passage. The nominal position of CTD CD62011 was reached by 1800/6th but was found to be on a steep slope so the station was moved southwestwards to avoid this. The CTD station was completed by 2155 but with many misfirings of the multisampler. The section continued northwards on 20W with continuing multisampler misfiring problems. The vessel stopped at 54N 20W at 1300/7th (219) to deploy two Argos-tracked drifters for Robin Pingree PML. The two buoys had different drogue types, one a "holey sock" plus a large plastic bin and the second with a drogue made of fishing net.

Before CTD62016 (0007-0134/8th) the multisampler lanyard tensions had been slackened and this seemed to cure the misfire problems with a full set of samples being achieved on that station. This situation continued to the end of the northward leg of CTDs on 20W (line B).

The vessel then headed westwards at 2110/8th (220) on line C with some CTD problems with noise spikes, possibly due to the considerable ship motion. On station CD62022 (0431-0638/9th) the multisampler problems reappeared with bottle 9 apparently being the cause of the problem. This bottle was taken out of the firing sequence and at station CD62023 a full set of samples was again recovered After CTD CD62026 (completed by 0742/10th) the weather deteriorated with 40-50 kt winds and very heavy seas. Passage speed was reduced until the vessel was hove to by 0930. Passage was resumed by 1500 but at only 3 knots. The vessel did not reach the next station (CD62027) until 2340. The sea cable had been reterminated to eliminate some bad birdcages in the bottom 30 m. On station CD62027 only two bottles closed and between this and the next station the multisampler was removed and dismantled.

It was then believed that the root cause of the misfire problem lay in lack of lubrication. The normal practice of spraying with WD40 could not be used because of the CFC measurements. From this point we instituted a schedule of bathing the firing mechanism in soapy water at the end of each station and lubricating it with silicon oil before deployment.

On station CD62028 (1250-1540/11th) all bottles fired and this pattern was generally repeated on subsequent stations.

Station CD62031 (0917-1042/12th) marked the junction with a southgoing leg (D) on 30W. Sea surface temperatures over the mid Atlantic Ridge in this area were very patchy. Westerly winds on the southward leg meant that the vessel had to remain on station until sampling was completed since the CTD was on the windward side of the vessel. On station CD62032 the bottom finding pinger failed as the bottom was approached and so the lowering was terminated at a safe separation.

A replacement pinger failed on CD62034 very early in the profile but again the lowering was made to a safe distance off bottom.

The D line was completed CD620036 by 1800/13th (225) and course was set at 12 kts with the wind on the starboard quarter back to the continuation of the C line towards Greenland. XBTs were deployed on the odd hours.

The section was resumed at 0700/14th (226). The weather moderated to the best so far in the cruise with light winds through much of 14th and 15th. The clear weather gave good displays of the aurora borealis on the nights 14/15th and 15/16th.

There appeared to be very few scatterers in the water column and as a consequence almost no ADCP data was collected on passage if speeds exceeded 10 kts. By nightfall on the 15th (227) the wind had freshened to a 25 kt westerly and by morning had increased to 35-40 kts. The start of CD62041 was delayed for 30 minutes while the weather and sea state prospects were assessed.

The station was completed by 1040/16th (228) despite a stuck multisampler bottle at 500 m requiring the upper part of the cast to be repeated. CTDs continued throughout the day (up to CD62046) as the Greenland slope was approached.

Station CD62047 was completed by 0323/17th (229) in light airs, heavy rain and a heavy confused swell. The vessel remained on station while the sampling was completed and then course set for the next station. At 0500 the weather suddenly changed with a 40 kt northerly wind springing up within 20 minutes. This was accompanied by a drop in air temperature from ca 9 to 4.5°C. These northerly winds continued throughout the day with gusts to over 50 knots and no work was possible.

By early evening the wind had abated and the vessel turned and ran back to position for the next station. This (CD62048) was completed by 2241/17th but a heavy confused swell meant that the wire had to be terminated at the end of the station as it had become badly birdcaged over the lowest 20 m.

By this time the wind had again freshened to 40-50 knots from the west and the temperature dropped further to 3.5°C. The vessel remained hove to and a T5 XBT was dropped over the 1200 m depth contour as the vessel edged up the continental slope.

Throughout the 18th the vessel remained hove to in 50 - 60 kt winds, with low sea and air temperatures. The wind was westerly and was pushing us towards Cape Farewell. XBTs were launched with only moderate success as the wind was blowing the wire onto ship. At noon the wind was put to starboard and the vessel steamed ahead at 3 kts to try to make an offing and to get south.

Icebergs were soon in the vicinity, and at 1900 the vessel turned and ran eastwards to 15 miles downwind of E3 to jog back overnight. E3 was worked (CD62049) still in very rough seas 0910 to 1052/19th. It was reluctantly decided that there was little point in trying to work the northern part of the E line so stations were worked southwards in continuing strong west to northwest winds.

CTDs continued throughout the 19th and 20th with intermediate XBTs. Heavy swells delayed the start of CD62054 for over 1.5 hrs. The run of northwesterly winds with accompanying heavy swell continued into the 21st. Again the start of a station (CD62056) was delayed and eventually was completed only with the master and 3rd mate handling the ship. By evening of the 21st our southeastward progress had been sufficient that the sea state had abated. The weather had however taken its toll and the mainmast wind speed indicator became intermittent.

During the 22nd (234) the weather improved markedly and the E section was completed by 2200 and course set eastwards on the F line towards 30W. The good weather continued as a welcome respite throughout the 23rd and into the 24th when course was set northwards for the completion of the D line.

During the late evening of the 24th on station CD62069 the wind again freshened from the west and by 0300/25th the vessel again hove to in 30/40 kt westerly winds. This poor weather continued through the day. The last CTD worked (D7) was markedly different from the station (D5) that had been worked earlier in the cruise. We were therefore very keen to work D6 and reoccupy D5. At noon the vessel turned eastwards and at 1900 hove to again to jog back towards D6 overnight.

The following morning (26th) found the vessel 10 miles north of D6 but with conditions still unworkable so a T5 XBT was deployed and the D line reluctantly abandoned. There had been many pilot whales around the ship while it was hove to and this suggested that we might have been in a frontal region.

The vessel turned and ran southeastwards at first and then southwards as conditions improved in order to occupy stations on a line (G) from 54N 30W to 51 45N 20W. G2 (CD62070) was reached at 2250/26th. Stations continued throughout the day but the weather again steadily deteriorated. On station G3 there was dense fog and 30 kt winds. As the vessel reached the position another ship was seen on radar on a collision course and the station was moved 2 miles to the south. The southerly winds meant that speed had to be reduced between stations in order that sampling could be carried out safely. On this station the first trial of the Mk V CTD was carried out (both Mk III ands Mk V units on the frame with a planned lowering of the Mk V to 1000 m and then return to the surface followed by a normal Mk III profile) but the data were poor so the trial was abandoned at 600 m.

Sampling was slow from the multisampler on desk/due to duplicate oxygen isotope ratios being taken and the next station was not reached until 0244/28th. Weather conditions were poor but the station went ahead with both master and 2nd mate on the bridge. During the station the weather deteriorated markedly and the bow thruster failed during a 20° wind shift with wind speeds to 50 kts. The station was completed with difficulty by 0610 and the vessel remained hove to while water sampling was completed.

The vessel remained hove to at the end of the station in strong winds and making a course towards the northeast. At 1230 the vessel altered course to run downwind on a course of 220. An XBT was dropped as the line of the stations was crossed and at 1830 after the wind and sea had moderated course was set towards station G6 (CD62074) which was completed by 2340. The G line was then continued through the 29th and at G8 (CD62076) the first test of the Mk V CTD was carried out alongside the Mk III. The initial lowering to 1000 m showed that there was a basic fault and the station was completed with the Mk III.

The line continued in good weather and was completed at G11 CD62079 (repeat of B1) using the now repaired Mk V 0940-1243 (30th). Course was then set northwards along the B line in order to repeat B4 and B6 (with the Mk V) where there had been problems on the initial occupation with very few multisampler samples having been collected.

The final section (H) across the Rockall Trough was started in excellent weather at 2210/31st and completed by 0757/3rd. The vessel then started an ADCP calibration run on courses of 030 and 120. This was completed at 1400 and the PES recovered and data logging ceased. Unfortunately it was later discovered that during the ADCP calibration run a fault had developed in the gyro input to the ADCP. The ADCP was left to record on disk overnight in bottom track mode with GPS positions being recorded every hour.

SCIENCE REPORTS

CTD Operations

CTD & Multisampler Hardware (TPJG)

The cruise was primarily a data gathering exercise, with the work concentrated on vertical profiling with the NBIS MKIII CTD and the collection of water samples with the 10 litre water bottle multisampler system. Some time was allowed however for an intercomparison of the MKIII CTD and the recently acquired MKV CTD.

The CTD/multisampler underwater unit carried the following equipment.

- Neil Brown MKIII CTD Number 01
- Neil Brown MKV CTD (for some stations)

- Sea Tech 100 cm transmissometer Serial No, 35
- IOSDL 10 KHz pinger.
- G.O. 10 litre 24 bottle rosette. Serial No. 02.

At various times up to 8 SIS digital thermometers

- Ser. Nos.: RVS T213E, T220D, T254F, T260F, T262D

  IOSDL T399, T400, T204

and SIS pressure sensors

- IOSDL B6075S, B6132H

were used.

The shipboard equipment consisted of the following:

- CTD PS2 system 1,
- CTD PS2 system 2,
- CTD 1401 deck units & rosette modules.

The MkIII CTD underwater unit worked reliably throughout the cruise giving very few problems. One hiccough that did occur however was after station CD62007 when, due to low sensitivity, it was decided to change the oxygen cell and in the process the conductivity cell leads were damaged and had to be replaced.

With the deployment of the CTD approximately every 4 hours it was decided to minimise any power interruption problems by maintaining supplies between stations.

The 10 litre multisampler system was the most recently acquired package and should have provided little or no problem. Unfortunately this was not the case.

Erratic bottle closing on early stations suggested problems with the lanyards and the methods used to cock the bottles. Even after alterations to these procedures water bottle firing was still unreliable. At station CD620011 a check on the insulation of the sea cable, after receiving noisy signals, gave results of 2.5-5 Mohms instead of near infinity. After cleaning the winch slip ring assembly, which had showed signs of sea water ingress, the insulation was increased to 50-100 Mohms. Although this resulted in an improved multisampler performance, the system was still not right. On station 13 only two bottles fired leaving the rosette on position 3. On recovery the unit still failed to fire on deck and it was very difficult to turn by hand. The top of the rosette was removed and on inspection score marks from the release pins on the holding ring were observed. The score marks were removed and the ring polished. The level of silicon oil in the stepper motor housing was low and required approximately 100 mls of silicon oil to top up. Station 14 showed little improvement in performance but again there was indications that the lanyards were too tight. For station 15 the tension in the lanyards was reduced and all 24 bottles fired correctly.

During this period the top plate of the rosette was washed down with soapy fresh water and lubricated with silicon oil, WD40 could not be used because of CFC contamination of the bottles.

The top plate of the rosette was again removed after station 22, when the cam jammed at position 9, and the assembly repolished. Although the system was providing sufficient samples it was not working 100%. According to the handbooks the working voltage specification was 30 ± 8 volts for normal working and with the unit connected across the CTD zener diode (22.5v). This should have been satisfactory. However, because of the problems with misfiring of bottles due to the tension in the lanyards there was a possibility that the power available at the stepper motor was reduced and providing insufficient torque. The voltage to the Rosette was increased to 25v by inserting a 11 ohm resistor between the CTD and the rosette. The result of this, and the cleaning and lubricating after each deployment, was a major improvement in performance and reliability.

During the earlier stages of multisampler problems, the back-up unit was installed with little success. It would appear that the electronic unit has sufficient problems that would require the facilities at the laboratory to bring it up to specification.

The 10 KHz pinger units worked satisfactorily throughout the cruise and only required regular battery changes to maintain performance

Apart from battery replacement only one of the SIS pressure temperature units was removed due to a fault, although T260 exhibited a blank display until heated up by hand and the results of T254 were usually preceded by a one.

The sea cable was reterminated twice during the cruise due to cable "kinks". These "kinks" usually develop in heavy swell conditions when the frame is being lowered and cable slack is generated. Because of the larger cross section of the 10 litre frame compared to the original 2.5 litre system, the drag is greater and hence the free fall velocity is lower. If the ship falls in swell the frame is unable to fall fast enough to keep the cable tight and any twist in the cable is released to form a kink. Modest lowering rates were used. In rough conditions these started at 20 m/min and increased to 40 m/min only after 500 m of wire had been paid out.

Once again the new 1401/PS2 deck unit system worked well with both system 1 and 2 in operation for all deployments.

MkV CTD Evaluation Tests (TPJG, PMS)

The first deployment of the MKV CTD on station 072 was only a partial success because of a fault condition in the underwater unit producing intermittent data. Inspection of the pcbs revealed a 'dry' joint where the common line was connected to the chassis.

The next deployment of the MKV was at station 076 where data was collected to 1000 metres and back to the surface. The MK3 was then switched in and the full station depth completed. A table of MKV deployments is set out below.

MKV TEST DEPLOYMENTS.

STN. NO.	MAX DEPTH (m)	DATA FILE. SYSTEM 1	DATA FILE SYSTEM 2.
CD62072	600	DA62D073	
		DA62U073	
CD62076	1000	DA62D076	
CD62079	3639	DA62D079	DA62D079
		DA62U079	DA62U379
CD62080	2297	DA62D080	DA62D380
		DA62U080	
CD62081	1463	DA62D081	DA62D381

The data collected from these tests will be studied back at the laboratory in order to assess the usefulness of the MKV for IOSDL.

The CTD and Sample processing paths (PMS,MB)

Each CTD station has as its principal end products;-

(a) An edited 2 db down cast

(b) A bottle file consisting of up to 24 levels of physical and chemical measurements.

The paths by which these are produced are described in the two following interlinked sections. The paths are complex: in all about 50 operations are performed and 20 files archived to tape during processing. It is important that users have a detailed understanding of them!

THE CTD PROCESSING PATH

	Activity	Procedures and (Notes)
(a)	Basic logging of raw data on RVS level A/B	
(b)	Transfer to Pstar format & split into up and down casts	ctdexec0
(c)	Calibrate p T with lab data	ctdexec1 + 2
(d)	Combine calibrated upcast with levels file-to yield the firing file	bottlecal
(e)	Calibrate salinity & oxygen using coefficients derived from the bottle file processing	ctdexec4 and ctdoxcal (see bottle file path (d))
(f)	Edit and reduce to 2 db average	ctdex5 + 6

THE BOTTLE FILE (SAMPLE) PROCESSING PATH

	Activity	Procedures and (Notes)
(a)	Manual entry of sample salts, oxygens and reversing p T instruments	Use Microsoft EXCEL spread sheets on Macintosh
(b)	Transfer to Pstar format on SUN, to create sample file	Program Excel62
(c)	Reconcile firing and sample files,and create bottle file	Program Sampbot (see accompanying text on topic)
(d)	Derive and verify salinity and oxygen field-calibrations for this station	Programs salcal, oxcoff and calplot
(e)	Calibrate CTD salinity and oxygen in this file	Programs ctdbot4,corox (See CTD processing path (e))
(f)	Add ancillary measurements (CFCs etc)	(Not yet determined)

Note.: *The upcast oxygen sample values are combined with downcast CTD measurements made at the same potential temperature.

