British Antarctic Survey
Marine Life Sciences Division

Pelagic Ecosystem Studies

Cruise Report No. 5

RRS JAMES CLARK ROSS

JR28

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VARIABILITY OF THE SOUTH GEORGIA MARINE ECOSYSTEM
PES CORE PROGRAMME III

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ABSTRACT
The Pelagic Ecosystem Studies Core Programme is aimed understanding the processes generating variability in the South Georgia marine ecosystem, with a particular emphasis on the interannual variation. JR28 was the third execution of the programme and began on January the 14th 1998 and ended on the 7th of February 1998 and started and ended in Port 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, 35km 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 chlorophyll concentration. There was also simultaneous squid jigging undertaken. 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. In the vicinity of South Georgia surveys of two mesoscale (80 x 80km) boxes consisting of 5 sets of paired transects were conducted. A towed undulating oceanographic recorder (UOR) was used to characterise the upper150 m water characteristics and a multifrequency acoustic system 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. Transecting was also undertaken to characterise the region of the north shelf not included in the survey boxes. 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 two 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.

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1. 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 executed 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 3rd execution of the Core Programme during January and February 1998.

2. Principal Objectives for JR28: Core Programme III

2.1 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. Specifically to carry out a hydrographic transect of 22 CTD stations at 35 km spacing with associated biological and chemical sampling. This will include zooplankton community sampling on station. Between stations underway monitoring will include OceanLogger, underway chemistry, bathymetry, ADCP, multifrequency hydroacoustics and seabird and seal observation with midpoint XBT profiles.

2.2 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. This will be done by traversing a series of paired hydroacoustic transects which have been previously randomly positioned within the survey regions. High resolution multifrequency acoustic data will be used to determine the fine scale distribution and abundance of krill. Within each area net sampling will be used to characterise acoustic targets and to provide size and maturity data on the krill.

2.3 To make direct measurements of the physical, chemical and biological characteristics of the surface 100 - 200 m in two mesoscale survey areas on the northern shelf of South Georgia. On the standard transects an undulating oceanographic recorder will be used to obtain measurements of temperature, salinity, chlorophyll fluorescence, PAR, transmissivity and

plankton size distribution and abundance using an optical plankton counting system. Other surface and sub-surface monitoring including: ADCP, OceanLogger and seabird and seal observation will also be undertaken.

2.4 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. This will include CTD, ZNET, FNET and RMT 8 sampling.

3. Timetable

RRS James Clark Ross JR28

January 1998

5	First part of science party arrives Port Stanley
14	Rest of science party arrives and *RRS* James Clark Ross departs
16	Test station
17	Start the Maurice Ewing Bank (MEB) transect.
21	Complete the MEB section
22	Acoustic Calibration I in Stromness Bay, South Georgia
23	Start the Eastern Core Box survey area on the north South Geogia shelf
28	Complete the Eastern Core Box
29	Acoustic Calibration II in Stromness Bay, South Georgia
30	Start the Western Core Box survey area on the north South Geogia shelf

February 1998

3	Completed the Western Core Box
4	Transecting completed picked up Alistair Fothergill - Right Whale Bay Left the area through Stewart Strait and commenced standard transect back to Poart Stanley
7	Arrived Port Stanley
9	JR28 Science party disembarked

4. Personnel

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Glostein, Michael E	R/O
Anderson, Duncan	Ch/Eng
Smith, Colin	2nd/Eng
Griffiths, David R	3rd/Eng
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Rowe, Anthony K	Elec
Trevett, Douglas P	Deck Eng
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5. Scientific Narrative

The RRS James Clark Ross (JCR) departed from Port Stanley on Cruise JR28 at 2200* on Wednesday the 14th of January. The science party had arrived on four different flights spread over a 2 week period because of the lack of available seats on the most convenient flights. This gave the opportunity for extensive mobilisation of gear prior to sailing. The final group of 8 scientists arrived on the evening of the 14th at 1900 following a 24 hour delay in departure from Brize Norton due to the high winds forecast in the Falklands for the evening of the 13th. The high winds duly arrived but the JCR sailed out on the evening of the 14th to a stunning sunset and slight seas.

Passage was made in slight seas and on the morning of Friday 16th a test CTD deployment was undertaken at 1120. At the same time the squid jigger system, located 3m aft of the CTD gantry, was tested with no problems encountered operating the 2 systems together. A test deployment of the Aquapack vertical profiling fluorometer was also successful but the test of the vertical zooplankton "Bongo" net ended with one of the springs from the motion compensator system unravelling out of its case. The station was completed by 1312 and the ship continued on to the start of the transect. The motion compensating system was fixed within the hour. Extensive fog with slight to moderate sea-state becoming rough made the passage to the head of the transect slightly uncomfortable but the JCR arrived on schedule.

5.1 Maurice Ewing Bank Transect

The Maurice Ewing Bank (MEB) transect began with station MEB1 at 0805 on the 17th of January following a difficult night for sleep. Station activities included: two zooplankton net hauls, a shallow (200m) and a deep (4500m) CTD. The conditions made it inadvisable to deploy the squid jigger at the station but an Aquapack deployment was made with the station activities completed by 1239. While on station about 70 long-finned pilot whales were sighted. Between stations the ship steamed at a constant speed of 10 knots and on all daytime sections bird observations were made whenever possible. A planned XBT launch between stations MEB 1 and 2 did not occur because of an electronic fault in the hand held XBT launching system.

On station MEB2, which began at 1527, a zooplankton net, a CTD (1000m), and an Aquapack profile were carried out. The squid jigger was also deployed with jigging to 350m throughout the CTD profile and the station was completed at 1713. Station MEB3 began at 1948 and was completed at 2320. The station activities were a zooplankton net haul, a deep (4500m) CTD with simultaneous squid jigging and an Aquapack deployment. The XBT system was now fixed so launches were made at the midpoints between each of the stations along the rest of the transect. During all standard CTD profiles squid jigging was undertaken.

So onto station 4 where activities began at 0303 and followed the standard sequence of a zooplankton net, a CTD (2000m) with squid jigging at the same time. There was then an Aquapack profile completing the station at 0524. Onto station MEB5 where the sequence of sampling was more extensive. The station began at 0812 with a zooplankton net, there then followed a shallow (200m) CTD profile for water samples, then another zooplankton net haul

to provide plankton samples for biochemical analyses. The standard CTD profile (2000m) followed, with simultaneous jigging and then the Aquapack profile completed the station at 1117. The ship then moved towards MEB6 arriving on station at 1345. The standard activities of a zooplankton net haul, CTD (1000m), simultaneous squid jigging and then an Aquapack profile completed the station at 1529. The bird observations indicated that there was not much about in this northern area compared to the previous season and there were very few albatrosses in particular. The ship arrived at station MEB7 at 1802 and activities were a zooplankton net haul, CTD (1000m), simultaneous squid jigging and then an Aquapack profile completed the station at 1942. Repeating the same schedule at station MEB8 which started at 2222 it was completed at 0009 on the 19th of January.

Station MEB9 started at 0252 and was completed at 0437 and station MEB10 began at 0718 and finished at 0900. Both stations involved 1000m CTD casts. Between stations 10 and 11 the UNIX acoustic data collection system disk crashed. This meant the data from the section were lost although a part of the section data was recoverd by starting the transecting after the station 11 activities back on the 10-11 section. At station MEB11 which began at 1134 with a zooplankton net haul, a shallow CTD (200m) profile for water samples was carried out and was followed by another zooplankton net haul to provide plankton samples for biochemical analyses. The standard CTD profile (2000m) followed with simultaneous jigging. The Aquapack profile completed the station at 1500. Then onto MEB12 which began at 1808 and was completed at 2024 and was composed of a zooplankton net, a CTD (2000m) and an Aquapack profile. The last station of the day (MEB13) began at 2255 and this time it comprised a zooplankton net, a CTD (3000m) and an Aquapack profile. The station was completed at 0153 on the 20th of January.

So on to station MEB14 work began at 0442 and was completed at 0731 and this time comprised a zooplankton net, a CTD (3000m) and an Aquapack profile. A minke whale also glided slowly past while the ship was on station in slight seas. Then on again without pause to station MEB15 where work was a zooplankton net, a CTD (1000m) and an Aquapack profile. The station began at 1014 and was completed at 1200. Phew, getting a bit out of breath now, but onwards to station MEB16 which began at 1442 and was completed at 1734. Station 16 comprised a zooplankton net, a CTD (3000m) and an Aquapack profile with work completed at 1734. Here, 2-4 sperm whales were spotted from the after deck. Pushing on, station MEB17 occurred at 2017 and finished at 2202. This comprised a zooplankton net, a CTD (1000m) and an Aquapack profile.

Into the final day of the MEB section with station MEB18 which began at 0053 on the 21 January and was completed at 0354 and again comprised a zooplankton net haul, a CTD profile (3000m), simultaneous squid jigging and an Aquapack profile. Station MEB19 was an extended station and began at 0629 and was completed at 0906. The station started with a zooplankton net haul, followed by a shallow CTD (200m) CTD profile for water samples, then a zooplankton net haul to provide plankton samples for biochemical analyses. The standard CTD profile (1000m) followed with simultaneous jigging and there was then an Aquapack profile. Onto station MEB20 at 1151 with a zooplankton net haul, a CTD profile (3000m) followed with simultaneous jigging. The Aquapack profile completed the station at 1450. Between stations 20 and 21 a test deployment of the undulator system was carried out which showed the system was performing well. Station MEB21 began at 1753 and comprised a zooplankton net haul, a CTD profile (1000m) with simultaneous jigging and an Aquapack profile completed the station at 1938. Then with the end in sight it was up onto the shelf slope with an extended but shallow station starting at 2210 with a zooplankton net haul, a CTD (150m) profile for water samples followed

by another zooplankton net haul to provide plankton samples for biochemical analyses. The standard CTD profile (150m) followed with simultaneous jigging and there was then an Aquapack profile.

The section was completed at 2354 on Thursday the 22 January, about half an hour behind the original schedule. It was a remarkable sprint and we were very fortunate with the weather. However, the detailed schedule which we were able to stick to, with the high level of competence and professionalism of the ships officers and crew along with the high level of expertise of the scientific group in a team effort made the section a calm, well ordered and scientifically exciting process.

Throughout the section, data analyses continued so that by the end of the transect the full transect data were available for examination and display and in many cases the data were completely calibrated. The data indicated that the sub-antarctic front was closer to the MEB than it had been in previous years. The ADCP data also suggested very strong eastward flowing water north of the MEB. There were no indications of the westward flowing cold water current at depth with Antarctic Zone characteristics as observed in the earlier cruises. On the southern side of the bank, at stations 10 and 11, there was what was probably a cold feature at a depth of between about 100 and 500m. This was on the northern side of the Polar Front but had the characteristics of Antarctic Zone water south of the front. It was on this station that zooplankton netting obtained plankton more characteristic of colder waters further south and the nutrient levels were enhanced. All this evidence indicates that this feature originated south of the front. At station 13 the Polar Front was identified associated with strong eastward flowing water on the Southern side. At stations 19 and 20 close to the shelf at South Georgia a westward flowing very cold (< -.5 ^{o}C) current was recorded at about a depth of 100m as had been observed on previous cruises. On each station squid jigging was undertaken but no squid were caught. Unlike previous crossings of the region no squid were observed in the water at night. This fact combined with the lack of squid eating predators in the region suggests that there was a general lack of squid in the region.

5.2 Acoustic Calibration I

The ship then sailed to Stromness Bay maintaining a course close to Bird Island to allow underway nutrient sampling. The JCR was off Stromness Bay at 0900 on Thursday the 22nd of January and tied up to the buoy at 1000. Lines to take the calibration spheres were rigged as soon as the vessel morred. A CTD profile was obtained for the acoustic calibration. The acoustic calibration was delayed by a snagging of one of the fishing lines on the hull. A calibration was achieved for the 38 and 120 Khz although this did mean working right until the last moment when the ship cast off at 1900. Following a test of the ships lifeboat in the bay RIB's were run ashore to allow people not involved in the calibration to walk around the whaling station and the valley. Two RIB's went to Husvik to pick up the scientific party studying fur seals. They were given a tour of the ship and lunch. The ship sailed out of Stromness as the barometer fell rapidly and the winds picked up.

5.3 Eastern Core Box

Friday the 23rd of January was spent hove-to in the vicinity of the start point for the first transect of the Eastern Core box. The winds gusted storm force 11 in the morning. The winds began to decrease in the early hours of Saturday the 24th of January and we then were able to start the first transect The core box survey follows a standard pattern of sampling beginning each day at about

0800 with a transecting phase which usually includes a pair of parallel transects each 80km long running perpendicular to the main axis of the shelf break.

The first transect began close to a large tabular iceberg, spectacular in the morning sun. The undulator (UOR), Chelsea Instruments NvShuttle model, was deployed at 0756 as the ship steamed through the waypoint of transect E1.1 in the offshore region. The hydroacoustic systems were also running as were the underway sensor systems of the OceanLogger and the underway nutrient analysis system; the autoanalyser. The transect was run in bright sunshine for much of the day from offshelf to onshelf. There were a lot of what looked like krill targets on the echosounder so it was decided to carry out target fishing at the offshore end of the transect pair. The UOR was therefore set to operate at a shallow level depth. As the ship turned at the head of the transect pair and started undulating again at the beginning of the next transect. The undulation depths were determined in relation to the bathymetry using profiles from the previous season. There were quite a lot of targets on the echosounder on both transects, quite a lot of birds and seals about and even a few Southern Right whales. The transecting was completed at 1738 and the ship moved along the transect to a point identified by the acoustics as a an area of fishable targets. A period of target fishing was then undertaken starting at 1951 and was completed at 2110. The ship then moved to the offshore station E1.2N a quarter of the way along the transect. The station began at 2155 with 2 zooplankton net hauls, followed by a 1000m CTD profile with simultaneous jigging. The CTD wire came off the roller but went back without a problem. An Aquapack profile was then executed and a standard double oblique fishing period followed centred on the station with simultaneous foredeck net hauls (FNET). The station activities were completed at 0230 on the Sunday the 25 January. The ship then moved to the onshore sampling station E1.2S a quarter of the way from the shoreward end of the transect. Sampling started at 0446 and included a zooplankton net haul, a shallow 150m CTD profile, another zooplankton net to provide plankton for biochemical analyses,. The planned Aquapack profile was not executed as time was limited so the station work was completed with a standard double oblique fishing period centred on the station with simultaneous foredeck nets. Many of the krill were in the 25-35 mm range but there were also some surprisingly large gravid female krill in some of the offshore nets. The work on transect pair was completed at 0721 and the ship moved to begin the next transect pair.

The second transect pair began inshore at 0826 on the 25 January with views of Cape Vakop and Hound Bay visible in the morning sun below the cloud. Then the transecting began again with a lot of krill type targets recorded by the hydroacoustics on both transect legs. Fog descended on the return leg which was completed at 1821. A period of target fishing followed between 1910 and *2030* when the ship moved to the inshore station E2.2S starting station activities at 2107, with a sequence of a ZNET, a CTD (150m) with squid jigging, an Aquapack profile followed by station RMT fishing and 2 FNET hauls which were completed by 0027 on Monday the 26 January. Then onto the offshore station at 0259 (E2.2N), where sampling included a zooplankton net haul, a CTD for water samples, another zooplankton net to provide plankton for biochemical analyses, a deep 1000m CTD profile. Again the Aquapack planned profile was not carried out because of time constraints. The station was completed at 0710.

Moving onto to the offshore end of the next transect pair, E3.1/E3.2, transecting began at 0830 on the 26 January and was completed at 1814. There were spectacular views of South Georgia as the ship traversed the head of the transect at about 1230. The target fishing period which began at 1913 was completed by 2051 following two RMT hauls. Station activities began at station E3.2N at 2130 with a zooplankton net haul, a CTD (1000m) with squid jigging, an Aquapack profile followed by an RMT haul and simultaneously 3 foredeck net hauls. The station

was completed at 0044 on Tuesday the 27th of January and the ship moved to the inshore to the next station E3.2S to begin station activities at 0248. These comprised 2 zooplankton net hauls, CTD (150m) with squid jigging and an Aquapack. This was followed by a period of station fishing with the RMT and 2 FNET hauls and the station was completed 0600.

The ship then moved to beginning the next pair of transects (E4.1/E4.2) at the inshore end passing the waypoint with the UOR in the water at 0745 on the 27January and completing the transecting at 1746. As we approached the end of the first transect at the offshore end we saw a number of whale blows in the distance. It was a clear and sunny day in a calm seas and there were 2 large icebergs in the area. As we traversed the head of the transect we steamed towards the area where the blows were centred. It was only when we turned onto the return leg of the transect that we realised that we would pass directly through the area where they were. It was amazing as everywhere we looked there were whales. The blows were high and we soon realised it was a mixed aggregation. There were Southern Right, Fin and Sei, a few fur seals and we even spotted about 3 or 4 hourglass dolphins. It was a spectacular and awesome sight as everywhere around the ship there were whales blowing, rolling and diving. There was probably between 30 and 50 animals although there may have been more. Surprisingly there were very few seabirds of any description in the vicinity. In the exact area of the whales there was very little on the echosounder, nothing of any significance but just a half mile on there was a massive aggregation of what was probably krill. It extended down to over 100m deep and was over 1km in the length. An incredible event to witness. Maybe the days of the great whale at South Georgia are not over. So after calming down from all the excitement we continued the transecting. We did see a few whales a little later, which were probably Southern Bottlenose whales with Prions above them, but by then it was difficult to get excited.

At the end of the transecting at the inshore end the ship moved back out towards station E4.2S to do some target fishing with the RMT. This began at 1834 and was completed by 1924. As the ship was in the vicinity of the station the planned RMT station fishing period was brought forward and completed between 2005 and 2114. The standard station activties were then carried out starting at 2142 with a ZNET, a CTD (160m) with squid jigging and an Aquapack profile. As a result of the extra timed gained in the fishing period 2 further ZNET hauls were undertaken to obtain live animals for grazing experiments. There were then 2 station FNET hauls as the ship moved off completing the station activities at 0009 on Wednesday the 29 January. The ship then proceeded to the deep station (E4.2N) starting at 0217 where work started with a ZNET, a shallow CTD (200m) for water samples, a further ZNET followed by a CTD (1000 m) with squid jigging. An Aquapack profile followed a station RMT haul with 2 FNET hauls and the activties were completed at 0610.

We were then able to get in position by 0752 on the 29 January at the offshore end for the final transect pair, E5.1/E5.2 of the eastern core box. The full transect was completed in fog by 1745. A deep CTD profile to near bottom (3750m) was then carried out with simultaneous squid jigging. The CTD was completed by 2033. The UOR was then deployed with the undulator profiling between 0 and 75m all the way back towards Stromness Bay where it was recovered at 0337. Nutrient analyses and acoustic data were also collected. Samples from the sea-water through flow system for chlorophyll extraction were collected frequently along the section to allow a night time calibration of the underway fluorometer system and the UOR fluorometer. Plotting of the data from Core Boxes was already underway with UOR and ADCP data coming through well.

5.4 Acoustic Calibration II

We moved towards Stromness Bay at 0900 on Thursday the 29 January and were tied up at the buoy in the bay at 1000. Lines to support standard calibration speheres were put in place immediately. A CTD profile was obtained for the calibration. The acoustic calibration went well and good calibrations were obtained for the 200 Khz, the 120 Khz and a reasonable one for the 38 Khz. A chance for walks on a sunny and slightly breezy day and a further visit from the Husvik fur seal field party. Shore leave ended at 1900 and the JCR cast off the buoy at 1930.

5.5 Western Core Box

The JCR proceeded in slight to rough seas to the Western Core Box arriving at the first Waypoint before 0800 on Friday the 30th of January. The UOR was deployed and the ship began steaming through the waypoint at 0758. There were two periods during the first leg of the transect when the echointegrator system crashed and some data were not collected. The weather was mainly foggy over the shelf in the morning and only cleared about 1400 near the offshore end of the second leg of the transect which was completed at 1749. There were not many birds about and the initial indications were that there were not many acoustic targets.

A period of target fishing was undertaken in the inshore area using the multinet system. This test of the system went well as both a target fishing exercice and as a test of the multinet which performed very well. The ship then moved onto station W1.2S at 2124 where the standard station activities of a zooplankton net haul, a CTD profile (150m) with simultaneous squid jigging and an Aquapack followed by an RMT with 2 FNET hauls completeing the station at 0018 on Saturday 31 January. The ship then relocated to the offshore station (W1.2N) where the standard station activities were repeated with the standard CTD profile to 1000m. On this station there was also an extra CTD for water samples and extra zooplankton net haul for samples for biochemical analyses. The station was completed at 0618 and the ship relocated to the offshore end of the next transect pair (W2.1/W2.2).The transecting began at 0752 and was completed at 1735. Then the target fishing followed with the offshore station (W2.2N) first with standard activties starting at 2128 and completed at 0024 on Sunday the 1 February . Then relocation to the inshore station (W2.2S) at 0307 where the standard activities were undertaken along with an extra zooplankton net haul. The station was completed at 0529 and the ship relocated to the inshore end of the next transect pair (W3.1/W3.2). There were no large aggregations on the acoustics which look like krill and very few targets in general so the target fishing has been on the more diffuse targets. There were some areas where there were seals loca6ted near the shelf break where the satellite tagged seals from Bird Island were operating. A problem arose with the deionising system which meant that the nutrient data on the sections were not as high quality.

Transecting started at 0752 on the 1 February and was completed at 1730. Then the target fishing followed with the inshore station (W3.2S) first with standard activities starting at 2147 and completed at 0025 on Monday the 2 February. Then relocation to the offshore station (W3.2N) at 0239 where the standard activities were undertaken along with an extra CTD profile and zooplankton net haul. The station was completed at 0632 and the ship relocated to the offshore end of the next transect pair (W4.1/W4.2). Excellent views of the Willis Islands at the onshore end and some nice icebergs in the area. The target fishing found the only aggregation for miles and it was a big one. The RMT net was split as it was hauled over the aft roller. From now all RMT's will use 2 instead of 3 nets. A catch of about 50 litres of krill still remained in the net. The krill had been eating a lot of phytoplankton of which there seems to be a lot in this box, although it is patchy. Generally a lot of copepods and *Themisto* about; a mixed zooplankton

community. Still not that many predators about either.

Transecting (W4.1/W4.2) began offshore at 0802 on the 2 February and was completed at 1749. There was a break in the communication with the UOR during the but the data were recovered successfully. Then the target fishing followed with the offshore station (W4.2N) first with standard activties starting at 2109 and completed at 0010 on Tuesday the 3 February. Then relocation to the onshore station (W4.2S) at 0255 where the standard activities were undertaken along with an extra CTD profile and zooplankton net haul. The station was completed at 0447 and the ship relocated to the inshore end of the next transect pair (W5.1/W5.2). The nutrient analysis system was now performing much better. The experimental work on krill excretion was also going well.

So it was into the final day of the main Core Programme. The weather had been good throughout the Western Box but today was stunningly beautiful with flat seas and strong sunshine. The transecting began at 0808 on the 3 February. As the ship crossed the shelf break area there were very large numbers of predators, thousands of fur seals and lots of prions. There were a few dense small krill type targets, close to the surface. The Predator-prey interactions in these areas are particularly interesting. At the end of the first transect (W5.1) the UOR was recovered and the ship steamed to the head of the next transect W5.2. An extra CTD (1000m) with squid jigging was then undertaken which was completed at 1434 and the second leg of the transect was steamed following redeployment of the UOR. The transect was completed at 1935.

