RRS *James Clark Ross*

Cruise JR 38

16 December 1998 - 12 January 1999

Variability of the South Georgia Marine Ecosystem

Pelagic Ecosystem Studies

Core Programme IV

Contents

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ABSTRACT

The Pelagic Ecosystem Studies Core Programme is aimed at understanding the processes generating variability in the South Georgia marine ecosystem, with a particular emphasis on interannual variation. JR38 was the fourth cruise in the programme series and began on 16 December 1998 at Stanley and ended there on 12 January 1999. On depareture from Stanley the ship steamed to the head of a standard oceanographic transect just to the north of the Maurice Ewing Bank (MEB). The transect consisted of 22 hydrographic stations, 35 km apart. On each station a CTD profile with water bottle samples was taken to generate profiles of standard physical characters and allow chemical analyses and the determination of chlorophyl concentration. Jigging for squid was also undertaken simultaneously. Zooplankton net hauls were used to characterise the zooplankton community on each station and a chlorophyll fluorescence profile was also obtained using an Aquapack system. On a number of stations extra water and zooplankton samples were obtained for detailed biochemical analyses. Between the stations two acoustic systems were operational, a SIMRAD EK500 echoounder was run integrating returned echo signals to 250 metres, and a passive hydrophone array to monitor whales.

In the vicinity of South Georgia, surveys of two mesoscale (80x80km) boxes consisting of 5 sets of paired transects were sampled. A towed undulating oceanographic recorder (UOR) was used to characterise the upper 150m of the water column and the EK500 was used to describe the distribution of krill and other acoustic scatterers. Underway chemistry and standard analyses of the surface water were also undertaken. A series of standard station activities of CTD, water bottle samples, RMT8 and zooplankton net hauls were carried out at on-shelf and off-shelf stations within each survey area. Experimental work on zooplankton grazing, excretion and development rates was also undertaken. Most of the data were validated and calibrated at sea and are available for comparative analyses with data from the previous three seasons. The preliminary figures indicate that there are some significant differences from earlier surveys in both the physical and biological regimes.

KEYWORDS Interannual variability, South Georgia, Antarctic Krill, Acoustics, Zooplankton, Physical Oceanography, Ecosystem, Polar Front, Shelf, Mesoscale, Whales.

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Pelagic Ecosystem Studies Core Programme

The Southern Ocean ecosystem shows marked interannual variation in the distribution and abundance of key pelagic species such as the Antarctic krill. This variability affects the operation of ecosystems from the microbial dynamics through to the higher predators which are dependent on krill as the main item in their diets. The Pelagic Ecosystem Studies Core Programme is part of an integrated research programme which is aimed at analysing the operation of the Southern Ocean Marine Ecosystem. The geographical focus for the work is the South Georgia area but the open nature of the ecosystem means that the system must be studied in the context of the operation of the Scotia Sea and the wider Southern Ocean. As part of the current five-year research programme for the period 1995/2000, a regional mesoscale survey is being undertaken each year to provide specific information to link regional and small scale investigations to studies of the large-scale, long term variability. This is being used to gain an understanding of the processes generating variability in the South Georgia ecosystem and the spatial and temporal links to the larger Scotia Sea ecosystem. The survey aims to provide a broad scale physical chemical and biological oceanographic description to set the South Georgia studies in a larger context. A further aim is to examine features of community composition both along a large scale hydrographic transect to the northwest of South Georgia and in two survey areas along the north coast of the island. Particular emphasis is placed on the collection of information on the population structure, distribution and abundance of krill. This document reports the 4th Core Programme during December and January 1998/1999.

Principal Objectives for JR 38: Core Programme IV

1. To make direct measurements of the physical, chemical and biological characteristics across the Maurice Ewing Bank and the Polar Frontal Zone to the shelf area north of South Georgia.

- Carry out a hydrographic transect of 22 CTD stations at 35km spacing with associated biological and chemical sampling.
- On station, to sample for zooplankton community composition.
- Between stations underway monitoring to include OceanLogger, underway chemistry, bathymetry, ADCP, multifrequency acoustics and seabird, seal and whale observations with midpoint XBT profiles.

2. To determine the status and distribution of the krill population in the South Georgia region in two mesoscale survey areas on the northern shelf of South Georgia.

- Sample a series of paired acoustic transects which have been previously randomly positioned within the survey regions.
- determine the fine scale distribution and abundance of krill using high resolution multifrequency acoustics.
- Sample with to characterise acoustic targets and to provide size and maturity data on the krill within each area.

3. To make direct measurements along standard transects of the physical, chemical and biological characteristics of the surface 100-200 metres in two mesoscale survey areas on the northern shelf of South Georgia.

- Determine temperature, salinity, chlorophyll fluorescence, photosynthetically active radiation (PAR), transmissivity using an undulating oceanographic recorder.
- Determine plankton size distribution and abundance using an optical plankton counting system.
- Monitor surface and sub-surface conditions using ADCP, OceanLogger
- Monitor density and locations of seabirds, seals and whales.

4. To make direct measurements of the physical, chemical and biological characteristics at a series of stations in on-shelf and off-shelf regions in two mesoscale survey areas on the northern shelf of South Georgia.

- Determine the physical characteristics of the survey area using CTD
- Determine the biological characteristics of krill
- Determine zooplankton communities using ZNET, FNET and RMT8

Cruise Schedule

The proposed timetable for the cruise was as follows:

14 December	RRS James Clark Ross arrives in Port Stanley
	Scientific contingent departs from UK
16	Mobilisation
18	Departure from Port Stanley for Cruise JR 38
21-25	Maurice Ewing Bank Transect
26	Acoustic calibration I at Stromness
27-31	Eastern Core Box study

1 January 1999	Acoustic Calibration II
2- 6	Western Core Box
7	Transects between core boxes
8	Acoustic calibration III
9-11	Return to Port Stanley
12	Demobilisation
13	Depart Falkland Islands for UK
14	Arrival in UK

The actual schedule achieved was as follows:

December 1998	
14	Main scientific contingent departs UK
15	Scientific contingent arrives in Port Stanley
18	RRS James Clark Ross departs from Port Stanley
19	Test CTD station
22	Commencement Maurice Ewing Bank transect
25	Completion of Maurice Ewing Bank transect
26	Acoustic calibration I in Stromness Harbour South Georgia
	RMT haul for fish larvae
27-31	Eastern Core Box study period
January 1999	
1	Acoustic calibration II in Stromness Harbour, South Georgia
2-6	Western Core Box study
7	Small scale predator/prey observations
8	RMT hauls for fish larvae at Shag Rocks
	Squid jigging trials at Polar Frontal Zone
10	Arrival at Falkland Islands
11	Demobilisation
12	Leave ship
13	Majority of scientific team depart from Falkland Islands
14	Majority of scientific team return to UK

General Scientific Cruise Narrative

Preparation and transit leading to first study period

The majority of the Scientific contingent arrived in Stanley on Tuesday 15 December having flown direct from UK. Just prior to departure from UK the Scientist in Charge (Dr Inigo Everson) had been informed of problems with the ship's computing system. On arrival on the ship Bruce Lamden and Jeremy Robst spent the evening determining the extent of these problems in order to report to the scientific group leaders early on 16 December. Their prognosis was that, with
the operational equipment on board, the programme could proceed adequately with data collection but that post processing would be seriously curtailed. Spare UNIX boxes, which had been ordered and consigned to air freight by RAF from Brize Norton three weeks previously, were not expected to arrive for several days at the earliest. The only option available was to transfer systems that had been active on JRUE, the system that had failed, to JRUA, the system
carrying ship's communications. Because of the sensitivity to modifying JRUA, and an earlier directive to the Master to seek approval from Cambridge before making any changes to JRUA, David Blake, Jim Summers and Jim Crawshawe were consulted by telephone and gave their approval to the transfer. This system was used throughout the cruise.

Communications with Cambridge at this time were difficult because the power supply to the SatCom on the ship was
out of action with the system running intermittently on a jury rig. The ship's SatCom system is essential for receiving information to feed into the DGPS, an essential interface to the ADCP, and was an item that had been notified, during the cruise planning meeting, would be required for the cruise. After sailing, a replacement power supply was built by Vsevelod Afansayev and Steve Mee (Comms. Officer).

The RRS James Clark Ross departed from Port Stanley on Cruise JR 38 at 1000 on Friday 18 December. Standard emergency drill training and safety briefing were given immediately on departure. This was followed by a scientific safety briefing, and discussion on the enhanced risks of working at sea. Passage was made in good weather and on 19 December test deployments with the CTD, squid jigger (JIG) and Bongo net were made. Following this test station, and with the vessel on track for the first station of the Maurice Ewing Bank transect (MEB), test deployments were made with the Undulating Oceanographic Recorder (Aquashuttle AQA) and the passive hydrophone for recording whale vocalisations (HYD). All these tests were completed satisfactorily. Trial XBT's were launched and it was found that these failed from the port quarter but were satisfactory from the starboard quarter; the reason was thought to be because the XBT wire may have fouled the HYD cable.

First Scientific Study Period: Maurice Ewing Bank Transect

The first MEB station commenced in fair weather at 17.29 Z on Sunday 20 December with BNE, CTD, JIG and PAK. A high point at this first station was that the squid jigger caught a small squid. Further stations were occupied along the transect according to a predetermined sampling regime. The transect went from north of the Maurice Ewing Bank towards the western end of South Georgia, traversing the bank between stations 7 to 10. At Station 10 a test deployment was made with the RMT net. This haul was satisfactory although bench testing of the spare net monitor indicated it was not functioning according to specification.

The weather continued fair throughout this period until we crossed the Antarctic Polar Front (APF) at around Station 13. At this point there was extensive mist and the sea colour changed from blue to grey although the weather remained calm. A pod of fin whales was seen just south of the APF and the echosounder had extensive acoustic indications, possibly of krill.

On 23 December the weather began to deteriorate and by midday on 24 December the wind and seastate had increased to cause the vessel to roll significantly, reducing the effectiveness of the echosounder. Course was altered to port to provide a more comfortable configuration but, when the vessel turned to starboard to cross the transect at the midpoint for the XBT, the weather had deteriorated to the point where little useful data were being collected and the vessel hove to. After approximately 14 hours the weather had moderated sufficiently to continue the transect. Arising from this, the section between stations MEB19 and MEB20 produced little usable data. The transect was completed in the afternoon of 25 December at which point the vessel proceeded along the north coast of South Georgia to Stromness Bay.

At 0600 on 26 December the vessel entered Stromness Harbour and moored with two anchors forward and with stern lines to the Admiralty buoy. The first echosounder calibration began at 0800. All calibration procedures were attempted, these were facilitated by the new target rigging system designed by Doug Bone. Some of the scientific party were able to get ashore for a brief period. At 1900 the vessel sailed and carried out a RMT haul close to the entrance of Stromness Bay; this produced a large catch of larval mackerel icefish.

Second Scientific Study Period: Eastern Core Box

The weather forecast indicated poor weather imminent and, on passage to the outer end of the first transect in the Eastern Core Box the wind and seastate increased significantly. The vessel moved slowly down the transect lines but weather conditions precluded any reasonable data collection. Rather than wait to repeat the first transect pair the decision was made to move to the second pair and attempt to sample E1.1 and E1.2 at the end of that study period. The second
transect pair were sampled in improving conditions on 28 December. Slight confusion arose over the sequencing of activities at the sampling stations with result that RMT hauls were made in daylight rather than after dark. This was a result of the change in day length associated with the earlier start time of the cruise in comparison to Core Programme 3.

To reduce net avoidance by zooplankton the standard RMT hauls at each station should be conducted during darkness. Due to the short period of daylight at the time of the cruise we fished the stations by RMT between sunset and sunrise. However this was not ideal because there was strong twilight on clear days. The alternative would be to conduct the survey slightly later when day length is shorter. An early morning discussion partially resolved this difficulty and a revised schedule prepared, this worked well for the remainder of the cruise and satisfied the sampling requirements of most groups.

The remaining transects were sampled without significant problems and transect E5.2 completed late on 31 December with a deep CTD station.