Reconciliation of Firing and Sample Files (PMS)

The firing of the Rosette on the up-cast generates, via its own level-A, a data file consisting of a time-stamped set of CTD properties averaged for a 10 second period about the firing time. A variable called ds/dt is also created; this quantity is the range of salinity encountered during the averaging, and hence estimates the non-uniformity of the conditions in which each sample is taken. The multisampler used on Cruise 62 should produce a file consisting of no more than 24 entries. Occasions may arise during malfunctions of the multisampler when this number may be exceeded. On the SUN the list is termed the FIRING file.

The water samples drawn from the multisampler on the same up-cast have an identifier constructed from the cruise, station number and position on the rosette. Thus sample 6204207 originates from location 7 of the Rosette on station 42 (Cruise 62). Each sample bottle has a unique identifier which is recorded for each sample number. For the salinity samples a consecutive numbering scheme was also employed using adhesive labels - with foresight they could have corresponded to the above sampling scheme but did not.

All of the sample data was entered manually on a Macintosh computer using EXCEL spread sheet software. The nutrient chemistry, oxygen, salinity and digital reversing thermometer and pressure meter data were entered by their respective analysts on common format master spreadsheets. These sheets were then merged using cut and paste commands. All sample observations were uniquely identified by the same sample number. Apart from errors or revisions this list is invariant. When transferred to the SUN it is termed the SAMPLE file.

Although all CTD seagoers are familiar with the merging of the firing file and the sample file there has been little discussion of procedures. The following guidance is offered. The problem is to match each sample number and its associated chemical measurements with the correct set of CTD measurements. An example of the uncorrected firing file and the sample file accompany this section.

It is helpful if the two files can be listed and placed side by side. Hard copy listings are one option, but on the SUN this operation can be performed on the screen in two 'windows'. The left hand window might contain the firing data with the following variables listed;- firing code, pressure, temperature, oxygen and salinity (all from the CTD). The right hand window containing the sample data might list sample salinity, sample oxygen, nutrients, reversing thermometers and pressure meters. If the firing file is placed in an editor then the operations can be simplified.

Edit operations are performed only on the firing file and in the main consist of:

(a) deletion of a record (dd on the SUN vi editor)

(b) duplication of a record (yy p on the SUN vi editor)

These operations denote a) the failure of a bottle to close and b) the closing of more than one bottle per firing command respectively. On rare occasions the firing file may miss a command entry and in this case the entry must be constructed from the data in the CTD upcast, which is logged and stored separately.

Decisions concerning operations a) and b) above are largely determined by the correspondence or its lack between CTD salinity and sample salinity. Temperature and pressure observations (on this cruise at 4 levels) must be reconciled too and duplicate firings where indicated by sample salinity confirmed by duplication of nutrient and oxygen values. Reconciliation is an important task and must be conducted with care and without haste. It is important that both the corrected and uncorrected firing files are archived so that further revisions can be made at a later date. Once the reconciliation has been performed sample numbers are assigned to the firing levels and the firing and sample files merged on this variable. An example of a corrected firing file accompanies this section.

Comparisons amongst pressure and temperature sensors (PMS)

On the cruise eight SIS reversing thermometers (RTM4002) and two reversing pressure meters (RPM6000) were available and were installed on four frames of the multisampler. A fifth frame was broken on impact with the ship's side shortly after the start of the cruise, its thermometer damaged and no further consideration will be afforded it here.

As on previous cruises quite large differences were encountered amongst paired thermometers, that is instruments on the same frame, both before and after calibration corrections had been applied. Thermometers had been calibrated at IOSDL Wormley and at RVS Barry; sometimes agreement was good, sometimes poor. Corrections to the indicated value ranged between 0 and 25 mK. The paired thermometer differences for the majority of the stations on the cruise is shown in the accompanying table. Clearly more careful calibrations are required of these instruments and this topic will be pursued ashore. Nevertheless the thermometers were extremely useful in identifying levels at which the rosette bottles closed, especially during the first one-third of the cruise when the rosette performance was erratic.

Differences in temperature (corrected) between pairs of thermometers reversed on the same frame

Pair	399(IOS)-219(RVS)	400(IOS)-260(RVS)	220(RVS)-254(RVS)	262(RVS)-213(RVS)
Number	60	55	33	60
Mean diff mK	-0.2	-6.2	10.0	9.2
Std dev mK	1.1	3.0	2.4	3.4

Comparisons were also made between reversing thermometers and the CTD platinum resistance sensor with the results shown below:-

Differences in temperature (corrected) between reversing thermometers and CTD (Tctd-Tnnn)

Thermometer	t400	t399	t262	t260	t254	t220	t219	t213
number	71	80	66	60	33	69	63	64
mean diff mK	-5.5	-8.2	-10.9	-10.9	-0.7	-9.6	-8.2	-7.4
std dev.mK	2.5	1.7	8.1	4.5	1.5	10.0	3.2	9.9

It will be observed that differences are without exception negative, that is the CTD temperature is lower than the reversing thermometer. A discrepancy of this sign is to be expected since the reversing thermometers are approximately one meter shallower than the CTD sensor. The mean temperature of the shallowest instruments t213 and t262 was about 6°C where the gradient did not exceed 0.5°C/100 m or 5 mK/m, and so accounts for some of the discrepancy. The deepest instruments t219 and t399 were generally in gradients an order of magnitude weaker and hence the height difference cannot account for much of the observed difference. Again the calibration of the reversing thermometers is believed less certain than that of the CTD. The CTD calibration has shown drift of only 1-2 mK since a modification was made to the sensor on Charles Darwin cruise 42 in 1989, and was remarkably stable over the previous six year period. However the last word on this issue will remain with the post-cruise calibrations at IOSDL.

It should also be noted that especially at the deepest levels the difference between the CTD and reversing thermometers was remarkably constant throughout the cruise. For t399 and t400 the differences from the CTD were the same for stations 1-35 as they were for stations 36-90, at the fraction of the millidegree K level, affording testimony to the stability of both instruments.

On a previous cruise, Charles Darwin 42, a systematic discrepancy was reported between the CTD pressure and the RPM 6075S. The instrument was returned to the manufacturer and the calibration was confirmed. Comparisons between the two digital pressure sensors employed on this cruise and the CTD pressure sensor have reproduced the results found earlier. See the table below;-

Differences in pressure, CTD-RPM (uncorrected)

Instrument	6075S	6132H
number	55	61
mean difference.db	18.1	16.9
std deviation db	7.2	8.5

The table above does not include the manufacturer's calibration corrections to the RPM instruments They are no more than 5 db for 6075 and 13 db for 6132, but we are uncertain of the sign. Especially then for 6075 a large discrepancy exists. This has caused us concern for the CTD pressure calibration, a concern which has been removed on this cruise

We have converted the pressure measured at the bottom of each cast into depth according to the method described by Saunders (J. of Physical Oceanography, **11**, 573-574, 1981). The height of the CTD above the bottom was measured by a 10 KHz Pinger installed on the Rosette frame and recorded by the echo-sounder. Closest approach was between 5 and 25 m with an error estimate of about 2 m. Adding the CTD maximum depth to the closest approach gave a CTD 'depth of bottom' estimate which could be compared with the echo-sounder depth, the latter corrected according to Carter's tables. A histogram of the difference between over the depth range 500-4500 m shows the preponderance of data grouped near zero with approximately only 15% of the data exceeding 10 m. Of course other than in flat terrain, differences are to be expected; the echo-sounder averages depth below the ship with a footprint size of order 100 m, whilst the CTD estimate is a local measurement not in general directly below the ship. The agreement is remarkably gratifying and confirms the accuracy of the laboratory calibration of the CTD pressure sensor. The explanation for the differences of the SIS instruments is unclear.

Salinity determinations (SB, MH)

Both IOSDL Guildline Autosal salinometers, the old one (model 8400) and the new one (model 8400A) were carried on this cruise and operated at 24°C in the Darwin constant temperature laboratory, which was maintained at 22°C. The former was operated for the first half of the cruise and the latter for the second half. Both machines showed unusual stability of standardisation, neither deviating from their original values by more than 0.001 equivalent salinity. The old machine was initially preferred over the new one because the latter showed a large change in standardisation over the value at which it left IOSDL. This may be attributable to knocks suffered during transportation to Barry; it did not affect the machine's subsequent performance. Towards the end of the cruise, a fault developed on the FUNCTION switch on the new machine which resulted in display instability in the standby (SBY) position. This will need to be rectified upon return. Previous operational difficulties associated with the new machine, in particular its instability when run from a noisy power supply, have been rectified; no difficulties on this count were experienced.

About 1800 CTD bottle samples and 200 samples drawn from the ship's non-toxic supply (for thermosalinograph calibration) were processed during the cruise. 200 pairs of duplicate samples are included in the CTD sample figure, for which the standard deviation of the difference between salinities was 0.001. Only one pair of duplicates was more than 0.002 different. 250 ampoules of standard seawater (batch P115) were consumed.

The data processing route was changed during the cruise. Initially, the Ocean Scientific International 'Salinity' program was used to generate files of salinity data on an IBM PS-2, which were transferred to an Apple Macintosh, edited as a Microsoft Word text file and then transferred to the shipboard SUN system. Latterly, the data were entered directly into an Excel spreadsheet program on a Macintosh into which was pasted the approved conductivity ratio to salinity conversion formula. After testing and comparison, the Excel system was used exclusively. This was more efficient; a text file saved from Excel could be transferred to the SUN with no requirement for intermediate stages of processing.

Chemistry (DSW, SMB, SH, RP)

The primary aim of the chemistry work was to collect a narrowly spaced data set to the precision and accuracy required by the WOCE Hydrographic Programme (WHP) in order to chemically characterise and age the water masses of this area of the North Atlantic. The data would subsequently be used for flux measurements and to calculate transport rates within the subpolar gyre. Measurements of CFCs were planned at as many locations as possible (limited by the rate at which samples could be analysed) and of oxygen and nutrients at each station. Samples were collected for oxygen and hydrogen isotope measurement by NERC Isotope Geosciences Laboratory (NIGL).

The CONVEX survey provided the first opportunity for comprehensive measurement of CFCs in both western and eastern basins of the subpolar gyre. Because much of the water in the area is relatively new (ie was at the surface less than a decade ago) it was thought that the CFC-12/CFC-11 technique widely used within the WHP would not give sufficient information (the ratio of CFC-12/CFC-11 upon which the aging technique is based has not changed much for more than a decade and so it can be difficult to age with any precision over this time period), and so measurements of the new CFC tracer, CFC-113 were planned. In contrast the ratio of CFC-113 to either CFC-11 or CFC-12 has changed substantially in the past decade. However, provided little or no mixing has taken place, it is possible to age core water mass with some reliability over the last 15 years using CFC-11 and CFC-12 data alone, by using a combination of the ratio with absolute concentrations. Comparison with T,S and nutrient data facilitates this aging technique. Aging from CFC-113 data is very new and requires some further development. It also suffers from potentially severe CFC-113 contamination problems; a problem which also hampers CFC-11 and CFC-12 measurements but to a lesser extent provided the research vessel does not contain these substances within its air conditioning and refrigeration systems. Since two CFC systems were taken to sea, one belonging to the JRC (for CFC-11 and 12 measurements) the other to PML (for additional CFC-113 analysis) the cruise provided an opportunity for intercalibration of the two systems. It had been hoped that the JRC system would be upgraded for CFC-113 measurement prior to the cruise but due to late delivery of a number of components this was not possible.

Like the CFCs, oxygen measurements are indicative of water which has recently left the surface and are usually enriched in cold polar waters such as the overflow through the Denmark Strait. The nutrients nitrate, phosphate and silicate compliment CFC and oxygen measurements in that water masses are often high in one and not in another. A combination of all measurements results in distinct fingerprinting for many of the oceans water masses.

Oxygen and hydrogen isotope measurements can be used as oceanographic tracers and have been used successfully for tracing waters with a polar origin. Both have heavy isotopes that are fractionated from their lighter more abundant counterparts during processes of evaporation and precipitation, where they are more concentrated in the liquid phase, and during freezing where the ice becomes enriched over the mother liquid. On melting the high levels of ^{18}O and ^{2}H remain and make them a useful tracer for assessing the amount of ice melt in a particular water mass. Most of the tracer work to date has been at high latitudes, very little has been carried out in the subpolar area. Furthermore the technique for oceanographic tracer use is new in the UK. The cruise provided the opportunity to collect samples for a combined investigation with NIGL for assessing analytical techniques and usefulness of such data at lower latitudes.

The cruise also gave an opportunity to evaluate the workload, personnel requirement and sample handling and analysis techniques for the forthcoming WOCE WHP A-11.

Sample collection

All samples were collected from depth using the IOSDL 10 litre multisampler bottles. These had been cleaned prior to the cruise using a high pressure water jet. All O-ring seals and taps had been removed, washed in decon solution and propan-2-ol then baked in a vacuum oven for 24 hours. Cleaning and reassembling of the bottles was carried out just prior to the cruise to minimise contamination due to long storage. 54 bottles were taken to sea in case of contamination or damage, but only 24 where used. All bottles, whether in use or not, remained on deck throughout the cruise. None of the 24 working bottles showed a CFC contamination problem during the entire cruise.

CFCS

The bulk of the CFC measurements were made using the JRC CFC system. Samples from 85 stations were analysed immediately after collection for CFC-11 and CFC-12. Due to the close station spacing and the required analysis time it was not possible to sample the full range of depth levels at all stations. When turn-over time was limited, sampling was concentrated on the deepest depth levels. (Data on number of samples taken on each station is given elsewhere in the CTD station list).

In general the JRC system worked extremely well. Only two mishaps occurred, both due to the extreme weather. First the cooling bath fell off the bench during a particularly bad roll and this fractured the flexible pipe. It was quickly removed from the laboratory so as not to contaminate the CFC equipment and replaced with a spare. No downtime resulted. The second problem started with a noisy baseline from the ECD in the gas chromatograph. The problem became substantially worse, rendering the system useless for measurement and eventually the signal died altogether. In the first instance, there appeared to be a correlation with the roll of the ship and so it was presumed that a wire had worked free due to the inclement weather. It was not possible to verify this because of the need to open the radioactive detector and JRC/IOSDL do not have a licence for such work. Fortunately the JRC system is fitted with a spare ECD and so this was brought on line and the system functioned perfectly for the remainder of the cruise. Approximately eight hours downtime resulted from this problem, with the loss of one station.