The ship then turned east along the shelf and relocated to carry out an overnight pair of onshelf - offshelf transects in between the two core boxes. These began at 2117 on the 3 February and were completed at *1000* on Wednesday the 4 February. The morning was very sunny and calm as we steamed along the north coast of South Georgia with the visibility excellent the island looked stunning. At 1500 we picked up Alistair Fothergill of the BBC in Right Whale Bay. We then proceeded through Stewart Strait to obtain an underway transect of nutrients close to Bird Island. Then it was back towards Stanley on a set course with XBT launches at intervals.

The Core Boxes had gone well and have produced an extremely valuable dataset. There are indications in a number of areas that there are some exciting differences in what was observed this year compared to the two previous years. The data from this cruise is helping us to gain an understanding of the operation of this complex and large scale ecosystem.

A standard XBT section was run on the way back towards Port Stanley. The ship arrived at FIPASS at 0800 on 7 February 1998. The science party packed caro on the 7th and left the ship on the 9th.

The Core Programme was completed fully with very few problems and we also managed to obtain some extra data addressing some the gaps in our knowledge of the area. The success of the cruise owes much to the professionalism and good humour of the officers and crew of the *RRS James Clark Ross* under the captain, Jerry Burgen. The catering department and the galley looked after us magnificently through the day and night watches. Thanks to all of officers and crew of the ship. The schedule of the cruise was extremely tight its successful completion reflects the skill and dedication of all the scientists who operated so well as team.

6. Principal Scientists Report and Recommendations

The Core Programme Operation

General Assessment and comments

The MEB transect operations went well and people were able to keep going well for the intensive period required by the schedule. Immediately after this period the acoustic calibration in Stromness provided a valuable chance for people to catch their breath and get ready for the next phase. This makes it even more difficult for those involved in the acoustic calibration. Twelve hours is a very restrictive time-scale for the calibration.

The Core Boxes are, in many ways, more difficult than the MEB transect. Although less intensive for some of the day it is difficult to have enough people around all the time to cover all the requirements. The quieter periods are when data checking and plotting gets done. This is required if data schedules are to be maintained back in Cambridge. There is a lot of work to get through in the 24 hour period and the RMT fishing in particular is difficult to schedule. The standard tows at the stations can only be fitted in if the ship does not relocate after it has carried out the ZNET, CTD and Aquapack. The target fishing period is only sufficient in most cases to allow one fishing period. It is simplest if this occurs close to the station.

Operation of nets

Although there is a lot of experience in RMT netting in the group a number of people are not available to assist the procedure as they are involved in plankton sorting. This inevitably means that people who are involved in other activities, particularly in the UIC, are called upon. Both groups are equally busy. The second part of this problem is that many of these people are not particularly experienced at much of the deck work, nor should it be expected when they have work to do elsewhere. This can be a real problem and emphasizes the importance of having people of sufficient technical experience and knowledge in all the appropriate areas of the group. Their knowledge is an extremely valuable resource which has been built up over a period of years.

The oceanographic/data side of things worked well because there were sufficient people to carry out the required tasks. These people often have to also carry the bulk of the work on the watch leader system because they are based in the UIC. The extra student input this year was particularly important. The other people in the UIC regularly are the acoustics/RMT people and they find it very difficult to balance all the requirements on them. They have acoustics to monitor, watch leader duties, but they also have to direct fishing operations and sort out catches in the wet lab. This takes them away from the UIC and this has to then be covered by the oceanographic/data group. The sorting on this cruise required input from the squid biologist and the doctor. The minimum complement for the acoustic group is 4 with input from Doug Bone. It would help most if this extra person knew the net and sorting operations to cover Doug and the krill group. Tony North and Martin White made extremely valuable contributions in this role in JR11.

Recommendation 1: An experienced net operations/plankton-nekton biologist is required to work alongside the acoustics group of 3 and Doug Bone.

Nutrients and chlorophyll

The other major area of lack of personnel was on the chemistry/plankton side. Two people operating the underway chemistry, station chemistry, Aquapack and chlorophyll analyses is insufficient. Either this section of the programme must be reduced or at least one other person in mainly an assistant role is required. Given the fundamental nature of the data it is unlikely that the data collection can be significantly cut back. A particular problem on the MEB section is the

chlorophyll sampling. Although there were people who could carry out the hourly extractions, these take people away from other tasks for 10-15 minutes each hour. This generates a backlog for analyses which the 2 people doing the work (in this case Julian Priddle and Andy Rees) have to catch up on. It would be far better if there were someone else taking the samples through the analysis stage more routinely. It is not desirable or safe to have people operating too many hours a day as they do not function properly may be a risk to themselves and others.

Recommendation 2: An assistant is required for the chlorophyll extraction and analysis work on the ship.

Overall time requirement

There is very little time in the programme for contingencies. At the start of the cruise 12 hours were lost due to a delay in the flights. A further 24 hours were lost due to bad weather at the start of the Eastern Core Box. The acoustic calibration is severely constrained by the 12 hour time limit for completeion. From the time the JCR sailed at 1900 on the 14th until about 0800 on the 7th of February the ship will have been at sea for 23 days and about 12 hours. It is not sensible to plan these cruises with the absolute minimum of ship time because lost time to weather will occur. The cruise should be planned around 25 days of sea time, which allows some flexibility with science planning and means that 2 days can be lost to weather before the core parts of the programme need to be cut. This is not an expansion of the programme but a realistic assessment of what is required to do the core programme in the light of experience. This is what was planned for this season. Cruise commitments have been reduced elsewhere in the Quinqenium (e.g. the Winter Cruise) to allow for the increased scientific profile of the Core Programme.

Recommendation 3: 25 days sea-time is required for the Core Programme. Mobilisation/de-mobilisation is not included in this but 1-2 days is required either end of the cruise bring the total to 28 full days.

Laboratory Safety

This is a complex area and one on which Julian Priddle has generated a separate document. It is clear that the implementation of COSHH on the ships with the full laboratory safety procedures will require a fundamental change in the attitude of the more experienced scientists. This requires clear and direct guidance from management.

Equipment

Once we finally recieved the software update from Chelsea Instruments the UOR performed well. This was all very much down to Doug Bone. The delay in getting the software update was not acceptable. Doug has put a large amount of time into generating a working system and has clearly undertaken a lot of development work on what should have been a finished system.

As we have stated elsewhere the Neil Brown CTD system works but requires a lot of more effort to generate useable data than more up to date systems. Not having a spare unit of some description on the ship makes the whole cruise very vulnerable to a major equipment failure or loss of the system. Loss of the system does happen, although infrequently, on oceanographic cruises. The Core Programme and indeed all MLSD cruises would be severely compromised by such a loss. Although it would be possible to do some things the core of the science would be lost. Witnessing the wire come off the CTD roller brings such a possiblility home to a PSO. The cost of the shiptime and potential loss of science time is such that some form of spare system

should be considered

Another piece of oceanographic equipment that is barely holding together is the Autosal, which is used to obtain calibration data for the CTD. The current system is old and breaks down. Again the potential disruption and loss of science time is such that purchase of a new system is necessary.

A key piece of MLSD kit is the down-wire net monitor. The spare system should be available onboard.

Constant Temperature Room

On biological cruises such as this where rate process measurements are routinely carried out space was once again at a premium in the CT room. On this occasion four people were regularly using these facilities which were often congested, particularly as krill were being studied involving their maintainance in large volumes of water. Similar problems were also experienced on the spring process cruise (JR25). Lack of space does not allow for the expansion of experimental design. A contributing factor is the use of the room to store samples collected on previous cruises. An alternative cool storage facility would certainly help ease congestion and free up space for experimental science in progress. Additional benching and better use of available space would also improve matters.

Pure Water System

We had a major problem with the ELGA *pure* water system on this cruise. The deioniser is a very important piece of equipment and the water it supplies is essential not only to BAS cruises but also to STAP and commissioned cruises. The system is in need of extensive refit but a better option would be to replace the unit with a new one. The Elgastat is now 6 years old and out of date. BAS HQ's preferred system is a Millipore purifier.

General Operations

<u>Documentation</u>

The situation over the instrument documentation is not good. This is a problem that has been commented on a number of times but it has not improved. There is no central catalogue of key instrument documents. These are distributed in the draws in the UIC and are often moved about on different cruises.

Recommendation 4: Catalogue the documentation and hold it in one area. The computer data preparation room would be a good area but the current cupboards are not suitable.

Computing and electronics support

The electronic and computing support on the cruise was superb.

It is incredibly frustrating to go to different PC's in the same area to find that at least the main parts of the PC setup are not the same. So for example standard printers are not configured into the system or standard Vista exceed access to Unix boxes is not available. These core things should not need to be set up in piecemeal fashion when they are required. Although different

users may change configurations during cruises that is not an excuse for not resetting everything at the start of the next cruise.

There is a lot of what appears to be rubbish and odd bits of kit in the draws in the UIC room These should be cleared prior to every cruise. There are also bits of loose kit under the desks and behind the light table. These should also be cleared out before cruises.

Recommendation 5: Generate standard documentation on procedures to ensure smooth change overs. This could include use of the ABC, PC setting up and laboratory management responsibilities.

UIC as a computing environment

The main computing area is an unpleasant environment as evidenced by the fact that it is often empty when there are lots of people on PC's in the UIC. The UIC is not an ideal environment for this and any health and safety assessment of the conditions for computer operation would not be favourable. A number of the PC's have to be set up in front of drawers. There is insufficient desk type space to move them to. The chairs are a vast improvement over the previous ones but they do not fit under the desk areas so people operate, often for 12 hours a day in some very strange positions.

Recommendation 6: An assessment should be made of the requirements people have for these areas with a view to redesign.

7. JR28 Station positions

Full Cruise Track is shown on front cover of this report.

7.1 Location of Maurice Ewing Bank Transect stations visited during JR28

	JR28 waypoints	
Station	latitude	longitude
MEB1	-47.889019	-43.343533
MEB2	-48.171944	-43.168095
MEB3	-48.453632	-42.991997
MEB4	-48.738338	-42.793011
MEB5	-49.033665	-42.588165
MEB6	-49.320210	-42.391685
MEB7	-49.614609	-42.187759
MEB8	-49.904728	-41.967873
MEB9	-50.189400	-41.759399
MEB10	-50.473099	-41.528099
MEB11	-50.763599	-41.292801
MEB12	-51.046902	-41.044399
MEB13	-51.325802	-40.823898
MEB14	-51.614700	-40.607498
MEB15	-51.897800	-40.383598
MEB16	-52.173599	-40.157501
MEB17	-52.463902	-39.894699
MEB18	-52.752800	-39.647800
MEB19	-53.038601	-39.402802

Station	latitude	longitude
MEB20	-53.319397	-39.148899
MEB21	-53.606186	-38.900372
MEB22	-53.892601	-38.653816

7.2 Location of Core Box stations visited during JR28

Station	Latitude	Longitude
E1.2.S	-54.0764	-35.9199
E1.2.N	-53.8778	-35.4117
E2.2.S	-54.2476	-35.7218
E2.2.N	-54.0483	-35.2125
E3.2.S	-54.3928	-35.5547
E3.2.N	-54.1927	-35.0443
E4.2.S	-54.5379	-35.3874
E4.2.N	-54.3372	-34.8761

Station	Latitude	Longitude
W1.2.S	-53.8173	-38.8744
W1.2.N	-53.4638	-38.9839
W2.2.S	-53.7851	-38.5835
W2.2.N	-53.4318	-38.6953
W3.2.S	-53.7504	-38.2781
W3.2.N	-53.3974	-38.3923
W4.2.S	-53.7141	-37.9658
W4.2.N	-53.3614	-38.0825

8. Oceanography, Data Systems and Analyses

8.1 Processing of Navigation data

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 two additional GPS systems on board the JCR for the ship's use. These are a Leica MX400 and an Ashtech G12 receiver. In addition there is a Racal SkyFix 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 JR28 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 "JR28_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 III - JR28.

The instruments

1. Trimble 4000

The Trimble 4000 receiver in differential mode was the primary source of positional information for the scientific work on Core Programme III. Experiments from data when the ship was both at anchor and moored to a buoy at Stromness harbour suggested an absolute accuracy of approximately 1.5 m in the vicinity of South Georgia. It is not currently posible to get access to better navigation at sea. 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 28 gps<jday>.raw
the other is after the datpik, this is 28 gps <jday>.

2. Ashtec GLONASS (GG24)

The *James Clark Ross* is the only British research ship currently installed with a GG24 receiver and on JR17 gave an accuarcy of position of order 7 m. On the present cruise the data were so poor that we stopped routinely reading in this stream. 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, when we came onto the ship in October 1997 the GLONASS system was unserviceable. It was repaired on JR25 but it is still striking that an instrument costing several thousand pounds, and considered last year as the primary position source should have become so rapidly neglected. Our suspicion is that the instrument still not operating correctly and so its quality is degraded.

It should be noted that the GLONASS frequently hangs. On these occasions the GG24 outputs a position of 0°N and 0°W, and more worryingly the data is flagged as good in the RVS system.

The instrument generally came back to life but occasionally it required ITS intervention (in the form of power cycling). There is no apparent reason for these dropouts as there certainly are satellites available for positional information (the other GPS instruments do not drop out). The source of the problems we started the season with should be investigated in a bid to establish whether the reciever is not functioning correctly or the GG24 is just not of sufficient quality for our purposes.

3. 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 JR28 it was configured with the settings in table 2. Throughout the cruise the Ashtec worked reasonably well, but with frequent (but not too serious) dropouts. The number of dropouts increased until Julian Day 023 when the Level A died. Whilst the Level A was replaced there was no a shtec data for the period jday 023 1043 to 024 0033 (18 hours 50 minutes).

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 28 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 28 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 28 ash < jday > .edit
and 28 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.

4. Gyrocompass

The gyrocompass is a fundamental data stream. It is used by the RVS program *bestnav* to derive dead reckoning in the (very rare) absence of gps data - as well as being used for ADCP processing (ADCP report) and derivation of true wind velocity (ocean logger report). For JR28 the gyrocompass data was 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 28 gyr < jday > .raw
The script also appends the day file to a master file called 28 gyr 01.

5. Electromagnetic Log

The electromagnetic log gives the water velocity relative to the ship in a fore-aft direction. The data was read in 12 hour chunks using the very basic exec called emexec0

emexec0:
purpose: This exec reads in data from the electromagnetic log 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.

The output file is in the form 28 eml < jday> .raw

6. Doppler Log

The Doppler log gives water velocity relative to the ship in both the fore-aft and port starboard direction. This vector information was read in as 12 hour chunks the using a simple exec dopexec0.

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 28 dop < jday> .raw

Daily Navigation Processing

As stated above the data was 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 was taken from the RVS file bestnav. This program uses the navigation data from various streams to construct a file with 30 second fixes. For JR28 the primary input to bestnav was the Trimble 4000 DGPS. In the absence of DGPS data the Ashtec data was substituted (essentially this is the raw gps signal). In the absence of this data as well, position was constructed from dead reckoning using the EM 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 abnv281 and was used for all pstar required navigation information (i.e ADCP processing, true wind derivation, UOR data ect.).

Suggestions

The navigational instrumentation on the JCR is constantly going through large changes, thankfully for the good. However there is a lack of documentation on the ship about current "best configurations" of such instrumentation as the Ashtec GPS3DF and the GLONASS. There was also a lack of documentation about the current set up of the systems. This should be rectified. In addition, the SkyFix module has 4 ports: 1 is dedicated to the Leica and another serves both the Trimble and G12 (the serial connection is split at the receivers). There are therefore 2 ports still available and perhaps it could be possible to provide the Ashtec GPS3DF with GPS SV range correction data to increase our capabilities still further?

8.2 Conductivity, Temperature, Depth (CTD)

Summary

In this report we give details of problems encountered and then the calibration route in detail for the CTD data collected on cruise JR28. A full station list is given in table 1. The route for the calibration process is detailed in figure 1. In all CTD stations the 2 dbar averages of the downcast data are reported as the final product. In some cases the 1 db and 3 db level are missing from the final file. In these cases the shallowest level with data present was copied to these pressure levels.

The CTD equipment

The CTD unit used for the measurement program was the BAS Neil Brown Mk IIIb (serial number 01 - 3838 - 1086). The most recent calibration had been carried out by Ocean Scientific International from 4 July to 6 August 1997. The CTD was mounted in a purpose built frame with a General Oceanics 12 position bottle rosette. On each position on the rosette was a 10 litre General Oceanics sampling bottle controlled via a General Oceanics RMS MKVI 1015 - PM controlling unit. The package was also fitted with a 10 kHz pinger to enable accurate near bottom approach. On two of the 10 L bottles were SIS temperature Sensors. These were in one pair (serial numbers T716 and T717) and serial number T713 alone. After CTD 28ctd214 SIS temperature sensor T717 failed and so was replaced with serial number T711.
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.

CTD data were logged via a Neil Brown Instrument Systems deck unit, model 1150, to a 386 Viglen PC running E.G. and G. Marine Instruments CTD data acquisition module version 2.02 control software, and also to the RVS ABC system through a dedicated microcomputer. The CTD level A, mainly through historical reasons, averages the data at this point to 1 second values and passes the data through a simple editing procedure. During this editing procedure pressure jumps of greater than 100 raw units (eg for the pressure transducer equivalent to 10 dB) are removed along with spikes in individual channels through a median sorting routine. The rate of change of temperature change over 1 second is also calculated. These one second data are then passed to the ship's UNIX system and archived. Calibration routines are then applied to the data as described below.

Problems
A Full list of problems encountered with the system is given in table 2.

The calibration of the CTD

As stated, the BAS Neil Brown MK IIIb serial number 01 - 3838 - 1086 was used for all CTD stations. This unit was calibrated by Ocean Scientific International using six temperature standards, ten pressure standards and four conductivity standards and we use values from this calibration for the pressure and temperature sensors. The conductivity sensor was calibrated against *in-situ* salinity samples from the GO water bottles. We report 6 sets of coefficients for the conductivity and this is described in greater detail below.

Temperature calibration

The temperature calibration was derived by Ocean Scientific International using six calibration points between 0.6° and 26°C and was applied to the data through the following equation

$$T = [illegible] + [illegible] \times 10^{-4} T_{raw} + 1.01587 \times 10^{-12} T_{raw}^{2} \quad (1)$$

To allow for the mismatch in response times between the temperature sensor and conductivity sensor, following the standard procedure, the temperature was lagged for the salinity calculation. This lag was achieved by adding a fraction Δ of the rate of change of temperature that is output from the level A (dT/dt) to the temperature. The temperature is then

$$T_{new} = T + \Delta \frac{dT}{dt} \quad (2)$$

From experiment the spiking in the derived salinity was minimized with $\Delta = 0.15$.

Pressure calibration

A pressure calibration derived by Ocean Scientific International from 10 pressures between 0 and 5500 DB was applied through the following equation

$$P = -6.87333 + 9.99769 \times 10^{-2} P_{raw} - 1.6916 \times 10^{-9} P_{raw}^{2} \quad (3)$$

Following King and Alderson (1994) the pressures were then modified by the addition of a factor ΔP, to take into account the effect of temperature on the pressure sensor so that

$$P = P + \Delta P \quad (4)$$

And ΔP is calculated from

$$\Delta P = -0.4 \times (T_{lag} - 20.0) \quad (5)$$

Here T_{lag} is a lagged temperature in °C and is constructed from the CTD temperatures. We use a time constant for the lagged temperature of 400 seconds and update the temperature following the method put forward in King (1996). If T is the CTD temperature and t_{del} the time interval in seconds over which the temperature is being updated, and T_{const} our time constant of 400 seconds then the factor W is

$$W = \exp\left(-\frac{t_{del}}{T_{const}}\right) \quad (6)$$

and now

$$T_{lag}(t = t_0 + t_{del}) = W \times T_{lag}(t = t_0) + (1 - W) \times T(T = T_0 + t_{del}) \quad (7)$$

We finally make an adjustment to the upcast pressure to take into account hysteresis in the sensor. The extent of the hysteresis was calculated using a series of laboratory measurements. The hysteresis after a cast to 5500 m (which we denote by *dp5500(p)*) is given in table 3. These values were derived from a laboratory calibration at IOSDL in 1994. Intermediate values are found by linear interpolation. If the pressure of the cast is outside the values in table 3 then *dp5500(p)* is set to zero. For a cast in which the maximum pressure reached is p_{max} dbar, the correction to the upcast CTD pressure (p_i) is

$$p_{out} = \left(dp5500(p_i) - \left(\left(\frac{p_i}{p_{\max}}\right) \times dp5500(p_{\max})\right)\right) \quad (8)$$

Salinity (conductivity) calibration

We first describe the principal of our method and then detail the steps. For this cruise we calibrated the conductivity against *in-situ* samples collected with the GO multisampler rosette. Once the conductivity of the CTD was calibrated, we derived salinity. A full data processing route is detailed at the end of this report. In brief, first we applied a nominal calibration of the form

$$cond = 1 \times cond_{raw} + 0.0 \tag{9}$$

From the salinity samples, once successfully matched, we calculated the bottle sample conductivity using *in-situ* temperature and pressure from the CTD. From this *in-situ* conductivity we calculated the difference of the bottle conductivity ($cond_b$) and CTD conductivity ($cond_{ctd}$) to derive a value ΔC. We now plot bottle conductivity (*x variable*) against ΔC (*y variable*). This should give a straight line where from

$$y = m x + c \tag{10}$$

and we have

$$\Delta C = m\, cond_b + c \tag{11}$$

After rejecting suspect salinity samples we use linear regression (the pstar program "cndcoef") to derive *m* and *c* for ΔC.
Now, as

$$\Delta C = cond_b - cond_{ctd} \tag{12}$$

the calibration coefficients for the CTD conductivity are derived through substituting equation (12) into (11), the CTD conductivities are now

$$cond_{ctd} = a + b\, cond_{raw} \tag{13}$$

and from the *m* and *c* in equation (11)

$$a = \frac{c}{1 - m} \tag{14}$$

and

$$b = \frac{1}{1 - m} \tag{15}$$

These values for *a* and *b* are output from the program "cndcoef" and are entered into the calibration files for both the pstar and RVS system. The processing route is then repeated and the

new graph of ΔC against $cond_b$ gives the conductivity residuals, which should now be random with a mean of zero.
This calibration procedure does have a feature in that as we travelled from the north to the south along the Maurice Ewing Bank section and moved into waters where the entire water column was of lower conductivity than the station used for the initial calibration, the validity of the original m and c are called into question because of extrapolation. Accordingly we used different sets of coefficients for a and b when the calibration broke down. These coefficients are detailed in table 4.
After applying these calibration coefficients to the relevant stations there is still a residual drift within the conductivity signal with time. For each station this drift is the mean of the ΔC values.

$$\Delta C = \textit{residual drift}$$

From substitution into our original equations we can now remove this residual drift.

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 455 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 a 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 8400 S/N 45363. This salinometer was serviced and electronically aligned by Ocean Scientific International in August 1997. The salinity samples were analysed two stations at a time, and using three vials of 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 as described below. On Julian day 022 the cooling fan on the back of the Autosal failed and the instrument overheated. The problem was cured for the rest of the cruise by using a twelve volt fan connected to an external power supply.

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 5 the mean of the remaining samples was 0.000 with a standard deviation of 0.0019 psu. In table 5 we list the conductivity calibration file number used for each station along with the residual offsets applied to the cast after calibration (ΔC). We can see in table 5 that the drift of the sensor is small.

Suggestions.

The most useful suggestion to make is to point out that the BAS CTD unit is now very old and we should be seriously thinking of replacement to a more modern instrument. The instrument has been, and will continue to be used by both BAS and on STAP cruises. At the very least the PC

should be updated to a new system. It also has to be noted that the organisation of space within the UIC / Winch area is poor. When doing a CTD to near bottom there is a constantly moving cycle where the operator moves from the PC the echo sounder PC. This situation could be greatly cured by making sure that a replacement CTD unit was fitted with an altimeter. Basically the same holds for the Autosal, it should be replaced. The instrument 20 years old and is seriously showing signs of its age. The recent servicing from OSIL pointed out that the critical internal temperature control electronics are barely within specification. On the basis of problems MLSD have had with the instrument on JR26 (see report) and the failing of a basic electronic component this cruise, it will continue to deteriorate and could seriously compromise our programmes.