The vessel then proceeded towards the outer end of transect E1.1 to attempt to sample the first transect pair again, but in better weather. By 1 January 1999 the weather had deteriorated to such an extent that it was clear that very little useful sampling would be possible along the transects on that day. The decision was made to break off at 0300 and proceed to Stromness Harbour to undertake the second echosounder calibration. The vessel arrived off Stromness Bay at around 0800 and moored up for the calibration, which began at 1000. The weather conditions in the harbour, with an onshore wind of up to 30knots made calibration difficult and consequently only limited, but adequate, measurements were possible in the time available.

Third Scientific Study Period: Western Core Box

At 1900 the vessel sailed, leaving Stromness Bay, and heading west to begin the westernmost transect at its shoreward end. The weather was poor but, the course being in the lee of the island, the vessel made good speed to arrive on time to start transect W1.1. Conditions at this time were marginal for the scientific programme. The decision was made to proceed with the transect, knowing that the acoustic data would be of very limited value but in the expectation that the AQA data stream would be adequate. The alternative would have been to heave to for 24 hours. The vessel turned onto course in time to go through the way point of W1.1 on time at 0500. Due to the strong wind and swell from the east the vessel rolled heavily throughout the day but kept to the designated transect line. As expected the acoustic data were of poor quality due to the rolling of the ship but the AQA data stream was good for all sensors.

By mid afternoon the wind had dropped significantly and station work overnight was completed without undue difficulty. The weather improved the following day and remained stable throughout the second, third and fourth transect pairs. There was a slight deterioration during the fifth transect pair but not sufficient to seriously prejudice the data collection.

Sampling on the western Core Box was completed in the late afternoon of 6 January.

It was noted that during the sampling of this Core Box that there had been significant concentrations of krill seen on the echosounder that appeared to be congruent with observed feeding aggregations of birds and seals. These aggregations appeared to be present on the landward side of the shelf break.

Completion of Scientific Sampling Programme

The schedule having slipped slightly due to bad weather, it was clear that, although there was 24 hours available for completion of the programme, there was insufficient time to do either of the two planned programme options; transects between Core Boxes or a third echosounder calibration, satisfactorily. Following discussion between the science group leaders it was decided to concentrate on the following topics: small scale predator/prey observations, sampling for larval fish, water samples for the marine chemistry group and squid jigging at the Antarctic Polar Front.

The last transects of the western Core Box having been completed at the shoreward end, we had approximately one hours relocation time to get to the vicinity of Cape North where a series of RMT and FNET hauls was made after dark. These provided very large concentrations of ‘0' group mackerel icefish, *Champsocephalus gunnari*, and other species. At dawn the vessel relocated to transect W5.2 and did a CTD cast to provide water samples for the chemistry group. The vessel then followed a predetermined search pattern looking for predator aggregations on which to undertake small scale surveys. This search continued from 0400 to 1700 and traversed areas where, in the very recent past, feeding aggregations of predators had been observed. No suitable aggregations were encountered and the search was called off in order to make time to satisfy our ETA in Port Stanley. Ironically one hour after calling off the search a large and very active predator feeding aggregation was encountered approximately ten miles to the west of the western core box.
The vessel proceeded to the Shag Rocks region and did two RMT and four FNET hauls at the shelf break, the first RMT in total darkness and the second at dawn, catching small numbers of larval fish. On the night of 8/9 January the vessel stopped for three hours for squid jigging at the Antarctic Polar Front. Squid were seen but none were caught.

The vessel then continued on its way westwards making underway observations with the ADCP, EK500 and hydrophone along the predetermined transect along latitude *** degrees South. In previous years this transect was also sampled with XBT’s; however due to the poor state of repair of the XBT system, this was not possible. On completion of the transect the vessel headed northwest to Cape Pembroke and arrived in Port Stanley at 14.00 on 10 January 1999.

Scientific cargo was loaded into the two containers on 11 January and the scientific contingent came ashore on 12 January. The majority of the team flew home from Mount Pleasant on 13 January.

Health and Safety issues

Prior to the cruise a Risk Assessment was prepared to cover activities on the cruise. This was circulated to all participants and also to Senior Management. Arising from this minor amendments were made. Immediately on sailing, the Scientist in Charge organised a Safety Meeting for the scientific team at which the Risk Assessment was discussed.

Concern was expressed during the cruise that COSHH forms were not always clearly displayed in the working spaces. Arising from this the Ship's Safety Officer provided folders, to be kept in a visible location in the relevant working spaces, to hold such documents.

Throughout the cruise there was a high state of awareness by all the Scientific Team which was helped by discrete interaction from the Ship's Company. This must have been a significant factor in ensuring that the cruise was free of significant H+S incident.

Recommendations from Scientist in Charge for future cruises.

Equipment

Ship's Computing system

During an earlier cruise this season it had become clear that there were major problems present with the main computing systems on the vessel. These problems had been uncovered during, what had been called ‘unscheduled scientific activities’. Whilst it is true that such activities should have been scheduled into the programme, in which case they would have received ITS support, it is clear that if this activity had not taken place the problems would only have become apparent at a latter date, probably during cruise JR38. This lead time did allow Bruce Lamden to order replacement UNIX boxes, which had been despatched in time but were not air freighted out because they were seen as low priority by RAF Brize Norton. Bruce Lamden and Jeremy Robst worked very hard to try to arrange a full system as quickly as possible using resources available and it is due to their resourcefulness that the cruise sailed on time. I feel this put them under excessive and unnecessary pressure.

The first key point which arises from this is that backup arrangements, whether by carrying spares or else re-organisation of resources, need to be provided. The precise nature of such arrangements would depend on medium and long term plans for the computing system on the ship. The second point is that any failure should be notified as soon as it is found

Recommendation: That in future appropriate backup arrangements be prepared and that any major failings be notified to the Scientist in Charge at the earliest opportunity.

Ashtec D-GPS and GLONASS

This is required for input into the ADCP system. At the start of the cruise the system was not operational due to the failure of the SatComm power supply. Latter in the cruise it became clear that the GLONASS system was also only supplying low quality data. Both were agreed operational systems for the cruise and consequently should have been running correctly. These systems are likely to be requirements of future oceanographic cruises, whether by MLSD or outside organisations.

Recommendation: That the systems be either fully serviced or replaced.

EK500 acoustic system

The following points related to this system warrant consideration: general noise level, regular pattern noise on 120kHz and use of towed body.

It has been suggested that an improvement in the reduction of the general noise level might be achieved by siting the control box adjacent to the transducer coffer dam and controlling the system via the Echo-Listener system. This would cause problems for operation of the system using a single control box and transducers mounted in a towed body.

The regular pattern of noise at 120kHz may be due to a transformer which is only switched ‘off’‘ when the vessel is operating under shore power. This might be tested when the vessel enters drydock during the annual refit.

Recommendation: That the MLSD acoustic group address each of these topics and advise on a suitable courses of action.

Towed body

During the cruise the quality of the acoustic data was severely compromised on a few occasions due to the vessel rolling heavily. The situation would have been greatly improved if the towed body had been available for the cruise. Further work is still required in setting up and trimming the towed body. This work cannot be undertaken during the normal course of a research cruise. Such tasks should be undertaken during sea trials prior to departure from UK.

Recommendation: That a period of seatrials be made available to set up the towed body for use during acoustic survey operations.

XBT

The XBT control box sited in the UIC room is now very old. Careful analysis of the results during this cruise indicated there to be a significant, but unpredictable, offset in the results when compared with adjacent CTD casts.

Recommendation: The XBT control box should be replaced with a modern unit.

Underway pCO2 Sensor

This system is installed in the laboratory and, so far as I can ascertain, has not worked for some considerable time. I am informed that it belongs to Plymouth Marine Laboratory. It takes up space and requests have been made, several times, for its removal. Each time it has been left in place on the basis that ‘BAS uses it’ - we do not, and have never been able to.

Recommendation: That the pCO2 Sensor system in the laboratory be removed immediately.

General points

Safety clothing

All participants were diligent about the use of safety equipment at all times during the cruise. Personal safety equipment is provided for some items and for deck work safety harnesses are available from the ship's stores. Currently we rely on individuals to provide their own laboratory safety equipment and also do not carry stocks to kit out individuals who might be called to undertake certain laboratory tasks at short notice. Following discussions with the Master it is clear that it is not practical to expect the ship to provide such items. It is not clear under which cost head such items should be allocated. Perhaps it might be appropriate for ‘personal’ type items to be included in the clothing issue.

Recommendation: That a Slop Chest' of laboratory coats, goggles and other laboratory safety equipment be carried as part of the cruise equipment.

Pre-cruise Planning

When I undertook to act as Scientist in Charge for the cruise, I recognised that the total science period, including mobilisation and demobilisation, would require 28 days. Knowing that this period was planned to span Christmas and New Year, I contacted the Master suggesting that he and I discuss plans. This action, I was informed, was totally out of line with current practice and I was instructed not to discuss the matter further with anyone from the ship. Subsequently I found out that no consultation had taken place with the ship and I was pressured into making time available during the cruise to allow some free time. Weather and pressure to complete the programme meant that no such time could be made available. It is my view that the practice of keeping the Master out of the discussion loop in cruise planning is bad; it is certainly alien to my own approach to management. I recognise that there may be good reasons why a certain course of action is necessary but that does not justify a process of management by edict.

This raises a more general point, because it is not clear what BAS Senior Managment policy on this issue. Either it is BAS policy that no time will be allocated for Christmas during a research, or additional time must be included in cruise allocations if they fall over the Christmas period.

Recommendation: That Senior Management, in conjunction with Masters and Principal Scientists, should provide guidance on the issue of time allocation for Christmas and New Year.

Computer desks

Criticism was made following JR28 of the desks and locations of individual computer terminals. No action has been taken on this presumably because a detailed specification has not been drawn up. Computers in the UIC room, Computing Room and also the Principal Scientist's Cabin would all be uncomfortable to use if set up ashore, on a moving ship they present extreme difficulties.

Recommendation: Consideration should be given to a redesign of the layout of these facilities using materials and chairs appropriate for a marine environment on a moving ship.

Role of Scientist in Charge

Even in the most carefully planned research cruise there will be situations when the Scientist in Charge is called on to make decisions at any time of the day or night. Such situations can occur as a result of insufficient attention being paid to detailed planning, adverse weather or just plain bad luck. In such situations it is important that the SIC is available and appraised of the situation as quickly as possible so that an effective and timely decision can be made. The people invited to act as SIC must have had some experience of working at sea and as a result are likely to be already in some position of responsibility, such as leaders of research groups. The large number of scientific personnel (26) and the diverse types of activities on this cruise meant that as SIC I was placed in a position whereby I might have to act against my own science interest group. In such circumstances it is better for the SIC to be separated from the interests of a group leader. This is quite a different situation to the groundfish surveys I have been leading in recent years whereby the main focus is confined to one goal with all others being subordinate.
Recommendation: That the Scientist in Charge should not undertake the role of Group Leader for any of the science activities.

The job of SIC is made very much easier by having a willing and motivated team. I was extremely fortunate in that respect because everyone appeared to be keen to do their own work, assist with others and support me; for that I am extremely grateful.

Processing of Navigation data on JR38 : Core Programme IV

Mark Brandon

There are six navigational instruments for scientific use on the RRS *James Clark Ross* (listed in table 1). Although the six instruments seem in some cases similar, they are all unique. As well as the three GPS systems listed in table one, there are three additional GPS systems on board the JCR for the ship's use. These are a Leica MX400 and two Ashtech G12 receivers. In addition there is a Racal Satcom which receives GPS SV range correction data via INMARSAT B. This data is passed to the Trimble, Leica, and G12 receivers allowing them to operate in Differential mode (DGPS). During JR38 the DGPS reference station at Stanley was used.

Table 1: **Scientific navigation instruments on the RRS James Clark Ross**.

Instrument	Type	Code	Use
Trimble 4000	GPS receiver	gps	Primary positional information
Ashtec GG24	GLONASS / GPS receiver	glo	positional information
Ashtec GPS3DF	GPS receiver	ash	Attitude information
Gyrocompass	Sperry Mk 37 model D	gyr	Heading information
Electromagnetic Log	Chernikeeff log Aquaprobe Mk V	eml	Velocity information
Doppler Log	Sperry SRD 421	dop	Velocity information

The collection and use of all of the navigation data are linked. On this cruise the data for all six instruments and the standard editing procedures were all done in one Unix script called "JR38_nav_go". This script requires the Julian day as an input and then executes a further 8 C shell scripts to read in 12 hours of data, and edit where necessary all six streams.