The PML system seemed dogged with problems from the outset. The computer running the calibration and data storage programs was not available due to failure on a previous cruise. Backup software was supplied with the system but this was not comprehensive. During set up one of the valve controllers failed and had to be rewired. This was shortly followed by one of the valve actuators burning out, and since no spare was supplied this meant the valve V4 had to be turned manually. Once set up the system developed a baseline oscillation that rendered data collection useless. Although various theories where tested and advise sought from PML, the reason for the fault was not established. After about 2 weeks at sea the system cured itself following particularly inclement weather and a time when the cryocool was not operational leaving the molecular sieves at ambient temperature for a few hours. This suggested either a possible loose contact somewhere in the system or a pressure problem that was resolved when the flow rate in the sieves changed during heating and subsequent cooling. By this stage, however, it was decided to concentrate on the JRC system as this was giving good results. Nevertheless work with the PML system did continue but the chromatography was poor, with considerable overlap of peaks. Since time and personnel were at a premium it was not feasible to spend hours trying to obtain better separation when it was not obvious that this would have been achieved. We therefore concluded that there remain several question marks against the use of the PML system as a routine analytical tool. Firstly, the chromatographic resolution needs improving. Secondly, the system is very fragile and requires constant attention to maintain high quality results. Thirdly, it is not robust enough to cope with the large sample turn around required by WHP cruises.

Both CFC systems were set up in the main laboratory of the ship. From the CFC contamination aspect, the RRS Charles Darwin is a clean vessel with results from the JRC system suggesting no major contamination problems. Some contamination was experienced with the PML system but this was traced to loose gas connections and it cleared once these had been tightened. No contamination was found from the opening of the air conditioning unit door on the boat deck as had been suggested after Darwin 58 and 59.

CFC concentrations as measured by the JRC system ranged from 0.5 - 1.8 ρmol l^{-1}CFC-12 and from 1.2 - 4.2 ρmol l^{-1} CFC-11 in the Western Basin and from 0.1 - 1.6 ρmol l^{-1} CFC-12, 0.1 - 3.8 ρmol l^{-1} CFC-11 in the Eastern Basin. The data suggests that Labrador seawater and Denmark Strait overflow water are of the order of 10 years old whereas the water at depth in the Eastern Basin is very much older corresponding to an age of nearer 50 years. Interesting profiles were observed along stations CD62 088 to 094 suggesting substantial vertical mixing of the old bottom waters with surface waters along the shelf edge.

Nutrients

Measurements of silicate and nitrate where made at a total of 92 stations using the JRC Alpkem autoanalyser set up in the ship's constant temperature laboratory. Phosphate measurements were also planned and the equipment was set up accordingly and initially appeared to be working well. During passage to the first station, however, the capped head on the non toxic seawater supply in the CT laboratory blew when the water supply was turned on. Nobody was in the laboratory at the time so this went unnoticed for some minutes. This resulted in the autoanalyser being flooded. The equipment was disassembled and dried but the flooding had damaged an electronic board in one of the photometer units and an air phase injection board on the pump assembly. This rendered one of the autoanalyser channels unserviceable and it was decided to sacrifice phosphate analysis. From then on the system worked well, with only one other problem - a flickering light source which was traced to a loose connection and repaired.

Precision, based on duplicate measurements was 0.53% (full scale deflection) for nitrate and 0.15% (full scale deflection) for silicate. Commercially available standards were taken to sea for quality control. These gave very encouraging results with the values as measured by the Alpkem system matching exactly for silicate and within 0.5% for nitrate those quoted by the manufacturer, the Sagami Chemical Company, Japan. These standards had been prepared in sodium chloride solution and normally the Alpkem system is run using standards made up in a similar medium. However during the cruise it was noticed that the recovery of silicate from standards made up in surface seawater was slightly lower than in the artificial solution. A number of test runs were carried out using standard addition techniques on surface seawater of varying salinity. This suggested that the correction was so small as to be negligible.

Concentrations ranged from below detection limits to 43 umols l^{-1} silicate and 25 umols l^{-1} nitrate in the Eastern basin and from below detection limits to 16 umols l^{-1} silicate and 17.5 umols l^{-1} nitrate in the Western basin. In the Eastern basin high nitrates were found at 1000 m but these were not mirrored by a high silicate value. In contrast at depth in the Eastern basin silicate values were high and corresponded well with the old water as aged by the CFC data. In the Western basin low silicate and nitrate signals were found at around 2000 m and at depth corresponding to Labrador sea water and Denmark Strait Overflow water respectively.

Oxygen

Samples for oxygen analysis were drawn at stations CD62004 to CD620096 and pickled immediately on deck. Duplicates were taken from two bottles on each cast. The analysis was performed using an automated Winkler titration system (with photometric endpoint detection) supplied by Sensoren Instrument Systeme. The system consisted of a solid state light source and photodiode detector peaked to the iodine signal and a Metrohm dossimat for automated delivery of the titrant. Titre volumes were substituted into the equation specified in the WOCE Operations and Methods manual. Blanking was performed using pure water instead of seawater to avoid differences due to depth and position. A buoyancy factor was applied to the weight of the potassium iodate standard.

In general, the equipment worked well, although precision was lower than expected on duplicates from station CD62012 to CD62025. Investigation into the problem revealed bubbles at the base of the aspirator tip. These were removed and precision improved greatly. For subsequent measurements the reproducibility of the oxygen measurements was calculated to be 0.007 ml/l (1sd). This equates to 0.09% of the highest oxygen concentrations encountered. The measurements agreed well with the oxygen electrode sensor measurements on the CTD.

The highest values encountered were at depth in the Western basin indicative of Denmark strait overflow water and the lowest values at depth in the Eastern Basin. These latter corresponded well with the old ages as calculated by the CFC data confirming that these waters were at the surface sometime ago.

Oxygen and Hydrogen isotope ratios

A total of 165 samples were collected from 7 stations for isotope analysis. These included 6 duplicate samples for assessment by NIGL and a complete set of duplicated from station CD62072 for analysis at UEA. The latter were requested by Karen Heywood to evaluate the UEA analytical capability. Samples were collected into 250 ml salinity bottles following an initial rinse and two fillings and emptying method. On the third fill the neck was covered with a sheet of aluminium foil and the lid screwed on tight. Care was taken not to rip the aluminium foil because this acts as a water impermeable barrier to prevent contamination.

The multimet system (RT)

Sensors

The sensors were situated on the foremast, mainmast, and on the port and starboard sides of the wheelhouse top. The forward mast carried a propeller vane anemometer (R.M.Young serial number (S/N) 6992) and a Gill sonic anemometer situated on the forward platform. Two aspirated psychrometers (Vector instruments (VI) S/N 1066, and S/N 1072) were situated port and starboard. The short wave radiation sensors were situated to the far port and starboard side of the forward mast platform (Kipp and Zonnen S/N 11902837 and 11871958). The long wave radiation sensor (Eppley S/N 27225F3) was situated at the top of the upper foremast. On the wheelhousetop there was an aspirated psychrometer (VI S/N 1058) situated to the port side, and also to the starboard side (VI S/N 1060), in each case just aft of the ladder. The main mast carried an anemometer (VI S/N 1895) and a wind direction sensor (VI S/N 2224) situated at the mast top.

Multimet

The IOSDL Multimet system recorded data once per minute throughout the cruise. All the data from all the sensors were recorded. Wind speed data from the mainmast anemometer stopped transmitting data on jday 233, and only transmitted intermittently from then on.

Problems with the recorded data included a possible calibration error with the starboard dry bulb temperature on the wheelhouse top, and the foremast anemometer data from day 237 onwards.

For each 24 hour segment, for head to wind (foremast anemometer direction 150° to 210°) values at night (20-24 and 0-8 hours) the mean starboard dry bulb temperature on the wheelhouse top read a maximum of 0.32°C high compared to the mean starboard dry bulb temperature on the foremast; and a maximum of 0.28°C high compared to the mean port dry bulb temperature on the wheelhouse, (possible calibration error). For jdays 213 to 242.0 the mean starboard dry bulb temperature on the wheelhouse top read 0.21°C high compared to the mean starboard dry bulb temperature on the forward mast; and 0.13°C high compared to the mean port dry bulb temperature on the wheelhouse.

The starboard wheelhouse top psychrometer was effected by heat from the funnel when the relative wind direction was between 72° and 144° (where 0° is the aft of the ship). The port wheelhouse top psychrometer was effected by heat from the funnel when the relative wind direction was between 288° and 360°.

Each time the wheelhouse psychrometers were filled the water in the starboard psychrometer was considerably lower than the water in the port psychrometer. There was no leak in the bottle, possible causes could be either funnel smoke or heat from bridge door being open.

The foremast anemometer was seen to be at an angle (instead of horizontal) on jday 237. This did not seem to have affected its ability to transmit data. But on day 237, the relative foremast wind direction seemed to be reading low by about 40-60° (should have been about 350° but it read about 290°), presumably due to the angle of the anemometer. Calculation of the true wind speeds and directions from then on were incorrect, in that when the ship changed directions a jump occurred in the true winds.

Shadowing by the foremast occasionally caused the port short wave solar radiation sensor to read lower than the starboard short wave solar radiation sensor.

Special interest should be taken of day 229 and 230, where there was a very sudden increase in wind speed.

Processing the Multimet Data

The time series of each sensor shown on the BBC computer were checked daily, as were the sensors. The data was processed on the Sun in 24 hour segments. The processing of the Multimet data used four execs (mmexec0 to mmexec3).

- mmexec0 extracts the daily meteorological data from the RVS files and applies calibrations to it (fig MM1).
- mmexec1 plots the daily data (fig MM2).
- mmexec2 calculates the specific humidities for each psychrometer, and then calculates the temperature and specific humidity differences for each sensor, it then calculates the head to wind values (using the foremast anemometer data) at night to find any possible calibration errors in the psychrometers (fig MM3).
- mmexec3 calculates the true wind speed and direction using the foremast anemometer data (fig MM4).

Problems with the Multimet Processing

Days 213 to 221 (inclusive) the meteorological calibration file was incorrect for the gyro (it read column one as 1, it should have read 1.4117). Thus for this period the archived data with file names:

mm$cruise$met: mm$cruise$met.hour: mm$cruise$met.q3: mm$cruise$met.qdf

the gyro is wrong. But it can be corrected by using a linear calibration of (gyro*1.4117) using pcalib. The gyro plots for this period are therefore also incorrect, the correct gyro plots can be seen in the true wind plots. The appended mm$cruise file thus also had an incorrect gyro, this was corrected using pcalib and this version archived. The meteorological calibration file was changed for days 222 onwards.

Up to and including day 225, there was a mistake in mmexec2, and the archived files mm$cruise$met.q3 were really mm$cruise$met.q archived. From day 226 onwards the archived files are correct.

Sonic Anemometer

The data from the sonic anemometer on the foremast was logged constantly on a PC. This data was backed up daily on to the Sun system, when the ship was steaming so as not to loose good data. The sonic stopped logging on day 238, but was restarted on day 239, this data was therefore not logged. Data before and after seemed to be good.

Shipborne Wave Recorder (SBWR)

The data from the shipborne wave recorder was logged constantly on a PC. This data was backed up daily on to the Sun system, when the ship was steaming so as not to loose good data. There were no problems.

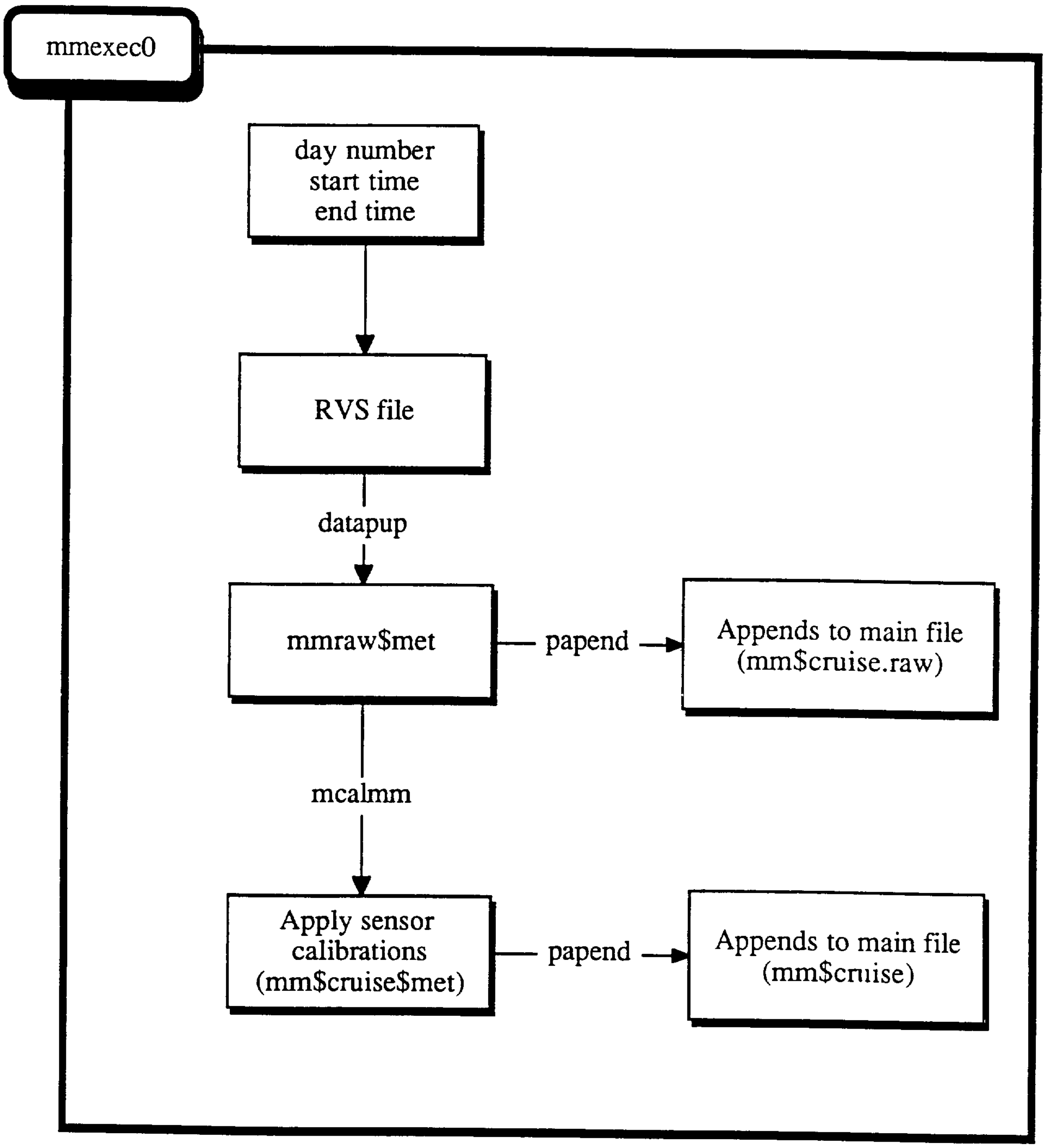
mmexec0
day number
start time
end time
RVS file
datapup
mmraw$met
papend
Appends to main file
(mm$cruise.raw)
mcalmm
Apply sensor
calibrations
(mm$cruise$met)
papend
Appends to main file
(mm$cruise)