The CTD processing route for JR28

Step 1: ctdexec0
Purpose: To read in the CTD data from the RVS stream.
The programmes are
datapup - input the data from an RVS stream (bas_ctd) into a pstar file.
pcopya - reset the raw data flag in the pstar file.
pheadr - set the header of the pstar file.
The output is 28 ctd $num .raw

Step 2: ctdexec1
Purpose: To calibrate the ctd data.
The programmes are
ctdcal - to apply a nominal calibration to the ctd data.
mlist - to determine the on-deck pressure offset.
pcalib - remove the deck pressure offset.
peos83 - derive a sigma0.

The output file is 28 ctd $num
Also output is the data cycle at the end of the downcast. Record this value for step 8.

Step 3: sal.exec
Purpose: To read in the sample file from the mac to the UNIX system.
The programmes are
getexel.exec - reads data file from the mac
There are two files output. An ascii file called sam $num.txt,
and a pstar file sam $num.bot.
The file has six variables. These are bottle number, the salinity of the bottle, the salinity of the duplicate and the three thermometer values.

Step 4: ctdexec2
Purpose: To merge the bottle firing data to the sample data.
The programmes are
mrkcal - create an ascii file containing 10 s averages of the data *before* bottle firing.
sed - here we use a sed script to clear unwanted information from the ascii file.
pascin - read the ascii bottle firing data into a pstar file.
pcopya - copy in six t extra variables to the firing file.
ppaste - paste the six variables from sam$num.bot into the firing file.
peos83 - calculate *in-situ* conductivities of the salinity samples.

parith - calculate conductivity residuals (ΔC above).
mlist - get a quick and dirty plot of ΔC vs $cond_b$.

The output file is in the form 28 sam $num .cond
The exec requires 12 bottle firing levels to run successfully. For some of the CTD stations - in particular the shallow stations, more than one bottle was closed at each level. Therefore we end up with an ascii file from mrkcal with less than twelve levels. The exec will detect this and finish cleanly. To cure the problem we must manually edit the ascii file from mrkcal (cal_output) and copy the missing levels in. For example if we fired five bottles at 150 m we copy the 150 m level in cal_output four times to give five lines in cal_output for the 150 m level. You must then run "ctdexec2_fix" to run the exec from the point at which the sed operates on the ascii file.

Step 5: Determine the individual ctd offset
Use phisto to calculate residual ΔC for the station. This value of ΔC is the input for ctdexec3.

Step 6: ctdexec3
Purpose: To add the ΔC offset for the station.
The programmes are
pcalib - add the ΔC offset to 28 ctd $num
peos83 - derive a salinity from the new conductivity.

The output of the exec is in the form 28 ctd $num.cal

Step 7: Find the start of the downcast
Here we use mlist on the file 28 ctd $num.cal to list the variables pressure, temperature and salinity to find the start of the downcast. In the standard operating procedure (see appendix N) the package should enter the water and descend to approximately 10 DB. After a couple of minutes the package will be brought to the surface (pressure will decrease) before descending. The data cycle at which the pressure is a minimum (but > 0) and salinity does not go to zero is recorded as the start data cycle.

Step 8: ctdexec4
Purpose: To get the final output from the ctd data
The programmes are

pcopya - use the data cycles from step 2 and step 7 to copy out the downcast.
peos83 - derive a potential temperature (θ) and potential density (σ_0).
pmdian - remove large spikes from individual data streams.
pintrp - interpolate missing data removed by pintrip.
psort - sort the down cast into a file containing only increasing pressure (28 ctd $num.1hz).
pavrge - create 2 dbar averages of the .1hz file.
pintrp - remove missing data from the 2dbar file (usually none).

The output files from the exec are 28 ctd $num .1hz for the sorted 1 second down cast
and 28 ctd $num .2db for the 2dbar averaged file.

Step 9: samexec0
Purpose: To create a sample file with the corrected CTD data and calculate residuals. This step is similar to step 4, ctdexec2
Programmes

mrkcal - create an ascii file containing 10 s averages of the data before bottle firing.
sed - use a sed script to clear unwanted information from the ascii file.
pascin - read the ascii bottle firing data into a pstar file.
pcopya - copy in six extra variables to the firing file.
ppaste - paste the six variables from sam$num.bot into the firing file.
parith - calculate salinity residuals (ΔS).

There are two output files 28 sam $num .final
and 28 sam $num .offsets
The same problem that exists with ctdexec2 when there are less than 12 bottle levels exists for samexec0. You must edit the ascii file (cal_output) in the manner described above and run "samexec0_fix" to successfully run the exec.

Step 10: plot the data
We use a programme such as plotxy to plot the temperature, salinity and potential density of the CTD data. A hardcopy of the data is not required at this stage. What we are looking for is to see if there are any unrealistic density inversions in the regions of high temperature and salinity gradients at the surface. If there are such inversions move onto step 11.

Step 11: plxyed
Here we use the pstar interactive editor to remove the spikes identified in step 10. This editor replaces the bad data points with missing data.

Step 12: ctdexec5
Purpose: To remove the missing data from step 12
The programmes are
pintrp - interpolate across the bad temperature and salinity data.
peos83 - re-derive potential temperature (θ) and potential density (σ_0).

The output file is again called 28 ctd $num .2db

TABLES

Table 1: A full Station list for JR28

Event	identifier	Jday	Time (hh:mm)	Lat	Lon	Cast depth (m)	Water depth (m)
28ctd001	test	16	11:20	-49.1435	-47.8320	2032	5867
28ctd006	GC1	17	08:35	-47.8812	-43.3402	206	5614
28ctd008	MEB1	17	09:30	-47.8824	-43.3345	4620	5615
28ctd012	MEB2	17	15:55	-48.1784	-43.1415	1025	6005
28ctd016	MEB3	17	20:10	-48.4629	-42.9270	4464	5760
28ctd021	MEB4	18	03:31	-48.7391	-42.7618	2049	5958
28ctd026	GC2	18	08:38	-49.0363	-42.5797	209	5639
28ctd028	MEB5	18	09:25	-49.0376	-42.5774	2045	4822
28ctd033	MEB6	18	14:07	-49.3284	-42.3839	1023	5329
28ctd038	MEB7	18	18:22	-49.6129	-42.1790	1023	2102
28ctd043	MEB8	18	22:43	-49.9013	-41.9583	1019	1767

28ctd048	MEB9	19	03:15	-50.1867	-41.7367	1014	1412
28ctd052	MEB10	19	07:43	-50.4639	-41.5285	1020	1712
28ctd057	GC3	19	11:56	-50.7546	-41.2866	202	2359
28ctd059	MEB11	19	12:45	-50.7394	-41.2803	2027	2313
28ctd064	MEB12	19	18:27	-51.0376	-41.0361	2042	2863
28ctd069	MEB13	19	23:18	-51.3025	-40.8197	2997	3475
28ctd074	MEB14	20	05:07	-51.6148	-40.6077	3076	3794
28ctd080	MEB15	20	10:37	-51.9047	-40.3851	1021	3768
28ctd084	MEB16	20	15:00	-52.1597	-40.1602	3054	3783
28ctd090	MEB17	20	20:38	-52.4638	-39.8949	1024	3796
28ctd094	MEB18	21	01:21	-52.7462	-39.6446	3077	3791
28ctd099	GC4	21	06:57	-53.0413	-39.4026	205	3816
28ctd101	MEB19	21	07:45	-53.0406	-39.4082	1024	3809
28ctd106	MEB20	21	12:15	-53.3190	-39.1566	3070	3691
28ctd111	MEB21	21	18:15	-53.6053	-38.9014	1023	1200
28ctd116	GC5	21	22:24	-53.8934	-38.6550	143	184
28ctd118	MEB22	21	23:05	-53.8938	-38.6590	163	181
28ctd120	AC1	22	11:24	-54.1585	-36.7003	47	53
28ctd125	E12N	24	22:45	-53.8602	-35.4025	1023	2601
28ctd133	E12S	25	05:10	-54.0759	-35.9182	204	218
28ctd142	E22S	25	22:07	-54.2453	-35.7333	204	229
28ctd149	GC6	26	03:29	-54.0402	-35.2168	204	2063
28ctd153	E22N	26	04:47	-54.0421	-35.2259	1449	2052
28ctd162	E32N	26	21:53	-54.1868	-35.0475	1023	2851
28ctd170	E32S	27	03:39	-54.3904	-35.5362	263	274
28ctd180	E42S	27	22:00	-54.5388	-35.3857	163	184
28ctd189	GC7	28	02:41	-54.3324	-34.8759	205	1814
28ctd190	E42N	28	03:29	-54.3293	-34.8791	1022	1825
28ctd197	E52N	28	17:57	-54.3575	-34.4455	3831	3794
28ctd201	AC2	29	11:20	-54.1585	-36.7004	45	65
28ctd205	W12S	30	21:58	-53.8200	-38.8786	194	221
28ctd212	GC8	31	02:53	-53.4639	-38.9896	206	3029
28ctd214	W12N	31	03:41	-53.4662	-38.9942	1026	3038
28ctd223	W22N	31	21:50	-53.4319	-38.6988	1025	3505
28ctd231	W22S	32	03:49	-53.7872	-38.5836	199	210
28ctd242	W32S	32	22:09	-53.7508	-38.2793	183	217
28ctd249	GC9	33	03:02	-53.3963	-38.3954	204	2922
28ctd251	W32N	33	03:51	-53.3946	-38.4008	1023	2951
28ctd261	W42N	33	21:30	-53.3619	-38.0830	1020	2667
28ctd269	W42S	34	03:24	-53.7119	-37.9679	125	137
28ctd276	W52N	34	13:32	-53.1454	-37.8240	1022	3359

Table 2: Full list of CTD problems.

Station event number	Identifier	Problem
008	MEB 1	Level A Reset.
012	MEB 2	Deepest bottle did not fire.
190	E42N	Bottles 7 and 8 screw caps loose on sampling.
214	W12N	Thermometer T717 failed, replaced with number T711

Table 3: The table of hysteresis corrections in the pressure sensor

p (dp)	dp5500(p) db
0.0	0.0
100	2.7
200	3.9
1000	5.9
1500	6.3
2000	5.8
2500	5.7
3000	5.1
3500	4.5
4000	3.7
4500	2.4
5000	1.5
5500	0.0

Table 4: Calibration coefficients used for the conductivity calibration

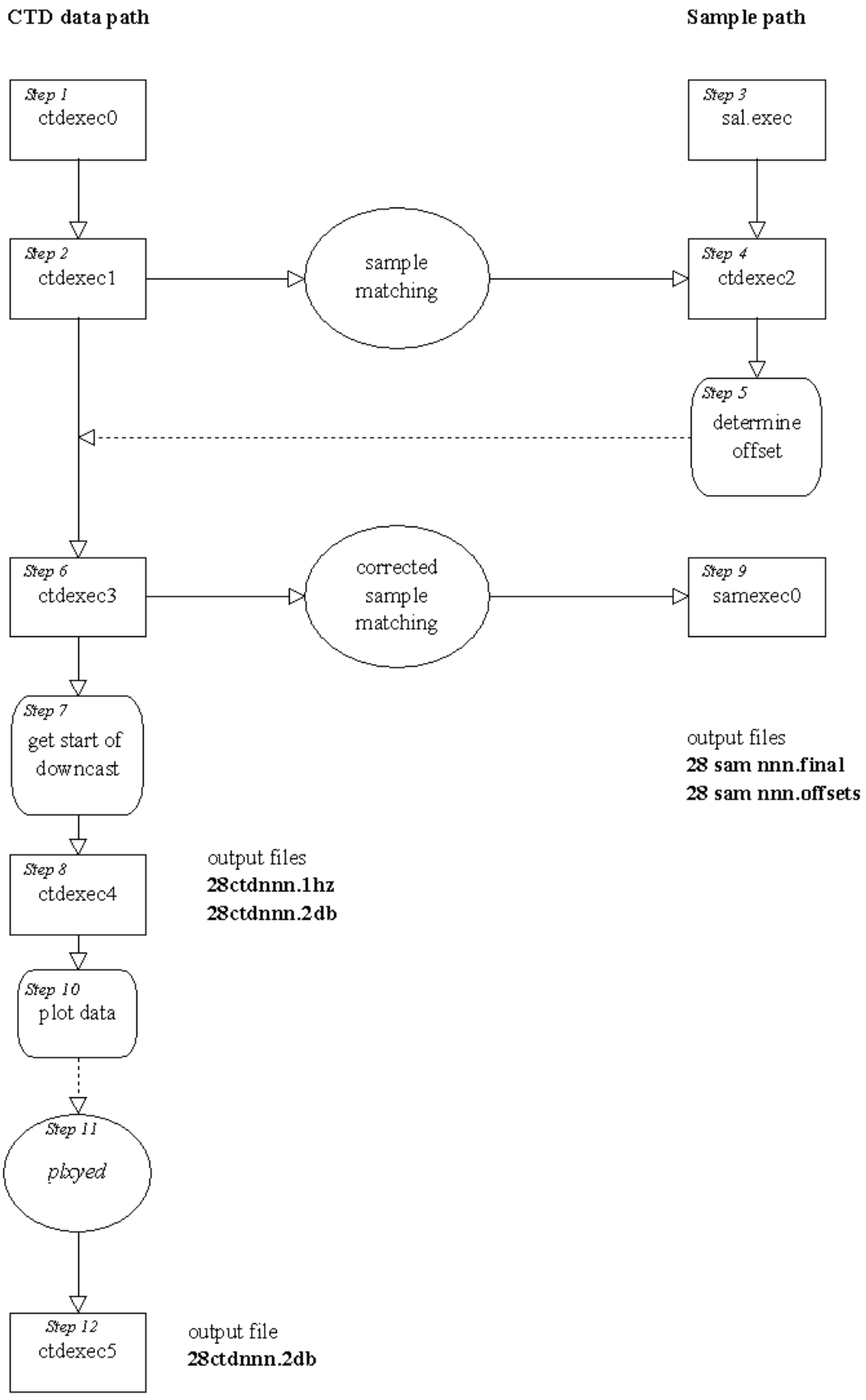
Calibration number	a	b	From station
1	-0.090969985	0.919640274	28ctd001
2	0.009260414	0.916684766	28ctd012
3	-0.128060504	0.923098032	28ctd016
4	-0.028106422	0.917735400	28ctd069
5	-0.064944782	0.918845750	28ctd084
6	-0.029766267	0.917756613	28ctd111

Table 5: Calibration summary for CTD stations on JR28

Station event number	Identifier	Offset	Rejected bottles	Calibration file
28ctd001	Test cast	-0.0005	11, 12	1
28ctd006	GC1	0.0011		2
28ctd008	MEB1	0.0011	9	2
28ctd012	MEB2	0.0000		2
28ctd016	MEB3	0.0000	1, 11	3
28ctd021	MEB4	-0.0018		2
28ctd026	GC2	-0.0031		2
28ctd028	MEB5	-0.0031		2

28ctd033	MEB6	-0.0036	9	2
28ctd038	MEB7	-0.0031	10, 11	2
28ctd043	MEB8	-0.0040	12	2
28ctd048	MEB9	-0.0033		2
28ctd052	MEB10	-0.0035	12	2
28ctd057	GC3	-0.0027		2
28ctd059	MEB11	-0.0027		2
28ctd064	MEB12	-0.0029		2
28ctd069	MEB13	0.0000	2	4
28ctd074	MEB14	0.0025	5	4
28ctd080	MEB15	0.0009		4
28ctd084	MEB16	-0.0006	7	5
28ctd090	MEB17	0.0002	6, 9	5
28ctd094	MEB18	0.0012		5
28ctd099	GC4	-0.0001		5
28ctd101	MEB19	-0.0001		5
28ctd106	MEB20	0.0019		5
28ctd111	MEB21	0.0000	8	6
28ctd116	GC5	0.0001		6
28ctd118	MEB22	0.0001		6
28ctd125	E1.2N	0.0008	11	5
28ctd133	E2.1S	0.0016		5
28ctd142	E2.2S	0.0014	1	5
28ctd149	GC6	0.0002		5
28ctd153	E2.2N	0.0002		5
28ctd162	E3.2N	0.0012		5
28ctd170	E3.2S	-0.0002	5	5
28ctd180	E4.2S	0.0005	1, 7	5
28ctd189	GC7	0.0005		5
28ctd190	E4.2N	0.0002		5
28ctd197	E5.2S	0.0022	8	5
28ctd205	W1.2S	0.0009	7	6
28ctd212	GC8	0.0012		5
28ctd214	W1.2N	0.0012	7, 10	5
28ctd223	W2.2N	0.0009	10	5
28ctd231	W2.2S	-0.0004		5
28ctd242	W3.2S	0.0008	8	5
28ctd249	GC9	-0.0020		5
28ctd251	W3.2N	-0.0020	8	5
28ctd261	W4.2N	0.0000		5
28ctd269	W4.2S	0.0020	8, 9, 12	5
28ctd276	W5.2N	-0.0001		5

Figure 1: The CTD processing path



CTD Appendix A: 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

Bottle levels in bold have reversing thermometers on them

Core Box CTD sampling strategy

There are three types of CTD stations
1) shallow
2) deep
3) Geoff Cripps specials.

Type 1: SHALLOW
These are at the inshore end of a UOR leg. The water depths will typically be around 200 m. The cast is to go to 10 m off the bottom. Bottles are to be closed at

bottom, 5 at 150, 125, 100, 80, 60, 40, 20

There should be Eight salt samples taken. One from each bottle level (i.e no duplicates).

Type 2: DEEP
These are at the offshore end of the UOR leg. Water depths will typically be over 2500 m. The cast is to go to 1000. Bottles are to be closed at

1000, 800, 600, 400, 200, 150, 125, 100, 80, 60, 40, 20

samples are to be taken from the all twelve levels.

Type 3: GEOFF CRIPPS SPECIAL
These are wherever Geoff needs them but are only to 200 m. Typically he needs six bottles closing at 200 m and six bottles at 30.
We do not take salt samples from these stations.

Appendix B: A Standard operating procedure for the BAS Neil Brown Mk III CTD unit
Mark Brandon, MLSD Pat Cooper, ETS.

At the CTD

Check the package is ready for deployment - i.e all the rosette bottles are both empty and cocked and screw valves at the top of each bottle are shut. Ensure protective cap is removed from temp/salinity probe. Set the reversing thermometers to sample.

In the UIC

1) Make sure the unit source selector above the CTD PC is switched to CTD.
2) Switch on the CTD PC, the EG+G software will automatically load.
3) Fill in the CTD form whilst the PC is booting up.
4) set the Level B terminal to show data for the bas_ctd data stream. Set the comments to be on for the bas_ctd.
5) Switch on the CTD deck unit. (Bottom unit to right of PC - silver front panel with digital display. Switch “source” should be “direct”. Switch “Audio” should be “off”. White switch should be set to “on”). The unit should start whirring and light up.
6) Switch the Level A stream on. (Grey unit labelled “Data Transfer Switch” above deck unit).
7) Check data is scrolling on the Level B terminal.
8) Check at least one “Bas_ctd clock correct” message prints on the Level B screen.

9) Switch clock input to off. (Silver faced unit to right of Level A switch labelled ESW-225. Put switch in position 2).

At the PC

To use the PC software you can move along the top of the menu's with the left and right keyboard arrow. The only important menu's is the "Settings " menu.

10) Select the "Graph Set up" screen in the "Settings Menu".

11) Select the axes limits using the up and down arrows keys. Enter the correct axes limits. It is a good idea to add an additional 100 m to the depth of the cast for the pressure axes.

12) To leave this form press F2 which means "read form".

13) Go to the "Acquisition Menu". "Deploy Instrument" will be highlighted. Press return.

14) Press Space Bar on PC to start PC logging.

15) Switch on Rosette Control Unit. (Black unit beneath Level A switch and clock. Switch on RHS, a bright red light and a green light should come on).

CTD can now be deployed

16) Notify winch operator that CTD is ready for deployment.

17) Deploy the CTD to 9 m depth. NOTE TIME IN WATER ON LOGSHEET.

18) Wait 2 minutes for package to "acclimatise".

19) Depending on conditions bring the CTD as close to the surface as is safe.

20) Start lowering the CTD increasing to a maximum rate of 60 m/min. NOTE TIME START DOWN ON LOGSHEET.

At the Bottom

21) NOTE RELEVANT DETAILS ON LOGSHEET.

22) Press control F10 on the PC.

23) Press return twice to get past unnecessary inputs.

24) Press "y" for "acquire data on the upcast", and then press space bar.

25) press F10 to pause the PC

26) switch off the Level A data stream.

27) Fire one rosette bottle - light on the rosette control unit will go from green to orange.

28) When the CTD deck unit digital display is stable *switch the Level A data stream back on.*

29) Check data stream on Level B monitor.

30) Press space bar on PC.

On the upcast

31) At each of the chosen levels for water samples, stop the package at that level and let it sit for 1 minute, turn off the level A and fire a bottle. (If the bottle has a reversing thermometer attached, the package is to sit for 30 seconds *after* the bottle has been closed)

32) press F10 to pause the PC

33) switch off the Level A data stream.

34) Fire one rosette bottle - light on the rosette control unit will go from green to orange.

35) When the CTD deck unit digital display is stable *switch the Level A data stream back on.*

36) Check data stream on Level B monitor.

37) Press space bar on PC.

38) Repeat until ALL bottles are closed.

39) Do not bring the package out of the water without firing all the rosette bottles.

At the End of the Cast

40) press control F10 on the PC followed by a couple of returns to avoid unnecessary inputs, and then "escape" to leave the software.

41) Switch off the Level A data stream.

42) Switch on the clock (to position 1).

43) Switch off the rosette control unit.

44) Switch off the deck unit.

45) Inform the watch leader that it is all done.

At The CTD package

1) Read reversing thermometers.

2) Using *one sample crate* per CTD cast, take one 300 ml sample of water from each bottle. Note carefully the sample and bottle numbers on the log sheet.

3) Place the sample crate in the prep lab and stow next to the salinometer for analysis.

Troubleshooting

There is not data scrolling on the Level B monitor

1) Check Monitor is switched to show data for bas_ctd.
2) Check Level A data stream switch is "on".
3) Make sure clock switched off.
   Switch off Level A data switch
   Press red reset switch on the CTD Level A (unit above data switches labelled "Quarndon Systems").
   Wait 30 seconds
   Switch on clock
   Wait until you see a clock correct message on the level B monitor
   Switch on Level A data stream
4) If data still does not scroll on the Level B terminal *seek technical assistance.*

WARNING

WHEN THE CTD IS ON DECK AND THE ROSETTE POWERED UP,
THE INSTRUMENT IS DANGEROUS

KEEP PEOPLE CLEAR OF THE CTD CONTROL EQUIPMENT

8.3 Expendable Bathymetric Thermograph (XBT)

Summary
During JR28 a total of 47 XBT probes were deployed. These probes were kindly supplied by the Hydrographic Office, Taunton. The probes were deployed in two phases, firstly one type T5 between CTD stations, on the Maurice Ewing Bank Section, and every two hours on the return from South Georgia to Stanley. In general the probes gave excellent data. There was one problem with the system at the start of the Maurice Ewing Bank section which was cured when a loose earth lead was re-attached to the system control unit.

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 allow the temperature shock as they enter the water to minimised. The computer system consists of an 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 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 returned 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
The only problem with the syatem was at the first XBT when there were three successive failures. This problem was traced to a loose earth lead on the deck unit. The unit then functioned perfectly.