In this short report we briefly describe each instrument and explain the processing, as was done on the Marine Life Sciences Core Programme IV - JR38.

The instruments

Trimble 4000

The Trimble 4000 receiver in differential mode was the primary source of positional information for the scientific work on Core Programme IV. Unfortunately on this cruise there were significant problems. Firstly when the ship sailed the power supply to the SkyFix was unserviceable, and until its repair by the on-board ETS engineer, the navigation data was not in differential mode. This problem was thankfuly sorted out before the start of the Maurice Ewing Bank Transect. The second problem was that data quality was poor. Experiments on data when the James Clark Ross was moored up at Rothera in November 1998, and Stromness in December 1998 showed that between these two periods the quality of the positional data reduced from approzimately 2 m at Rothera, to 8 m at Stromness. A possible reason for this deterioration in quality could be that the American and British Air Forces launched Operation Desert Fox and bombed Iraq in December. We will carry out similar experiments on data collected at the end of the cruise to see if data quality improved. The

data were logged at 1 second intervals and read into 12 hour pstar files using the Unix script gpsexec0. Individual steps in this exec are
gpsexec0:
purpose: To read Trimble data into the pstar format.
The programmes are

datapup - transfers the data from RVS binary files to pstar binary files.
pcopya - resets the raw data flag on the binary file.
pheadr - sets up the header and dataname of the file.
datpik - removes data with a dilution of precision (hdop) greater than 5.

Two files are output from this script.
One is just before the editing stage (datpik) and is called 38 gps<jday>.raw
the other is after the datpik, this is 38 gps <jday>.

Ashtec GLONASS (GG24)

The *James Clark Ross* is the only British research ship currently installed with a GG24 receiver. The GG24 works by accepting data from both American GPS and the Russian GLONASS satellite clusters. This extends the constellation of available satellites to 48 and should theoretically be significantly more accurate. However, experiments suggested that the accuarcy of the system was approximately 15 m. One supposes that the accuracy was being dragged down by the GPS data quality.

Ashtec GPS3DF

The Ashtec 3DFGPS is used to correct errors in the gyrocompass heading that are input to the ADCP. The configuration of the receiver is complex, for JR38 it was configured with the settings in table 2. Throughout the cruise the Ashtec performed rather poorly with frequent data gaps of several hours. Although this has been reasonably comon in the past, on this cruise user intervention did not seem to aleviate the problem and a thorough investigation was carried out by ETS, ITS and myself. An investigation of the hardware was carried out in as much detail as possible and revealed nothing. Other possible causes were suggested - the most likely being again, the Desert Fox offensive. There was discussion with Cambridge about whether to return the unit back to the manufacturers, the result was that the unit remains and will be investigated by different personel on JR39.

Table 2: The sub menu settings on the Ashtec 3DF GPS system (menu 4 and sub-menus)

POS	54:17.0S, 35:40,W,+0.0m
Alt known	N
Ranger	0
Unhealthy SV	N
Rec. Intv	20
Min no. Sv	4
Elev mask	10
Pdop mask	40

PORT A (not used)	
nmea	off
real time	off
VTS	off
baud	9600

PORT B (Level A logging)

nmea	on
real time	off
VTS	off
baud	4800
OPTIONS	PAT ON 1 s rate

Attitude Control Menu

max rms	8			
search ratio	0.5			
1 s update	Y			
3 Sv search	N			
	TAU	**TO**	**Q**	**R**
Hdg	999	000	1.0e-2	1.0e-2
Pitch	020	000	4.0e-2	1.0e-2
Roll	020	000	4.0e-2	1.0e-2
Kalmann filter reset	N			

The coordinates in the following table are from a survey using the Ashtec software in Grimsby in September 1996. The port-aft antenna is designated number 1, port-fwd is 2, stdb-fwd is 3 and stbd-aft is 4. The XYZ vectors have been adjusted so that heading is defined by the direction normal to the 1-4 baseline (i.e. that baseline has Y = 0)

Vector	**X(R)**	**Y(F)**	**Z(U)**
1-2	2.955	4.751	0.0
1-3	11.499	4.754	0.0
1-4	13.227	0.0	0.0
offset	0(H)	0(P)	0(R)
Max cycle	0.2 cyc	smoothing	N
Max mag	0.08	Max angle	10

Our complex data processing procedure is designed with using the Ashtec to correct the gyrocompass error in mind. There were three execs involved in the processing these are ashexec0, ashexec1 and ashexec2

ashexec0:
purpose: This exec reads in data from the GPS3DF into pstar format
The programmes are

datapup - transfers the data from RVS binary files to pstar binary files.
pcopya - resets the raw data flag on the binary file.
pheadr - sets up the header and dataname of the file.

The output file is in the form 38 ash < jday> .raw

ashexec1:

purpose: This exec merges the Ashtec data to the master gyro file from gyroexec0
The programmes are

pmerg2 - merge the ashtec file with the master gyro file.
parith - calculate the differences in the ashtec and gyro headings (delta heading).
prange - force delta heading to lie around zero.

The output file is in the form 38 ash < jday > .mrg

ashexec2:
purpose: This exec is complicated as it edits the merged data file.
The programmes are.

datpik - reject all data outside the following limits
heading outside 0° and 360°
pitch outside -5° to 5°
roll outside -7° to 7°
attf outside -0.5 to 0.5
mrms outside 0.00001 to 0.01
brms outside 0.00001 to 0.1
delta heading outside -5° to 5°
pmdian - we remove flyers in delta heading of greater than 1° from a 5 point mean.
pavrge - set the data file to be on a 2 minute time base.
phisto - calculate the pitch limits.
datpik - further selection of bad data outside the following limits
pitch outside the limits created
mrms outside the range 0 - 0.004
pavrge - again set the data file to be on a 2 minute time base.
pmerge - merge back in the heading data from the gyro from the master gyro file.
pcopya - change the order of the variables.

The output files are 38 ash < jday > .edit
and 38 ash < jday > .ave.

We then followed an elaborate manual editing procedure following the suggestions and written notes of Raymond Pollard (S.O.C.) that is described in the ADCP data processing report.

Gyrocompass

The gyrocompass is a fundamental data stream. It is used by the RVS program *bestnav* to derive dead reckoning in the absence of gps data - as well as being used for ADCP processing (ADCP report) and derivation of true wind velocity (ocean logger report). For JR38 the gyrocompass data were read in 12 hour chunks using the Unix exec gyroexec0

gyroexec0:
purpose: This exec reads in the gyrocompass data and removes the inevitable bad data.
The programmes are.

datapup - transfers the data from RVS binary files to pstar binary files.
pcopya - resets the raw data flag on the binary file.
pheadr - sets up the header and dataname of the file.
datpik - forces all data from the gyro to be between 0 and 360°.

The output file is in the form 38 gyr < jday > .raw
The script also appends the day file to a master file called 38 gyr 01.

Electromagnetic Log

The electromagnetic log should give the water velocity relative to the ship in a fore-aft direction but was completely unserviable for JR38.

Doppler Log

The Doppler log gives water velocity relative to the ship in both the fore-aft and athwartships direction. There is clearly a problem with this sensor and it will be replaced soon. There were frequent dropouts when the instrument was power cycled by the officer on the bridge. This also meant the Level A unit had to be power cycled. This vector information was read in as 12 hour chunks using a very simple c shell script called dopexec0. The operations within this script were as follows:

dopexec0: This exec reads in data from the Doppler log into pstar format.
    datapup - transfers the data from RVS binary files to pstar binary files.
    pcopya - resets the raw data flag on the binary file.
    pheadr - sets up the header and data name of the file.
The output file is in the form 38 dop < jday> .raw

Daily Navigation Processing

As stated above the data were read in as twice daily (12 hour) files; the time periods being either from 0000 Z to 1159Z or 1200Z to 2359Z. Our primary navigation data were taken from the RVS file bestnav. This program uses the navigation data from various streams to construct a file with 30 second fixes. For JR38 the primary input to bestnav was the Trimble 4000 DGPS. In the absence of DGPS data the Glonass data were substitued, in the abscence of that, Ashtec data were substituted (essentially this is the raw gps signal). In the absence of these data as well, position was constructed from dead reckoning using the Doppler Log and the gyrocompass. This navigation file was read into a pstar file using the scrip navexec0.
navexec0:
purpose: This exec reads in data from the bestnav stream into pstar format.
The programmes are.
    datapup - transfers the data from RVS binary files to pstar binary files.
    pcopya - resets the raw data flag on the binary file.
    pheadr - sets up the header and data name of the file.
    posspd - here we calculate the east and north velocities from position and time.
    papend - the output file is added to the master file.
    pdist - we now recalculate the distance run variable.
    pcopya - and take out the RVS calculated distance run.

The output master file was called abnv381 and was used for all pstar required navigation information (i.e ADCP processing, true wind derivation, UOR data ect.).

Data Logging and Computing

Bruce Lamden, Jeremy Robst

1. Data Logging

With one notable exception, at the time of sailing, the ABC Data Logging System performed at its best. The LevelB gave no problems during this cruise. However, very soon after the ship left FIPASS, and before entering the narrows to exit Stanley harbour, all the LevelA systems alarmed and the LevelB hung. The LevelB required power cycling several times before it resumed normal operation. At the same time the ADCP and ADCP PC also crashed and took some time to recover. Earlier in the year, at the beginning of AMT South, a spike in the ship's electricity supply had crashed all the LevelA systems which then required reprogramming to recover. These events may draw attention to the possibility of a problem with the ship's mains supply.

The following instruments were logged via the ABC system: ADCP, Anemometer, Doppler Log, GLONASS, GPS Trimble (differential), GPS Ashtech (3d), gyro, ocean logger, net monitor, Simrad EA500, TSSHRP (pitch/roll), UOR, winch.

The EM Log had failed and was not available.

CTD data was logged to the CTD PC and then transferred to the Novell NetWare Server.

Difficulties were encountered with the following instruments:

1.1 ADCP

Logged directly to the LevelC. Occasionally the fromadcp program ceased to acquire data from the ADCP PC. This may have coincided with the ADCP being switched between water track and bottom track. To recover it was necessary to kill and restart the fromadcp and adcpin processes.

1.2 Doppler Log

The Doppler log periodically stopped outputting data and required power cycling to recover. The associated LevelA then required resetting before it would accept further input This resulted in gaps in the data file.

1.3 GLONASS

The Ashtech GG24 GLONASS receiver outputs null data when it cannot calculate a position. The LevelA converts this null data into zeros for all fields. The receiver generally recovers and outputs correct data after a while. However, occasionally it does not recover and requires power cycling. Prior to this cruise the GG24 required instructing, via a laptop, to resume outputting data after being power cycled. It has now been reconfigured so that this is no longer necessary.

1.4 GPS Ashtech

The Ashtech 3DF calculates attitude (pitch/roll/heading) as well as position. It uses 4 antennae and at least 4 space vehicles must be locked onto via antenna 1 to determine position. To determine attitude the remaining three antennae must lock onto the same space vehicles as antennae 1. The antennae are poorly positioned, on the rails around the monkey island, and their view of the sky is blocked by the ships funnel etc. During periods of poor satellite coverage the receiver fails to determine attitude for prolonged periods and frequently cannot even calculate position.

Prior to the cruise the receiver had failed and had undergone repair by the manufacturer. At the time of writing it is unclear wether the poor performance of the receiver is due to poor satellite cover (in combination with poor antennae positioning), or due to a persisting fault.

1.5 Ocean Logger

The air temperature sensor had failed and data could not be collected.

1.6 Winch

It was noted that to enable data logging the input cable to the LevelA must be connected after LevelA power up or reset ie. resetting the LevelA whilst the input is connected will prevent data capture.

2. Computing

2.1 Unix

Between leaving Grimsby and three weeks prior to JR38 two of the ships four Unix systems failed: jurc the Sun IPC spare for the levelC, and jrue the Sun Ultra1 data processing system. A Sun Sparc20 was immediately dispatched for airfreight to Stanley and a new dual processor Sun Ultra60 purchased and dispatched for airfreight a week later. Sun Microsystems were consulted about jrue and supplied a replacement motherboard under the terms of the maintenance contract.

On the day we left to join the ship we were notified that the airfreight would not arrive prior to the date the ship was due to sail. We therefore hand carried an extra IPC system from HQ along with a 9GB external disk preconfigured with jrue's application software.