Figure: MM1

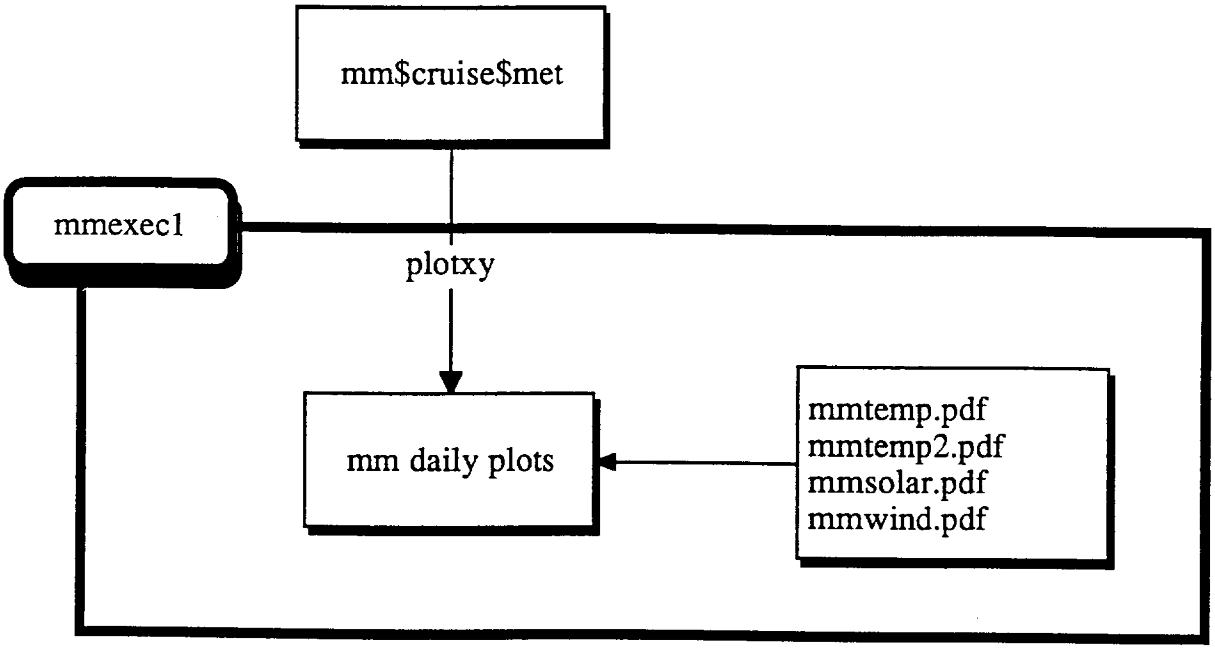
mm$cruise$met
mmexec1
plotxy
mm daily plots
mmtemp.pdf
mmtemp2.pdf
mmsolar.pdf
mmwind.pdf

Figure: MM2

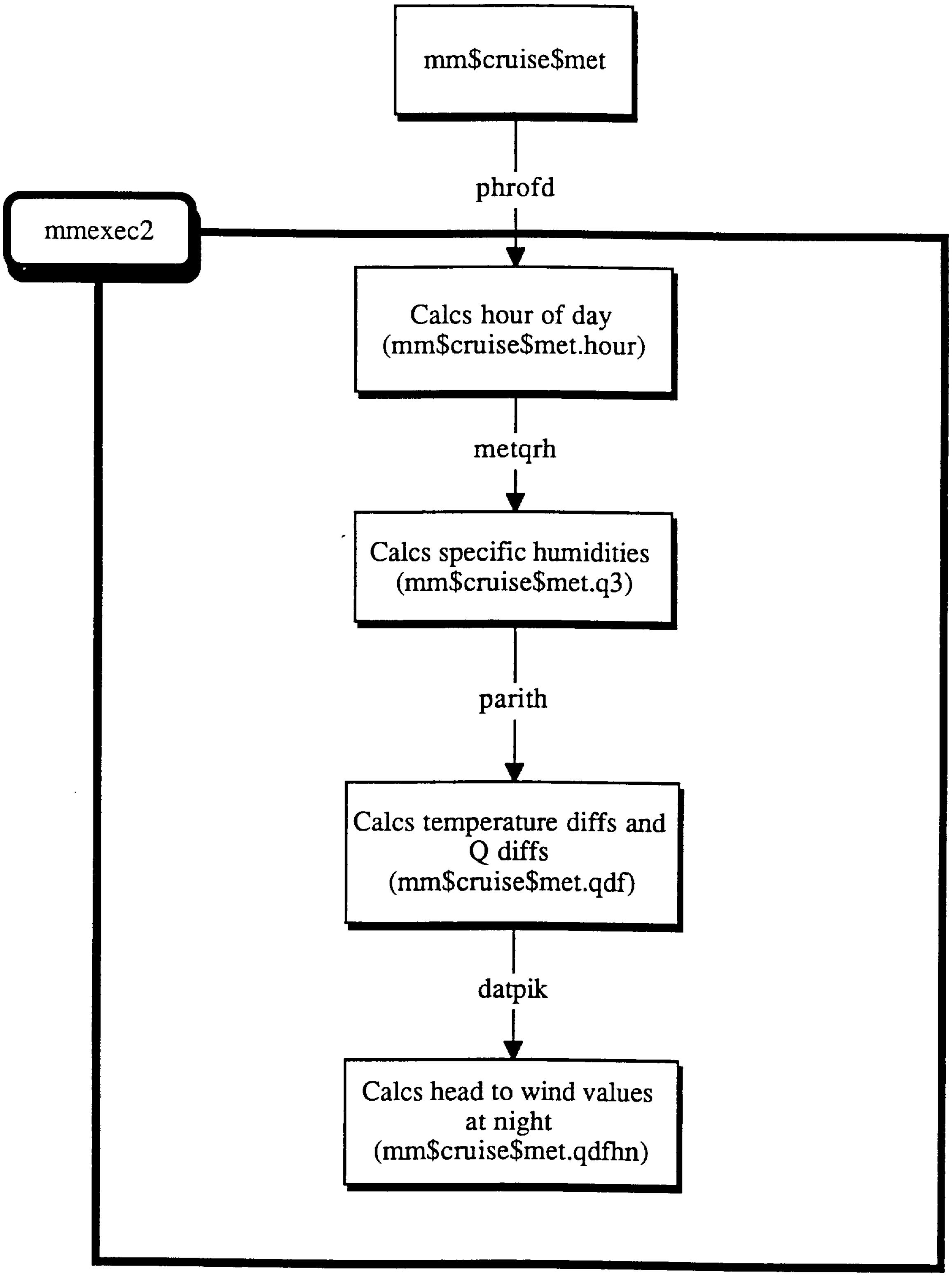
mm$cruise$met
phrofd
mmexec2
Calcs hour of day
(mm$cruise$met.hour)
metqrh
Calcs specific humidities
(mm$cruise$met.q3)
parith
Calcs temperature diffs and
Q diffs
(mm$cruise$met.qdf)
datpik
Calcs head to wind values
at night
(mm$cruise$met.qdfhn)

Figure: MM3

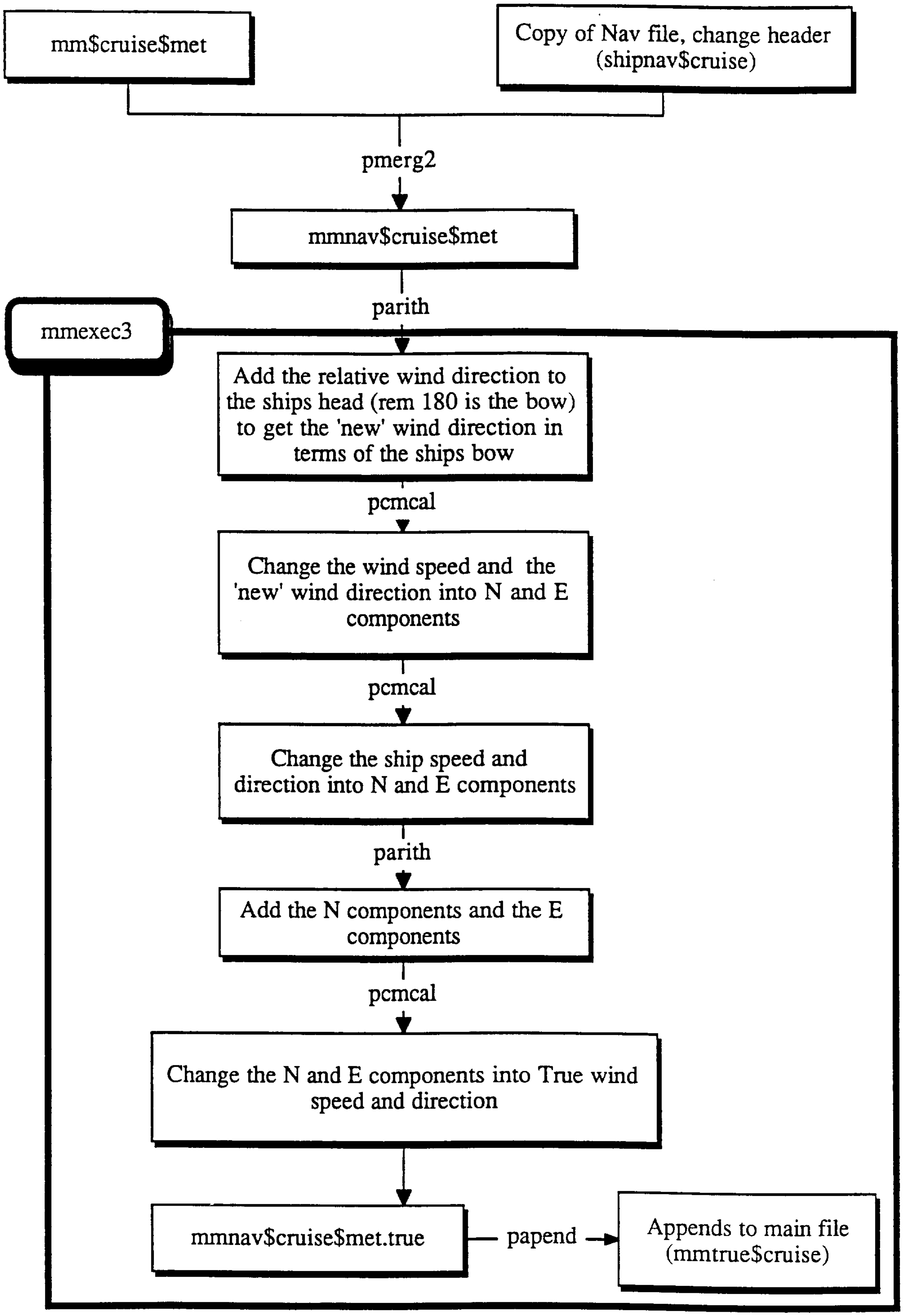
mm$cruise$met
Copy of Nav file, change header (shipnav$cruise)
pmerg2
mmnav$cruise$met
parith
mmexec3
Add the relative wind direction to the ships head (rem 180 is the bow) to get the 'new' wind direction in terms of the ships bow
pcmcal
Change the wind speed and the 'new' wind direction into N and E components
pcmcal
Change the ship speed and direction into N and E components
parith
Add the N components and the E components
pcmcal
Change the N and E components into True wind speed and direction
mmnav$cruise$met.true
papend
Appends to main file (mmtrue$cruise)

Figure: MM4

XBT DATA (WJG, LP)

XBT data were obtained between the CTD stations and on some passage legs in order to provided improved spatial resolution of mesoscale features. The shipboard system used was a Bathystems SEAS system transmitting data via the GOES satellite. The system was supplied and installed by the MoD Hydrographic Department.

We were supplied with a new version of the Seas system software and were sent to sea with only very limited documentation. A fault developed in system on day 224 that indicated that the GOES buffer was not being cleared and that the real time data were probably not being transmitted to the satellite. The problem was not fully diagnosed until day 234 when contact with MoD through RVS revealed that the power supply that was charging the batteries was not working. The problem was rectified and thereafter no problems were encountered. In future the vessel should carry a complete handbook of hardware and software documentation.

The new software has a number of annoying faults

a) the logged time for an XBT is the time at which the programme is set up. Previous versions have attributed the drop time to the time when the probe is launched, clearly much better and sometimes up to 10 minutes later than the setup time producing consequent errors in position.

b) A most annoying feature is the format for entering positions. A <return> is required for the numerical value but not for the N/S E/W entry. Similarly a 3 digit degree entry is required for longitude and an entry of 2 or less (e.g. 16 rather than 016) leads to errors.

c) When the water depth is less than the probe's maximum depth the programme asks whether a shallower cutoff is required. It would be much better to ask the operator to specify a cutoff level after the profile is complete so that a partial trace can be transmitted.

d) There is no way to dump the plot of the profile to the printer, a serious omission, and no way to dump data except at the raw data rate. One would like to be able to list data every say 10 or 20 metres and to specify the particular isotherms for which depths are required rather than just whole degrees.

The probes used were Sippican T-7 and T-5 and Plessey T-7. Few probes failed and these can be attributed largely to problems with the XBT software, a leakage in the launcher cable and to the XBT wire fouling the ship in the often poor weather. This latter problem was helped by the use of a length of plastic tubing that fitted over the probe canister. In rough weather probes could not be launched safely from the stern and so they were often deployed near the hatch in a relatively sheltered position. This seemed to work well. Some T-5 probes were launched at too high a speed early in the cruise and these are noted in the XBT table.

Data were transferred from the PC floppies to the PSTAR system using a programme written on board by Doriel Jones. No transfer software, nor indeed any information on PC file formats was supplied. The data were subsequently edited in PSTAR to remove spikes and near surface transients.

The temperatures matched well to the thermosalinograph values.

The times and positions of XBT drops are listed in table.

Thermosalinograph (WJG, LP)

The thermosalinograph was based on Sea Bird temperature and conductivity sensors mounted in an enclosure in the Hydro Lab. The data together with the sea water intake temperature were logged on the RVS computer system and later transferred to PSTAR. Calibration samples were taken at two hourly intervals from the outflow from the thermosalinograph housing. These were analysed and the data for the whole cruise plotted. A rather constant offset was seen until day 230 after which time the offset decreased with time. There appeared to be marine growth in the output pipe from the thermosalinograph and presumably also therefore on the conductivity sensor. This was not cleaned off since the sensor was known to be fragile. The logged thermosalinograph salinity values have yet to be corrected.