Suggestions
The XBT system is getting a lot of use, in this season at least 300 XBT probes have been launched. With this degree of use, update of the system should be considered. For modifications to the existing system the cable to the XBT launcher should be lengthened by at least 10 m. To greatly improve our system we should aim to have a hull mounted launcher fitted to one of the

stern quarters - with the option of using the hand launcher if sea conditions make the hull mounted launcher unsatisfactory. We should be looking at a more modern system as the current one is 8 years old and has apparently not been updated.

Table 1: XBT deployments during JR28

Event	Jday	hh:mm	Lat (°)	Lon (°)	Water Depth (m)
28xbt019	018	01:37	-48.2150	-44.4640	3782
28xbt024	018	06:55	-48.9015	-42.6840	5995
28xbt031	018	12:34	-49.1891	-42.4821	5126
28xbt036	018	16:47	-49.4644	-42.2919	4831
28xbt041	018	21:04	-49.7660	-42.0717	1915
28xbt046	018	16:47	-50.0439	-41.8666	1567
28xbt050	019	06:00	-50.3298	-41.6444	1453
28xbt055	019	10:16	-50.6200	-41.4096	2039
28xbt062	019	16:41	-50.9029	-41.1683	2596
28xbt067	019	21:46	-51.1935	-40.9304	3168
28xbt072	020	03:35	-51.4819	-40.7091	3817
28xbt077	020	08:47	-51.7444	-40.5052	3765
28xbt082	020	13:22	-52.0349	-40.2697	3775
28xbt088	020	19:00	-52.3102	-40.0321	3799
28xbt092	020	23:29	-52.6149	-39.7611	3791
28xbt097	021	05:16	-52.8972	-39.5248	3800
28xbt104	021	10:28	-53.1757	-39.2786	3876
28xbt114	021	20:55	-53.7414	-38.7856	337
28xbt280	035	21:01	-53.8047	-39.1846	342
28xbt281	035	22:54	-53.6343	-39.8362	2343
28xbt282	036	01:03	-53.4123	-40.5520	2302
28xbt283	036	01:09	-53.4032	-40.5860	2339
28xbt284	036	03:00	-53.2479	-41.1444	2215
28xbt285	036	04:58	-53.0920	-41.6900	2217
28xbt286	036	07:01	-52.9978	-42.2591	1849

28xbt287	036	08:59	-53.0036	-42.8932	1986
28xbt288	036	10:55	-53.0015	-43.5822	1921
28xbt289	036	13:03	-52.9996	-44.3378	2368
28xbt290	036	15:05	-53.0020	-45.1080	2288
28xbt291	036	17:04	-53.0026	-45.8601	2367
28xbt292	036	18:54	-52.9973	-46.5427	1805
28xbt294	036	20:51	-52.9927	-46.8084	2227
28xbt295	036	22:59	-53.0002	-47.5505	2657
28xbt296	037	00:58	-52.9949	-48.2714	3050
28xbt297	037	03:00	-52.9948	-48.9628	3121
28xbt298	037	05:02	-52.9918	-49.6899	2590
28xbt299	037	07:00	-53.0106	-50.3561	2504
28xbt300	037	09:03	-53.0022	-51.0314	2751
28xbt301	037	10:59	-53.0151	-51.6818	2831
28xbt302	037	12:58	-53.0063	-52.3445	2754
28xbt303	037	15:02	-52.9999	-53.0172	3170
28xbt304	037	17:00	-53.0052	-53.6549	3116
28xbt305	037	19:07	-53.0064	-54.3000	2910
28xbt306	037	20:59	-52.9362	-54.7135	2418
28xbt307	037	22:56	-52.9282	-55.3027	2340
28xbt308	038	01:02	-52.6452	-55.8999	1860
28xbt309	038	02:12	-52.4717	-56.2194	1430

8.4 Underway Monitoring - Oceanlogger

Standard processing scripts for dealing with oceanlogger data are given in Appendix a to H following this section.

Appendix A: JR26_ocean

```
#############################################################################
#
#  JR26_ocean
#
#  Description:
#   Hell man - this is exec is going to do it all (I hope )
#
#
```

```
#  Processing steps:
#
#      STEP_01: run oclexec0
#      STEP_02: run oclexec1
#      STEP_03: plot the daily ocean file
#      STEP_04: plot the daily met file
#
#  History:
#  Version Date     Author Description
#
#  01               MAB    original and I suspect the only EVER version!
#
#  NEXT    ??/??/?? ???    please fill in the details here
#
################################################################################

echo " "
echo " "
echo " This exec will run the 2 daily oclexecs and plot the data "
echo " For one JDAY "
echo " All you must do is enter the Jday "
echo " "
echo " "
echo -n " Continue (y/n)? "
set ans = $<
if ($ans != "y") exit

echo " "
echo " "
echo " "
echo " "
echo -n "Please enter the Jday in the form (N)   "
set jday = $<

touch JR26.talk

echo " "
echo " Step 01: reading in the oceanlogger for day $jday "

oclexec0 >> JR26.talk << !
y
$jday
!

if ($status != 0) then
   echo " Problem reading in oceanlogger data"
   exit
endif


echo " "
echo " Step 02: tidying up the data "

oclexec1 >> JR26.talk << !
y
$jday
!

if ($status != 0) then
   echo " Problem tidying the data "
   exit
endif

echo " "
echo " Step 03: Plotting out the ocean data for day $jday "

ocean_plot >> JR26.talk << !
y
$jday
!

if ($status != 0) then
   echo " Problem plotting the ocean data "
   exit
endif
```

```
echo " "
echo " Step 04: plotting the met data for day $jday "

met_plot >> JR26.talk << !
y
$jday
!

if ($status != 0) then
   echo " Problem plotting the met data "
   exit
endif

flocean0 >> JR26.talk << !
y
$jday
!
if ($status != 0) then
   echo " Problem running the flocean0 stuff "
   exit
endif
/bin/mv JR26.talk $jday.oceanlogger.output

echo " "
echo " That is the and of JR26_ocean "
echo " "
echo " I suggest you go through it and pick up the pieces....."
echo " "
echo " These pieces are stored in a file called $jday.oceanlogger.output "
echo " "
echo "        **** The End **** "

exit
```

Appendix B: oclexec0

```
###############################################################################
#
#  oclexec0
#
#  Description:
#               read in and perform preliminary processing on oceanlog data
#
#  Processing steps:
#  STEP_01  read in data from rvs format
#  STEP_02
#  STEP_03  create archive copies
#
#  History:
#  Version Date     Author       Description
#  00               SGA          original version
#  01      29/11/96 MAB          Drake Passage R96 (JR16)
#  02      10/12/96 MAB          JR17 - to convert to BAS conventions
#  03      17/10/97 MAB          JR25 - brought up to the JR25 conventions
#  NEXT    ??/??/?? ???         Please make a note of your changes here -
#                                using as many lines as necessary.
#                                If the changes are substantial perhaps a new
#                                exec might be better?
#
###############################################################################

########## Initialisation ###################################

#  check directories
echo " "
echo " "
echo " "

   if ($?P_OCL) then
     echo "changing directory to P_OCL: $P_OCL"
     cd $P_OCL
   endif
echo " "
echo " "

#  set up variables and files

  /bin/rm -f ocltmp
  /bin/rm -f oclexec0.talk
   touch oclexec0.talk

#############################################################


########## Get information from the user ###################

   echo "> This exec will require the following information:"
   echo ">   the jday of the oceanlog file number"
   echo " "
   echo " "
   echo -n "> Continue (y/n)? "
   set ans = $<
   if ($ans != "y") exit

#
   echo " "
   echo " "
   echo -n "* Please enter the Jday number : "
   set num = $<

  if ( -e ${CRUISE}ocl$num.raw ) then
    echo "* The file ${CRUISE}ocl$num.raw already exists.  If you mean"
    echo "* to overwrite it, you must remove it first."
    exit
  endif
```

```
   if ( $num < 100 && $num >= 10 )   then
     set num = 0${num}
   endif

   if ( $num >= 0 && $num < 10 ) then
     set num = 00${num}
   endif

   set start = 97${num}000000
   set stop  = 97${num}235959
   echo " "
   echo $start
   echo $stop
   echo " "

     set start = "-s"$start
     set stop  = '-e'$stop

   set rvs_fil = oceanlog
   set rvs2 = anemom

############################################################
########## Main processing steps ###########################
############################################################
#  STEP_01
#
#  read in from rvs format file - set of variables in RVS file
#  check this list against the var names - rvs command 'variables'
#  the variable 'time' is automatically supplied as the first
#  variable in the output file
   echo "> running datapup for the oceanlogger"

   datapup $start $stop $rvs_fil ./ocean.raw -

   if ($status != 0) then
     echo "> *** problem running datapup  ***"
     exit
   endif

#
#  reset raw data flag
#

   echo "> running pcopya"
   cat << ! | sed 's/^   //' | pcopya >> oclexec0.talk
   ocean.raw
   y
   /
   /
   /
!
   if ($status != 0) then
     echo "> *** problem running pcopya - see oclexec0.talk ***"
     exit
   endif

############################################################
# STEP_02 - Read in the anemometer data
#

   echo ""
   echo "> Running datapup for the anemometer "
   datapup $start $stop $rvs2 ./anemom.raw -
   if ($status != 0) then
     echo "problem running datapup "
     exit
   endif

#  Reset raw data flag
   pcopya >> oclexec0.talk << !
anemom.raw
y
/
/
/
```

```
!
   if ($status != 0) then
     echo "problem running pcopya - see oclexec0.talk"
     exit
   endif

############################################################
# STEP_03 merge the data files together
 echo " "
 echo " merging the two files together on time "
 echo "  "
   pmerge >> oclexec0.talk << !
ocean.raw
ocltmp
time atemp sstemp par tir fluor flow press cond tstemp /
anemom.raw
time wind_spd wind_dir /
!
   if ($status != 0) then
     echo "problem running pcopya - see oclexec0.talk"
     exit
   endif


############################################################
#  STEP_04 Now set the header information
#
#

   echo "> Running pheadr"
   print_datnam ocltmp old
   cat << ! | sed 's/^   //' | pheadr >> oclexec0.talk
   ocltmp
   y
   1
   ${CRUISE}ocl$num
   2
   oceanlog
   ship
   $SHIPNAME
   $CRUISE
   5       seconds
   /
   /
   y
!
   if ($status != 0) then
     echo "> *** problem running pheadr - see oclexec0.talk ***"
     exit
   endif
   pinq -FD ocltmp

############################################################
#  STEP_03
#  Just rename the data

   /bin/mv -f ocltmp ${CRUISE}ocl$num.raw

########## Keep directories tidy ############################

   /bin/rm -f ocltmp
   /bin/rm -f anemom.raw
   /bin/rm -f ocean.raw
   /bin/rm -f oclexec0.talk

   echo "> file created: ${CRUISE}ocl$num.raw "
   pinq -FD ${CRUISE}ocl$num.raw

########## The End ##########################################

   echo " "
   the_end:

   echo "> end of oclexec0"
   exit
```

Appendix C: oclexec1

```
###############################################################################
#
#  oclexec1
#
#  Description:
#  This is an exec to despike the conductivities, calculate
#  the salinities,
#  average it all and then merge in the navigation.
#
#  was put together from the "old" tsgexec1 by Mark Brandon (BAS)
#
#  Files produced:
#
#  ${CRUISE}met$num.raw       The meterological data
#  ${CRUISE}ocl$num           The slightly cleaned surface data (with salt)
#  ${CRUISE}ocl$num.2min      as above + 2min average + gps navigation
#
#  Main processing steps:
#  STEP_01      Copy out the ocean logger data
#  STEP_02      Copy out the met data
#  STEP_03      Tidy the conductivity (only using pmdian)
#  STEP_04      Calculate the salinity
#  STEP_05      average the data into 2 minute bins then merge in navigation
#
#  History:
#  Version Date     Author      Description
#             0  0                                    1  3  /  1  1  /  9  6       M  A  B
Original version, Drake Passage JR16
#             0  1                                    1  0  /  1  2  /  9  6       M  A  B
JR17 Converted to BAS conventions.
#             0  1                                    1  7  /  1  0  /  9  7       M  A  B
JR25 Updated to keep up with the times
#
#  NEXT    ??/??/?? ???         Please make a note of your changes here
#                               - using as many lines as necessary.  If
#                               the  changes are  substantial perhaps a
#                               new exec might be better?
#
###############################################################################

#  Set up variables and files
#  check directories
echo " "
echo " "
echo " "

   if ($?P_OCL) then
     echo "changing directory to P_OCL: $P_OCL"
     cd $P_OCL
   endif
echo " "
echo " "


   /bin/rm -f oclexec1.talk
   touch oclexec1.talk
   set output = oclexec1.talk

#############################################################

########## Get information from the user ###################

   echo "> This exec will require the following information:"
   echo ">    The Jday of the oceanlogger file "
   echo -n "> Continue (y/n)? "
   set ans = $<
   if ($ans != "y") exit


#  File sequence number. This may need to be changed from
#  time to time.
```

```
   echo -n "Enter  the JDAY        :"
   set num = $<

   if ( $num < 100 && $num >= 10 )   then
     set num = 0${num}
   endif

   if ( $num >= 0 && $num < 10 ) then
     set num = 00${num}
   endif


#################################################################
# STEP_01 copy out the ocean data
#
   echo " "
   echo " Copying out the ocean data "
   pcopya >! $output <<!
${CRUISE}ocl$num.raw
n
${CRUISE}ocl$num.raw.tmp
time sstemp tstemp cond flow fluor flow /
/
/
!
if ( $status != 0) then
  echo 'Problem Running Pcopya'
  exit
endif

  pheadr >! $output <<!
${CRUISE}ocl$num.raw.tmp
/
/
7
press
db
2
sstemp
degrees
3
tstemp
degrees
4
cond
mmho/cm
5
flow
uncalib
6
fluor

/
/
!
if ( $status != 0) then
  echo 'Problem Running Pheadr'
  exit
endif

   echo " "
   echo " Taking out the howlers in the ocean file"
   pedita >! $output <<!
${CRUISE}ocl$num.raw.tmp
y
/
flow -100 250 /
y
0/
!
if ( $status != 0) then
  echo 'Problem Running pedita'
  exit
endif
```

```
#################################################################
# STEP_02 copy out the met data
#

   echo " "
   echo " Copying out the met data "
   pcopya >! $output <<!
${CRUISE}ocl$num.raw
n
${CRUISE}met$num.raw
time atemp wind_spd wind_dir press par tir /
/
/
!
if ( $status != 0) then
  echo 'Problem Running Pcopya'
  exit
endif

#################################################################
# STEP_03 calculate the salinity for the ocean data
#

# Set pressure to zero
  pcalib >! $output << !
${CRUISE}ocl$num.raw.tmp
y
press 0 0 0/
/
!
  if ( $status != 0) then
    echo 'Problem Running pcalib'
    exit
  endif

#################################################################
# STEP_03 - tidy up the conductivity a little
#
# Median despiking on conductivity
  echo " "
  echo " Tidying the conductivity "
  pmdian >! $output << !
${CRUISE}ocl$num.raw.tmp
y
cond 0.05/
/
!
  if ( $status != 0) then
    echo 'Problem Running pmdian'
    exit
  endif

#################################################################
# STEP_04 - derive a raw salinity
#

  peos83 >! $output << !
${CRUISE}ocl$num.raw.tmp
${CRUISE}ocl$num.raw.tmp2
time sstemp tstemp cond flow fluor/
1
press tstemp cond
rawsalin
/
!

if ( $status != 0) then
  echo 'Problem Running Peos83'
  exit
endif

#################################################################
# STEP_05 - average the data and then merge in the navigation
#
#  Create 2 min averages
```

```
  echo " "
  echo " Averaging the data into 2 minute bins "
  pavrge >! $output << !
${CRUISE}ocl$num.raw.tmp2
${CRUISE}ocl$num.raw.tmp3
1,0,120,0/
!
  if ( $status != 0) then
    echo 'Problem Running pavrge'
    exit
  endif
   echo " "

#  echo -n "> Enter number of pstar nav file (eg 1 gives file abnv${CRUISE}1): "
#  set nav = $<
#  set nav = 01

  echo "  "
  echo " Now merging the navigation to the averaged ocean file "
  pmerge >! $output << !
${CRUISE}ocl$num.raw.tmp3
${CRUISE}ocl$num.raw.tmp4
/
/users/mlsd/pstar/data/nav/gps/${CRUISE}gps$num.raw
time lat lon/
!
  if ( $status != 0) then
    echo 'Problem Running pmerge'
    exit
  endif


/bin/rm -f ${CRUISE}ocl$num.raw.tmp ${CRUISE}ocl$num.raw.tmp3
/bin/rm -f oclexec1.talk
/bin/mv ${CRUISE}ocl$num.raw.tmp2 ${CRUISE}ocl$num
/bin/mv ${CRUISE}ocl$num.raw.tmp4 ${CRUISE}ocl$num.2min

echo " "
echo " "
echo " The output datanames and versions are "
echo " "

pinq -FD ${CRUISE}met$num.raw
pinq -FD ${CRUISE}ocl$num
pinq -FD ${CRUISE}ocl$num.2min

#/bin/mv ${CRUISE}met$num.raw /users/mlsd/pstar/data/met/${CRUISE}met$num.raw
#echo " "
#echo " The file : ${CRUISE}met$num.raw moved to ~/data/met "

echo " "
echo " "
echo " "
echo "*** THE END ***"
echo " "
echo " "
echo " "
exit
```

Appendix D: ocean_plot

```
#############################################################
#
#    OCEAN_PLOT EXEC
#
#    Description:
#    Exec to take the daily oceanloger files and plot out
#    certain standard plots.
#
#    Processing Steps
#    STEP_01 Plot out the SST and SSsal data
```

```
#    STEP_03 Plot out the fluorescence data
#
#    History
#    Version   Date        Author         Description
#    00        3/1/96      MAB            original
#    01        12/12/96    MAB            update
#
#
############################################################
############################################################
########## Initialisation ##################################
#  set up variables and files
#  check directories
echo " "
echo " "
echo " "

   if ($?P_OCL) then
     echo "changing directory to P_OCL: $P_OCL"
     cd $P_OCL
   endif
echo " "
echo " "

   /bin/rm -f ocean_plot.talk
   touch ocean_plot.talk

############################################################
########## Get information from the user ###################
   echo "* "
   echo "* we need the following information:"
   echo "* The JDAY of the file "
   echo -n "* Continue (y/n)? "
   set ans = $<
   if ($ans != "y") exit

   echo -n "* Enter jday of file (eg 01 gives file ${CRUISE}oce001): "
   set num = $<

   if ( $num < 100 && $num >= 10 )   then
     set num = 0${num}
   endif

   if ( $num >= 0 && $num < 10 ) then
     set num = 00${num}
   endif

#############################################################################

############################################################
############################################################
########## Main processing steps ###########################
############################################################
############################################################
#  STEP_01  Run plotxy to get the SStemp and SSsal plots
#
   echo " "
   echo "* Running plotxy for the temperature and salinity"
   echo " "
   plotxy >> ocean_plot.talk << !
pdfs/SStemp.pdf
4
${CRUISE}ocl$num
/
y
3
${CRUISE}ocl$num
s mpost;e


!
   if ($status != 0) then
     echo "problem running plotxy"
     echo " See ocean_plot.talk "
     exit
```

```
   endif

   /bin/mv POST SSts.pst
   lpr -Pscience -h SSts.pst

#################################################################
#################################################################
# STEP_02
#
   echo " "
   echo "* Finally running plotxy for the fluoro data"
   echo " "
   plotxy >> ocean_plot.talk << !
pdfs/fluoro.pdf
4
${CRUISE}ocl$num
/
y
3
${CRUISE}ocl$num
s mpost;e


!
   if ($status != 0) then
     echo "problem running plotxy"
     echo " See ocean_plot.talk "
     exit
   endif

   /bin/mv POST fluro.pst
   lpr -Pscience -h fluro.pst

#
# Now just tidy up
#
   /bin/rm -f ocean_plot.talk
   /bin/rm -f uniprnt
   /bin/rm -f *.pst

########## The End ########################################

   echo " "
   echo "* end of ocean_plot exec"
   echo " "
   echo "* The plot files that have been sent to the science printer"
   echo " "
   the_end:
  exit
```

Appendix E: met_plot

```
#################################################################
#
#    MET_PLOT EXEC
#
#    Description:
#    Exec to take the daily met files and plot out
#    certain standard plots.
#
#    Processing Steps
#    STEP_01 Plot out the air temperature data
#    STEP_02 Plot out the wind and air pressure data
#
#    History
#    Version   Date        Author         Description
#    00        3/1/96      MAB            original
#
#
#################################################################
#################################################################
########## Initialisation ########################################
```

```
#  set up variables and files
echo " "
echo " "
echo " "

   if ($?P_OCL) then
     echo "changing directory to P_OCL: $P_OCL"
     cd $P_OCL
   endif
echo " "
echo " "

   /bin/rm -f met_plot.talk
   touch met_plot.talk

############################################################
########## Get information from the user ###################
   echo "* "
   echo "* we need the following information:"
   echo "*    The JDAY of the file"
   echo -n "* Continue (y/n)? "
   set ans = $<
   if ($ans != "y") exit

   echo -n "* Enter jday of file (eg 01 gives file ${CRUISE}met001): "
   set num = $<

   if ( $num < 100 && $num >= 10 )   then
     set num = 0${num}
   endif

   if ( $num >= 0 && $num < 10 ) then
     set num = 00${num}
   endif

#############################################################################

   if ( ! -e ${CRUISE}met$num.raw ) then
      echo "* The file ${CRUISE}met$num.raw does not exist."
      exit (1)
   endif

############################################################
########## Main processing steps ###########################
############################################################
############################################################
#  STEP_01
#
    echo " "
    echo "* Running plotxy for the air temperature"
    echo " "
   plotxy >> met_plot.talk << !
pdfs/temp.pdf
4
${CRUISE}met$num
/
y
3
${CRUISE}met$num.raw
s mpost;e


!
   if ($status != 0) then
     echo "problem running plotxy"
     echo " See met_plot.talk "
     exit
   endif

   /bin/mv POST temp.pst
   lpr -Pscience -h temp.pst

############################################################
# STEP_02
#
```

```
   echo " "
   echo "* Now running plotxy for the wind and air pressure"
   echo " "
   plotxy >> met_plot.talk << !
pdfs/wind.pdf
4
${CRUISE}met$num
/
y
3
${CRUISE}met$num.raw
s mpost;e


!
   if ($status != 0) then
     echo "problem running plotxy"
     echo " See met_plot.talk "
     exit
   endif

   /bin/mv POST wind.pst
   lpr -Pscience -h wind.pst


#################################################################
# STEP_02
#
   echo " "
   echo "* Now running plotxy for the radiation data"
   echo " "
   plotxy >> met_plot.talk << !
pdfs/rad.pdf
4
${CRUISE}met$num
/
y
3
${CRUISE}met$num.raw
s mpost;e


!
   if ($status != 0) then
     echo "problem running plotxy"
     echo " See met_plot.talk "
     exit
   endif

   /bin/mv POST rad.pst
   lpr -Pscience -h rad.pst

#
# Now just tidy up
#
   /bin/rm -f met_plot.talk
   /bin/rm -f uniprnt
   /bin/rm -f *.pst

########## The End ########################################

   echo " "
   echo "* end of met_plot exec"
   echo " "
   echo "* The plot files that have been sent to the science printer"
   echo " "
   /bin/mv ${CRUISE}met$num.raw $P_MET/${CRUISE}met$num.raw

   the_end:
   exit
```