Upon arrival we had hoped to repair jrue but replacing the motherboard failed to work. After consulting Cambridge we decided to implement the fall back procedure to use jrua for data processing as well as the email gateway to HQ (jrua and jrue were both Sun Ultra1's and acted as spares for each other). The jruc IPC was replaced, but retaining the original internal disk from jruc.

Even without the two systems being airfreighted there were enough Unix systems on board to survive another system failure. There was no threat to the email gateway or data logging. A further system failure would have resulted in data processing being undertaken on a less powerful system. Bsumlsb (used by MLSD for krill acoustics logging and data processing) was present during the cruise and could have taken some of the data processing load.
It was necessary to use software to spoof the hostid of jrua (to make it look like jrue) to satisfy the license managers of some of the applications software. This temporary measure will be disabled when the Ultra60 is commissioned.

After reconfiguring jrua performed well.

The 2 Unix DLT drives were found to be unserviceable upon arrival and DAT had to be used for backups and transferring data back to Cambridge. The presence of the DLT drives causes SCSI errors and write errors to the system disk.

2.2 PCs, LAN,, and the Dreaded GroupWise.

The LAN and Novell server performed well giving no problems.

The general purpose PCs had suffered an invasion by Microsoft products eg. attempting to start GroupWise resulted in an MS Mail startup window appearing. One likely cause of this is due to MS Mail and Internet Explorer being selected for installation by default when additional products eg. fonts, are installed from the NT CD. MS Mail and Internet Explorer must be de-selected every time and update/install is attempted. NT was re-installed on the PCs in the Data Prep room.

The number of problems experienced with GroupWise is too numerous to mention. The problems are well known in Cambridge and the solution appears to be to wait for an upgrade. One notable problem is the personal address book. Attempts to use this caused all sorts of problems.

3. Communications

The move to GroupWise 5 has added a whole new series of problems to the Unix based Antarctic communications system. One feature worth noting here is the GW reply mechanism which now adds a colon before the text in the subject box. This results in the comms system failing to differentiate between message categories. This problem has now been resolved on the JCR system.

Also, there seems to be a problem with mail routing and some local traffic addressed to JCRPO mailboxes gets routed through SMTP and is forwarded to Cambridge (NB this happens to mail which is not destined for Cambridge. It is in addition to the well known problem with local carbon copies being sent to Cambridge).

JR38 DATA MANAGEMENT

Sharon Grant

1. Background

In order to over come the problems of many disparate devices logging to data in diverse formats, data collected during MLSD cruises are converted to ASCII format. Data from instruments logging continuously are divided into files containing a days data (from 00:00:00 to 23:59:59 GMT). Data from instruments which log for specific events are divided into files containing data from one event. The naming convention for this follows the format of :

<CRUISE NUMBER><EVENT CODE><EVENT NUMBER/JULIAN DATE>.<pro/raw>

.pro - final version of data file having been validated and calibrated
.raw - raw version of data file as logged

During the cruise data were extracted from the ships logging system (The RVS ABC system) using a series of scripts. Rawdata.cshv4 and rawdata.cfg which convert RVS data into ascii format and stores the files on the UNIX server JRUA in the /data/pesto/JR38/ data area, a third script, resets.csh1 creates lat lon files for the acousticians. At the end of the cruise this data was copied to DAT tape and returned to BAS HQ for storage by the PES Data manager.

Table 1. Data holdings for Core Programme 4 (JR38)

Instrument	Data held by:
adp - Acoustic doppler current profiler	Data Manager
amm - Ammonium (underway)	M.Whitehouse
ane - Anemometer	Data Manager
aqa - Aquashuttle	Data Manager
ash - Ashtech 3-D global positioning satellite	Data Manager
aut - Autoanalyser	M. Brandon
bne - Bongo net	P.Ward, R. Shreeve, A. Aitkinson
bsn - Best navigation (derived data drawing together the most accurate positional data from all navigation instruments)	Data Manager
chl - Chlorophyll (underway)	J.Priddle
ctd - CTD	M.Brandon
dnm - Downwire net monitor	Data Manager
dop - Doppler log	Data Manager
ea5 - EA500 echosounder	Data Manager
ek5 - EK500 echosounder	A.Brierley, C.Goss
em - Electromagnetic log	Not in use
fne - Foredeck net	G.Cripps
glo - Global positioning satellite (Glonass)	Data Manager
gps - Global positioning satellite (Trimble)	Data Manager

gyr - Gyro compass	Data Manager
jig - Squid jigging	K.Anderson
nia - Nitrate (underway)	M. Whitehouse
nii - Nitrite (underway)	M. Whitehouse
oce - Oceanlogger	Data Manager
opc - Optical plankton counter	Data Manager
paq - AquaPack	Data Manager
pho - Phosphate (underway)	M.Whitehouse
rev - Reversing thermometer	Not in use
rmv - Relmov (derived navigation variable)	Data Manager
rm8 - Rectangular mid-water trawl (mouth area 8m)	T. North, C. Goss, A. Brierley
sil - Silicate (underway)	M. Whitehouse
tra - Transit satellite	Data Manager
tss - Heave, pitch, roll sensor	Data Manager
win - Winch	Data Manager
xbt - Expendable bathymetric thermograph	M.Brandon

The event log

A written log of the timings of all events carried out during the cruise is maintained by the bridge officer on watch, a copy of this is also held by the PES data manager. An electronic copy was created as a Quattro-Pro spreadsheet, using a PERL script (latlon.prl) to add accurate latitude and longitude information from the RVS gps_nmea data stream.

CTD Operations JR38: Core Programme IV

Mark Brandon

Summary

In this report we give details of the method of acquisition, and calibration of CTD data on JR38. The system performed excellently throughout the cruise, and no significant problems were encountered. CTD casts consisted of two types, the first were to obtain hydrographic profiles, the second type were to gather bulk water samples for biological and chemical experiments. A full station list is given in table 1. In all profile CTD stations the 2 dbar averages of the downcast data are reported as the final product.

The CTD equipment

The CTD unit used for the measurement program was a Sea-Bird 911 plus (serial number 09P15759-4080). This CTD had three sensors: A series 410K-105 Digiquartz pressure transducer (S/N 067241) calibrated on 2 June 1997 by Paroscientific Inc (updated on 28 July 1998 by SBE Inc), an SBE 3 plus temperature sensor (S/N 2307) calibrated on 24 July 1998 by SBE Inc., an SBE 4C conductivity sensor (S/N 1912) calibrated on 20 August 1998 by SBE Inc. The SBE 3 plus and SBE 4C were connected to an SBE 5 T submersible pump (S/N 051813). The CTD was connected to an SBE 32, 12 position carousel water sampler (S/N 3215759-0173) carrying 12 10 L bottles. In addition the CTD was connected to an SBE 35 Reference Temperature Sensor (S/N 0315759-0005) last calibrated on 13 August 1998 by SBE Inc. Full calibration values are given in Appendix A. At the end of the Maurice Ewing Bank section the package was also fitted with a 10 kHz pinger to enable accurate and safe near bottom approach.

Deployment of the CTD package was from the midships gantry and A-frame on a single conductor, torque balanced cable. This CTD cable was made by Rochester Cables and was hauled on the 10T traction winch. There were no problems deploying the CTD package as close control was maintained with the gib arm and two hand lines by the ship's crew whilst the package was suspended above the surface. Part way through the Maurice Ewing Bank section the CTD frame was fitted with extra lead ballast to ease deployment in heavy seas. The CTD data were logged via an SBE 11 plus deck unit to a 486 Viglen PC running version 4.225 of Seasoft Data Acquisition Software (Sea-Bird Electronics Inc.). This 486 PC ran an undocumented ITS written script on startup that enabled easy access to the Seasoft system. For data acquisition this interface was used to first reset the PC clock to the ship clock, then to enter the SEASAVE module of the Seasoft software. This module is used for real time data acquisition. As well as allowing graphs of various parameters to be drawn in real time the software allows the user to set a data rate. On JR38 this rate was set to average four data cyles into one (6Hz). When the CTD cast was over and the SEASAVE module exited, there were four files created: a data file with the extension .dat, a configuration file containing calibration information with the extension .con, a header file containing just the sensor information with the extension .hdr, and a file containing data cycle numbers when a bottle was closed on the rosette with extension .bl. The data was converted to ascii engineering units by running the seasoft module DATCNV. The calibration for each sensor was as follows:

For the Pressure Sensor:

Where P is the pressure, T is the pressure period in µS, D is given by

U is the temperature in degrees centigrade, T_o is give by

and C is

all other coefficients are listed in Appendix A

For the Conductivity Sensor:

Where the coefficients are given in Appendix A, δ = CTcorr and ε = Cpcorr, *p* is pressure and *t* temperature.

and for the temperature sensor:

Where all of the coefficients are given in Appendix A, and *f* is the frequency output by the sensor.

This output an ascii file with the extension cnv. Finally the seasoft module CELLTM was used to remove the conductivity cell thermal mass effects from the measured conductivity. This correction followed the algorithm

dt = temperature - previous temperature
ctm = (-1.0 * b * previous ctm) + (a * dcdt * dt)

and

corrected conductivity = c + ctm.

And

a = 2 * alpha / (sample interval * beta + 2)

$$b = 1 - (2 * a / alpha)$$
$$dcdt = 0.1 * (1+ 0.006 * (temperature - 20)$$

And alpha was set = 0.03, beta was set = 7.0.

This routine output a file also with extension cnv, but with a different filename.

This series of files where then copied to the Q drive, and then copied to UNIX using FTP and read into a pstar data file following a scheme detailed below.

SBE35 High precision thermometer

Every time a water sample is taken using the rosette, the SBE 35 recorded a temperature in EEPROM. This temperature was the mean of 8.8 seconds data. At a suitable time the data from this thermometer was downloaded to the same 486 PC used for the CTD data acquisition by plugging the thermometer through an interface box to the PC, and using the Sea Bird supplied program TERM35. The thermometer has the facility to record 157 measurements but we downloaded the data approximately every 5 casts (60 measurements). Once downloaded the data were converted to temperature using the Sea Bird programme CNV35.

and

and n is the output from the SBE 35, the other constants are listed in appendix A. These data were then copied to the Q drive, and then copied to UNIX using FTP and read into a pstar data file following a scheme detailed below.

Salinity Samples

Twelve salinity samples were taken for all of the Maurice Ewing Bank CTD casts. For the core box stations twelve samples were taken from the 1000 m stations and eight samples from the shallow inshore stations. This gave a total of 468 samples. The salinity samples were taken in 200 ml medicine bottles, each bottle being rinsed twice before being filled to just below the neck. The rim of the bottle was then wiped with tissue, a plastic seal inserted and the screw cap replaced. The salinity samples were then placed near to the new salinometer which was sited in the Radio Lab and left for at least 24 hours before measuring them. This allowed the sample temperatures to equalise with the salinometer. The samples were then analysed on the BAS Guildline Autosal model 8400B, S/N 63360.

This salinometer was purchased from Ocean Scientific International in 1998. The salinity samples were analysed two stations at a time, and using standard seawater (batch P132, 1997). One vial of OSIL standard seawater was run through the salinometer at the beginning and end of each stations samples to enable a calibration offset to be derived and check the stability of the salinometer. Once analysed the conductivity ratios were entered by hand into an Apple Macintosh based EXCEL spreadsheet using software written by Dr Brian King (S.O.C.) before being transferred to the UNIX system and read into a pstar data file following a scheme detailed below.

The quality of the conductivity calibration procedure

After applying the calibration coefficients and adjusting for the residual offset ΔC, the salinity of the bottle sample was differenced with the derived CTD salinity. After rejecting samples detailed in table 2 the mean of the remaining samples was 0.000 with a standard deviation of 0.0015 psu. In table 2 we The residual offsets applied to the cast after calibration are also listed in table 2 and we can see that the conductivity cell is reasonably stable.

The CTD processing route for JR38

Step 1: seactd0
Purpose: To read in the CTD data from the ascii data file..
The output is 38 ctd $num .raw and
38 ctd $num

Step 2: seactd2
Purpose: to create sample files from the CTD data, the salt samples and the SBE 35 data
The output files are:
38 ctd $num . bottle - This a file with 12 levels containing the CTD data averaged for the 10 seconds around the bottle confirmation data cycle number in the Sea Bird .bl file
38 ctd $num . samp - This contains the data in the above file with the addition of the salinity sample data and the temperature data from the SBE 35 thermometer.
38 sam $num . dif - This is the .samp file with the pre conductivity salinity residual.