The offsets obtained in the very cold, low salinity water around Greenland were very scattered but no cause for this scatter could be found. It was not attributable to a time lag between the time the value was sensed and the time the sample was taken.

The temperature sensor values were compared with near surface CTD values and were found to be constant with time.

Simrad Echosounder (WJG, CP)

This was used throughout the cruise and performed well. It is pleasant not to have to fold Mufax rolls. However we spent much time using it in pinger mode and a serious defect is the multiplicity of menu commands that need to be made in order to change from pinger to echosounder and back again. What is required is a limited number of preset menus that can be swapped between at a single keystroke. We resolved the situation by running the Simrad and PES Mk III in parallel while on station.

New programmes for the cruise (PMS)

During Cruise 62 a number of new PSTAR programmes were written and modifications were made to old ones. They are listed below along with brief descriptions.

New programmes

Allav. Averages all rows of a gridded file into one column.

Density. Creates a potential density variable with a reference pressure which varies with depth.

Dstat. Calculates the statistics of the difference between two variables in a file.

Salcal. Performs a linear regression of salinity correction on pressure and potential temperature.

Pxtrap. Takes a gridded file and fills any bottom rows of the file containing absent data with the last good value in that column.

Modifications to programmes

Subroutine Entrdd. Option 4 was modified to allow latitude and longitude to be entered as either decimal degrees or as degrees and minutes. Entry to pheadr need modification under this option.

Pliste, a modification to plistd, requests repeated entry of data cycles without recalling variable list.

Plistu, a modification of plista, requests repeated entry of data cycles without recalling variable list.

Biological Sampling (KJH)

Plankton samples were taken at 35 stations (40 casts) using a vertically hauled 150 μm mesh net with opening area of 0.25 m^2, kindly loaned by Dr R Harris of PML. Details of the casts are given in Table 3. During the first two weeks of the cruise, the kevlar winch on the CTD A frame was used, but this only held 200 m, depth being determined by marks on the rope. Later, the Effer crane and small winch on the aft deck were attached to a 450 m spool of kevlar and this system was used thereafter so that deeper hauls could be achieved during the day. The disadvantage was that, given the close proximity of the winch to the ship's propeller, we were not allowed to do nets during strong winds. Wire out was determined using a meter sheave with electronic readout. Large wire angles during rough weather meant that actual cast depths were sometimes much less than the wire out.

Nets were hosed down when brought to the surface, and samples were sieved to remove excess water before being placed in 250 ml sample jars. Samples were preserved in 10% formalin for later identification and analysis at UEA. In the east (legs A and B) catches were primarily green and fluoresced when hosed - it is assumed that these were mainly phytoplankton. They were very difficult to sieve since the net clogged. The largest catches were obtained in the coldest waters near Greenland - these consisted of a dense dark pink mass of small animals (1-2 mm). The third type of catch was pale pink shrimp-like animals about 1 cm in length.

Acoustic Doppler Current Profiler (KJH, MH)

The ADCP recorded throughout the cruise using 64 8 m bins (50 x 4 m on the shelf) and a 2 minute sampling interval. It worked well on the whole and a good data set was collected. Given a transducer depth of 5 m and blank beyond transmit length of 4 m, the first bin was centred at a depth of 13 m. Three zigzag calibration runs were conducted in the early part of the cruise, two in bottom tracking mode and one in deep water. One calibration run was conducted on the last day whilst steaming across the shelf.

We encountered problems with the RVS logging on the level ABC, which appeared to happen when we changed from bottom tracking to deep water mode, and again when we returned to bottom tracking mode. The RVS programme crashed both times and seemed unable to read the headers. When we changed into bottom tracking, bottom velocities and water depth were not being logged in the RVS data stream. On both occasions, the ADCP set up was investigated but no problems were found there - and when the RVS programme was restarted, it was again able to read the data stream. The source of this problem wasn't identified.

The hard disk on the PC crashed only 3 days after leaving port (Disk controller error), thereby losing some data which had not been logged by RVS while programmes to read the data stream had been sorted out. It is hoped that the pingdata files on the hard disk might be recoverable. Luckily a spare PC was available and the boards were changed around. ADCP DAS software version 2.48 was installed from floppy disk, and the logging configurations set up again. Initial problems with the data stream to the level ABC were due to the fact that the new PC has the level ABC attached to COMS1 not COMS2. Apart from 4 hours of lost data, the only repercussion was that logging of 'Ancillary Data' - ship's heading and water temperature - was not set to YES after the crash, and this was not noticed for a week. We would recommend in future that the spare PC is identical to that used for ADCP logging, since a great deal of time was spent swopping circuit boards around - the two PCs having different sets of boards.

The ADCP is not sending its wake-up message correctly on startup. This is easily remedied by switching the ADCP off and then on again, then reinitialising (command RI). This is an irritating fault and appears to be getting worse.

During the ADCP calibration run at the end of the cruise, after changing to bottom tracking mode, the ADCP did not log ship's heading correctly - it got stuck at 360°. This is obvious on the

ADCP screen. The ADCP was restarted using exactly the same configuration file and ship's heading was now fine. The cause of this problem was not found.

During the first few weeks of the cruise, good depth penetration was achieved - about 450 m on station and 350 m whilst steaming. However near the Greenland coast penetration was particularly poor and at times there were no bins with %good more than 25%, even on station. This may have been caused by bubbles since the sea was very rough. The ADCP Top Hat was bled but no air was found trapped. After leaving Greenland, the penetration never recovered and we obtained no data while steaming on leg G. This was probably because the weather was calm and we were steaming at 12 knots. It appears that 10 knots is the maximum for good ADCP data.

Logging of the acoustic backscattered signal strength from the 4 individual beams was undertaken throughout, for comparison with zooplankton abundance. A separate ADCP logging file for these data - adcpraw - was maintained by RVS on the level ABC. This was read and processed in the same way as the current data, and was then archived using 1Gb Exabyte tape. Some tests for acoustic backscatter noise level were conducted in Barry and in the middle of the cruise when the files from the PC hard disk were backed up. Temperature of the ADCP electronics was noted regularly and was found to vary by at least 5°C despite the air conditioning thermostat controls.

Data Processing route

The data from the PC running the ADCP software were read into the RVS level ABC logging system, retrieved from level C, and processed using a Sun Spark Workstation running SUNOS. The data were divided into two sets of files - stations and passage legs. The executives used in the processing route were : adpexec0, adpexec1, adpexec2, adpexec3, adpexec4, preport and adppage1.

adpexec0 converts the data into pstar format and creates two files, one bottom, one gridded.

adpexec1 corrects for ADCP clock drift.

adpexec2 applies the amplitude and pointing angle corrections. It also averages the data to 15 minute intervals.

adpexec3 was used to plot the averaged ADCP data against the navigation before merging the two.

adpexec4 merges the averaged ADCP data with the navigation data from which the absolute currents are determined.

preport uses the plotting programs ucontr and parrog to create postscript files of percent good, relative amplitude of backscatter and absolute current velocities.

adppage1 arranges and does some editing on the postscript files created by preport so that three plots are produced on the same page.

When the ship's speed was changing, spikes occurred in the absolute velocities, probably a function of the 15 minute averaging performed within adpexec2. Although the start time entered was the first datapoint with constant ship's velocity, the averaging program adpav2 appears to take this point as the midpoint of its 15 minute average, thus averaging data from up to 7.5 minutes before. The start times for files were delayed by 10 minutes to counter this. Even so, some very large vectors were still inccured, these were subsequently edited.

The program allav was run on each station and for the passages between these were appended for the whole cruise.

Key to CTD Station List

Station number:	S	=	Start
	B	=	at bottom
	E	=	end

Position derived from GPS navigation

Depth (metres) derived from PES and corrected using Carter's tables

MW MAX	=	Maximum wire out (metres)
HT OFF	=	bottom separation at bottom of cast derived from 10 KHz pinger on CTD package
S, O, Si, N, F, R		are number of discrete levels for which samples for salinity, oxygen, silicate, Nitrate, Freon 11 and 12 and oxygen isotope ratio were collected

Key to XBT station list

Logged time	=	time on Bathysystems file
Drop time	=	recorded drop time by operator
Depth Max	=	gradient depth to which good data were recorded
Tap SSG	=	measured hull intake temperature as recorded by thermosalinograph

TABLE 1

CTD station List

Station No.	DATE	TIME(Z)	LAT N	LONG W	DEPTH	MW MAX	HT OFF	S	O	Si	N	F	R	Remarks
CD62001S	3/8/91	0002	51 29.79	11 10.36										
CD62001B	215	0032	51 29.65	11 10.44	185	185	10	2	2	0	0	0	0	
CD62001E	3/8/91	0056	51 30.43	11 10.52										
CD62002S	3/8/91	0508	51 32.74	12 13.02										
CD62002B	215	0541	51 32.69	12 12.94	1127	1102	20	2	0	0	0	0	0	
CD62002E	3/8/91	0608	51 32.74	12 12.87										
CD62003S	3/8/91	1043	51 35.75	13 16.50										
CD62003B	215	1118	51 35.52	13 16.32	1018	990	18	1	1	1	1	1	0	
CD62003E	3/8/91	1151	51 35.25	13 16.38										
CD62004S	3/8/91	1558	51 38.81	14 16.30										
CD62004B	215	1612	51 38.78	14 16.39	397	380	15	10	10	10	10	0	0	
CD62004E	3/8/91	1635	51 38.78	14 16.44										
CD62005S	3/8/91	1941	51 40.47	14 53.75										
CD62005B	215	2004	51 40.54	14 53.57	685	665	17	14	13	14	11	0	0	
CD62005E	3/8/91	2039	51 40.62	14 53.06										
CD62006S	3/8/91	2348	51 40.94	15 28.32										
CD62006B		0115	51 41.21	15 27.79	3090	3080	15	20	20	20	20	13	0	
CD62006E	4/8/91	0251	51 41.45	15 26.52										
CD62007S	4/8/91	1014	51 41.74	16 35.74										
CD62007B	216	1218	51 41.09	16 34.74	4457	4405	25	24	21	24	24	4	0	
CD62007E	4/8/91	1415	51 40.48	16 34.25										
CD62008S	4/8/91	1924												CTD faulty
CD62008B	216		51 43.21	17 43.64	4574	200	-	0	0	0	0	0	0	No salinity data
CD62008E	4/8/91	2150												Only partial cast
CD62009S	5/8/91	0925	51 44.91	18 51.38										
CD62009B	217	1121	51 46.19	18 50.56	4475	4530	17	21	21	21	21	21	0	
CD62009E	5/8/91	1345	51 47.11	18 49.62										

TABLE 1

CTD station List

Station No.	DATE	TIME(Z)	LAT N	LONG W	DEPTH	MW MAX	HT OFF	S	O	Si	N	F	R	Remarks
CD62010S	5/8/91	1801	51 45.07	19 59.98										
CD62010B	217	1933	51 45.23	20 00.22	3643	3632	16	22	22	22	19	16	22	
CD62010E	5/8/91	2107	51 45.19	20 00.01										
CD62011S	6/8/91	1822	52 18.24	20 04.02										
CD62011B	218	2000	52 17.69	20 02.85	3823	3812	13	8	8	8	8	8	0	
CD62011E	6/8/91	2156	52 17.04	20 02.63										
CD62012S	7/8/91	0150	52 53.94	20 00.09										
CD62012B	219	0257	52 53.46	20 00.20	2735	2747	13	15	15	15	15	15	0	
CD62012E	7/8/91	0426	52 52.92	20 00.64										
CD62013S	7/8/91	0813	53 28.27	20 00.20										
CD62013B	219	0911	53 27.90	20 00.63	2322	2305	9	2	2	2	2	2	0	
CD62013E	7/8/91	1010	53 27.26	20 01.14										
CD62014S	7/8/91	1409	54 02.96	20 00.20										
CD62014B	219	1446	54 02.88	20 00.50	1397	1375	15	9	9	9	9	9	0	
CD62014E	7/8/91	1553	54 02.85	20 00.63										
CD62015S	7/8/91	1936	54 37.49	20 00.24										
CD62015B	219	2014	54 37.62	20 00.64	1475	1451	10	4	4	4	4	4	0	
CD62015E	7/8/91	2052	54 37.76	20 01.01										
CD62016S	8/8/91	0007	55 12.07	20 00.42										
CD62016B	220	0052	55 12.12	20 00.17	1653	1625	18	15	14	15	15	15	0	
CD62016E	8/8/91	0134	55 12.13	19 59.70										
CD62017S	8/8/91	0448	55 46.59	19 59.81										
CD62017B	220	0532	55 46.81	19 59.00	1775	1769	17	15	15	15	15	13	0	
CD62017E	8/8/91	0635	55 46.67	19 58.35										
CD62018S	8/8/91	0955	56 21.15	20 00.47										
CD62018B	220	1033	56 21.34	20 00.70	1377	1352	13	13	13	13	13	0	0	
CD62018E	8/8/91	1128	56 21.58	20 00.80										

TABLE 1

CTD station List

Station No.	DATE	TIME(Z)	LAT N	LONG W	DEPTH	MW MAX	HT OFF	S	O	Si	N	F	R	Remarks
CD62019S	8/8/91	1510	56 55.64	20 00.19										
CD62019B	220	1537	56 55.68	19 59.92	983	965	12	14	13	14	14	14	0	
CD62019E	8/8/91	1605	56 55.65	19 59.66										
CD62020S	8/8/91	1957	57 30.14	19 59.84										
CD62020B	220	2026	57 30.40	19 59.58	1170	1150	15	15	14	15	15	15	0	
CD62020E	8/8/91	2110	57 30.60	19 59.01										
CD62021S	8/8/91	2338	57 34.07	20 30.26										
CD62021B	221	0034	57 34.57	20 29.30	2045	2032	12	15	15	15	15	0	0	
CD62021E	9/8/91	0206	57 35.08	20 28.15										
CD62022S	9/8/91	0431	57 37.94	21 05.06										
CD62022B	221	0537	57 37.31	21 05.88	2407	2387	15	6	6	6	6	6	0	
CD62022E	9/8/91	0638	57 36.79	21 06.58										
CD62023S	9/8/91	0912	57 42.34	21 42.08										
CD62023B	221	1025	57 41.66	21 42.66	2965	2940	12	18	18	18	18	5	0	
CD62023E	9/8/91	1124	57 41.09	21 43.46										
CD62024S	9/8/91	1319	57 46.91	22 13.31										
CD62024B	221	1447	57 46.66	22 14.68	3005	2986	15	16	16	16	16	16	16	
CD62024E	9/8/91	1635	57 46.07	22 16.01										
CD62025S	9/8/91	2043	57 54.97	23 20.11										
CD62025B	221	2200	57 55.31	23 19.17	2991	2981	9	15	15	15	15	4	0	
CD62025E	9/8/91	2310	57 55.74	23 18.67										
CD62026S	10/8/91	0438	58 02.85	24 26.13										
CD62026B	222	0606	58 02.69	24 24.67	2856	2825	18	11	11	11	11	11	11	
CD62026E	10/8/91	0742	58 02.25	24 23.95										
CD62027S	10/8/91	2342	58 12.00	25 33.18										
CD62027B	223	0127	58 11.90	25 33.95	2693	2678	18	2	2	2	2	1	0	
CD62027E	11/8/91	0341	58 11.59	25 34.80										