Appendix F: flocean0

```
#########################################################################
#
#  flocean0 exec
#
#  Description:
#  Exec to prepare oceanlogger data for the fluroescence calibration
#  the actual idea is simple but it turned out a bit long winded
#  Processing steps:
#  The individual programs are
#
#           pheadr  - change the dataname of the file
#           pcopya  - copy out an extra fluor variable
#           pheadr  - change the names of the fluor variables
#           pmdian  - on one of the fluor variables
#           pintrp  - on the "medianed" fluor
#           pcopya  - copy out the medianed fluor
#           pheadr  - change the name of one fluor
#           pfiltr  - 5 minute top hat filter on fluor
#           pavrge  - average into one minute bins
#
#
#  History:
#  Version Date     Author      Description
#  00      14/02/96 MAB         Original version.
#
#  NEXT    ??/??/?? ???         Please make a note of your changes here
#                               - using as many lines as necessary.  If
#                               the  changes are  substantial perhaps a
#                               new exec might be better?
#
#########################################################################
#############################################################
########## Get information from the user ####################
   echo " "
   echo " "
   echo "* This exec prepares an oceanlogger file for selection"
   echo "  of data for Alistairs calibration "
   echo "* we need the following information:"
   echo " "
   echo "* The jday of the file"
   echo " "
   echo -n "* Continue (y/n)? "
   set ans = $<
   if ($ans != "y") exit
   echo " "
   echo " "
   echo -n "* Enter jday of file (eg 14 gives file ${CRUISE}oce014): "
   set num = $<

   if ( $num < 100 && $num >= 10 )   then
     set num = 0${num}
   endif

   if ( $num >= 0 && $num < 10 ) then
     set num = 00${num}
   endif

   if ( ! -e ${CRUISE}ocl$num ) then
      echo "* The file ${CRUISE}ocl$num does not exist."
      exit (1)
   endif

#############################################################
#  STEP_01  set up a new dataname
/bin/cp ${CRUISE}ocl$num $num.tmp
echo " "
echo " "
echo -n "       running pheadr - "
pheadr >! flocean0.talk << !
$num.tmp
y
```

```
1
fl_$num
-1
-1
y
!
  if ($status != 0) then
    echo "problem changing the dataname of the file "
    echo " see flocean0.talk " ; exit
  endif
  echo "OK"

echo -n "       running pmerge - "
pmerge >! flocean0.talk << !
$num.tmp
hold
time sstemp fluor fluor flow /
/users/mlsd/pstar/data/met/${CRUISE}met$num.raw
time par tir /
!

  if ($status != 0) then
   echo " problem merging in par and tir  "
   echo " See flocean0.talk "; exit
  endif
  echo "OK"

# now change fluor variable names
echo -n "       running pheadr - "
pheadr >! flocean0.talk << !
hold
y
-1
3
rawfluor

4
mdnfluor

-1
y
!
  if ($status != 0) then
    echo " problem changing variable names "
    echo " See flocean0.talk"; exit
  endif
  echo "OK"

# now we run a median filter on the mdnfluor
echo -n "       running pmdian - "
pmdian >! flocean0.talk << !
hold
y
mdnfluor 1.0 /
/
!
  if ($status != 0) then
    echo " problem running pmdian "
    echo " see flocean0.talk "; exit
  endif
  echo "OK"

# now interpolate the missing mdnfluor
  echo -n "       running pintrp - "
pintrp >! flocean0.talk << !
hold
y
mdnfluor /
!
  if ($status != 0 ) then
    echo " problem interpolating the missing fluorescence "
    echo " see flocean0.talk "; exit
  endif
  echo "OK"
```

```
# now copy out an extra fluorescence (the medianed one)
/bin/rm $num.tmp
  echo -n "       running pcopya - "
pcopya >! flocean0.talk << !
hold
n
$num.fl
time sstemp par tir rawfluor mdnfluor mdnfluor flow /
/
/
!
  if ($status != 0 ) then
    echo " problem copying in an extra fluorescence "
    echo " see flocean0.talk "; exit
  endif
  echo "OK"

# now change the name of that new fluorescence
   echo -n "       running pheadr - "
pheadr >! flocean0.talk << !
$num.fl
y
-1
7
filfluor

-1
y
!
  if ($status != 0 ) then
   echo " problem changing the name of a fluoresence variable "
   echo " see flocean0.talk "; exit
  endif
  echo "OK"

############################################################
#
# THE REASON THE NEXT TWO PROGS ARE BLANKED OUT IS BECAUSE
# TO AVOID JUNKING GOOD DATA IN THE PFILTR PROGRAM WE MUST
#  APPEND THE DATA BEFORE FILTERING, AND THEN AVERAGING
#
#
# now top hat filter fluorescence with 5 minute filter
# this corresponds to a half width of 30 data cycles
#/bin/rm hold
#echo -n "       running pfiltr - "
#pfiltr >! flocean0.talk << !
#$num.tmp
#hold
#filfluor /
#30
#/
#!
#  if ($status != 0 ) then
#    echo " Problem filtering data "
#    echo " See flocean0.talk "; exit
#  endif
#  echo "OK"
#  echo " "
#
## and finally average into 1 minute bins
#
#echo -n "       running pavrge - "
#pavrge >! flocean0.talk << !
#hold
#$num.fl
#1 0 60 /
#!
#
# if ($status != 0) then
#   echo " Problem averaging to 1 minute data "
#   echo " see flocean0.talk "; exit
# endif
# echo "OK"
# echo " "
```

```
   /bin/rm hold
#   /bin/rm $num.tmp
   /bin/rm flocean0.talk

########## The End ########################################

   echo " "
   echo "* end of flocean0"
   echo " "
   echo "* The file created is $num.fl"
   echo " "
   echo "  AT VERSION.......... "
   echo " "
   pinq -FD $num.fl
   echo " "
   echo " "
   the_end:
   exit
```

Appendix G: oclexec3 sample path

```
#############################################################################
#
#  oclexec3
#
#  Description:
#  this exec creates time in the sample files in seconds
#
#  Files produced:
#  $nam$CRUISE$num.raw        Pstar format of RVS data; variables still in
#
      raw form.
#
#  Main processing steps:
#  STEP_01     Just change the times in the samples file
#
#  History:
#  Version Date     Author      Description
#            0 0                                        2 / 1 2 / 9 6       M A B
Original version, Drake Passage JR16
#            0 1                                        1 / 1 2 / 9 7       M A B
Some mods on Geneflow JR25
#
#  NEXT    ??/??/?? ???         Please make a note of your changes here
#                                - using as many lines as necessary.  If
#                                the  changes are  substantial perhaps a
#                                new exec might be better?
#
#############################################################################
# first make shure the temporary files are cleared

# set up the variables and files
  touch oclexec3.talk
  set output = oclexec3.talk

#################################################################
#
  if ( $#argv != 1 )then
    echo " "
    echo -n "Enter file number ( oclbtNNN.bot file): "
    set num = $<

  /bin/rm -f temp files

  echo " "
  echo " Running pcopya  - put in an extra variable"
  pcopya >! $output  <<!
oclbt$num.bot
n
temp1
sampnum,botlnum,jday,jday,hrs,mins,botsal/
/
```

```
/
!
  if ($status != 0) then
     echo " Problem running pcopya "
     echo " see $output "
     exit
  endif

  echo " "
  echo " Running pheadr - change the extra variable name "
  pheadr  >! $output << !
temp1
y
/
3
time
secs
/
/
!
  if ($status != 0) then
     echo " Problem running pheadr "
     echo " see $output "
     exit
  endif

  echo " "
  echo " Running pcalib - take one from jday "
  pcalib >! $output <<!
temp1
/
time,-1,1,0/
/
!
  if ($status != 0) then
     echo " Problem running pcalib "
     echo " see $output "
     exit
  endif

  echo " "
  echo " Running pcalib - turn jday, hrs and mins into seconds"
  pcalib >! $output <<!
temp1
/
time,0,86400,0
hrs,0,3600,0
mins,0,60,0
/
!
  if ($status != 0) then
     echo " Problem running pcalib "
     echo " see $output "
     exit
  endif

  echo " "
  echo " Running parith - add time and hrs (now seconds) "
  parith >! $output <<!
temp1
temp2
sampnum,botlnum,jday,hrs,mins,botsal/
add time hrs
0/
time+hrs
/
!
  if ($status != 0) then
     echo " Problem running parith "
     echo " see $output "
     exit
  endif

  echo " "
  echo " Running parith - add time and mins (now seconds) "
```

```
  parith >! $output <<!
temp2
oclbt$num.samples
sampnum,botlnum,jday,hrs,mins,botsal/
add time+hrs mins
0/
time
seconds/
!
  if ($status != 0) then
     echo " Problem running parith "
     echo " see $output "
     exit
  endif

  echo " "
echo " "
echo " "
echo " The output file is oclbt$num.samples"
echo " "
echo " "
pinq -FD oclbt$num.samples
echo " "
echo " "


  /bin/rm -f temp1
  /bin/rm -f temp2
  /bin/rm -f temp3
  /bin/rm -f $output

  echo " *** The End *** "
  exit
```

Appendix H: twvelexec

```
#############################################################################
#
#  twvelexec
#
#  Descr  Description:
#  Gets the true wind velocity from our system on the JCR
#
#  History:
#  Version Date     Author      Description
#  01       2/12/97 MAB         new exec.
#
#  NEXT    ??/??/?? ???        Please make a note of your changes here
#                               - using as many lines as necessary.  If
#                               the  changes are  substantial perhaps a
#                               new exec might be better?
#
#############################################################################
########## Initialisation ###################################
#  This exec looks at P_MET for a directory to run from

   if ($?P_MET) then
     echo " "
     echo " "
     echo " Changing directory to P_MET: $P_MET"
     cd $P_MET
     echo " "
     echo " "
   endif

#  set up variables and files
   touch talk.file

########## Get information from the user ####################
#  STEP_00  Do we want to run this exec ?

  echo " This exec derives true wind data "
     echo " "
```

```
  echo " It requires only the Jday:"
     echo " "
  echo -n " Continue (y/n)? "
  set ans = $<
  if ($ans != "y") exit

  echo " "
  echo -n " Enter the JDAY please  "
  set jday = $<

 if ( ! -e ${CRUISE}met$jday.raw ) then
   echo "the file ${CRUISE}met$jday.raw does not exist"
   exit
 endif
 echo " "
 echo " "
 echo " Input file : "
 echo " "
 echo -n " "
pinq -FD ${CRUISE}met$jday.raw
 echo " "
 echo " "

echo -n " Merging gyrocompass - "

# first merge with the gyrocompass to get the heading in the file
pmerge >! talk.file << !
${CRUISE}met$jday.raw
hold
/
/users/mlsd/pstar/data/nav/gyr/26gyr01
/
!

if ($status != 0) then
  echo " problem running pmerge "
  echo " See talk.file "
  exit
endif
echo "OK"

# Now add the wind direction (foremast) to the ships head (gyro)
echo -n " Adding directions - "
parith >! talk.file << !
hold
hold.1
/
add heading wind_dir
0/
windD
degrees
!
if ($status != 0) then
  echo " Problem running parith "
  echo " See talk.file "
  exit
endif
echo "OK"

echo -n " Running prange - "
prange >! talk.file << !
hold.1
y
windD 0 360 /
/
!
if ($status != 0) then
  echo " Problem running prange "
  echo " See talk.file "
  exit
endif
echo "OK"

# Bish bosh
# Change the wind from Knots to m/s
```

```
echo -n " Changing wind velocity scale - "
pcalib >! talk.file <<!
hold.1
y
wind_spd 0, 0.5144444, 0 /
/
!

 if ( $status != 0) then
   echo " Problem running pcalib"
   echo " See talk.file "
   exit
 endif
 echo "OK"

echo -n " Changing  variable units - "
pheadr >! talk.file << !
hold.1
y
-1
wind_spd

m/s
-1
y
!
 if ( $status != 0) then
   echo " Problem running pheadr"
   echo " See talk.file "
   exit
 endif
 echo "OK"

#change the wind speed and direction into north and east components
echo -n " Breaking wind speed to components - "
pcmcal >! talk.file << !
hold.1
hold.2
2
wind_spd windD
!
if ($status != 0) then
  echo " problem running pcmcal"
  echo " See talk.file "
  exit
endif
echo "OK"

# multiply by -1 since wind direction is where it comes from

echo -n " Reversing wind direction - "
pcalib >! talk.file << !
hold.2
y
east 0 -1 0
north 0 -1 0
/
!

if ($status != 0) then
  echo " Problem running pcalib"
  echo " See talk.file "
endif
echo "OK"


# Now bring in the navigation fixes

echo -n " Merging navigation - "
pmerge >! talk.file <<!
hold.2
hold.3
/
/users/mlsd/pstar/data/nav/bsn/abnv261
time lat lon ve vn  /
```

```
!

if ( $status != 0) then
  echo " Problem running pmerge"
  echo " See talk.file "
  exit
endif
echo "OK"


# Step 05 Derive ship velocity from position

echo -n " Deriving ship velocity - "
posspd >! talk.file <<!
hold.3
y
time lat lon ve vn /
!

if ( $status != 0) then
  echo " Problem running posspd"
  echo " See talk.file "
  exit
endif
echo "OK"


echo -n " Converting ship speed to m/s - "
pcalib  >! talk.file << !
hold.3
y
ve 0 0.01 0
vn 0 0.01 0
/
!

if ($status != 0) then
  echo " problem running pcalib"
  echo " See talk.file "
  exit
endif
echo "OK"

#add the north and east components of wind and ship
echo -n " Adding components - "
parith >! talk.file << !
hold.3
hold.4
/
add east ve
add north vn
0/
Wve+Sve
m/s
Wvn+Svn
m/s
!
if ($status != 0) then
  echo " Problem running parith"
  echo " See talk.file "
  exit
endif
echo "OK"

#change the north and east components back to true wind speed and direction
echo -n " Deriving true ws and direction - "
pcmcal >! talk.file << !
hold.4
hold.5
1
Wve+Sve Wvn+Svn
!
if ($status != 0) then
  echo "> problem running parith ***"
  echo "  See talk.file "
```

```
  exit
endif
echo "OK"

#sort out data description
echo -n " Changing variable names - "
pheadr >! talk.file << !
hold.5
y
/
ve
/
m/s
vn
/
m/s
speed
truews
/
dirn
truewd
/
-1
y
!
 if($status != 0)then
   echo " Problem with pheadr "
   echo "see talk.talk "
   exit
 endif
 echo "OK"

#delete unwanted variables using pcopya
echo -n " Removing unwanted variables - "
pcopya >! talk.file << !
hold.5
n
${CRUISE}met$jday.true
time lat lon atemp wind_spd wind_dir press par tir heading truews truewd /
/
/
!
if ($status != 0) then
   echo " Problem with final pcopya"
   echo " see talk.file"
exit
endif
echo "OK"

#remove all the junk files
/bin/rm hold*
/bin/rm talk.file

echo " "
echo " "
echo " End of twvelexec for day $jday  "
echo " "
echo " "
echo " Input file : "
echo " "
echo -n " "
pinq -FD ${CRUISE}met$jday.raw
echo " "
echo " "
echo " "
echo " File created ${CRUISE}met$jday.true "
echo " "
echo " At version :"
echo " "
echo -n " "
pinq -FD ${CRUISE}met$jday.true
echo " "
echo " "
echo " "
exit
```

8.5 Acoustic Doppler Current Profiler (ADCP)

Summary

This report describes the method of acquisition of ADCP data on JR28 and the problems encountered. In general the ADCP worked extremely well with velocity information generally obtained down to 250 m depth. The underway data is compromised for a 13 hour 50 minute period when the Ashtec 3DFGPS was down.

The configuration of the ADCP

The RRS *James Clark Ross* is fitted with an RD Instruments 150 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 400 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. The reason for this was to increase the amount of bottom track data available for calibration purposes and was a development arising from the WOCE leg SR1B (JR27).

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 (for historical reasons) 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 28adpexec0 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
As stated above, the transducer head of the ADCP is behind an LPDE screen and in a bath of silicone oil. King and Alderson (1994) recognised that this oil within the sea chest requires a correction to be made to the 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 amusing 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

$$Correction = 1 - 0.004785T \times 0.0000355T^2$$

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 28adpexec0.1.

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 28adpexec1.

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 a 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 28adpexec2.

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 28adpexec3.

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 28adpexec4.

Method of derivation of the calibration coefficients A and ϕ .
To derive values for A and ϕ a standard procedure was followed. This procedure is described below.

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 28adpexec3 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

$$\phi = \phi_{gps} - \phi_{adcp}$$

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 III we have identified 135 individual periods suitable for calibration periods totalling almost 75 hours of data suitable for calibration.
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 0.9335, and for ϕ -1.7767. Future inspection of the calibration data may lead to improvements in these values.

Problems encountered
The only problem in the ADCP data was a result of the lack of Ashtec data for the period jday 023

1043 to 024 0033 (18 hours 50 minutes). This means that the underway data for this period are of doubtful quality compared with the rest of the data set. Fortunately this period coincided with the period when the ship was hove to in a storm.

Summary

The ADCP on JR28 has performed better than we have seen it on any previous MLSD cruises. There are three clear reasons for this. Firstly access to the finest navigation data currently available through the Skyfix Differential correction and the Ashtec 3DFGPS has made the data quality as good as it is currently possible to get. Secondly the scatterers in the water column were such that underway water track data were good to generally almost 250 m. Finally the data are good because there were sufficient people on board to enable us to catch any problem before any damage was done.

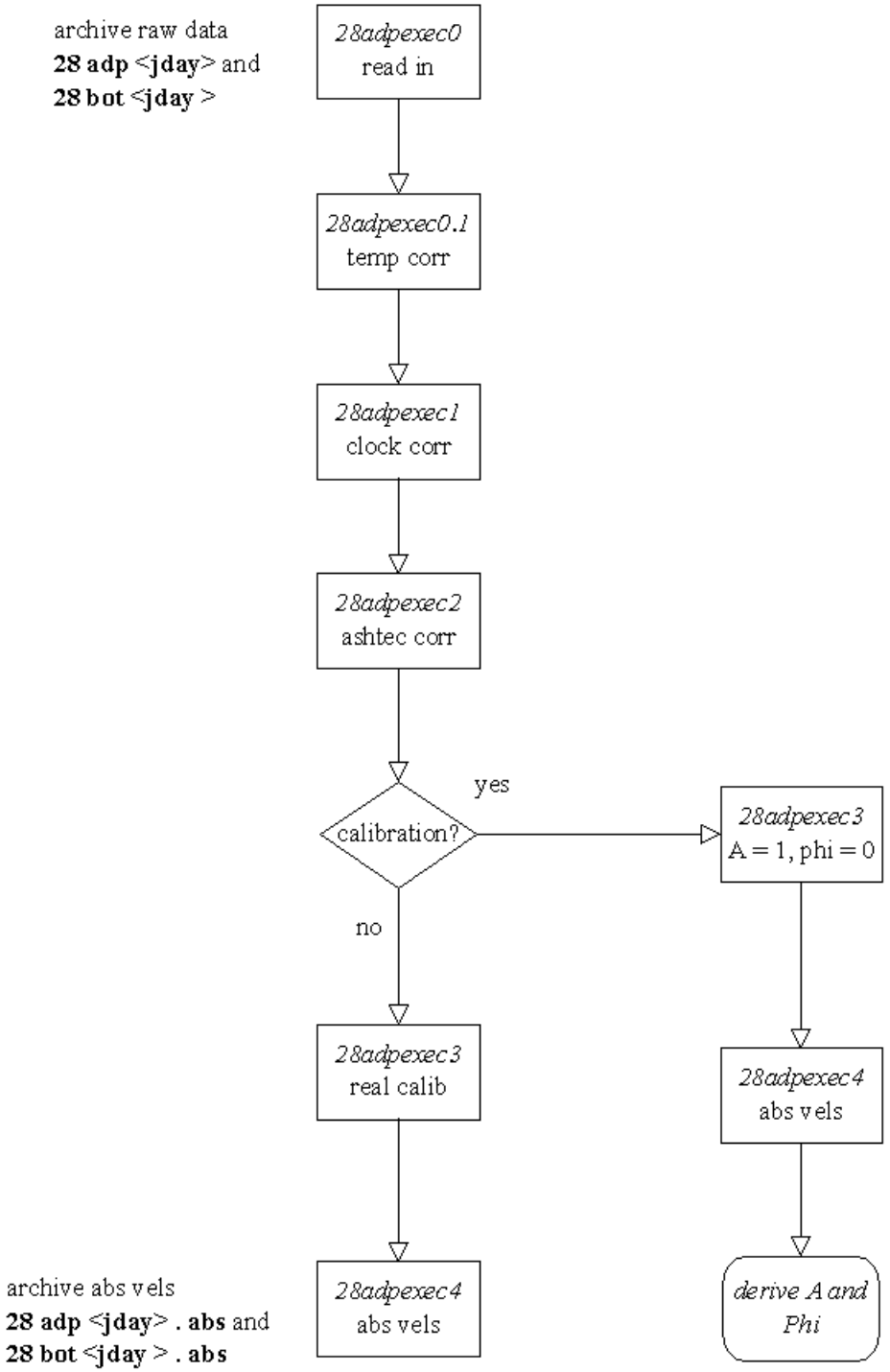
Suggestions

We have two suggestions:

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

ii. The oil in the transducer sea chest be removed and replaced with sea water. Even in heavy ice conditions we have data to show the transducers do not get below 6 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.

Figure 1: The ADCP data processing route



8.6 Undulating Oceanographic Recorder (UOR= NvShuttle)

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

Hardware Upgrades

A number of modifications were carried out to the hardware in preparation for the 1997/98 season. Some were carried out prior to JR25 and JR26, whereas others were completed prior to JR28.

Cable and winch

The original cable was scrapped after last season, having done two seasons work and been subject to some abuse in 1996 when the NvShuttle had a tendency to rotate. Prior to this season, the new cable (365 m) was fitted with copper anti-stacking rings in the manner developed during JR17. The rings were placed at approximately 1.5 metre intervals to accommodate the Fathom Flexnose fairing in lengths of 15 linked sections. A total of 130 m of fairing was installed.

During the summer of 1997 the drum of the winch was shot blasted, zinc sprayed and painted. The original paint had not lasted very well and rust from the drum was staining the cable.

The plastic fairing inverter shoe supplied with the winch had suffered considerable wear by the end of last season. This was mainly due to the long catenary of cable between the winch and the towing block, the weight of which weighed heavily on the shoe. A new inverter shoe was designed and built with two rollers to take this weight.

In past seasons, the original cable/fairing guide between the spooling gear and the drum was inadequate to prevent the newly spooled cable from overlaying that already on the drum. As a first move toward eliminating this problem an extra guide in the form of a wooden block was added last season. As this proved to be reasonably successful, a guide employing a conical plastic roller was installed for this season. This was entirely successful in terms of setting the fairing during normal recovery and meant that the extra people previously needed to push the fairing over to the appropriate angle, were no longer required. However when it was necessary to recover the NvShuttle in marginal weather conditions, the fairing came under high strain and tended to catch in the roller. Therefore, immediately prior to JR28 a new guide was machined that removed any residual problems.

In previous seasons, the fairing was not correctly orientated by the inverter shoe as the ship's stern gantry lifted to bring the vehicle inboard for recovery. Prior to JR28, a spring loaded accessory inverter shoe was built and fitted. This shoe is restrained until the vehicle is about to leave the water. As the gantry lifts and the cable angle increases the shoe follows it up. This solution proved to be very successful and now leaves the winch driver free to concentrate on the vehicle recovery, thus reducing the risk of it being wound into the block.