Step 3: seactd4
Purpose: This exec takes the .samp file from seactd2, derives a conductivity for the salinity sample, derives the conductivity residual and plots two diagnostic plots.
The file output is 38 ctd $num . cond

Step 4: ctdoff
Purpose: To calculate the conductivity offset for the station.

Step 5: seactd5
Purpose: To apply the conductivity residual to the file 38 ctd $num and re-derive salinity.
The output file is 38 ctd $num .cal

Step 6: seactd6
Purpose: This is a repeat of seactd2 except with the corrected salinity.
The output files are:
38 ctd $num . cbottle - This a file with 12 levels containing the CTD data averaged for the 10 seconds around the bottle confirmation data cycle number in the Sea Bird .bl file
38 ctd $num . csamp - This contains the data in the above file with the addition of the salinity sample data and the temperature data from the SBE 35 thermometer.
38 sam $num . cdif - This is the .samp file with the pre conductivity salinity residual.

Step 7: seactd7
Purpose: To derive the down cast of the ctd data.

The output file is again called 38 ctd $num .2db

TABLES

Table 1: A full Station list for JR28

Event	ID	Date	Lat (°)	Lat (°)	Lon (°)	Lon (°)	Depth of cast (db)	Depth of water (m)
003	TEST	19 12 1998	49 48.58S	-49.8096	50 16.66W	-50.2777	1015	2490
013	MEB1	20 12 1998	47 58.59S	-47.9766	43 16.44W	-43.2740	4601	5831
018	MEB2	21 12 1998	48 15.27S	-48.2545	43 04.82W	-43.0804	1017	6083
024	MEB3	21 12 1998	48 32.64S	-48.5440	42 52.02W	-42.8671	4603	5716
030	MEB4	21 12 1998	48 49.64S	-48.8273	42 39.32W	-42.6553	2017	5983
040	MEB5	21 12 1998	49 06.88S	-49.1146	42 26.08W	-42.4346	2035	4881
046	MEB6	21 12 1998	49 23.35S	-49.3892	42 13.98W	-42.2330	1017	5328
052	MEB7	22 12 1998	49 39.94S	-49.6656	42 01.38W	-42.0230	1013	1935
057	MEB8	22 12 1998	49 56.80S	-49.9467	41 48.81W	-41.8135	1017	1718
063	MEB9	22 12 1998	50 13.85S	-50.2308	41 35.65W	-41.5941	1017	1379
069	MEB10	22 12 1998	50 30.55S	-50.5091	41 22.56W	-41.3760	1015	1785
079	MEB11	22 12 1998	50 47.25S	-50.7875	41 08.62W	-41.1437	2037	2300
085	MEB12	23 12 1998	51 04.32S	-51.0720	40 55.81W	-40.9302	2023	2984
091	MEB13	23 12 1998	51 21.25S	-51.3541	40 42.31W	-40.7052	3045	3649
097	MEB14	23 12 1998	51 38.21S	-51.6369	40 29.16W	-40.4859	3065	3764
103	MEB15	23 12 1998	51 55.32S	-51.9220	40 15.92W	-40.2654	1013	3760
109	MEB16	23 12 1998	52 12.28S	-52.2046	40 02.46W	-40.0410	3045	3781
116	MEB17	24 12 1998	52 28.96S	-52.4827	39 48.56W	-39.8094	1017	3796
122	MEB18	2412 1998	52 45.99S	-52.7665	39 34.73W	-39.5788	3069	3787
130	MEB19	24 12 1998	53 02.90S	-53.0484	39 21.61W	-39.3602	1017	3809
132	MEB20	25 12 1998	53 20.23S	-53.3371	39 07.76W	-39.1293	3061	3468
138	MEB21	25 12 1998	53 36.65S	-53.6108	38 53.54W	-38.8924	1019	1252
149	MEB22	25 12 1998	53 53.20S	-53.8866	38 39.47W	-38.6579	155	170
162	E2.2S	28 12 1998	54 15.06S	-54.2510	35 43.39W	-35.7231	203	221

173	E2.2N	29 12 1998	54 02.35S	-54.0392	35 12.43W	-35.2071	1021	2169
182	E3.2N	29 12 1998	54 11.56S	-54.1926	35 02.80W	-35.0467	1017	2646
195	E3.2S	30 12 1998	54 23.55S	-54.3925	35 33.51W	-35.5585	259	270
204	E4.2S	30 12 1998	54 32.26S	-54.5377	35 23.12W	-35.3854	175	187
217	E4.2N	31 121998	54 20.17S	-54.3361	34 52.60W	-34.8767	1019	1729
225	E5.2N	31 12 1998	54 22.20S	-54.3701	34 27.43W	-34.4571	3577	3579
235	W1.2S	02 01 1999	53 49.00S	-53.8166	38 52.56W	-38.8759	199	224
249	W1.2N	03 01 1999	53 27.59S	-53.4598	38 59.96W	-38.9993	1017	3137
258	W2.2N	03 01 1999	53 26.00S	-53.4334	38 41.85W	-38.6975	1015	3499
272	W2.2S	04 01 1999	53 47.26S	-53.7876	38 35.25W	-38.5874	193	198
280	W3.2S	04 01 1999	53 45.02S	-53.7503	38 16.71W	-38.2785	195	213
295	W3.2N	05 01 1999	53 23.85S	-53.3975	38 23.82W	-38.3970	1017	2902
303	W4.2N	05 01 1999	53 21.74S	-53.3623	38 05.07W	-38.0844	1017	2652
317	W4.2S	06 01 1999	53 45.21S	-53.7535	37 56.54W	-37.9423	145	153
323	W5.2N	06 01 1999	53 08.90S	-53.1483	37 49.94W	-37.8323	1017	3352

Table 2: Calibration summary for CTD stations on JR38

Station	Identifier	Offset	Bottles Rejected in Calibration
003	TEST	0.00688	6
010	GC 1	0.00655	
013	MEB 1	0.00655	10
018	MEB 2	0.00394	9, 10
024	MEB 3	0.00640	6, 7, 8, 11
030	MEB 4	0.00491	9, 12
037	GC 2	0.00358	
040	MEB 5	0.00658	5, 12
046	MEB 6	0.00567	5, 8, 12
052	MEB 7	0.00528	
057	MEB 8	0.00545	7, 9
063	MEB 9	0.00711	9, 10
069	MEB 10	0.00567	6, 8
076	GC 3	0.00563	
079	MEB 11	0.00563	8, 9
085	MEB 12	0.00607	6,7,8
091	MEB 13	0.00636	7, 8
097	MEB 14	0.00644	8, 9
103	MEB 15	0.00642	10
109	MEB 16	0.00596	12
116	MEB 17	0.00578	6, 7
122	MEB 18	0.00646	6
128	GC 4	0.00635	
130	MEB 19	0.00635	6
132	MEB 20	0.00585	5
138	MEB 21	0.00660	6
143	GC 5	0.00621	
149	MEB 22	0.00621	8
150	AC 1	0.0075	
162	E22S	0.00789	1
169	JP 1	0.00734	
171	GC 6	0.00734	
173	E22N	0.00734	6, 7
182	E32N	0.00693	5, 6, 7
195	E32S	0.00629	2, 3
198	GC 7	0.00629	
204	E42S	0.00674	1, 2
217	E42N	0.00697	6
221	GC 8	0.00697	
225	E52N	0.00906	6, 9
229	AC 2	0.00932	
235	W12S	0.00959	3, 5, 7
249	W12N	0.00738	5, 8
252	GC 9	0.00738	
258	W22N	0.00746	5, 6
272	W22S	0.00758	
275	GC 10	0.00758	

280	W32S	0.00881	1, 4
295	W32N	0.00783	7
298	GC 11	0.00783	
303	W42N	0.00772	6, 7
317	W42S	0.00722	4, 6
320	GC 12	0.00722	
323	W52N	0.00720	
333	GC 13	0.00720	

Appendix A: Calibration data.
Pressure Sensor SN 67241
Calibration date 2 June 1997.
Coefficients:
C1 = -44614.18 psia D1 = 0.036455
C2 = 3.038286E-02 psia / degc D2 = 0
C3 = 1.22413E-02 psia /deg c^2
T1 = 29.99608 µS
T2 = -3.512191E-04 µS / degc
T3 = 3.72924E-06 µS / deg c^2
T4 = 4.91876E-09 µS / deg c^3 T5 = 0
AD509M = 1.283280E-02
AD590B = -9.474491E+00
calibration update 28 July 1998
A0= 5010.50929, A1 = -1.300330E+00, A2 = 2.509185E-08.

SBE 3 plus temperature sensor S/N 2307
Calibration date 24 July 1998
g = 4.33420717e-03
h = 6.44230587e-04
i = 2.34916901 e-05
j = 2.24160096e-06
fo = 1000.000

SBE 4C conductivity sensor S/N 1912
Calibration date on 20 August 1998
g = -4.15856853e+00
h = 5.35866120e-01
i = -6.20046081e-04
j = 5.81708310e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

SBE 35 Reference Temperature Sensor S/N 0315759-0005
Calibrated on 13 August 1998
a0 = 5.731929187e-03 Slope = 0.999992, Offset = 0.000085
a1 = -1.634408781e-03
a2 = 2.346628834e-04
a3 = -1.294062389e-5
a4 = 2.724825969e-7

Appendix B: Bottle depth information

MEB transect bottle levels

Station	**Water depth**	**Cast depth**	Bottle Levels
WP1	5757	4500	4500, 2500, 1000, 600, 200, 150, 125, 100, 80, 60, 40, 20
WP2	5942	1000	1000, 800, 600, 400, 200, 150, 125, 100, 80, 60, 40, 20
WP3	5712	4500	4500, 2500, 1000, 600, 200, 150, 125, 100, 80, 60, 40, 20
WP4	5894	2000	2000, 1500, 1000, 600, 200, 150, 125, 100, 80, 60, 40, 20

WP5	4503	2000	2000, 1500, 1000, 600, 200, 150, 125, 100, 80, 60, 40, 20
WP6	4821	1000	1000, 800, 600, 400, 200, 150, 125, 100, 80, 60, 40, 20
WP7	1901	1000	1000, 800, 600, 400, 200, 150, 125, 100, 80, 60, 40, 20
WP8	1684	1000	1000, 800, 600, 400, 200, 150, 125, 100, 80, 60, 40, 20
WP9	1362	1000	1000, 800, 600, 400, 200, 150, 125, 100, 80, 60, 40, 20
WP10	1767	1000	1000, 800, 600, 400, 200, 150, 125, 100, 80, 60, 40, 20
WP11	2254	2000	2000, 1500, 1000, 600, 200, 150, 125, 100, 80, 60, 40, 20
WP12	2918	2000	2000, 1500, 1000, 600, 200, 150, 125, 100, 80, 60, 40, 20
WP13	3578	3000	3000, 2000, 1000, 600, 200, 150, 125, 100, 80, 60, 40, 20
WP14	3694	3000	3000, 2000, 1000, 600, 200, 150, 125, 100, 80, 60, 40, 20
WP15	3689	1000	1000, 800, 600, 400, 200, 150, 125, 100, 80, 60, 40, 20
WP16	3710	3000	3000, 2000, 1000, 600, 200, 150, 125, 100, 80, 60, 40, 20
WP17	3715	1000	1000, 800, 600, 400, 200, 150, 125, 100, 80, 60, 40, 20
WP18	3712	3000	3000, 2000, 1000, 600, 200, 150, 125, 100, 80, 60, 40, 20
WP19	3730	1000	1000, 800, 600, 400, 200, 150, 125, 100, 80, 60, 40, 20
WP20	3498	3000	3000, 2000, 1000, 600, 200, 150, 125, 100, 80, 60, 40, 20
WP21	1236	1000	1000, 800, 600, 400, 200, 150, 125, 100, 80, 60, 40, 20
WP22	170	160	160, 150, 150, 125, 125, 100, 100, 80, 60, 40, 20, 20

JR38 XBT Report

Mark Brandon

Summary

During JR38 a total of 21 XBT probes were deployed. These probes were kindly supplied by the Hydrographic Office, Taunton. The probes of type T5, were deployed between CTD stations, on the Maurice Ewing Bank Section. In general the probes themselves gave excellent data. Unfortunately there is a serious problem with the system in that each XBT probe had a temperature offset. This could be removed where the deployment bracketed CTD stations, but precluded the deployment of XBT probes from South Georgia back to Stanley. **The system is currently unservicable.**

System and procedure

The XBT system on the RRS James Clark Ross consists of two distinct parts: The deck system and the computer system. The deck system currently consists of a Sippican hand held Launcher and the XBT probes. Before use the XBT probes were stored on deck in their cardboard crates and lashed to a palette to minimise the temperature shock as they enter the water. The computer system consists of a stand alone 286 PC Running Sippican MK 9 Data Acquisition System software at version 5.2, connected to a MK 9 Digital XBT System Deck Unit running on 115 V. Both software and deck unit were manufactured by Sippican Ocean Systems, MA. The deployment of XBT probes is a 2 person job and all deployments followed the procedure written by Brandon and Cooper (1996). A full list of the 21 XBT deployments is given in table 1.