TABLE 1

CTD station List

Station No.	DATE	TIME(Z)	LAT N	LONG W	DEPTH	MW MAX	HT OFF	S	O	Si	N	F	R	Remarks
CD62028S	11/8/91	1250	58 19.97	26 40.17										
CD62028B	223	1409	58 19.53	26 40.75	2356	2321	17	24	24	23	24	24	0	
CD62028E	11/8/91	1540	58 19.31	26 40.88										
CD62029S	11/8/91	1955	58 27.91	27 47.03										
CD62029B	223	2050	58 27.31	27 46.93	2136	2215	22	16	16	16	16	6	0	
CD62029E	11/8/91	2141	58 26.81	27 46.90										
CD62030S	12/8/91	0229	58 37.09	28 52.83										
CD62030B	224	0329	58 37.06	28 53.60	2212	2188	12	17	17	17	17	17	0	
CD62030E	12/8/91	0422	58 36.87	28 54.08										
CD62031S	12/8/91	0917	58 44.83	30 00.24										
CD62031B	224	1001	58 44.34	30 00.45	1447	1480	27	14	14	14	14	6	0	
CD62031E	12/8/91	1042	58 43.93	30 00.55										
CD62032S	12/8/91	1607	58 08.88	30 00.08										
CD62032B	224	1716	58 08.80	30 00.86	2567	2520	*	17	17	17	17	15	0	* No pinger this stn
CD62032E	12/8/91	1815	58 08.64	30 01.28										
CD62033S	12/8/91	2343	57 33.87	30 00.10										
CD62033B	225	0042	57 33.63	30 00.25	2195	2186	17	6	6	6	6	4	0	
CD62033E	13/8/91	0156	57 33.25	30 00.38										
CD62034S	13/8/91	0711	56 58.00	29 59.97										
CD62034B	225	0822	56 57.82	30 00.09	2587	2556	*	16	16	16	16	16	0	* Pinger failed
CD62034E	13/8/91	0924	56 57.63	29 59.93										
CD62035S	13/8/91	1419	56 23.05	29 59.85										
CD62035B	225	1531	56 22.98	29 59.08	2826	2793	20	14	14	14	14	14	0	
CD62035E	13/8/91	1653	56 22.78	29 58.79										
CD62036S	14/8/91	0709	58 52.25	31 11.98										
CD62036B	226	0748	58 52.80	31 12.06	1428	1449	12	15	15	15	15	15	0	
CD62036E	14/8/91	0831	58 53.33	31 11.87										

TABLE 1

CTD station List

Station No.	DATE	TIME(Z)	LAT N	LONG W	DEPTH	MW MAX	HT OFF	S	O	Si	N	F	R	Remarks
CD62037S	14/8/91	1252	59 00.95	32 25.11										
CD62037B	226	1341	59 00.23	32 25.27	1252	1341	15	16	16	16	16	6	0	
CD62037E	14/8/91	1426	59 00.41	32 25.20										
CD62038S	14/8/91	1800	59 07.10	33 37.18										
CD62038B	226	1856	59 06.99	33 38.68	2320	2283	15	15	15	15	15	15	0	
CD62038E	14/8/91	1950	59 07.08	33 39.51										
CD62039S	15/8/91	0005	59 15.14	34 50.83										
CD62039B	227	0109	59 14.96	34 52.20	2562	2595	12	2	2	2	2	2	0	
CD62039E	15/8/91	0210	59 14.68	34 53.13										
CD62040S	15/8/91	0304	59 14.87	34 49.85										
CD62040B	227	0356	59 14 68	34 50.33	2615	2200	*	17	17	17	17	2	0	* Second cast
CD62040E	15/8/91	0446	59 14.61	34 51.21										
CD62041S	15/8/91	0823	59 22.02	36 03.24										
CD62041B	227	0938	59 22.01	36 03.40	3114	3089	7	20	20	20	20	20	0	
CD62041E	15/8/91	1040	59 22.00	36 03.19										
CD62041S	15/8/91	1040	59 22.00	36 03.19										
CD62041B	227	1053	59 21.94	36 03.25	3109	525	*							Cast 2 for bottles
CD62041E	15/8/91	1108	59 21.92	36 03.25										
CD62042S	15/8/91	1534	59 29.04	37 14.06										
CD62042B	227	1651	59 29.27	37 13.66	3185	3158	8	18	18	18	18	18	18	
CD62042E	15/8/91	1758	59 29.37	37 13.30										
CD62043S	15/8/91	2212	59 35.80	38 26.00										
CD62043B	227	2329	59 34.96	38 26.59	3038	3000	9	21	21	21	21	21	0	
CD62043E	16/8/91	0045	59 34.35	38 27.92										
CD62044S	16/8/91	0804	59 41.42	39 14.45										
CD62044B	228	0922	59 41.24	39 14.60	2878	2843	18	16	16	16	16	9	0	
CD62044E	16/8/91	1038	59 40.95	39 14.48										

TABLE 1

CTD station List

Station No.	DATE	TIME(Z)	LAT N	LONG W	DEPTH	MW MAX	HT OFF	S	O	Si	N	F	R	Remarks
CD62045S	16/8/91	1454	59 45.09	39 59.96										
CD62045B	228	1600	59 44.82	39 59.61	2715	2683	10	21	21	21	21	21	21	
CD62045E	16/8/91	1657	59 44.46	39 59.29										
CD62046S	16/8/91	2045	59 49.93	40 43.10										
CD62046B	228	2153	59 49.95	40 42.71	2573	2550	9	17	17	17	17	9	0	
CD62046E	16/8/91	2302	59 49.77	40 42.13										
CD62047S	17/8/91	0135	59 53.95	41 26.32										
CD62047B	229	0224	59 53.96	41 25.90	1926	1900	12	17	17	17	17	14	0	
CD62047E	17/8/91	0323	59 53.79	40 25.21										
CD62048S	17/8/91	2103	59 55.91	41 51.86										
CD62048B	229	2155	59 55.32	41 51.76	1824	1804	9	16	16	16	16	16	0	
CD62048E	17/8/91	2241	59 54.70	41 51.96										
CD62049S	19/8/91	0911	59 16.63	42 28.33										
CD62049B	231	1008	59 16.20	42 29.73	1959	1935	7	17	17	17	17	15	0	
CD62049E	19/8/91	1053	59 15.85	42 30.95										
CD62050S	19/8/91	1352	59 06.93	42 13.20										
CD62050B	231	1457	59 06.17	42 14.66	2266	2259	11	17	17	17	17	13	0	
CD62050E	19/8/91	1603	59 05.51	42 15.97										
CD62051S	19/8/91	1752	58 55.25	41 56.48										
CD62051B	231	1913	58 55.16	41 57.45	2683	2646	10	20	20	20	20	9	0	
CD62051E	19/8/91	2021	58 55.12	41 58.28										
CD62052S	20/8/91	0003	58 41.86	41 41.08										
CD62052B	232	0134	58 41.94	41 40.89	2928	2919	6	21	21	21	21	4	0	
CD62052E	20/8/91	0238	58 41.99	41 40.99										
CD62053S	20/8/91	0633	58 17.33	41 09.25										
CD62053B	232	0803	58 17.13	41 09.83	3187	3155	15	21	21	21	21	0	0	
CD62053E	20/8/91	0930	58 16.78	41 10.27										

TABLE 1

CTD station List

Station No.	DATE	TIME(Z)	LAT N	LONG W	DEPTH	MW MAX	HT OFF	S	O	Si	N	F	R	Remarks
CD62054S	20/8/91	1617	57 46.33	40 28.69										
CD62054B	232	1759	57 46.12	40 29.46	3256	3230	8	20	20	20	20	10	0	
CD62054E	20/8/91	1913	57 45.92	40 29.73										
CD62055S	20/8/91	2315	57 14.82	39 40.18										
CD62055B	233	0049	57 14.49	39 40.54	3239	3217	11	21	21	21	21	0	0	
CD62055E	20/8/91	0218	57 13.91	39 40.56										
CD62056S	21/8/91	0945	56 43.79	39 00.17										
CD62056B	233	1128	56 43.98	39 00.70	3292	3262	14	21	20			17	0	
CD62056E	21/8/91	1257	56 44.50	39 00.91										
CD62057S	21/8/91	1819	56 12.99	38 31.68										
CD62057B	233	1951	56 12.07	38 31.70	3240	3240	12	22	22	22	22	19	0	
CD62057E	21/8/91	2101	56 11.48	38 31.69										
CD62058S	22/8/91	0125	55 40.0	37 46.12										
CD62058B	234	0243	55 39.74	37 46.32	2818	2804	8	21	21	21	21	13	0	
CD62058E	22/8/91	0341	55 39.48	37 46.71										
CD62059S	22/8/91	0743	55 07.10	36 59.99										
CD62059B	234	0856	55 07.36	36 59.75	2571	2543	10	18	18	18	18	18	0	
CD62059E	22/8/91	1005	55 07.60	36 59.50										
CD62060S	22/8/91	1357	54 32.91	37 00.15										
CD62060B	234	1511	54 32.51	37 00.34	2955	2930	6	22	22	22	22	2	0	
CD62060E	22/8/91	1609	54 32.12	37 00.43										
CD62061S	22/8/91	1914	53 59.98	36 59.87										
CD62061B	234	2026	53 59.74	36 59.75	2548*	2524	10	18	17	18	18	18	18	*Variable 2538-2557m
CD62061E	22/8/91	2145	53 59.68	36 59.50										
CD62062S	23/8/91	0138	53 59.94	35 49.76										
CD62062B	235	0221	53 59.76	35 49.96	1487	1436	15	14	14	14	14	14	0	
CD62062E	23/8/91	0307	53 59.47	34 40.29										

TABLE 1

CTD station List

Station No.	DATE	TIME(Z)	LAT N	LONG W	DEPTH	MW MAX	HT OFF	S	O	Si	N	F	R	Remarks
CD62063S CD62063B CD62063E	23/8/91 235 23/8/91	0716 0814 0858	54 00.0 53 59.58 53 59.54	34 40.29 34 40.96 34 41.66	2132	2116	7	17	17	17	17	0	0	
CD62064S CD62064B CD62064E	23/8/91 235 23/8/91	1301 1417 1529	53 59.93 53 59.97 53 59.92	33 29.93 33 30.02 33 29.77	2430	2401	9	18	18	18	18	14	0	
CD62065S CD62065B CD62065E	23/8/91 235 23/8/91	1922 2036 2130	54 00.00 53 59.41 53 58.83	32 19.95 32 20.24 32 20.40	2745	2712	15	19	19	19	19	3	0	
CD62066S CD62066B CD62066E	24/8/91 236 24/8/91	0211 0354 0509	53 59.93 53 59.87 54 58.83	31 10.11 31 10.71 31 10.43	2996	3020	12	21	21	21	21	18	0	
CD62067S CD62067B CD62067E	24/8/91 236 24/8/91	0904 1034 1156	53 59.71 53 59.66 53 59.49	29 59.82 29 59.55 29 59.47	3125	3095	11	20	20	20	20	15	0	
CD62068S CD62068B CD62068E	24/8/91 236 24/8/91	1520 1636 1736	54 36.10 54 35.85 54 35.79	30 00.20 30 00.58 30 01.07	3095	3075	8	21	20	21	21	0	0	
CD62069S CD62069B CD62069E	24/8/91 236 24/8/91	2121 2247 2351	55 12.23 55 12.12 55 12.11	29 59.98 29 58.47 29 58.45	2973	2973	24	20	20	20	20	17	0	
CD62070S CD62070B CD62070E	26/8/91 239 27/8/91	2252 0037 0202	53 47.41 53 47.28 53 46.98	28 59.91 28 59.17 28 59.01	3206	3184	13	21	21	21	21	21	0	
CD62071S CD62071B CD62071E	27/8/91 239 27/8/91	0615 0744 0855	53 33.56 53 33.94 53 34.14	28 00.20 27 59.61 27 59.46	3388	3390	6	22	22	21	22	12	0	

TABLE 1

CTD station List

Station No.	DATE	TIME(Z)	LAT N	LONG W	DEPTH	MW MAX	HT OFF	S	O	Si	N	F	R	Remarks
CD62072S	27/8/91	1708	53 17.92	26 58.27										
CD62072B	239	1859	53 17.49	26 57.70	3720	3699	12	21	22	23	23	23	23	Follows trial of MkV
CD62072E	27/8/91	2029	53 17.15	26 57.69										
CD62073S	28/8/91	0244	53 07.11	25 59.94										
CD62073B	240	0434	53 07.72	25 59.01	3592	3570	13	23	23	23	23	13	0	
CD62073E	28/8/91	0609	53 07.74	25 56.56										
CD62074S	28/8/91	2028	52 52.00	25 00.20										
CD62074B	240	2211	52 52.28	25 00.82	3520	3507	10	21	21	21	21	21	0	
CD62074E	28/8/91	2339	52 52.47	25 00.67										
CD62075S	29/8/91	0328	52 39.03	23 59.85										
CD62075B	241	0512	52 38.79	23 58.65	3760	3739	4	24	24	24	24	17	0	
CD62075E	29/8/91	0627	52 38.65	23 58.61										
CD62076S	29/8/91	1158	52 30.60	22 58.70										
CD62076B	241	1400	52 31.11	22 56.65	3787	3787	10	23	23	23	23	15	0	Follows trial of MkV
CD62076E	29/8/91	1532	52 31 38	22 55.38										
CD62077S	29/8/91	1851	52 20.99	21 59.83										
CD62077B	241	2043	52 20.46	21 57.91	4095	4145	5	24	22	24	24	14	0	
CD62077E	29/8/91	2208	52 19.99	21 57.22										
CD62078S	30/8/91	0155	51 59.91	21 00.00										
CD62078B	242	0341	51 59.67	20 59.78	4155	4163	6	24	24	24	24	19	0	
CD62078E	30/8/91	0513	51 59.87	20 59.59										
CD62079S	30/8/91	0940	51 44.85	20 00.05										
CD62079B	242	1122	51 45.26	20 00.10	3643	3640	10	23	23	23	23	14	0	Mk V CTD used
CD62079E	30/8/91	1243	51 45.29	20 00.08										