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

NvShuttle

During previous seasons the maximum undulation depth of the NvShuttle was limited to 135 m. This was largely a result of the vehicle's inability to pull up from depth and was probably caused by the alternator failing to generate adequate power supplies. In an attempt to increase power output, larger impellors were supplied by Chelsea Instruments. Two impellors were supplied that had dimensions of 11" diameter × 6" pitch and 10" diameter × 6" pitch.

During trials on JR25, the alternator shaft fractured from metal fatigue, presumably as a result of the additional load generated by the use of the large impellor. The ship's 4th Engineer (Steve Eadie) machined a new shaft from scrap stainless steel. Steve was careful to avoid machining sharp shoulders into the shaft, the probable cause of the failure in the original. The remaining new impellor (10" × 6") was subsequently attached to the new alternator shaft and found to generate adequate power. With the wing angle at it's maximum, the NvShuttle is now capable of undulating to depths of 150 m without any sign of stalling. The alternator shaft manufactured by Steve Eadie has provided reliable service throughout the whole of cruise JR28.

Software Upgrades

Last season the undulation envelope was limited by the NSHUTTLE software. A new version of the NSHUTTLE software was supplied by Chelsea Instruments in time for JR28. This enabled the NvShuttle to undulate between the surface and depths of up to 150 m.

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 is fitted for, but not with, 10 further channels for light measurement. These will accommodate 5 up-welling and 5 down-welling sensors comparable with the wavelengths measured by the SeaWiFs sensors on the SeaStar satellite.

The PAR sensor failed towards the end of the cruise, during event 278. One of the electrical terminals in the sea cable had corroded due to seawater action. All other sensors provided uninterrupted service.

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 6 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 was triggered as a result of radio interference caused by the ship's radio officer transmitting data. To prevent this happening during cruise JR28 the radio officer carried out a series of test transmissions at a variety of power settings and over a range of frequencies. Those frequency/power combinations that inadvertently triggered the strain gauge alarm were subsequently avoided by the radio officer.

Transmission type	Frequency kHz	Activates Strain Alarm y/n
Telex	3186	N
Telex	4553	Y
Telex	7623	N
Telex	9106	Y
Telex	11565	N
Telex	3800	N
Telex	4030	Y
Telex	7450	N
Telex	8198	N
Telex	11255	N
Telex	14475	N
Telex	4067	N
Radio	7775	N
Radio	9106	N
Radio	11055	N
Radio	14915	N

Table 1: Experiments in 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 an X terminal sited near to the NvShuttle control PCs. Ship's position was also continually reflected to the X terminal, as was the datastream passed from the NvShuttle to the Level C . Paper plots of the bathymetry covered by previous occupations of the transects were also an invaluable aid to safe deployment of the NvShuttle, particularly where uncharted bathymetric features reach above 150 m.

All of these aids improve 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 cm s^{-1} (the default), thereby generating inaccurate depth values. 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.

NvShuttle Flight Parameters Used During Data Collection

At the beginning of each deployment, and also at the time of recovery the flight parameters were set to upper = 30, lower = 30 and climb rate = 45. Deployment or recovery was normally in-line with the transect, unless the sea state was sufficient to require that the ship alter heading 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)
-10	152	55	6	145	~6	275
-8	130	45	5	131	~6	275
-5	100	35	4	101	~6	200
-5	75	26	4	76	~6	135
0	50	20	3	51	~5	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 JR28 a total of 2145.72 km was covered by 14 deployments of the NvShuttle.

Event	Transect	Length (km)	Comments
109	Test	39.41	
121	E1.1	80.78	
	E1.2	80.88	
139	E2.1	80.37	
	E2.2	80.82	
157	E3.1	81.99	
	E3.2	80.45	
176	E4.1	80.40	
	E4.2	80.70	
196	E5.1	80.36	
	E5.2	80.81	
199	Fluorescence calibration	126.79	
202	W1.1	81.23	
	W1.2	80.49	
220	W2.1	83.13	
	W2.2	80.16	
237	W3.1	85.92	Communications failure
	W3.2	80.83	
258	W4.1	80.46	
	W4.2	79.97	
275	W5.1	80.58	
278	W5.2	82.98	No PAR
279	MW.1	80.80	No PAR
	MN.1	50.24	No PAR
	ME.1	81.17	No PAR

Table 3: Deployments of the NvShuttle during JR28

Communication Failures

Only on one occasions during the cruise did communication fail with the NvShuttle. The incident happened during event 237 over shallow water, emphasising the necessity of always maintaining constant vigilance during an NvShuttle deployment. On this occasion PC-1 was restarted, after which the Aquasoft software on PC-2 was also restarted. Communication was re-established and data collection resumed.

During the period that PC-1 communications failed, 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 10 minutes was therefore present in the Level C datastream. During subsequent data processing, an attempt was made to fill this data gap. The logging file (filename CI03208.D98) on the C: drive of PC-1 was examined. Unfortunately when PC-1 had crashed it had failed to close the file, and when the PC was restarted a new file of the same name had been created. Norton software was used to recover the original CI03208.D98 file, and this was subsequently joined with the later version. A data gap of a few minutes was still present. This gap was subsequently filled by using Aquasoft software to convert the data logged to PC-2. This datastream does not have flight control parameters, only those from the suite of instruments used for recording oceanographic variables. Nevertheless these data were considered adequate to merge with the rest of the datastream. The final gap left in the dataset was thus reduced to approximately 20 seconds.

During the process of recovering the dataset, it was noted that data logged to PC-1 had a different data structure to that logged to the Level C. On PC-1 PAR and Trans were logged in reverse order. Furthermore, negative command depths were logged as very large positive numbers. As part of the recovery processing PAR and Trans were reversed, and 2^{16} subtracted from negative command depths. Following these modifications, data were compatible with those from the Level C.

NvShuttle Procedures and Log sheets

Examples of the operating procedures and the log sheets used for recording each event are shown in Appendix A and Appendix B.

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, NvShuttle command depth, NvShuttle actual depth, NvShuttle wing angle and wire strain; all variables are formatted in engineering units.

In normal use, raw data from the NvShuttle is also logged to the NvShuttle control PC (PC-1); this data is 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 prepended with the current time from

the ship's clock and includes a field for each instrument with data recorded in engineering units. 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 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 8 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 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 (this usually requires that the navigation 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 the event. Transects were then separated on the basis of 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.

Stages 4+5: OPC data were processed from the files FTP-ed to UNIX. Times were converted to PSTAR format by a purpose written Fortran programme and the data subsequently loaded into PSTAR files. The script used to carry out this processing was opcexec0. Data were then merged with the UOR distance run files already produced as part of the Stage 3 output (above). The script used to carry out this processing was opcexec1.

Following completion of Stage 5, 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 6 to 8 below).

Stage 6: Following comparison with the Neil Brown Mk III CTD, temperature and salinity data from the NvShuttle were adjusted with uorexec4.

Stages 7+8: 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 to the east, and the westerly end of each transect was at 0 km. Interpolation and gridding was carried out with uorexec6.

Instrument Calibrations

The Aquapack suite of sensors on board the NvShuttle were calibrated during the summer of 1997 by Chelsea Instruments. The calibration equations derived from these calibration equations are based on the output from each sensor in bits and are as follows:

Pressure sensor

$$\text{Pressure (bdar)} = -2.2952 \times 10^{-10} \times \text{bits}^2 + 3.36097 \times 10^{-3} \times \text{bits} - 9.8793$$

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

Temperature sensor

$$\text{Temperature (°C)} = 7.0822 \times 10^{-11} \times \text{bits}^2 + 6.21689 \times 10^{-4} \times \text{bits} - 3.6439$$

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

$$\text{Temperature (°C)} = \text{T-68} \times 99.9760057 \times 10^{-2}$$

Conductivity sensor

$$\text{Conductivity (mS cm}^{-1}) = -3.9095 \times 10^{-11} \times \text{bits}^2 + 1.10747 \times 10^{-3} \times \text{bits} - 0.8064$$

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

Fluorometer

$$\text{Concentration of Chla } (\mu\text{g l}^{-1}) = -0.2250 \times 10^{-2} \times \text{bits} + 0.7377 \times 10^{2}$$

The calibration was reported to be valid in the range 0 to 75 $\mu\text{g l}^{-1}$, with an uncertainty of 0.09 $\mu\text{g l}^{-1}$ + 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 (I_v) = -7.49249 - 2.28653 × 10^{-4} bits

and

PAR (I_z) = 1.12 × 10^{-2} × 10 I_v

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 becomes 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 temperature and 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 JR28.

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 JR28 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 Neil Brown Mk III 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 0.15 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 1997.

Comparison With Underway Ocean logger Data

After adjustment to match the temperature and conductivity sensors on the Aquapack and on the Neil Brown Mk III CTD, the T/S data for the NvShuttle were compared against the Seebird Thermosalinograph data, part of the ship's Ocean logger system. As the calibration of the TSG is still to be completed, these comparisons were carried out at this stage principally as a check to ensure that no gross errors had been made.

Archive of Data Files

NvShuttle data were archived after the cruise. Data files were named using the standard Marine

Life Sciences Pelagic Ecosystems Core Programme convention. Thus:

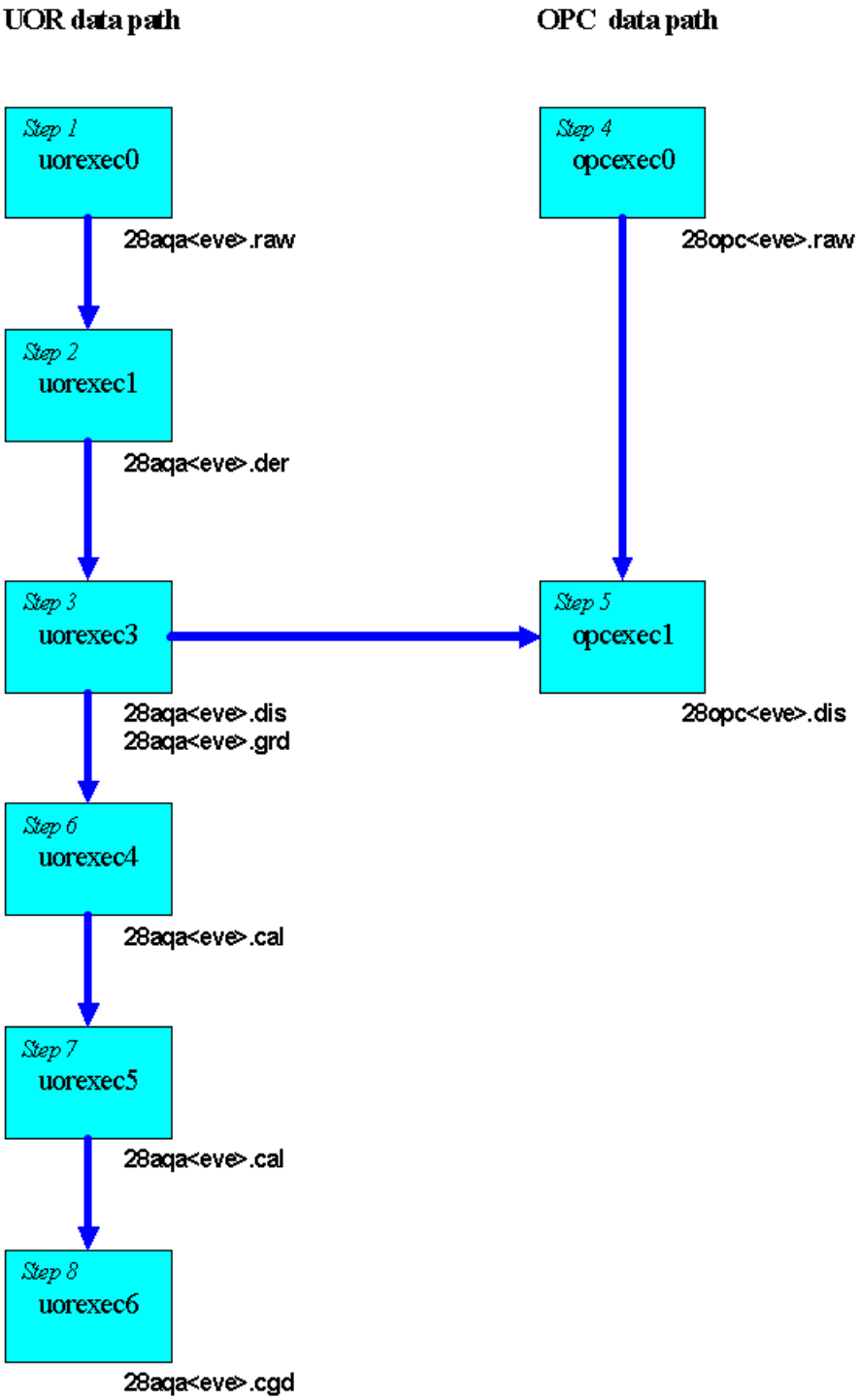
Raw data	<cc>aqa<eve>.raw_<tid>
Derived data	<cc>aqa<eve>.der_<tid>
Position and distance run	<cc>aqa<eve>.dis_<tid>
Gridded on latitude	<cc>aqa<eve>.grd_<tid>
Adjusted data files	<cc>aqa<eve>.cal_<tid>
Adjusted and gridded on distance	<cc>aqa<eve>.cgd_<tid>

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

Data from the OPC were archived using a similar convention:

Raw data	<cc>opc<eve>.raw_<tid>
Position and distance run	<cc>opc<eve>.dis_<tid>

Figure 1: The UOR data processing path



UOR Appendix A

NvShuttle procedures

1. Ensure the instrument is connected to the wire, the NvShuttle covers are in place, the PAR meter cover is removed and that the ship has the correct speed and heading for the deployment.

2. PC-1 is the NvShuttle control system. PC-2 is the Aquasoft control system and PC-3 is the OPC control system.

3. Re-Boot all 3 PC systems. Exit the Aquasoft menu using the cursor keys to select the 'Quit' option. Reset the time clock on both PC-1 and PC-2. (Use the DOS 'time' command and enter the exact time from the ship's Radiocode clock).

4. Turn on the NvShuttle System Interface Unit (switch 0 to 1). After about 20 seconds and a series of noises the 'line ready' red light will come on. If this does not happen then turn the unit off, wait 10 seconds and turn it on again.

5. Turn on the OPC deck unit.

6. On the NvShuttle control system (PC-1) type 'nshuttle' at the C:\NSHUTTLE prompt. The control windows should appear and in the top left hand corner of the screen it should say 'Sending system parameters'. The system should then say 'Hello everybody' and eventually display 'Idle'. A graph should appear and various lines should be plotted.

7. On Aquasoft control system (PC-2) type 'aquasoft' at the C:\AQUASOFT prompt. Select Data Acquisition. Under Utilities check the Cruise number (e.g. 28= JR28) and under Station enter the event number; each deployment must have an unique event number.

8. Under the Setup option start with Cast Set-up. Enter the operator name, the latitude and longitude and the water depth. The calibration file used during JR28 was ISAP0021.c03. Press F2 to save the form.

9. Check the Instrument Setup. This should have 012345 in the select active channels option. The acquisition rate was set to 1 second for JR28. Press F2 to save the form.

10. Check the Graph Setup and ensure that the axes are adequate for the deployment. Press F2 to save the form.

11. Choose the Acquisition menu and Synchronise time, then select the Deploy Instrument Now option. The message 'Connecting to Instrument' should be displayed. The screen should go into graph mode, after which you will then be asked to press any key to start the data display.

12. On the OPC control system (PC-3) type 'opc' at the C:\OPC prompt. Enter a suitable name for the logging file; the file should be named following the standard convention <CR>OPC<EVE>.D00, for example, 28opc039.d00 for event 039 on cruise JR28. After the program has started use Alt-A to select the Acquire menu and choose the Start Aquire option. The system will now display the main screen. Use the Tab keys to move around within a panel and the Alt-Tab keys to move between panels. Select the bottom panel and choose log, setting logging to on with the cursor keys. Select Switch and press return to choose the graphical display. The graph is not updated automatically, so the Update option must be periodically selected; the axes

for the graph may also require periodic updating.

13. During an event the flight control parameters can be reset on PC-1. To change the flight parameters select F2. Choose a field with the cursor and press return to clear the existing value; enter the new value and press return. When finished press F3 to transmit the new flight control parameters to the NvShuttle. The system should display the message 'Sending shuttle parameters' after which the parameter values should change in the upper left area of the screen.

14. When the event is complete and the NvShuttle is back on deck select Quit on the OPC control system (PC-3). On the Aquasoft control system (PC-2) press the spacebar and Ctrl-F10 to end data capture; return to the top level menu to exit the programme. On the NvShuttle control system (PC-1) press F4 to exit the program.

15. Turn off the power on the System Interface Unit and the OPC deck unit. Replace the cover on the PAR meter.

16. On the OPC control system (PC-3) select Convert and choose Save chart file. Ensure the current log file is selected and set the bin sizes to 0.0 to 0.5 mm, 0.5 to 1.0 mm and 1.0 to 100.00 mm. Save the chart file with the filename in the standard form <CR>OPC<EVE>.C00, for example, 28opc039.c00 for event 039 on cruise JR28.

17. There is a network connection on PC-3 and to load the network type netload at the DOS prompt. Transfer all files from the event to the appropriate directory under o:\mlsd\uor\jr28 on the shared filespace. The files from PC-1 and from PC-2 will need to be transferred to PC-3 by means of floppy disc. From PC-1 copy all files named 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. From PC-2 copy all files named JA<CR>C<EVE>.* where CR is the cruise number and EVE is the event number. From PC-3 copy both <CR>OPC<EVE>.D00 and <CR>OPC<EVE>.C00; the latter of these two files should also be FTP-ed to the appropriate UNIX account and directory.

Cruise JR28 UOR Event ..... Sheet .....

Jday_time (Z)	Activity	Activity	Activity

Latitude: _ _ _ _ _ _ Longitude: _ _ _ _ _ _ Depth: _ _ _ _

98 _ _ _ /_ _ _ _ _ _	Reboot PC1	Reboot PC2	Reboot PC3
98 _ _ _ /_ _ _ _ _ _	Time on PC1	Time on PC2	
98 _ _ _ /_ _ _ _ _ _	SIU on	OPC deckunit on	
98 _ _ _ /_ _ _ _ _ _	Nshuttle started		
98 _ _ _ /_ _ _ _ _ _	Aquasoft started	Station number _ _ _	
98 _ _ _ /_ _ _ _ _ _	Cast setup	Instrument setup	Graph setup
98 _ _ _ /_ _ _ _ _ _	Time synchronised		
98 _ _ _ /_ _ _ _ _ _	Deploy instrument	RVS Level B	RVS Level C
98 _ _ _ /_ _ _ _ _ _	OPC started	Acquire	Log on

98 _ _ _ /_ _ _ _ _ _	Ship at 4.5 knots		
98 _ _ _ /_ _ _ _ _ _	Aquashuttle in water		

98 _ _ _ /_ _ _ _ _ _	Ship at 4.5 knots		
98 _ _ _ /_ _ _ _ _ _	Aquashuttle on deck		

98 _ _ _ /_ _ _ _ _ _	OPC stopped	Convert	
98 _ _ _ /_ _ _ _ _ _	Aquasoft stopped		
98 _ _ _ /_ _ _ _ _ _	Nshuttle stopped		
98 _ _ _ /_ _ _ _ _ _	SIU off	OPC deckunit off	

Cruise JR28 UOR Event ..... Sheet .....

Jday_time (Z)	Depth	Top/Bot/Climb	Ship speed	Comments
98 _ _ _/_ _ _ _ _				
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8.7 Satellite Data

During the period of the cruise, the meterological group at Rothera kept a watching brief on the images received from the NOAA polar orbitting satellites. These satellites carry Advanced Very

High Resolution Radiometers that provide information on sea surface temperatures covered by the swath.

The centre of focus for the cruise, to the north of South Georgia, is some distance from the satellite receiving station at Rothera, Adelaide Island. The relative positions of Rothera and South Georgia are such that only ~2 overpasses are recorded each day. Given the prevailing weather conditions at South Georgia, and the frequency of fog along the MEB transect (particularly over the Polar Frontal Zone) the coincidence of clear cloud-free days and satellite overpasses is very rare.

During the cruise 2 images were received from Rothera. The second of which provided very useful information over the Core Programme area. The image was recorded on January 28, 1998. This was just as the Eastern Core Box was completed and prior to the commencement of the Western Core Box.

8.8 EA500 Bathymetric Echosounder

Bathymetric soundings were collected using a Simrad EA500 12 kHz echo sounder sited on the bridge with a hull-mounted transducer at 6.3 m depth. The EA500 sounder was synchronised with the EK500 bioacoustic sounder, causing the ping interval of the former to be dependant upon the settings of the latter which varied according to water depth and operational requirements. Thus soundings are obtained at somewhat irregular intervals.

The EA500 generated suspect bathymetric data on a number of occasions. The bad data normally occured in moderate to rough sea conditions, when the ship changed course very quickly, or when a rapid change in sea depth caused the instrument to report a false bottom. Data were processed on a twice daily basis in 12 hour sections using the UNIX script JR28_sim to remove as many as possible of the bad data spikes. At this stage plots were made of the data at 30 second spacing and further spikes were occasionally visible. Remaining bad data were located by use of an interactive graphical data editor (plxyed) and removed from the data set. A record was generated of the points which were edited. Only data which showed very obvious spikes were removed.

The settings on the EA500 sounder were noted at the end of the cruise and are shown in the table below. The default sound velocity of 1500 m/s has been used in the soundings. The transducer depth was 6.3 m for the cruise. Some of these settings were changed from time to time by the officer of the watch in an attempt to regain a reading of the depth when the instrument lost the bottom. The instrument is fairly complex and sometimes these efforts resulted in less reliable bottom detection. It is suggested that a short manual be written explaining the basic principles of the EA500 and which settings should be left unchanged and how to adjust those which can help in finding the bottom. The bottom tracking algorithm in the EA500 is not sophisticated and it can readily lose the bottom in areas where the depth changes rapidly such as the shelf break around South Georgia. Also, when operating over deep water with the sounder in external trigger mode so that the ping rate is determined by the scientific EK500 sounder, the ping rate may be too high for the EA500 to detect the bottom on every ping. In rough weather it can be several pings before the sounder finds bottom again. In very rough weather the EA500 sounder gives very poor quality data - as also does the EK500 38 kHz sounder, this is possibly due to entrainment of air under the hull.

Bathymetric data are supplied to the hydrographic office at the end of each cruise. In view of the

data quality problems mentioned above it is essential that these are extracted from the processed and edited data in order to ensure high quality soundings are provided.

Instrument settings for Simrad EA500 12 kHz echo sounder on cruise JR28 (Noted on 6/Feb/97)

MENU	SETTING
OPERATION MENU/ PING MODE	EXT. TRIG.
OPERATION MENU/ TRANSMIT POWER	NORMAL
OPERATION MENU/ NOISE MARGIN	12 dB
TRANSCEIVER MENU/TRANSDUCER DEPTH	6.3 m
TRANSCEIVER MENU/ ABSORPTION COEFF	1 dB/km
TRANSCEIVER MENU/ PULSE LENGTH	LONG
TRANSCEIVER MENU/ BANDWIDTH	AUTO
TRANSCEIVER MENU/ MAX POWER	2000 W
TRANSCEIVER MENU/ ANGLE SENSITIVITY	20.0
TRANSCEIVER MENU/ 2-WAY BEAM ANGLE	-15 dB
TRANSCEIVER MENU/ Ss TRANSDUCER GAIN	14 dB
BOTTOM DETECTION MENU/ MINIMUM DEPTH	variable
BOTTOM DETECTION MENU/ MAXIMUM DEPTH	variable
BOTTOM DETECTION MENU/ MINIMUM LEVEL	-50 dB (varied)[1]
SOUND VELOCITY MENU/ PROFILE TYPE	ABSOLUTE
SOUND VELOCITY MENU/ DEPTH UPPER	0
SOUND VELOCITY MENU/ DEPTH LOWER	12000
SOUND VELOCITY MENU/ VELOCITY MIN.	1600 m/s
SOUND VELOCITY MENU/ VELOCITY MAX.	1490 m/s
SOUND VELOCITY MENU/ Edit Prof. Menu	Sound velocity = 1500 m/s

[1] On at least two occasions this value was found to have been set to -18 dB or greater resulting in no bottom detection. The Simrad recommended value is -66 dB.