The data route

At each deployment the pc software produced a raw data file with an extension ".sip". All of these files will be sent to the Hydrographic Office on return. The raw data file was transferred to ascii file containing depth and temperature using the Sippican Mk9 Post Trace Analysis Application Version 3.2 (December 1990). As the 286 PC is not on the ships network, these ascii files were copied to a DOS disk and transferred to the Unix system using "ftp". Once in the Unix system the files were converted to pstar format using the c shell script "xbtexec0". The position in the XBT file was then corrected to the position from the Trimble DGPS (see navigation report) at the actual time of launch using the script "xbtpos". Finally the data were edited using the interactive PSTAR programme *plxyed*.

Problems

It was noted on the first XBT deployment that although the actual temperature profile was very realistic in shape, the indicated temperatures were clearly too high. When the XBT profile was compared with a close CTD station it was found that there was a simple offset. Unfortunately this offset was not constant between deployments (Table 2). Consultation with the Sippican documentation on board the James Clark Ross suggested to us that the system had a fault during the pre-launch checks phase of system initialisation. The problem was explained in great detail to the ETS engineer who explained that with such a problem there was nothing he could do. As there were no CTD stations on the run back to Stanley, with such a problem it was not possible to make sense of the data. Therefore the XBT measurements were abandoned.

Suggestions

The XBT system should be replaced. As of the time of writing this report we have been informed that the system will be replaced within two months (pers comm. S. Bremner).

Table 1: XBT deployments during JR38

XBT	Time	Date	Latitude (S)	Longitude (W)	Water Depth (m)
38xbt008	14:15	20 / 12/ 98	48º 12.56	44º 10.07	5918
38xbt016	00:23	21 / 12/ 98	48º 12.60	43º 10.70	5978
38xbt022	04:38	21 / 12/ 98	48º 24.00	42º 58.00	5776
38xbt028	10:48	21 / 12/ 98	48º 40.20	42º 46.00	5811
38xbt035	15:47	21 / 12/ 98	48º 57.95	42º 33.41	5351
38xbt044	21:25	21 / 12/ 98	49º 14.00	42º 20.00	5033
38xbt050	01:32	22 / 12/ 98	49º 30.00	42º 8.00	2931
38xbt055	06:16	22 / 12/ 98	49º 48.00	41º 55.00	1807
38xbt061	10:32	22 / 12/ 98	50º 4.00	41º 42.00	1509
38xbt067	14:32	22 / 12/ 98	50º 21.00	41º 30.00	1530
38xbt074	19:45	22 / 12/ 98	50º 38.04	41º 16.86	2056
38xbt083	01:31	23 / 12/ 98	50º 55.00	41º 3.00	2634
38xbt089	06:31	23 / 12/ 98	51º 12.00	40º 50.00	3326
38xbt095	11:59	23 / 12/ 98	51º 28.00	40º 37.00	3822
38xbt101	17:41	23 / 12/ 98	51º 45.00	40º 23.00	3747
38xbt107	21:47	23 / 12/ 98	52º 3.00	40º 9.00	3752
38xbt114	03:18	24 / 12/ 98	52º 20.00	39º 55.00	3791
38xbt119	07:29	24 / 12/ 98	52º 37.00	39º 42.00	3785
38xbt126	12:59	24 / 12/ 98	52º 53.63	39º 28.69	3794
38xbt136	08:40	25 / 12/ 98	53º 27.00	39º 0.00	3109
38xbt142	12:52	25 / 12/ 98	53º 44.00	38º 46.00	322

Table 2: Offsets between XBT deployments and CTD stations

XBT Event	Min depth (m)	Max depth (m)	XBT mean temp (°C)	CTD1 mean temp (°C)	CTD2 mean temp (°C)	XBT - CTD1 (°C)	XBT - CTD2 (°C)
16	700	1000	5.0728	2.8514	2.7919	2.2214	2.2809
22	650	900	5.172	2.8385	2.8248	2.3335	2.3472
28	700	1050	5.3726	2.7538	2.5723	2.6188	2.8003
35	650	1000	6.1402	2.6197	2.4879	3.5205	3.6523
44	550	1000	4.9426	2.531	2.458	2.4116	2.4846
50	700	1000	4.5941	2.4006	2.2368	2.1935	2.3573
61	600	1000	4.7025	2.2442	2.2433	2.4583	2.4592
74	700	1000	5.2069	2.1481	2.229	3.0588	2.9779
83	600	1000	4.1533	2.271	2.1321	1.8823	2.0212
89	650	1000	4.1282	2.1124	1.8847	2.0158	2.2435
95	600	1000	4.0437	1.9058	1.7749	2.1379	2.2688
101	600	1000	4.5294	1.7749	1.7655	2.7545	2.7639
107	700	1000	3.8826	1.7275	1.3334	2.1551	2.5492
114	600	1000	3.9191	1.3138	1.7638	2.6053	2.1553
119	700	1000	3.8153	1.7341	1.7151	2.0812	2.1002
136	650	1000	4.2157	1.7762	1.8067	2.4395	2.409

where CTD1 is the CTD to the north of the XBT
and CTD2 is the CTD to the south of the XBT.

ADCP measurements on JR38: Core Programme IV

Mark Brandon

Summary

This report describes the method of acquisition of ADCP data on JR38 and the problems encountered. The system was operated in two modes: in water track when water depths were greater than 300 m and in bottom track in shallower waters. In general the ADCP worked well with velocity information generally obtained down to 250 m depth. However, underway measurements are seriously compromised by poor data from the Ashtec 3DF. This problem does not significantly affect on-station. Problems with the Ashtec are further discussed in the navigation report.

The configuration of the ADCP

The RRS *James Clark Ross* is fitted with an RD Instruments 153.6 kHz hull-mounted acoustic Doppler current profiler (ADCP). In contrast to other research ships in the NERC fleet, the orientation of the transducer head is offset by approximately 45° to the fore-aft direction in the hope that the instrument would give a better response in the main direction of motion (i.e for-aft). Another difference with other British ships is that to protect the transducer from ice, it is mounted in a sea chest that is recessed in the hull. This sea chest is closed to the sea by a 33 mm thick window of Low Density PolyEthylene (LDPE) and the cavity around the transducers filled with a silicone oil. The version of the firmware used by the ADCP was 17.07 and the version of RDI Data Acquisition Software (DAS) was 2.48 and the software ran on a IBM 386.

Throughout the cruise the ADCP was operated in both water track mode and bottom track mode in water depths of less than 300 m. In bottom track mode there were two commands in the DAS direct commands menu, firstly the command FH0004 which gave one bottom track ping to four water tracked pings, and secondly a command altering the DAS bottom detection algorithm. This algorithm was altered by reducing the threshold of the jump in AGC counts when the bottom was in range from FF00040 to FF00035 to increase the amount of bottom track data available for calibration purposes.

The ADCP recorded data in 2 minute ensembles in 64 x 8 m bins. The 'blank beyond transmit' was set to 4 m, this coupled to the depth of the transducer being approximately 6 m gave the centre of the first bin depth at 14 m. Unlike virtually all the other instruments on the RRS *James Clark Ross*, the ADCP has no Level A application and does not log directly to the Level B. The 2 minutes ensembles of data are fed through a printer buffer directly into the Level C. This means that when there is a problem with the ships Level C system, the only way in which the data is stored is on the dedicated PC and the files have to be recovered later.

Standard Method of processing

The data, once in the Level C, were read into pstar files of 12 hours length and processed using the pstar data processing software. The processing of the ADCP is complex and involves data from several navigation streams (described in the navigation data report). A schematic of the data processing path for the ADCP data is shown in figure 1.

Step 1: Read in the data.

The data were read using our conventions for underway data in 12 hour chunks containing either the period 0000 to 1159 or 1200 to 2359. This was achieved with a Unix script 38adpexec0 which outputs two files. One containing the water track data and one containing the bottom track data. When the ADCP was set to record only water track information the bottom track file contains only engineering data and zero's for the bottom velocity.

Step 2: Correction for temperature around transducers

The bath of silicone oil surrounding the transducer head of the ADCP requires that a correction be made to the ADCP derived water speed data. The standard method of deriving the speed of sound at the transducer head within the DAS software is to use the temperature of the water around the transducer head (this is recorded by the DAS software as "water temperature") and a salinity of 35 psu. Unfortunately the DAS software has no facility for the problem when the temperature of the water reported is not that of water but of another substance such as oil. The oil causes a problem as variation of the speed of sound in the oil is opposite to that in of the variation of the speed of sound in seawater. This can lead to large errors in the derived water velocity. King and Alderson (1994) document the story of how they tried to find out exactly what oil is contained in the sea chest. In short, nobody knows exactly what the oil is and it has received no "topping up" or maintenance since the construction of the *James Clark Ross* in 1990.

Following King and Alderson (1994) we apply a correction factor based on the variation of the speed of sound with temperature in Dow Corning 710 silicone oil. This correction is then

$$Correction = 1 - 0.004785\,T \;\; x\, 0.0000355\, T^2$$

and T is the "water temperature" reported by the DAS software. This correction is applied to both the raw water and bottom tracked velocities using the Unix script 38adpexec0.1.

Step 3: Correction for the PC clock drift.

Another problem that has to be accounted for in ADCP processing is that the DAS software time stamps the data. Unfortunately this time stamp comes from the 386 PC clock which drifts at a rate of approximately one second per hour. To correct this to the ships master clock, the time drift was measured several times a day and a correction derived and applied to the ADCP data time using the Unix script 38adpexec1.

Step 4: Correction for the gyrocompass error.

The ADCP actually measures water velocity relative to the ship. To calculate east and north water velocities from the data an input into the ADCP is taken from the ship's gyrocompass (described in the navigation report). However it is well known that as well as having an inherent error, gyrocompasses can oscillate for several minutes after a turn before steadying on a new course. As well as that there is an additional deviation that varies as cosec (latitude). To overcome these difficulties the ADCP data is "corrected" with data from the Ashtec GPS3DF. We cannot use the Ashtec as a gyrocompass substitute because we do not have continuous coverage, we can however correct the data on an ensemble by ensemble basis. From the navigation report, after the "standard processing" the Ashtec data has been edited on standard criteria and is a file of 2 minute averages. The data still however contains both gaps, and large spikes. These spikes are removed using an interactive editor, and the gyrocompass correction linearly interpolated. The correction is applied to the ADCP data through the Unix script 38adpexec2.

Step 5: Calibration of the ADCP data

A final correction is now required to correct for the misalignment between direction as defined by the Ashtech GPS3DF antenna array and the actual direction of the ADCP transducers. This correction is called the heading misalignment φ. There is also an inherent scaling factor, A, associated with the ADCP which the water velocities must be multiplied by to scale them correctly. The method of calculating A and φ is described below. These corrections are applied through the Unix script 38adpexec3.

Step 6: Derivation of Absolute velocities

By this stage the data contains calibrated water velocity relative to the ship. To derive absolute velocity we merge the files with position from the “bestnav” navigation file (see navigation report for description) and derive ship velocity between ensembles. This velocity is then removed from the water velocity data to give absolute water velocity. This is performed using the Unix script 38adpexec4.

Method of derivation of the calibration coefficients A and φ .