TABLE 1

CTD station List

Station No.	DATE	TIME(Z)	LAT N	LONG W	DEPTH	MW MAX	HT OFF	S	O	Si	N	F	R	Remarks
CD62080S CD62080B CD62080E	30/8/91 242 30/8/91	2133 2231 2305	53 28.52 53 28.42 53 28.35	19 59.64 19 59.06 19 58.74	2300	2278	14	17	17	17	17	17	0	Mk V CTD used
CD62081S CD62081B CD62081E	31/8/91 243 31/8/91	0533 0608 0639	54 37.39 54 37.44 54 37.52	20 00.04 19 59.80 19 59.61	1466	1448	8	15	15	15	15	15	0	Mk V CTD used
CD62082S CD62082B CD62082E	31/8/91 243 31/8/91	2216 2253 2320	57 30.17 57 30.33 57 30.62	19 59.79 19 59.67 19 59.45	1170	1155	10	13	13	13	13	5	0	Repeat of CD62020
CD62083S CD62083B CD62083E	1/9/91 244 1/9/91	0242 0314 0342	57 14.85 57 14.73 57 14.70	19 00.03 19 00.41 19 00.82	1297	1280	12	14	14	14	14	11	0	
CD62084S CD62084B CD62084E	1/9/91 244 1/9/91	0709 0747 0827	57 01.32 57 01.68 57 01.86	17 59.83 17 59.52 17 59.24	1300	1288	11	14	14	14	14	11	0	
CD62085S CD62085B CD62085E	1/9/91 244 1/9/91	1217 1233 1252	56 46.07 56 46.07 56 46.04	16 59.70 16 59.61 16 59.51	687	678	6	11	11	11	11	8	0	
CD62086S CD62086B CD62086E	1/9/91 244 1/9/91	1613 1628 1647	56 31.14 56 31.13 56 31.21	15 59.90 16 00.00 16 00.05	564	551	7	10	10	10	10	0	0	
CD62087S CD62087B CD62087E	1/9/91 244 1/9/91	2052 2102 2117	56 16.17 56 16.18 56 16.17	14 59.77 14 59.75 14 59.82	229	215	12	8	8	8	8	0	0	

TABLE 1

CTD station List

Station No.	DATE	TIME(Z)	LAT N	LONG W	DEPTH	MW MAX	HT OFF	S	O	Si	N	F	R	Remarks
CD62088S	1/9/91	2337	56 08.20	14 26.62										
CD62088B	245	0010	56 08.56	14 26.19	971	964	11	12	12	12	12	9	0	
CD62088E	1/9/91	0041	56 08.75	14 25.85										
CD62089S	2/9/91	0213	56 02.57	14 07.28										
CD62089B	245	0309	56 02.63	14 07.15	1913	1906	8	16	16	16	16	12	0	
CD62089E	2/9/91	0359	56 02.62	14 06.90										
CD62090S	2/9/91	0824	55 46.02	12 59.67										
CD62090B	245	0932	55 46.14	12 58.97	2732	2727	5	20	20	20	20	16	0	
CD62090E	2/9/91	1033	55 46.22	12 58.90										
CD62091S	2/9/91	1402	55 31.01	11 59.83										
CD62091B	245	1521	55 31.15	12 00.01	2856	2846	9	20	20	20	20	17	0	
CD62091E	2/9/91	1633	55 31.03	12 00.06										
CD62092S	2/9/91	2050	55 15.07	11 00.22										
CD62092B	245	2205	55 15.54	11 00.91	2625	2616	9	19	19	19	19	17	0	
CD62092E	2/9/91	2306	55 15.77	11 01.10										
CD62093S	3/9/91	0110	55 07.94	10 31.66										
CD62093B	246	0212	55 07.95	10 31.61	2160	2175	10	17	17	17	17	14	0	
CD62093E	3/9/91	0256	55 07.88	10 31.61										
CD62094S	3/9/91	0423	55 03.93	10 13.46										
CD62094B	246	0454	55 04.01	10 13.52	992	986	11	12	12	12	12	5	0	
CD62094E	3/9/91	0521	55 04.11	10 13.61										
CD62095S	3/9/91	0554	55 03.34	10 10.67										
CD62095B	246	0612	55 03.39	10 10.72	610	603	6	9	9	9	9	-	-	
CD62095E	3/9/91	0627	55 03.48	10 10.71										
CD62096S	3/9/91	0740	55 01.77	10 05.72										
CD62096B	246	0748	55 01.76	10 05.75	197	183	9	6	6	6	6	-	-	
CD62096E	3/9/91	0758	55 01.80	10 05.77										

TABLE 2

XBT station List

XBT	DATE/DAY	Logged time(z)	Drop time(z)	LAT(N)	LONG (W)	PROBE TYPE	DEPTH Max(m)	TEMP TSG C	COMMENTS
001	2/8-214	1845	1850	51 12.8	09 45.9	T7	116	14.91	Test drop on shelf
002	3/8-215	0251	0258	51 31.5	11 44.0	T7	763	15.41	
003	3/8-215	0838	0846	51 35.5	12 50.1	T7	763	15.18	
004	3/8-215	1347	-		13 48.0	T7	-	15.00	Did not work
005	3/8-215	1358	1358	51 36.7	13 49.5	T7	602	15.03	
006	3/8-215	1821	1827	51 40.0	14 38.0	T7	429	15.07	
007	3/8-215	2223	2225	51 41.7	15 13.7	T5	1170	15.10	
008	4/8-216	0514	0517	51 41.2	16 03.8	T7	764	15.17	
009	4/8-216	1706	1709	51 42.4	17 15.2	T7	720	15.19	
010	4/8-216	2301	2315	51 44.9	17 42.1	T5	1676	15.07	In place of aborted ctd
011	5/8-217	0301	0301	51 48.5	18 19.6	T5	1170	16.00	
012	5/8-217	1610	1614	51 46.0	19 32.0	T7	746	14.87	
013	5/8-217	2305	2315	51 42.4	20 29.0	T5	1144	14.75	Wire broke at 1200
014	6/8-218	0101	0101	51 39.6	21 00.0	T7	943	14.59	Transmitted as t5
015	6/8-218	0256	0300	51 36.8	21 35.0	T7	763	14.58	
016	6/8-218	1059	1103	51 37.1	21 43.1	T7	763	14.50	
017	6/8-218	1318	1328	51 45.9	21 21.2	T7	763	14.72	
018	6/8-218	1506	1508	52 02.5	20 42.9	T7	763	14.57	
019	6/8-218	2359	2359	52 35.0	20 00.1	T7	763	14.75	
020	7/8-219	0613	0615	53 11.9	20 00.1	T7	763	14.63	
021	7/8-219	1158	1200	53 47.1	20 00.7	T5	1170	14.77	
022	7/8-219	1751	1755	54 19.9	20 00.6	T5	1140	14.38	
023	7/8-219	2244	2252	54 59.5	20 00.3	T5	1207	14.62	Ship at 5knts
024	8/8-220	0302	0314	55 30.3	19 59.9	T5	1162	14.29	Ship at 5 knts
025	8/8-220	0802	0810	56 03.7	20 00.0	T5	1463	14.32	Problems with GOES buffer
026	8/8-220	1258	1304	56 38.6	19 59.3	T5	899	14.06	Ship at 5 knts
027	8/8-220	1810	1812	57 12.8	20 00.1	T5	1102	13.94	"Failed, cable leak"
028									"Dummy number, no drop"
029									"Dummy number, no drop"
030	9/8-221	1840	1844	57 50.8	22 45.3	T7	763	13.81	

TABLE 2

XBT station List

XBT	DATE/DAY	Logged time(z)	Drop time(z)	LAT(N)	LONG (W)	PROBE TYPE	DEPTH Max(m)	TEMP TSG C	COMMENTS
031	10/8-222	0136	0145	57 59.3	23 56.2	T7	763	13.15	Many inflection points
032	10/8-222	1732	1735	58 02.9	25 00.1	T7	763	12.66	
032	11/8-223	0918	0923	58 17.7	26 06.6	T7	763	12.28	
034	11/8-223	1741	1744	58 25.2	27 12.9	T7	763	12.51	
035	12/8-224	0005	0005	58 32.2	28 20.0	T7	763	12.00	
036	12/8-224	0646	0649	58 40.9	29 24.1	T7	763	12.01	
037	12/8-224	1344	1345	58 25.9	30 01.3	T7	763	11.31	
038	12/8-224	2110	2130	57 48.8	29 59.9	T7	763	11.06	
039	13/8-225	0457	0500	57 15.0	30 00.2	T7	763	11.30	
040	13/8-225	1207	1210	56 40.1	30 00.1	T7	763	12.02	
041	13/8-225	1900	1901	56 36.9	30 05.5	T7	763	11.42	Failed
042	13/8-225	1913	1917	56 40.0	30 06.7	T7	763	11.54	
043	13/8-225	2056	2100	56 59.5	30 16.6	T7	763	11.24	
044	13/8-225	2303	2310	57 23.2	30 27.9	T7	763	11.04	
045	14/8-226	0058	0100	57 44.4	30 38.2	T7	763	11.37	
046	14/8-226	0257	0300	58 07.5	30 49.4	T7	763	10.85	failed
047	14/8-226	0305	0305	58 08.4	30 49.9	T7	763	11.15	
048	14/8-226	0500	0504	58 30.9	31 01.2	T7	763	11.27	
049	14/8-226	1102	1107	58 56.2	31 52.0	T7	763	10.38	
050	14/8-226	1615	1620	59 03.9	33 03.6	T7	763	10.41	
051	14/8-226	2206	2215	59 11.4	34 16.8	T7	763	09.79	Delay between setup and launch
052	15/8-227	0637	0639	59 18.7	35 31.5	T7	763	09.66	"First attempt failed,redid drop"
053	15/8-227	1339	1342	59 25.7	36 40.6	T7	763	09.01	
054	15/8-227	1955	1958	59 32.4	37 48.8	T7	763	09.17	
055	16/8-228	0234	0245	59 36.8	38 43.2	T7	763	08.86	Failed
056	16/8-228	0243	0245	59 36.8	38 43.2	T7	763	08.86	
057	16/8-228	1308	1310	59 43.6	39 36.2	T7	763	08.03	
058	16/8-228	1855	1858	59 47.7	40 25.6	T7	763	08.57	
059	17/8-229	0013	0015	59 51.5	41 03.9	T7	763	08.68	
060	18/8-230	0441	0446	59 53.6	41 37.7	T5	1170	08.80	

TABLE 2

XBT station List

XBT	DATE/DAY	Logged time(z)	Drop time(z)	LAT(N)	LONG (W)	PROBE TYPE	DEPTH Max(m)	TEMP TSG C	COMMENTS
061	18/8-230	1123	1123	59 45.0	42 40.5	T7	199	02.90	Failed
062	18/8-230	1132	1132	59 44.7	42 40.7	T7	256	02.93	
063	18/8-230	1244	1245	59 40.9	42 43.0	T7	387	02.80	"Many inflection points,failed"
064	18/8-230	1350	1355	59 36.3	42 48.3	T7	602	02.96	
065	18/8-230	1452	1453	59 32.5	42 53.2	T5	489	03.18	Noisy but transmitted
066	18/8-230	1612	1620	59 26.7	43 00.4	T5	389	03.16	
067	18/8-230	1840	1840	59 20.2	43 13.9	T7	763	02.99	
068	20/8-232	0447	0448	58 29.0	41 24.2	T7	763	06.87	
069	20/8-232	1203	1206	58 07.8	40 56.4	T7	763	07.18	
070	20/8-232	1330	1332	57 56.5	40 41.1	T7	763	07.07	
071	20/8-232	2043	2046	57 38.0	40 02.1	T7	763	07.50	
072	20/8-232	2154	-			T7	-	-	Failed
073	20/8-232	2158	2200	57 25.6	39 50.0	T7	763	07.83	
074	20/8-232	2313	2315	57 14.8	39 40.2	T7	763	08.00	
075	21/8-233	0416	0419	56 59.1	39 15.2	T7	763	08.13	
076	21/8-233	1317	1319	56 45.3	39 01.2	T7	763	08.12	
077	21/8-233	1630	1634	56 28.4	38 45.8	T7	763	08.00	
078	21/8-233	2326	2330	55 55.0	38 08.4	T7	763	08.83	
079	22/8-234	0454	0456	55 29.9	37 31.5	T7	199	09.16	Wire stretch after 200m
080	22/8-234	0459	-			T7	-	-	Failed
081	22/8-234	0503	0505	55 28.5	37 29.6	T7	763	09.12	
082	22/8-234	0620	0627	55 17.0	37 13.5	T7	763	09.24	
083	22/8-234	1223	1225	54 49.4	37 00.0	T7	763	09.56	
084	22/8-234	1737	1742	54 15.2	37 00.0	T7	763	09.93	
085	22/8-234	2313	2315	53 59.8	36 33.1	T7	243	09.62	Failed after 250m
086	22/8-234	2318	2319	53 59.8	36 31.8	T7	763	09.55	
087	23/8-235	0010	0013	54 00.0	36 13.8	T7	529	09.77	
088	23/8-235	0450	0452	54 00.1	35 24.3	T7	763	09.90	
089	23/8-235	0558	0600	54 00.0	35 01.0	T7	763	09.50	
090	23/8-235	1029	1031	53 59.8	34 14.5	T7	763	10.29	Ragged trace?