8.9 Geographical Information Systems (GIS)

Summary

This report outlines the use that was made of the Geographical Information System (GIS) Arc/Info on the British Antarctic Survey research cruise JR28.

Introduction

It is inevitable that as the sophistication of instrumentation which can be operated on board a research vessel such as the R.R.S. James Clark Ross increases so does the amount of data which is collected. This was one of the of the justifications for the a PES data manager, as a result, since JR11, PES data has been systematically collated and archived and has led to the development of the pesto data access system. This coupled with an increasing demand for some mechanism by which data can be quickly viewed in a graphical manner has led to the decision to use the GIS Arc/Info in an attempt to provide this quick access to data whilst at sea.

The Arc/Info software

Arc/Info is a software package created by ESRI for the storage and analysis of information which has a spatial component. It's most common use within B.A.S. is as a tool for producing cartographic maps, however, this is only a small component of it's capabilities. It is also a powerful tool for data analysis, which allows the scientist the opportunity to overlay datasets which have been referenced geographically and carry out selections on data from different layers There is also a facility built into Arc/Info for writing macros and menus which was. utilised to create a small interactive programme for viewing and printing, appendix I shows a flow diagram of the macros and scripts which make up the cov_view program.

The use of Arc/Info during JR28

Unlike other MLSD cruises carried out during the austral summer of 1997/98 the MLSD Core Programme covered a limited geographical area in great detail, and the detailed charts of all areas visted were available throughout the trip. As result emphasis was placed on the collation of regularly collected data sets into a format usuable by the Arc/Info GIS suite to allow inter-annual comparisons of both oceanographic and biological data.

Development of the PES GIS during JR28 was centred around the incorperation of aquashuttle data into Arc/Info coverages in a form similar to that used for the creation of oceanlogger coverages during JR26, with the added dimension of depth, which allows the user to view data from the aquashuttle variables at a particular depth. A suite of scripts were created to directly access files which had been previously calibrated and cleaned by the oceanography team and were held as pstar files.

The second aspect of the PES GIS which was developed during JR28 was the creation of a simpler system for creating ships track plots than was presently available from the RVS system. A menu driven system was developed by members of the PES team together with ITS employing an interactive graphical Arc/Info interface which runs mutli scripts to obtain data directly from the bestnav data stream (bestnav is created by merging data from the various ships navigation instruments, which are described elsewhere in the report). A working copy of this was available

for most of JR28 and further development of this particular facet of the PES GIS in tandem with ITS is hoped to provide a generic track plotting system for BAS cruises.

The PES GIS

Since data from PES cruises runs into many millions of bytes of information it is becoming increasingly necessary to find ways of subsetting and displaying this data in a simple manner. The Arc/Info system is a highly complex suite of programs with can be used to manipulate and compare data from a wide range of sources. However, since it is such a large piece of software it was necessary to create a system by which PES scientists could easily display and compare their data sets without necessarily becoming Arc/Info experts. The development of a PES GIS with it's own series menus and graphical interfaces to allow the creation of coverages peculiar to biological and physical oceanographic would be a benifical additon to the PES data management system (PESTO) which is currently in use within the PES group for the archival of cruise data.

Arc/Info output from JR28

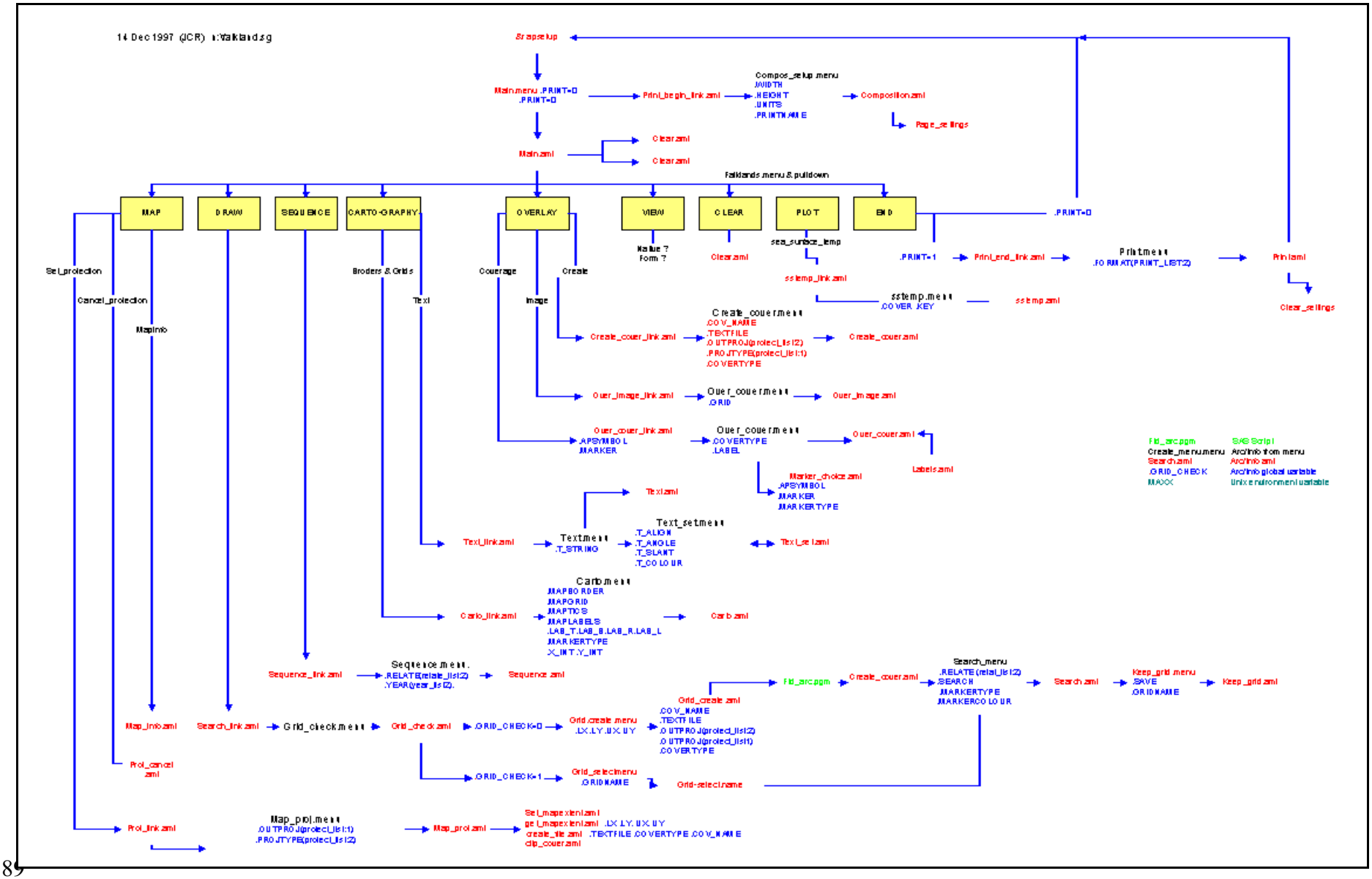
Table 1: Description of Arc/Info coverages held presently for JR28

Arc Cover name	**Description**
coast_p	line coverage in polar projection of the scotia arc from the BAS coastline coverage
JR26_bathy	line coverage from gebco '96 bathymetry. clipped to the scotia arc and peninsula, and retaining the 100m, 200m, 500m and 1000m contours
JR28_rmt	point coverage of start position of rmt hauls
JR28_meb_ocl JR28_ecb_ocl JR28_wcb_ocl	point coverage of oceanlogger surface data for the MEB transect the Eastern corebox and the western coreboxes respectively including pstar variables: sstemp tstemp rawsalin flow fluor
JR28_ecb_aqa	point coverage of aquashuttle data for the Eastern corebox including pstar variables temp cond sigma0 depth par

JR28_track	line coverage of the cruise track plot
JR28_meb_ctd JR28_core_ctd	point coverage of MEB and corebox stations respectively
JR28_xbt	point coverage of xbt locations
JR28_sstemp	point coverage containing sstemp data from the oceanlogger

Coverages generated during JR28 will be held at Cambridge for general use as will postscript files of any plots created during the cruise.

GIS Appendix I: cov_view script documentation



9 Biological Acoustics

9.1 Acoustics

Jon Watkins, Cathy Goss and Inigo Everson

Introduction

The general goals of the acoustic studies are to use multi-frequency echo-sounding to provide information on variability in abundance and distribution of biological scattering organisms found within the study area. During the MEB transect echo-sounding down to 1000 m provides information on the distribution of the deep-scattering layers present. In the east and west core boxes acoustic surveys are undertaken to provide detailed information on the distribution and abundance of Antarctic krill (*Euphausia superba*) plus more general information on other macrozooplankton and micronekton targets. Finally fine resolution acoustic data are collected during macrozooplankton net hauls as part of studies investigating acoustic classification techniques.

Description of standard methods

Simrad EK500

Acoustic data were collected using the Simrad EK500 scientific echo-sounder operating through hull-mounted transducers with frequencies of 38, 120 & 200 kHz. To ensure consistency within and between cruises, standardized equipment settings were used for the 3 major categories of activities undertaken (respectively deepwater surveys, core box surveys and net hauls). These standard configurations were loaded into the EK500 using a PC computer connected to the serial port. This PC also served to record any changes made to the EK500 via the joystick on the monitor and also any messages produced by the echo-sounder. A full description of settings used are available in o:\mlsd\acoustic\logging\commands\jr28\.

Calibration

Echo-sounder calibration using the standard-sphere technique (see o:\mlsd\acoustic\ek500pro.wp6 for further details) was carried out in Stromness Harbour on 22 & 29 January. Using well-established routines, the ship was fixed fore and aft using twin anchors at the bow and stern moorings to the Stromness buoy. A CTD was undertaken to provide information on salinity, temperature and sound velocity prior to each calibration session. Problems were encountered with operation of the EK500 on 22/1 and with excessive ship's movement due to high winds on 29/1, however, a basic calibration of the system was obtained. Details of the calibration can be found in the narrative in Appendix II, which also contains a full record of the results. Calibration constants calculated and those used throughout the cruise are also shown in appendix II.

Data logging

Acoustic data were logged via ethernet to a dedicated Sun UNIX workstation (bsumlsb). The network between EK500 and the workstation was connected to the general scientific LAN using a Gandalf microbridge. Data output from the EK500 were logged on bsumlsb using a custom logging program, the resulting files are in Simrad binary format. Each raw file (and each of the

succeeding processed files) was named using the standard PES convention of cruise, activity, jday and start time (jr28ek5jjjhhmm.). A log of data collected is available in PC QuattroPro (o:\mlsd\acoustic\ekunixlg.wb2). A complete set of instructions on EK500 logging procedures can be found on bsumlsb in directory /users/mlsd/krill/ek500_logging/INSTRUCTIONS.

Acoustic data were logged routinely during all surveys, underway net sampling and when squid jigging. To assist in identifying data sets each leg of the underway surveys was given a unique transect number. A log of all the transects undertaken is available in a PC QuattroPro spreadsheet (o:/mlsd/acoustic/jr28tran.wb2).

Data processing

All raw binary data files were converted to ASCII using custom processing software (instructions on bsumlsb in ~/krill/ek500_logging/INSTRUCTIONS). The raw binary files were then archived on bsumlsb in /local1/data/ek500/Archive/. Subsequent data processing and editing was carried out in AVS using the specially developed acoustic analysis modules. The various processing steps within AVS are described completely in ~/krill/ek500_processing/AVS_INSTRUCTIONS. Briefly, within AVS, the following procedures were carried out (the relevant AVS network name is given in parenthesis):

- creation of AVS binary files (JR28ReadMarkTVG&Write)
- marking suspect data values (such as bottom signals) (JR28ReadMarkTVG&Write)
- removal of TVG-amplified noise (JR28ReadMarkTVG&Write)
- application of calibration corrections for each frequency (JR28AddLat&Calib)
- incorporation of latitude and longitude data (JR28AddLat&Calib)
- calculation of acoustic biomass (JR17CalculateBiomass2)

Status of data processing at end of JR28

The UNIX processing log (ekunixlg.wb2) will continue to provide full details of all processing carried out on the acoustic data sets. However, a brief summary of the status of data at the end of the cruise is provided below:

MEB Transects - editing and TVG noise removal completed for each frequency, but cruise calibration needs to be applied. Most up-to-date data are stored in AVS binary format in /local1/data/ek500/pjc_avs/head_ascii/binary/.

Core box surveys - all stages of processing completed. Biomass of krill and other biological scatters has been calculated for each core box. Most up-to-date data are stored in AVS binary format in /local1/data/ek500/pjc_avs/headed_ascii/with_nav. In addition, ascii files containing Sa data are stored in /local1/data/ek500/pjc_avs/headed_ascii/SA/. Note however, that mark files need to be checked for integrated bottom signal.

RMT8 net hauls and squid jigging acoustic data - AVS binary files created but no further processing undertaken.

Problems - descriptions and solutions

External disk on UNIX system

On 19/1/98 at 0730 (L) while steaming acoustic transect T010 (between MEB stations 9 & 10) the external disk (/local1; a Mecropolis 4 Gbyte disk)) crashed. For several hours prior to this the unit had been making noises which had been attributed to the cooling fan. Several hours work by Jim Crawshaw resulted in all data being retrieved from the disk with the exception of that for T010. After this the disk was removed from use and logging for the rest of the cruise was diverted to the disk of UNIX workstation JRUE. The only visible effect for acoustic logging and data processing was an increased response time especially when working in AVS. It is important that prior to the next cruise a new disk is purchased.

EK500 crashes

The EK500 has stopped working on a number of occasions. Each time the only way to restart the system has been to switch the power off and then on again. Problems were first encountered during calibration as noted above. In addition the EK500 stopped working on 26/1/98 at 1432 (L), with the loss of 10 minutes of transect data; in the middle of transect T038 on 29/1/98 at 0759 (L) and at 0920 (L); and finally on 30/1/98. Since that time the system has run satisfactorily. However, we believe that the system should be checked by Simrad prior to any further scientific usage.

Printer hangups

From 27/1/98 the HP PainJet printers used to print out echo-chart have proved to be extremely unreliable. A printer will stop printing and can only be started again by switching off and on, this action causes a page feed further interrupts the recording and continuity of the transects. On one occasion some percussive maintenance was tried but this had no lasting effect. Stoppages have occurred as frequently as every 5-10 mins with printer II. These printers went out of production in 1993 and consumables will not be produced after next year, they are therefore due for replacement at the earliest opportunity, indeed it is vital that suitable replacements are identified and purchased before the next cruise.

System noise

Previous cruise reports (JR25, JR26) have highlighted various sources of background noise particularly on 120 kHz. Following on from these findings, at the beginning of cruise JR28 we investigated equipment positions and wiring combinations in an attempt to reduce noise occurring on the 120 kHz system. We again found that noise increased if both EK500 monitors were in use. Even quite small movements in the position of monitors could have a major effect on the amount of background noise seen on the 120 kHz echo-chart. To undertake target fishing the second EK500 monitor was positioned next to the PC for the DWNM (Down Wire Net Monitor). However, to keep background noise to a minimum, when this monitor was in use the RGB inputs to the primary monitor were disconnected although the no adverse effects were detected if the remote control cables were left attached.

Background noise on the 200 kHz system has been very variable. Large changes have occurred at various points during the cruise. Attempts to identify the source have revealed that it is unlikely to be linked to running of emergency generators, bow & stern thrusters, seawater pumps or winch power packs. Unfortunately, the degree of variability makes analysis extremely difficult and time consuming and makes the routine use of 200 kHz data impossible.

We consider that investigation of all aspects of background noise is extremely important but that

it is very difficult to carry out during regular science cruises. Rather dedicated time is required where all ships and scientific equipment can be switched off and on under controlled conditions. Such conditions are probably best obtained during a period of sea trials in the northern hemisphere.

It appears that much noise may be introduced through the long cable runs between transducer space and the system box in the UIC. It may be possible to reduce electrical noise significantly if the EK500 system box is installed as close to the transducers as possible. This would depend on suitable place being found in the transducer space. The feasibility of such an installation should be assessed, paying particular attention to the humid and salty atmosphere in that space, and costed as soon as possible.

Tow-fish trials

The multi-frequency tow-fish was not used on the core programme because of worries over comparibility between hull and tow-fish results. However, the tow-fish was deployed over several transects to gather comparative data on the tilt angle of ship and tow-fish. Tow-fish data were logged through a temporary PC logging system built and programed by Pat Cooper. This proved to be very successful and for next cruise a permanent system should be set up.

At present the transducer cables are screwed directly into the back of the EK500. To change between tow-fish and hull-mounted transducers one set of cables have to be unscrewed and the other set connected. This is not only time consuming and difficult because of the restricted access to the rear of the machine but also may change the background noise level by changing the delicate arrangement of cables. For the future we recommend that a break-out box be designed and constructed.

Future requirements

- Sea trials to investigate system noise and make comparative measurement between tow-fish and hull-mounted transducers
- Simrad service
- New printers
- New disk for logging system
- New calibration equipment (see calibration section).

9.2 Calibrations

A narrative of each of the two calibration periods follows. Further details are available in a QuattroPro spreadsheet in mlsd shared space on the pc network under o:\mlsd\acoustic\calib\jr28. Data from the two days are shown in Table1.

22 January 1998

The ship's mooring to the buoy at Stromness was complete by 10:30 Z. A CTD cast was made at 11:30 Z. The first sphere was in position by 12:00 Z.

The sounder then stopped, it failed to restart after all three frequencies had been set to the test signal at once (in order to read internal test oscillator). Error messages 'SP1 not responding' and 'SP2 not responding' were displayed on the monitor. The sounder was powered off and then on a number of times, but did not immediately restart. At first only one, then two frequencies were switched into active mode and 200 kHz was still switched off. Normal operation resumed only after 200 kHz was restarted. With ping rate set to 0.0, a noticeable increase in ping rate occurred when all unnecessary ethernet logging was switched off.

By 13:44 Z the 38 kHz sounder had been calibrated successfully, but the lines snagged during execution of lobe programme. At 15:30 Z forward port line broken while trying to free snagged line. The snagged line was finally released at 17:05 Z. All plaited lines were then replaced with nylon monofilament, and the lobe programmed scrapped in view of short time remaining.

The 120 kHz calibration was started at 19:14 Z. It was found that the TS minimum setting had a considerable effect on the echo strength: low settings such as -70 or -80 dB giving poor stability, while -50 or -40 dB gave good returns. After an initial straightforward TS calibration (that suggested a 1 dB increase in gain setting since the last cruise), the Sv calibration was slow and drifted in the opposite direction from the first setting measured.
After 9 iterations of the TS gain calibration, and 11 iterations of the Sv gain calibration, at 22:00 Z this frequency was completed. The cruise schedule required that we then left the mooring.

29 January 1998

All spheres were put to soak in detergent solution at 09:15 Z. The ship moored onto the buoy at Stromness at 10:00 Z. The weather was clear, but with strong winds. The EK500 was set up for the calibration as advised in the manual and the settings dumped to a file called calib_29.dat. The test signal was sent to each tranceiver in turn; it was noted that the 120 response at -56.9 dB is only just within the limits prescribed by Simrad (-55 ± 2 dB). All ethernet outputs were switched off to reduce the processing load. New marks were put on the starboard suspension line: a yellow mark at the 20 m position and green and yellow striped at the 25 m mark. (Note this is a colour change from earlier marks). A CTD cast was carried out at 11:58 Z. The wind speed at 11:50 Z was 8 m s^{-1} with gusts up to 11.8 m s^{-1}.

The first sphere calibration (200 kHz) commenced at 12:15 Z. The sphere was positioned 1.2° to starboard in the 120 kHz TS screen, as it swung this varied between 0.9° and 1.5° at the extremes. A striking drop in TS occurred as pulsed noise commenced at 12:18 Z. Checks with the Radio operator, bridge and engine room showed no events could be connected with this, other than the return of the two humbers alongside. The default TS setting of -50 dB does not pick up this sphere when it is at the edge of the beam, so this level was decreased to -70 dB instead. A projection was noted below the port forward rod, and this was moved to position further aft than usual. A reasonably stable calibration was obtained.

At 13:41 Z the 120 kHz calibration commenced. Increasing wind speed meant that the sphere was

hard to centre and it was noted that the ship swung up to 10°. Unstable TS readings were listed (up to 64 readings per setting) in order to obtain averages. An alternative was found: logging EchoTrace over the serial port includes ping by ping TS output, compensated and uncompensated, depth and angle values. Data from 14:55 Z to 15:55 Z were logged to file 29_120.TS.dat, while also recording Sa values on paper.

The 38 kHz TS measurement begun at 17:00 Z was made extremely difficult by the ship swinging on the buoy (and two forward anchors). When the wind speed rose to 16 m s^{-1} the sphere could not be centred and the operation was abandoned.

Recommendations

1. Time required for calibration

The two calibration periods together provided us with little more than the minimum calibration we need for acoustic survey, owing to a combination of problems on the first day and bad weather on the second. At least 24 hours should be allocated for calibration on any future cruise to allow for these eventualities. While some time saving might have been made by combining the two periods, having them separate gave us a greater chance of having some calibration time in good weather, and avoided the need for the personnel involved to work around the clock. An alternative would have been a single calibration period on a date chosen during the cruise, dependent on the weather.

2. New equipment to improve calibration

Items that were considered for future purchase or construction were:

a) A keypad, available from Simrad, to avoid the labourious joystick setting changes that take up so much of the calibration time.

b) A temperature probe in the transducer space. Ambient temperature is known to affect transducer performance (the ADCP transducers have a temperature sensor which is used to compensate for such performance changes in that instrument). The instability we have encountered when calibrating at higher frequencies is not reported by other users of the Simrad sounder, but few of them operate in the low temperatures encountered on our surveys.

c) Booms, motors and controller for remote operation of suspension lines.

3. Facilities

a) A less weather dependent site might be investigated for future years. Also a site that permitted the use of strongbacks as used in Bergen, may help to avoid the excessive swinging that terminated the second set of calibrations on this cruise

b) A boat on standby to help release snagged lines could help when this is a problem during future calibration sessions.

4. Consultation

Other EK500 users should be contacted to find out whether drifting of results has been widely encountered, or whether it is a feature of our operation in low temperature water.

10 Net Sampling

10.1 Macrozooplankton/micronekton net sampling

Jon Watkins

Introduction

Macrozooplankton and micronekton net sampling was carried out in the east and west core boxes to characterize the community structure of the area, to provide information on the composition of acoustic targets detected during surveys and to describe the population stucture of Antarctic krill, *Euphausia superba*. To achieve these three separate aims net sampling of the integrated water column at standard stations and target net hauls at key acoustic targets were carried out. Different sampling strategies were required for sampling the water column and for sampling acoustic targets; these are described separately below.

Standardized station sampling

To characterize the macro-zooplankton community within each survey box, standard nets, the RMT8 and FNET, were deployed at each station. A double oblique RMT8 haul sampled from ~0 m to 250 m, unless the water depth was shallower in which case the net was fished to within 20 m of the bottom. Two nets were fished, each for half an hour, within a haul. At the same time, the FNET surface sampler was deployed from foredeck, one 20 min FNET tow corresponding to each RMT8 net.