To derive values for A and φ a standard procedure was followed:

1. Periods where identified when the ADCP gave bottom tracked velocities - that is when the ship was working in water depths of generally less than 300 m. With the survey plan of the Core Programme we have many such periods.
2. The files with bottom tracking velocities were then calibrated with a nominal scaling in 38adpexec3 by setting the scaling factor A to one and the misalignment angle φ to zero.
3. The two minute ensembles of ADCP data were then merged with bestnav position fixes. From these bestnav fixes the ships east and north velocity of the ship over ground were calculated. Time periods within each data file were then identified where the ships heading and velocity did not deviate greatly over a period of at least 6 minutes.
4. The ADCP bottom track velocities are then multiplied by -1 as the velocity of the ship given by the bestnav fixes is in the opposite sense to the velocity of the bottom as derived by the ADCP.
5. Values for A and φ for each time period are then derived from vector mathematics using

$$A = \frac{U_{gps}}{U_{ADCP}}$$

where U_{adcp} is the bottom tracked ADCP derived ship speed and U_{gps} is the GPS position fix derived ship speed (that is ship speed over ground) , and

$$\varphi = \varphi_{gps} - \varphi_{adcp}$$

where φ_{gps} is the direction of motion derived from the GPS navigational fixes and φ_{adcp} is the direction of motion as derived from the bottom tracked ships motion. This was achieved using a Unix script adcp_calibration_exec.

In Core Programme IV we have identified 177 suitable for calibration periods totalling almost 68 hours of data. These data were then inspected carefully to see that the standard deviation of the ship's velocity and heading were small, and periods when the ashtec data were poor were edited from the file. The data was then culled by stating that we will only use derived values of A and φ within 2 standard deviations from their respective mean values. The final value used for A was 0.8510 , and for φ -1.2530. Future inspection of the calibration data may lead to changes in these values.

Problems encountered

There were two problems encountered with the ADCP. The first was the lack of Ashtec data, throughout the cruise, second was that on three occasions the ADCP PC unplugged itself during large rolls of the ship. This has been rectified.

Summary

The ADCP on JR38 has worked well. However the underway data is generally seriously compoimised by the poor gyrocompass correction data available. This problem is discussed further in the navigation report.

Recommendations

The oil in the transducer sea chest be removed and replaced with some chemically treated sea water. Even in heavy ice conditions we have data to show the transducers do not get below 2 C, a long way from the -2 C needed to freeze the seawater. This would reduced the complexity of analysis of the ADCP data on this ship, bring it in line with the rest of the British research Fleet, and could possibly increase depth penetration of the instrument.

The ADCP PC should be updated as it is getting very old.

References:

King and Alderson .....

NvShuttle Report for Cruise JR38

Phil Trathan, Doug Bone, Mark Brandon and Sharon Grant

The undulating oceanographic recording (UOR) system used during the cruise comprised the Chelsea Instruments NvShuttle vehicle, Fathom Flexnose faired cable, Lebus International Engineers towing block and Lebus International Engineers winch.

Hardware Upgrades

Cable and winch

The cable used during JR38 was originally streamed during the 1997-98 season when it was used during 3 separate cruises (JR25, JR26 and JR28). The cable was used with the existing arrangement of copper anti-stacking rings set at approximately 1.5 metre intervals. This was sufficient to accommodate Fathom Flexnose fairing in lengths of 15 linked sections. A total of 130 m of fairing was installed.

The existing plastic fairing inverter shoe designed and built last season was used throughout the cruise. This provided excellent service and, as was the case last year, proved very reliable. Similarly, the existing plastic guide to ensure uniform spooling on the drum was successfully used throughout the cruise.

At the end of the cruise the cable was disconnected from the NvShuttle, wrapped around the winch and pressure washed for 10 minutes with the winch rotating. After drying, the winch was covered to prevent salt spray from getting back onto the cable.

NvShuttle

Following the failure of the alternator drive shaft during cruise JR25, the shaft was replaced by Chelsea Instruments during the summer of 1998. The site of the failure, a sharp shoulder, is radiused on the new shaft, but not to any great extent so should be regarded with caution.

Chelsea Instruments have also taken up our suggestion that they should use 4 bladed impellors. The water flow over the rear of the vehicle is essentially 2 dimensional, which will induce constant bending moments in the alternator shaft during rotation of a 3 bladed impellor. The new 4 bladed impellors should reduce this effect. The new impellors are 10 inch diameter × 6 inch pitch. The newly supplied impellor provides adequate power to enable the NvShuttle to undulate between ~10 m and ~140 m. The new impellor also allowed control of the NvShuttle at low ship speeds, such that in some conditions, control of the NvShuttle was obtained at ship speeds of approximately 4 knots.

Sensors

A suite of 10 SeaWiFS sensors were added to the NvShuttle during 1998 in preparation for the cruise. These comprised 6 downwelling channels (sensor 1 - 412 nm; sensor 2 - 443 nm; sensor 3 - 490 nm; sensor 4 - 510 nm; sensor 5 - 555 nm; sensor 6 - 665 nm) and 4 upwelling channels (sensor 1 - 443 nm; sensor 2 - 490 nm; sensor 3 - 510 nm; sensor 4 - 555 nm). The sensors were fitted in 2 blocks of 5, situated outboard of the main NvShttle housing. Anti-reflective paint was applied to the NvShuttle surfaces adjacent to the SeaWiFS sensors.

Software Upgrades

The previous version of the NSHUTTLE software supplied by Chelsea Instruments was not correctly configured for the arrangement of SeaWiFS sensors. However, Chelsea Instruments were able to supply a new version of software which they sent to the ship and which arrived just in time for the main cruise programme. This version performed satisfactorily, it also fixed a long-standing minor formatting bug for the data stored on PC-1 (the NvShuttle control PC).

Instrument Payload

The NvShuttle was fitted with the following instruments: Chelsea Instruments Aquapack (depth [pressure transducer], temperature [PRT], conductivity [inductive] and fluorometer), transmissometer (light beam attenuation coefficient at 660 nm), PAR irradiance meter, Biospherical Quantum Cosine Profiling Sensor and a Focal optical plankton counter (OPC-1T 640 nm - 25 cm). The system was also fitted with the new SeaWiFS sensors for light measurement.

System Operation

Three PCs control the NvShuttle and manage the data display and logging. One of the data handling PCs also interfaces with the shipboard RVS ABC data management system. The basic operation of the NvShuttle is relatively straight-forward. PC-1 controls the shuttle and displays the shuttle performance, PC-2 logs and displays the sensor data and PC-3 logs and displays the OPC data. All data except the OPC data are also sent to the shipboard (ABC) logging system.

The NvShuttle is normally deployed with the ship travelling at about 4.5 knots. Before deployment the required flight parameters of upper depth, lower depth, and climb rate are sent to the servo, however the servo system does not start to power the flight control mechanics until the ship is running at about 7 knots. Prior to the servo beginning operation, control over vehicle depth can only be achieved by limiting the amount of wire paid out.

NvShuttle Alarms

On previous cruises the NvShuttle cable strain gauge alarm has been triggered as a result of radio interference caused by the ship's radio transmitter. To prevent this happening during NvShuttle deployments during cruise JR38, the radio officer avoided use of the frequencies shown in Table 1.

Transmission type

Frequency kHz	Activates Strain Alarm y/n	Telex
4553	Y	Telex
9106	Y	Telex
4030	Y	

Table 1: Radio interference with the NvShuttle control package.

NvShuttle Safe Running

During each deployment a number of tools were used to ensure that the NvShuttle was operating within a safe depth envelope. Due to the rugged bathymetry around South Georgia the ship's position was continually plotted on a large scale Admiralty Chart. As such charts only provide an approximate depth, the continuous output from the Simrad EA500 datastream from the RVS Shipboard Level C was reflected to a PC (running an X terminal emmulator) sited near to the NvShuttle control PCs. Ship's position was also continually reflected to the PC, as was the datastream passed from the NvShuttle to the Level C. Paper plots of the bathymetry covered by previous occupations of the Core Box transects were also an invaluable aid to safe deployment of the NvShuttle, particularly where bathymetric features reached above 150 m.

All of these aids improved the safety of deploying the NvShuttle in shallow water, however, they do not provide complete safety. For example, the EA500 is considered to be part of the ship ’s equipment, rather than scientific equipment. As a consequence the speed of sound in seawater is usually left at 1500 m s-1 (the default), thereby overestimating depth by about 5%. In comparison, the EK500 is usually configured with the correct sound velocity profile, however it is not reflected to the Level C and therefore not accessible for use by NvShuttle operators.

Heavy reliance upon bathymetry logged during previous cruises can be misleading if the transect path varies from the designed waypoints (for example if the ship’s course deviates due to weather). Even small variations from the path can result in substantial depth variations. During JR38, NvShuttle operators always erred on the side of caution in areas where bathymetry was uncharted.

NvShuttle Flight Parameters Used During Data Collection

At the beginning of each deployment flight parameters were set to upper = 30, lower = 30 and climb rate = 60, whereas during recovery flight parameters were set to upper = 10, lower = 10 and climb rate = 50. Deployment or recovery was normally in-line with the transect direction, unless the sea state was such as to require that the ship alter course and head into the wind/swell. If the ship needed to alter course during any phase of the operation, the NvShuttle was set to maintain horizontal flight at 30 m; this was to ensure that the cable didn’t slip out of the block. In addition, if the ship altered course no cable was veered, or hauled until the course change was complete.

Flight control settings were changed on some transects in order to evaluate the parameters necessary to achieve a consistent pattern of undulations. Servo parameter settings were determined for undulations over deep water and for over the shelf. Following a number of flights the following parameters were settled upon.

Command

upper depth (m)	Command lower depth (m)	Climb rate (m min-1)	Actual upper depth (m)	Actual lower depth (m)	Undulation time (minutes)	Cable veered (m)- 15
155	60	10	140	circa 6	275	- 10
110	50	10	100	circa 6	275	- 5
80	35	10	75	circa 6	135	

Table 2: Flight control parameters for the NvShuttle.

In order to maintain a regular and smooth set of undulations it was critical that the ship maintained sufficient speed. If ship's speed was allowed to fall away, then undulations became irregular, particularly near the upper part of the undulation cycle. On some transects the upper command depth was varied according to sea state and ship’s speed. This was necessary to ensure that the upper water column was adequately sampled, yet prevent the NvShuttle from surfing over the surface, should it come too high in the water column.

NvShuttle Deployments

During JR38 a total of 1800.73 km were covered during 14 deployments of the NvShuttle; included in this were 1 test deployment, 1 fluorescence calibration deployment and the 20 Core Box transects.

Event

Transect	Length (km)	Comments	001
Test	30.06		
154	E1.1	81.81	No OPC output. Data lost for 3 min
E1.2	74.67	No OPC output	156
E2.1	81.65	Data lost for 3 min	
E2.2	79.85		
178	E3.1	80.25	Data lost for 3 min
E3.2	80.49		
199	E4.1	80.56	
201	E4.2	80.75	
222	E5.1	80.59	
E5.2	83.44		
228	Fluorescence calibration	43.38	
230	W1.1	82.83	
W1.2	81.09	PAR sensor cable failed	253
W2.1	81.00		
W2.2	80.95		
276	W3.1	80.47	Data lost for 3 min
W3.2	80.14		
299	W4.1	80.18	
W4.2	80.63		
321	W5.1	80.20	Data lost for 3 min325
W5.2	81.04		
Transect Heads	114.70		

Table 3: Deployments of the NvShuttle during JR28

The PAR sensor failed during the latter part of transect W1.2 (event 230). On recovery it was apparent that the sea cable connector had come undone. The exposed connector had been eroded by galvanic action and required replacement. Adhesive tape has been applied to the connector to prevent a reccurence of the problem. All other sensors provided uninterrupted service.

Communication Failures

On a number of occasions during the cruise communication with the NvShuttle failed; the exact reason for the failures was not diagnosed, but was possibly associated with timing problems in the control software. Following any communication failure, the NvShuttle was thoroughly checked after it was recovered on deck; particular attention was always paid during the inspection of the cable connections.