TABLE 2

XBT station List

XBT	DATE/DAY	Logged time(z)	Drop time(z)	LAT(N)	LONG (W)	PROBE TYPE	DEPTH Max(m)	TEMP TSG C	COMMENTS
091	23/8-235	1133	1135	54 00.0	33 54.0	T7	763	10.54	
092	23/8-235	1702	1704	54 00.1	33 03.8	T7	763	10.86	
093	23/8-235	1801	1802	54 00.0	32 43.7	T7	529	10.47	
094	23/8-235	2342	2345	53 58.8	31 53.0	T7	763	11.15	
095	24/8-236	0046	0048	53 59.9	31 33.2	T7	763	11.05	Spikes at top.
096	24/8-236	0643	0643	54 00.0	30 43.2	T7	763	11.62	
097	24/8-236	0744	0745	54 00.1	30 22.2	T7	763	11.53	
098	24/8-236	1339	1343	54 19.4	30 00.0	T7	763	11.48	
099	24/8-236	1931	1932	54 54.4	30 00.1	T7	763	10.97	
100	25/8-237	0247	0250	55 28.8	30 00.1	T7	763	10.87	
101	25/8-237	1423	1425	55 39.7	29 59.5	T7	763	10.98	
102	26/8-238	0901	0905	55 55.9	29 58.6	T5	1134	11.14	
103	26/8-238	1000	1000	55 51.6	29 54.7	T7	763	11.23	
104	26/8-238	1102	1102	55 43.4	29 44.9	T7	763	11.11	
105	26/8-238	1300	1301	55 27.2	29 25.0	T7	763	10.69	
106	26/8-238	1500	1503	55 09.7	29 08.8	T7	763	10.59	
107	26/8-238	1700	1701	54 49.7	29 07.0	T7	763	11.04	
108	26/8-238	1859	1901	54 27.7	29 02.7	T7	763	11.55	
109	26/8-238	2059	2100	54 05.0	29 00.7	T7	763	11.48	
110	27/8-239	0351	0353	53 42.0	28 35.8	T7	763	12.05	
111	27/8-239	0440	0453	53 37.9	28 18.6	T7	763	12.15	
112	27/8-239	1111	1115	53 30.1	27 40.6	T7	763	12.22	
113	27/8-239	1326	1330	53 24.9	27 19.8	T7	763	12.27	
114	27/8-239	2342	2345	53 09.3	26 39.6	T7	763	12.86	
115	28/8-240	0056	0058	53 08.1	26 20.9	T7	763	12.88	
116	28/8-240	1014	1015	53 14.7	25 25.0	T7	763	12.80	
117	28/8-240	1759	1802	52 59.9	25 25.8	T7	763	13.08	
118	29/8-241	0105	0107	52 48.7	24 40.0	T7	-	13.10	
119	29/8-241	0109	0111	52 48.3	24 38.8	T7	763	13.18	
120	29/8-241	0213	0214	52 43.7	24 19.7	T7	763	13.23	

TABLE 2

XBT station List

XBT	DATE/DAY	Logged time(z)	Drop time(z)	LAT(N)	LONG (W)	PROBE TYPE	DEPTH Max(m)	TEMP TSG C	COMMENTS
121	29/8-241	0823	0830	52 35.3	23 38.2	T7	763	13.50	
122	29/8-241	0942	0945	52 33.1	23 20.1	T7	763	13.40	
123	29/8-241	1701	1704	52 26.4	22 30.9	T7	746	14.89	
124	29/8-241	2328	2335	52 11.8	21 35.0	T7	763	14.80	
125	30/8-242	0030	0031	52 06.9	21 19.6	T7	763	14.72	
126	30/8-242	0704	0706	51 55.3	20 39.0	T7	763	14.97	
127	30/8-242	0812	0818	51 50.3	20 19.0	T7	763	16.69	
128	30/8-242	1500	1500	52 11.7	19 59.9	T7	763	16.79	
129	30/8-242	1700	1704	52 36.5	20 00.0	T7	763	14.93	
130	30/8-242	1901	1902	53 00.6	19 59.9	T7	763	14.59	
131	31/8-243	0100	0101	53 56.2	19 59.2	T7	763	14.93	
132	31/8-243	0301	0301	54 10.5	19 59.8	T7	763	14.87	
133	31/8-243	0904	0908	54 58.4	19 59.8	T7	763	14.39	
134	31/8-243	1108	1109	54 22.5	20 00.1	T7	763	14.00	
135	31/8-243	1258	1301	55 44.4	20 00.0	T7	763	13.45	
136	31/8-243	1459	1500	56 07.2	20 00.1	T7	763	13.37	
137	31/8-243	1659	1700	56 30.5	20 00.0	T7	763	13.50	
138	31/8-243	1904	1906	56 55.6	20 00.2	T7	763	13.30	
139	31/8-243	2105	2110	57 20.3	19 59.9	T7	763	13.37	
140	1/9-244	0049	0051	57 23.1	19 33.3	T7	763	13.32	
141	1/9-244	0519	0521	57 08.2	18 30.1	T7	763	13.24	
142	1/9-244	1035	1037	56 48.4	17 10.4	T7	763	13.31	
143	1/9-244	1427	1428	56 38.9	16 29.2	T7	623	13.88	
144	1/9-244	1909	1910	56 23.3	15 29.0	T7	303	13.98	
145	1/9-244	2251	2255	56 10.3	14 33.4	T7	492	14.28	
146	2/9-245	0112	0113	56 06.3	14 17.7	T5	1208	14.50	
147	2/9-245	0554	0555	55 57.2	13 44.2	T7	764	14.82	
148	2/9-245	0700	0702	55 51.7	13 22.4	T7	763	14.93	
149	2/9-245	1212	1215	55 38.6	12 29.1	T7	763	14.80	
150	2/9-245	1855	1857	55 16.0	11 13.9	T7	763	15.35	

TABLE 3
Net hauls

Station Number	Date	Day of year	Time of Uphaul	Latitude (North)	Longitude (West)	Nominal Depth (m)
CD62004	3/8/91	215	1648-1652	51 38.75	14 16.53	100
CD62005	3/8/91	215	2053-2103	51 40.64	14 52.77	200
CD62007A	4/8/91	216	0840-0844	51 41.23	16 34.43	100
CD62007B	4/8/91	216	0858-0908	51 41.17	16 34.02	200
CD62007C	4/8/91	216	1428-1436	51 40.31	16 34.26	200
CD62008A	4/8/91	216	1909-1914	51 43.16	17 43.82	200
CD62008B	4/8/91	216	1938-1945	51 43.23	17 43.62	100
CD61010	5/8/91	217	2122-2131	51 45.16	19 59.94	200
Mooring Net 1	6/8/91	218	0513-0518	51 34.02	22 02.67	100
Mooring Net 2	6/8/91	218	0528-0533	51 33.99	22 02.81	100
Mooring Net 3	6/8/91	218	0544-0549	51 34.02	22 03.01	100
CD62011	6/8/91	218	2205-2210	52 17.01	20 02.58	100
CD62014	7/8/91	219	1611-1620	54 02.81	20 00.71	200
CD62019	8/8/91	220	1619-1630	56 55.53	19 59.48	200
CD62020	8/8/91	220	2123-2132	57 30.64	19 58.66	200
CD62022	9/8/91	221	0649-0659	57 36.65	21 06.78	200
CD62024	9/8/91	221	1650-1700	57 45.95	22 16.28	200
CD62030	12/8/91	224	0432-0436	58 36.84	28 54.28	100
CD62032	12/8/91	224	1840-1855	58 08.46	30 01.10	450
CD62034	13/8/91	225	0944-1001	56 57.45	29 59.93	450
CD62035	13/8/91	225	1714-1732	56 22.70	29 58.58	450
CD62036	14/8/91	226	0847-0904	58 53.59	31 11.82	450
CD62038	14/8/91	226	2007-2024	59 07.11	33 40.34	450
CD62041	15/8/91	227	1125-1142	59 21.94	36 03.19	450
CD62045	16/8/91	228	1715-1730	59 44.30	39 58.92	450
CD62048	17/8/91	229	2300-2310	59 54.43	41 51.97	200
CD62051	19/8/91	231	2040-2050	58 55.03	41 58.23	100
CD62057	21/8/91	233	2123-2140	56 11.09	38 31.62	450
CD62059	22/8/91	234	1028-1045	55 07.56	36 59.43	450
CD62062	23/8/91	235	0317-0325	53 59.38	35 50.44	200
CD62065	23/8/91	235	2156-2213	53 58.34	32 20.44	450
CD62070	27/8/91	239	0219-0226	53 46.95	28 58.81	200
CD62075	29/8/91	241	0644-0655	52 38.61	23 58.59	300
CD62078	30/8/91	242	0531-0545	51 59.89	20 59.39	400
CD62081	31/8/91	243	0658-0715	54 37.59	19 59.40	450
CD62084	1/9/91	244	0845-0901	57 01.93	17 58.95	450
CD62086	1/9/91	244	1709-1725	56 31.22	16 00.33	450
CD62089	2/9/91	245	0420-0436	56 02.57	14 06.71	450
CD62091	2/9/91	245	1652-1707	55 30.87	12 00.30	450
CD62095	3/9/91	246	0646-0702	55 03.52	10 10.78	450

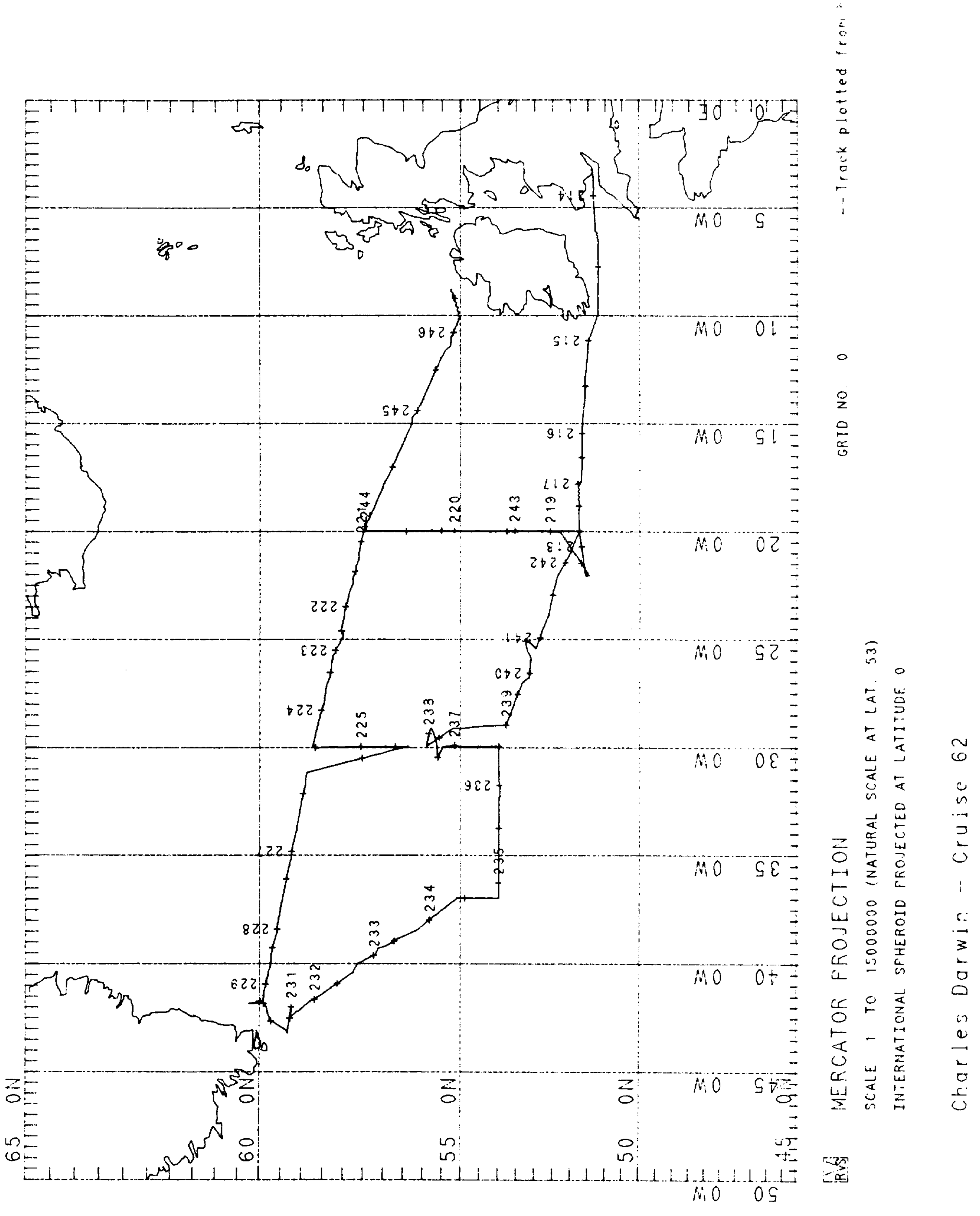

Figure 1. RRS "Charles Darwin" Cruise 62, 01 Aug-04 Sep 1991. Track chart.

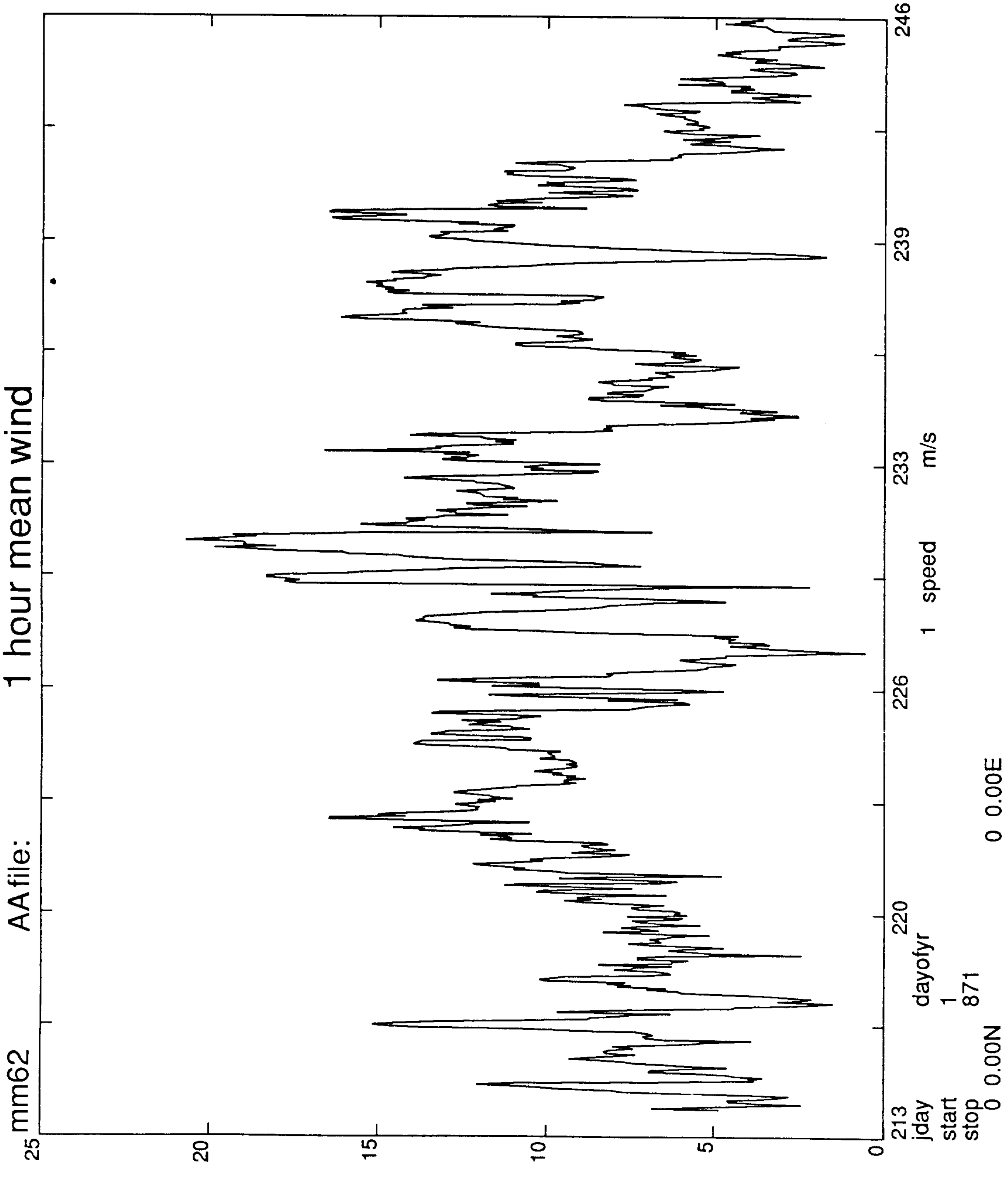

Figure 2: Wind speed