The most serious incident happened during event 154 over shallow water, emphasising the necessity of always maintaining constant vigilance during any NvShuttle deployment. On this occasion PC-1 was restarted, after which the Aquasoft software on PC-2 and the OPC software on PC-3 were restarted. Communication was re-established and data collection resumed. Unfortunately the crash caused the loss of the OPC data for transect E1.1 and E1.2. Attempts to recover the data using a variety of PC tools failed to locate the lost files.

During the period whilst communication with the NvShuttle was lost, data were not passed to the RVS Shipboard Level C. Data flow only resumed after both PC-1 and the Aquasoft software on PC-2 were restarted. A data gap of approximately 3 minutes was therefore present in the Level C datastream. Similar NSHUTTLE software crashes during events 156, 178, 201, 276 and 321 also caused similar losses of data.

Data Routes

Data flow from the NvShuttle is complex and presents a number of data management problems. The main data path for the NvShuttle is to the RVS Shipboard computing system. The data reflected to the RVS Level B are transferred onwards to the Level C. The dataset reflected to the Level B contains variables for temperature, conductivity, pressure, PAR, fluorescence, transmissance, SeaWiFS, NvShuttle command depth, NvShuttle actual depth, NvShuttle wing angle and wire strain; all variables are formatted in engineering units (bit counts).

In normal use, raw data from the NvShuttle are also logged to the NvShuttle control PC (PC-1); these data are logged to hourly files with names of the format CI<DDD><HH>.D<YY> where DDD is the Julian day of the year, HH is the hour of the day and YY is the current year. Data are logged to these files at a rate of 1 record per second. Each record is prefixed with the current time from the ship's clock and includes a field for each instrument with data recorded in engineering units (bit counts). These PC files form a back-up in case the main data path for the NvShuttle fails, in normal use these datasets are backed up, but not used.

Data for temperature, conductivity, pressure, PAR, fluorescence, transmissance and SeaWiFS are also reflected to PC-2 running Aquasoft software. These data are logged in a binary format that can be converted to conventional units by the Aquasoft software. In normal use these datasets are backed up, but not used.
Data from the optical plankton counter (OPC) control PC (PC-3) running the Focal software are logged to PC-3. These data are logged to a file that requires conversion by the Focal software at the end of the deployment. The converted data can then be transferred to the Shipboard computing system by means of FTP.

The main processing of data occurs in UNIX, using the data from the Level C and from the FTP-ed OPC files. All processing, calibration, analysis and plotting is carried out by means of UNIX shell scripts running PSTAR programs written in Fortran.

Data were processed via a number of shell scripts that were developed from scripts written during previous cruises. Data processing was carried out in 6 stages:

Stage 1: UOR data were copied into PSTAR files. This was achieved by either reading data from the RVS Level C datastream (the normal case) or by reading the CI<DDD><HH>.D<YY> files transferred from PC-1. Thus, uorexec0 and uor_from_pc0 read the engineering data (bit counts) into PSTAR format.

Stage 2: UOR data were converted from engineering units (see below) to conventional scales. Temperature data were further converted from the IPTS 68 scale to the IPTS 90 scale and salinity calculated from the lagged temperature. The degree of lagging necessary to reduce spikes and similar artefacts in salinity, was determined empirically during cruise JR11 and cruise JR17. Density was calculated from the 'clean' salinity and from the unlagged temperature. The script uorexec1 was used for this calibration.

Stage 3: UOR data from a given event were left as a single transect (uorexec2) or split into individual transects (uorexec3); both scripts produce similar output, the only difference being the transect split. The script uorexec3 was used for the Core Programme NvShuttle events where two transects were completed during a single event. The script merges in the appropriate navigation data (this usually requires that the navigation data has been processed and therefore entails a 12 hour delay) and constructs a distance run variable. The distance run was set at 0 km at the beginning of each event. Transects were then separated by time, with the end points of each transect being the time that the Way point was reached. Each transect was then gridded to allow contour plots to be produced. Density was recalculated for the gridded transects.

Stage 4: Following completion of Stage 3, data were available for plotting and comparison with other instruments, in particular physical data could be compared with the CTD casts taken at Core Programme stations. Inconsistencies in the data, were examined in detail at this point, prior to final adjustment (Stages 5 to 6 below).

Following comparison with the Seabird 911*plus* CTD, temperature and salinity data from the NvShuttle were adjusted with uorexec4.

Stage 5: After adjustment, data were interpolated onto a regular grid. Interpolation was carried out using pressure as the Y coordinate and distance run as the X coordinate. Distance run was adjusted with uorexec5 so that distance increased off shelf, and the on-shelf end of each transect was at 0 km.

Stage 6: Interpolation and gridding was carried out with uorexec6.

In previous years data from the OPC were converted from binary format (file extension .d00) to chart file format (file extension .c00) after which they were transferred to UNIX where PSTAR scripts were used to combine the data with UOR data. However, during JR38 OPC data were converted into text file format (file extension .t00) after which processing was carried out using a combination of PERL and SAS scripts (read_t00_v10.prl and opc_uor_info.pgm respectively). As OPC text files are generally very large (~13 MBytes), a method for processing the binary files was also developed which allowed OPC data to be combined with UOR data. This software also allowed data from standard RVS datastreams to be viewed, as well as the creation of chart files. Further development of this software and calibration of the OPC will be undertaken at BAS HQ in conjunction with ITS.

Instrument Calibrations

The suite of sensors on board the NvShuttle were calibrated during the summer of 1998 by Chelsea Instruments. The calibration equations derived from these calibrations are based on the output from each sensor in bits and are as follows:

Pressure sensor

Pressure (bdar) = -2.17572 × 10-10 × bits2 + 3.36057 × 10-3 × bits - 9.8659

This calibration was reported to be valid in the range 0 to 200 dbar, with an uncertainty of 0.1 dbar.

Temperature sensor

Temperature (°C) = 7.13659 × 10-11 × bits2 + 6.21509 × 10-4 × bits - 3.6570

This calibration was reported to be valid in the range -2 to 35°C, with an uncertainty of 3 mK. As this calibration was undertaken using the IPTS-68 scale, temperatures were converted to the IPTS-90 scale using the following adjustment:

Temperature (°C) = T-68 × 99.9760057 × 10-2

Conductivity sensor

Conductivity (mS cm-1) = -4.27148 × 10-11 × bits2 + 1.10872 × 10-3 × bits - 0.8207

This calibration was reported to be valid in the range 0 to 70 mS cm-1, with an uncertainty of 0.01 mS cm-1.

Fluorometer

Concentration of Chla (µg l-1) = -3.33 × 10-3 × bits + 1.0931 × 102

The calibration was reported to be valid in the range 0 to 75 µg l-1, with an uncertainty of 0.09 µg l-1 + 9% of the reading.

Photosynthetically active radiation (PAR) sensor

The PAR sensor was calibrated in the summer of 1995 and at that time the following equations were established:

Output voltage (Iv) = 2.28653 × 10-4 bits - 7.49249
and
PAR (Iz) = 1.12 × 10-2 × 10 Iv

SeaWiFS sensors

The SeaWiFS sensors were calibrated by the following equations:

SeaWiFS down welling channel 1 (412 nm) - Output voltage (Iv) = 9.0906 × 10-3 bits - 297.925

SeaWiFS down welling channel 2 (443 nm) - Output voltage (Iv) = 9.2918 × 10-3 bits - 304.491

SeaWiFS down welling channel 3 (490 nm) - Output voltage (Iv) = 9.1414 × 10-3 bits -

299.625

SeaWiFS down welling channel 4 (510 nm) - Output voltage (Iv) = 9.1969 × 10-3 bits - 301.411

SeaWiFS down welling channel 5 (555 nm) - Output voltage (Iv) = 8.9732 × 10-3 bits - 294.134

SeaWiFS down welling channel 6 (665 nm) - Output voltage (Iv) = 9.1905 × 10-3 bits - 300.789

SeaWiFS up welling channel 1 (443 nm) - Output voltage (Iv) = 1.49378 × 10-4 bits - 4.88355

SeaWiFS up welling channel 2 (490 nm) - Output voltage (Iv) = 1.49470 × 10-4 bits - 4.88867

SeaWiFS up welling channel 3 (510 nm) - Output voltage (Iv) = 0.91265 × 10-4 bits - 2.98455

SeaWiFS up welling channel 4 (555 nm) - Output voltage (Iv) = 0.91823 × 10-4 bits - 3.00278

Matching Conductivity With Temperature

As the NvShuttle travels through regions of the water column where there are strong gradients, a mismatch in the response times of the temperature and conductivity sensors is sometimes apparent. This mismatch is evident as spiking in the salinity trace. In order to correct salinity spikes that result from the mismatch of sensors, the conductivity streams can be lagged. During cruise JR11 a lag of 0.6 s was found to reduce salinity spikes to a minimum. During JR17 attempts to lag the temperature and conductivity streams resulted in a lag of 0.65 s. Lagging experiments on JR17 were conducted on data taken from different events and in very different oceanographic conditions, therefore a lag of 0.65 s was used during cruise JR38.

Comparison With CTD Casts

As a means of calibrating the NvShuttle data, the temperature/salinity (T/S) profile for an event can be compared with the CTD casts made at the Core Programme stations. During JR38 CTDs were taken at stations positioned along alternate transect legs. Thus, at least 2 CTD casts were available for comparison with most NvShuttle events.

Overlaying the T/S profile for a transect (in particular the 20 minute section of the transect closest to the position of the CTD station) revealed that substantial variability exists between the temperature and conductivity sensors on the Aquapack and on the Seabird 911*plus* CTD. However, in all cases a linear offset for salinity brought both sets of T/S results into close agreement. Following exploratory plots of the NvShuttle transects with the relevant CTD casts, it was determined that the linear offset for salinity was 0.068 psu. The magnitude of the offset was constant for both the East and the West Core Boxes. This adjustment is extremely high considering that the NvShuttle Aquapack was calibrated by Chelsea Instruments in summer 1998.

Archive of Data Files

NvShuttle data were archived upon completion of the scientific programme of the cruise. Data files were named using the standard Marine Life Sciences Pelagic Ecosystems Core Programme convention. Thus data were archived as follows:

Raw data	<cc>aqa<eve>.raw_<tid>
Derived data	<cc>aqa<eve>.der_<tid>
Position and distance run	<cc>aqa<eve>.dis_<tid>
Gridded on latitude	<cc>aqa<eve>.grd_<tid>
Adjusted data files	<cc>aqa<eve>.cal_<tid>
Adjusted and gridded on distance	<cc>aqa<eve>.cgd_<tid>

Where <cc> is a cruise number, <eve> is an event number and <tid> is a transect identifier.

For the OPC,data were archived in a similar manner:

Raw data	<cc>opc<eve>.txt_<tid>
Position, distance run and chart	<cc>opc<eve>.cht_<tid>

Year 2000 Compliance Tests

At the end of the cruise year 2000 tests were run on PC-1, PC-2 and PC-3. The tests run were those distributed by NSTL (Magraw-Hill) at version 98.02.15. All 3 PCs passed the tests.

In addition, the Aquasoft software was run on PC-2 with the PC clock set to the end of the century, and to the end of the year 2000, and 2001. In each case the software ran successfully across the year change logging data from the NvShuttle. The current version of the Aquasoft software is V2.06 and is stated by Chelsea Instruments to be year 2000 compliant.

The NSHUTTLE.EXE software was also run on PC-1 with the PC clock set to the end of the century, to the end of 2000, and 2001. Though sensor data were logged across the year change, dates logged internally by the NvShuttle were set to the beginning of 1970, indicating that NSHUTTLE.EXE is not year 2000 compliant.

The tests carried out on the ship should only be considered as preliminary as the NvShuttle system takes an input from the ship’s clock.This could not be set to future dates during the period of the cruise.

Recommendation

The current configuration of the UOR, cable and winch is satisfactory and provides adequate coverage of the upper water column. Unfortunately the NSHUTTLE.EXE software will need updating in order to comply with year 2000 requirements. It is therefore recommended that a new version of the software is obtained as soon as possible, and that adequate testing time is made available at the start of the next cruise.

The problem with the alternator shaft last year resulted in a temporary fix which was only possible because the ship’s engineering staff had individuals capable of machining the necessary parts. It would be advantageous to carry spare components for the UOR in case this was not always the case. It is therefore recommended that selected UOR components are obtained for future cruises.

This year valuable UOR winch control and UOR software driving experience was gained by additional people; it is recommended that this process continues in the future.