The two RMT8 and FNET samples were treated as replicate samples. The first net was sorted on board to identify number and volume of key components. The second net was formalin preserved for archiving in Cambridge.

Net hauls to characterize acoustic targets

Up to 2 RMT8 hauls were undertaken each afternoon after the completion of the acoustic transects. The depth and trajectory of each haul was determined from the position of acoustic targets in the water column. Fishing was limited to areas between the end of the last transect and the position of the first sampling station of the evening. However due to the alternation of transect end points both offshore and shelf samples were obtained.

Positions of net hauls are shown in Figure 1 (Section 10.3).

Sample analysis

Samples sorted on board were treated as follows. The total volume of the catch was estimated and then an appropriate subsample was sorted through. The macrozooplankton was identified and counted. Volumes of each species (or species group) were also obtained as appropriate. Data were recorded on catch sheets (o:\mlsd\nets\jr28\catchshe.wp6) prior to entry into PC QuattroPro spreadsheets. The spreadsheet template, provided by the data manager was modified during the cruise and can be found in o:\mlsd\nets\jr28\rm8tem2.wb2.

Fish for analysis in Cambridge were selected from all nets and preserved in ethanol. Archive

macrozooplankton samples were preserved in formalin. A list of preserved samples is available in o:\mlsd\nets\jr28\samples.wb2.

Random samples of 100 krill from each net when available were measured on board by a single observer. The total length of each krill was measured from the anterior edge of the eye to the tip of the telson to the nearest mm below. The maturity stage of the krill was determined using the key of Makarov and Denys (1982) and the nomenclature of Morris et al (1988). The total length of krill measured was 83.8 m.

Problems - descriptions and solutions

1) Towards the end of the first core box we noticed that catches in net 3 (which was not fished except to complete the net monitor sequence) were greater than in the other two nets (which were fishing for 30 min each). This result was observed in a number of net hauls and finally the entire system was checked by firing the nets near to the surface and then retrieving for inspection. This revealed that the Down Wire Net Monitor was out of sequence and so the nets had not been fishing as expected. While this will have caused problems for the assessment of zooplankton biomass, we consider that results of species composition and krill length frequency will be valid. In future, net operation should be checked frequently and catches from all unfished nets monitored.

2) Sample sorting was carried out by Jon Watkins and Kirsty Anderson with major assistance from Geof Cripps, Cathy Goss, Inigo Everson and Angus Atkinson. The net sampling is labour intensive and it should be the major task for two people plus a secondary task for at least 2 other people. Personnel numbers on future cruises must take these requirements into account.

10.2 Rectangular Midwater Trawl (8m mouth)

The Rectangular Midwater Trawl comprises three nets each with a theoretical mouth area of $8m^2$ and is operated in conjunction with the BAS Down-wire Net Monitor and 4 Jaw release gear. One haul was made at each Core Box station in order to collect macrozooplankton and micronekton for characterisation of the communities within the two Core Boxes and for lipid analysis. Up to two hauls were made at the end of each Core Box transect pair in order to characterise targets identified by the EK500 echo-sounder.

Deployment at Core Box Stations

Hauls were fished with two nets, the first on a downward oblique trajectory to 250m and the second upwards to the surface. The third net was opened at the surface and then closed thirty seconds later before recovery. The first two nets were intended to be open for thirty minutes each. For a 250m profile, this gives a descent/ascent rate of 8.3 m/min. The rates of veer and haul of the wire out were adjusted in accordance with the achieved rate of change of depth. In calm conditions with no swell, the ship's speed remains fairly constant making it fairly easy to obtain a rate of change of depth of about 8-9 m/min. To achieve this, a veer or haul rate of about 15 m/min of wire is sufficient at a speed of 2.5 knots. In windy conditions and especially if the ship is pitching, the ship's speed may be much less constant, sometimes changing by half a knot or more over a period of a couple of minutes. In such conditions, frequent adjustments to the rate of wire veer/haul may be required if the intended even oblique sample of the water column is to be obtained. There is a certain amount of lag in the system and it is probably not worth making adjustments over a shorter period than two minutes.

Deployment at end of Transect Pairs

Up to two hauls were made after the completion of the acoustic transect. The depth and trajectory of each haul was determined from the position of acoustic targets in the water column. Fishing was limited to areas between the end of the last transect pair and the first of the two stations on that transect. This provided samples from both on and off shore.

Problems

Much of the RMT equipment is now of great age and in need of replacement. Two new nets and three new Cod-end tubes were purchased for this season. The net was originally assembled for JR26. It was clear that the net had very hard use on this cruise, many very large catches of krill were made, causing considerable wear and necessitation a number of repairs before use on JR28. Many of the wires used in the net do have a finite life and replacement is routine. The side wires, which take the greatest strain, were renewed at the start of this cruise. One opening bridle needed to be replaced subsequently.

The net generally worked well throughout the cruise and few problems were experienced. The only major one occurred when the release gear somehow got out of sequence and was opening nets Two and Three before net One. The cause of this is obscure but probably resulted from either an extra release at the end of a haul or possibly radio transmissions triggering the release gear whilst on deck.

Originally, the release gear had an indicator to show release cam position but its use was discontinued with the acoustic net monitors on "John Biscoe". This will now be reinstated.

During the penultimate day of netting, a very large and dense krill swarm was encountered. The net must have been fished through this for some time and collected a large quantity of krill without the operator realising. The haul was not terminated to recover this catch but fished down to some depth before recovery. On recovery the cod-end was found to be full of krill but the main net had burst, having a hole some 5 m long. For the few hauls made after this, the RMT was fished as a two net rig. This event and the wear and tear that took place on JR26 indicate that net operators should remain alert to the possibility of making unnecessarily large catches.

Two factors contributed to the net damage. Firstly, catches on the new cod-end tubes were prominent and sharp, catching in the meshes of adjoining nets and causing small tears. It is anticipated that this problem can be solved for future seasons by attaching faired plastic blocks ahead of each catch. Secondly, the surface of the stern roller, which does not roll under the influence of aa RMT net, and is rusted sufficiently to cause considerable abrasion. This problem would only be solved by chipping and re-painting so long as the roller was not used for any purpose that damaged the point. A better solution may be to cover the roller in a protective sheet of heavy duty rubber or plastic material.

10.3 Down Wire Net Monitor

Summary

This report describes the collection of data associated with the deployment of the British Antarctic Survey Down wire net-monitor, in association with the RMT-8 net and the Horizontal Antarctic Multiple Plankton Sampler (HAMPS) and during JR28, and also the data pathway which was used to process the data collected from it.

Introduction

The RMT 8 was the main method used for collecting biological samples during JR28. There were

two planned types of net haul. Following each UOR/Acoustic/Predator transect, there was a period of target fishing and at the end of each of the stations a double-haul was carried out.The Fnet was a secondary collection instrument and was generally fished in tandem with the RMT8, from the foredeck. In total there were 24 RMT hauls, 35 FNET tows and a single HAMPS deployment. Figure 1 shows the locations of the RMT tows and Appendix I contains a summary of net deplyments and net firing depths. Fnets were only towed together with the RMT 8 and so no figure is included charting their positions. There was also a single HAMPS deployment.

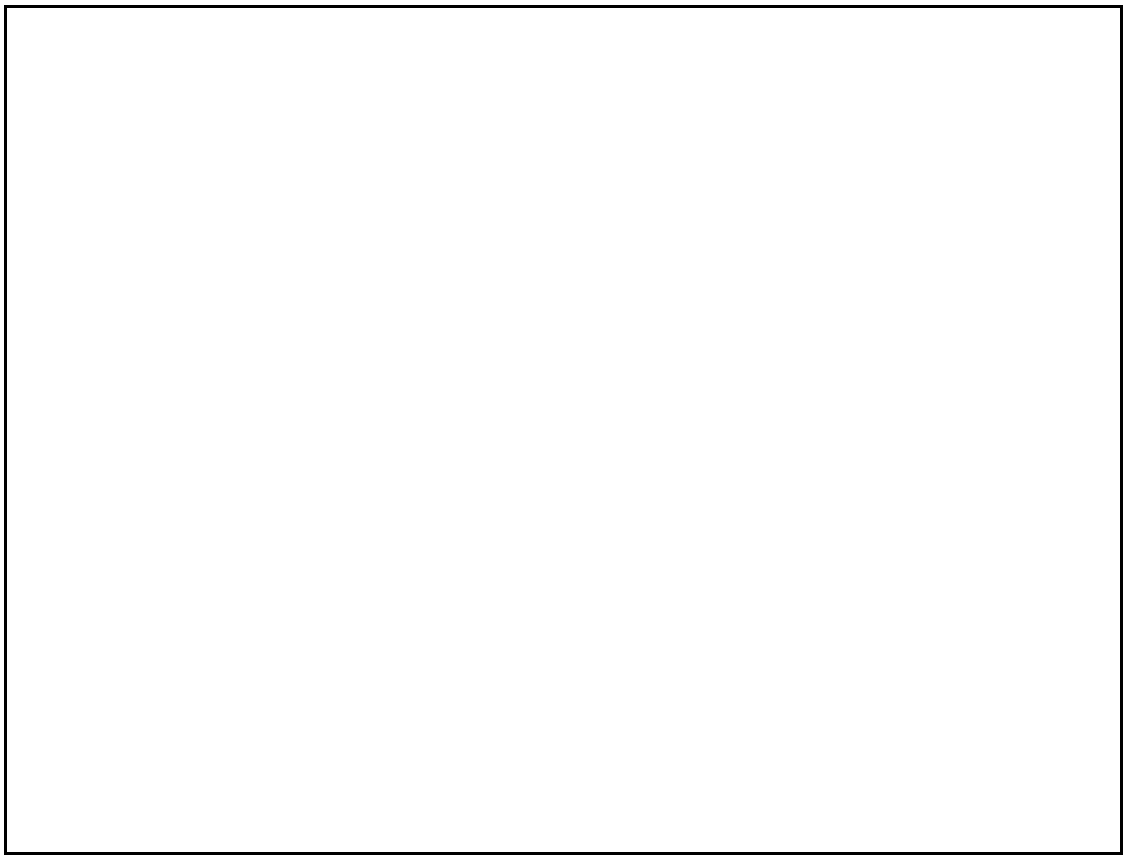


Figure 1: Locations of RMT net hauls during JR28

General information:

Both the RMT 8 amd the HAMPS can be fitted with a package called the Down Wire Net Monitor (DWNM) which is made up of; an electro-mechanical device which is used to facilitate the opening and closing of the nets on the 3 RMT 8 nets and the 5 HAMPS nets, a series of sensors for recording oceanographic variables, and a software package which allows the operator to monitor the position of the net in the water, which allows the operator to open and close nets and collects data from the sensors. The DWNM is also used for operating the Longhurst-Hardy Plankton Recorder but this facility was not used on this cruise.

The mechanical section of the DWNM is attached to the net cross and causes a pair of bridles holding the mouth of each of the nets closed, to be released when signals are received from the software. It is also where the various sensors are attached.

The software which controls the DWNM and which receives data from the sensors is called dwnm56 and was originally created in 1995/96 by Paul Woodroffe (B.A.S.), and an updated version was created in October 1997 for use in the austral summer season of 97/98 (dwnm71), however, after testing with the LHPR on JR25 it was found that the new version was not performing correctly and so version dwnm56 was used for the duration of both JR26 and JR28 instead.

Net-monitor data:

Net-monitor instrumentation:

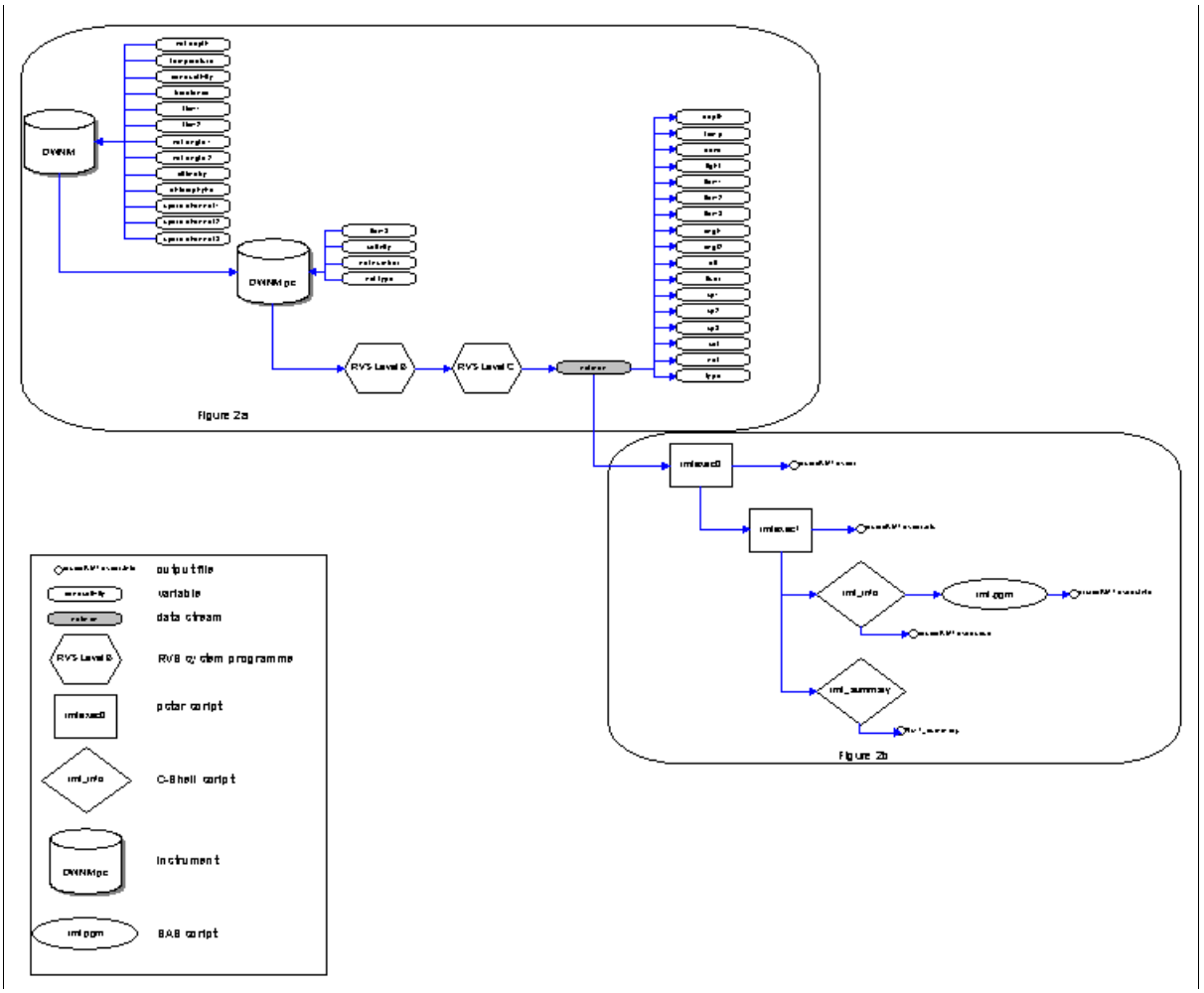
There were 10 instruments on the DWNM during JR28, plus three spare channels (sp1 sp2 and sp3), descriptions of these are given in table1, and for detailed information reference should be made to the Down Wire Net Monitor System Documentation a copy of which is held at B.A.S. Cambridge by the MLSD Gear development section and one with the electonics department.

Not all of the instruments where operational during JR28, as a result no data were collected from the light meter, flow meters 2 and 3, from inclinometer 2 or from the fluorometer**.** The light meter was not used to avoid having to take it on and of the monitor if the net was required to go below 500m. Data from all the other instruments were logged directly to the DWNM pc, at which point three further variables were added to the data stream, these being salinity (derived from conductivity), net number and net type. Output from the DWNM pc was in the RVS ship message protocol (SMP) format and so was passed directly to the RVS Level-B system for archiving and then to the Level-C system to produce the data stream netmon with data logged every 2 seconds (see fig 2a).

No.	Quantity measured (Variable Name)	Units	Sensor description
1	Net depth (depth)	metres	TransInstrument BHL-4269-01 Pressure range 0 - 250 bA
2	Sea Water Temperature (temp)	degrees Celsius	Sea-Bird SBE3 Range: -5.0°C - 35°C
3	Sea Water Conductivity (cond)	Siemans/metre*	Sea-Bird SBE4 Range: 0 - 7 Siemans/metre*
4	Irradiance (light) **NOT USED ON JR28**	Output: mV** Calibrated: ln µW cm^{-2}	Chelsea Instruments PR46
5	(flow1)	?	B.A.S. radial flow meter / LHPR axial flow meter 1
6	(flow2) **NOT USED ON JR28**	?	LHPR axial flow meter 2
7	(flow3) **NOT USED ON JR28**	?	LHPR axial flow meter 2
8	(angl1)	degrees	Sensorex 41600 Inclinometer Range +/- 90 degrees
9	(angl2) **NOT USED ON JR28**	degrees	Sensorex 41600 Inclinometer Range +/- 90 degrees
10	Depth above sea bed (alt)	metres	Tritech ST200 Range 0 - 100m
11	Chlorophyll-a (fluor) **NOT USED ON JR28**	Output: mV Calibrated: µg/l	Chelsea Mk III Aquatracker Range 0 - 100µg/l +/- 0.005 µg/l + 5% of value.
12	Spare channel (sp1)		Not in use
13	Spare channel (sp2)		Not in use
14	Spare channel (sp3)		Not in use
15	Salinity (sal)	ppt	Derived from sa water conductivity
16	Net number (net)	Integer 0,1,2,3 or 4	
17	(type)		RMT8, RMT25 or LHPR

Table 1: Descriptions of the sensors present on the Down wire net-monitor during JR28.

* - mmho/cm = Siemans/metre * 10
** - PAR (ln µW cm^{-2}) = 6.9767 - (0.005147 * light)
*** - Concentration (µg/l) = 0.01121 x 10^{output} - 0.0182
? - Information unavailable during JR28



Net-monitor data processing:

During JR28 data from the Level C netmon data stream were processed using the pstar execs rmtexec0, rmtexec1, the C-Shell script rmt_info and the SAS script rmt.pgm. These were used, to create a series of data files, one for each RMT event and a series of net summaries for the whole cruise (see Fig. 2b). These were placed on the pc network and also on the unix server jrue. Copies of these files were returned to B.A.S. Cambridge by the ITS group for subsequent retrieval. The execs and scripts can be found in Appendix II and table 2 shows an example of Figure 2: Data pathway used for processing raw data from the B.A.S. net-monitor on JR28.

the output from rmt_info. Figures 2a and b outline the data processing path. The tables produced in this way were created as a complement to the catch data which was recorded by the Krill acoustics team who hold a combination of electronic and paper records of the contents of the hauls, whilst data from the DWMN will be held at BAS HQ in Cambridge by the PES data manager.

NET	N Obs	Variable	Minimum	Maximum	Mean
0	399	DEPTH	0	221.9000000	97.0172932
		FLOW1	0.1000000	1.3000000	0.8453634
		TEMP	-1.2329000	2.1672000	-0.1913190
		COND	-0.00010000	2.9838000	2.3822506
		SAL	33.0931000	34.9070000	33.8984305
1	825	DEPTH	203.800000	244.400000	220.6727273
		FLOW1	1.0000000	1.6000000	1.3427879
		TEMP	0.9903000	1.6394000	1.3760395
		COND	2.9371000	3.0012000	2.9747895
		SAL	34.1933000	34.3164000	34.2553868
2	480	DEPTH	51.3000000	225.000000	143.2681250
		FLOW1	1.3000000	1.9000000	1.5937500
		TEMP	-0.9764000	1.0717000	-0.4440521
		COND	2.7352000	2.9493000	2.7957758
		SAL	33.7964000	34.2608000	33.9703592
3	848	DEPTH	26.3000000	50.0000000	30.3737028
		FLOW1	1.2000000	1.9000000	1.5628538
		TEMP	-1.0459000	-0.6591000	-0.8868514
		COND	2.7201000	2.7599000	2.7387183
		SAL	33.6929000	33.8083000	33.7695368
4	87	DEPTH	0	26.9000000	14.4517241
		FLOW1	0.1000000	2.0000000	1.4942529
		TEMP	-3.4859000	-0.6288000	-1.2244632
		COND	0	2.7629000	2.2423172
		SAL	33.5300000	33.8139000	33.7100803

Details of RMT haul 21:09 Wednesday, December 10, 1997 2

NET=0

OBS	Date of haul	Start Latitude	Start Longitude	Depth net fired (m)	Temp. when net fired	COND	LIGHT	Flow when net fired (m/s)	FLUOR	Salinity (ppt)	
1	971121	-54.5681	-39.2056	0	-0.7331	2.7	6.978	0.2		0	33.0931

OBS	DISTRUN	ANGL1	Time net fired	Event number	ACTION	Length of time net open	AVR_ANG	Volume of Water filtered
1	0.2502	80.1	18:54:26	068	downcast	0:12:14	128.935	4963.97

NET=1

OBS	Date of haul	Start Latitude	Start Longitude	Depth net fired (m)	Temp. when net fired	COND	LIGHT	Flow when net fired (m/s)	FLUOR	Salinity (ppt)
2	971121	-54.5747	-39.2176	220.6	1.4921	2.9852	6.978	1.4	0	34.2615

OBS	DISTRUN	ANGL1	Time net fired	Event number	ACTION	Length of time net open	AVR_ANG	Volume of water filtered
2	1.331	68	19:06:40	068	open 1	0:29:22	67.9336	18927.94

NET=2

OBS	Date of haul	Start Latitude	Start Longitude	Depth net fired (m)	Temp. when net fired	COND	LIGHT	Flow when net fired (m/s)	FLUOR	Salinity (ppt)
3	971121	-54.5846	-39.245	225	1.0717	2.9493	6.979	1.4	0	34.2608

OBS	DISTRUN	ANGL1	Time net fired	Event number	ACTION	Length of time net open	AVR_ANG	Volume of water filtered
3	3.521	67.5	19:36:02	068	open 2	0:17:08	56.035	13107

NET=3

OBS	Date of haul	Start Latitude	Start Longitude	Depth net fired (m)	Temp. when net fired	COND	LIGHT	Flow when net fired (m/s)	FLUOR	Salinity (ppt)
4	971121	-54.5893	-39.2664	50	-0.963	2.7355	6.978	1.8	0	33.7988

OBS	DISTRUN	ANGL1	Time net fired	Event number	ACTION	Length of time net open	AVR_ANG	Volume of water filtered
4	5.02	47	19:53:10	068	open 3	0:30:06	60.9792	22580.11

NET=4

OBS	Date of haul	Start Latitude	Start Longitude	Depth net fired (m)	Temp. when net fired	COND	LIGHT	Flow when net fired (m/s)	FLUOR	Salinity (ppt)
5	971121	-54.5983	-39.3029	26.9	-0.6385	2.762	6.978	1.7	0	33.808

OBS	DISTRUN	ANGL1	Time net fired	Event number	ACTION	Length of time net open	AVR_ANG	Volume of water filtered
5	7.6212	59.5	20:23:16	068	upcast	.	92.1172	.

Table 2: Example of Net-monitor summary table produced by rmt_info

rmt_info variable name	Description and derivation
depth	mean, minimum and maximum depth of the net during the time that it was open.
flow1	mean, minimum and maximum rate of flow of water through the open net.
temp	mean, minimum and maximum water temperature during the time that it was open.
cond	mean, minimum and maximum conductivity of the water during the time that the net was open
sal	mean, minimum and maximum salinity of the water during the time that the net was open.
Date of Haul	GMT date of net opening
Start Latitude	Location that net was fired
Start Longitude	Location that net was fired
Depth net fired	Depth recorded when the net vasriable changes value
Temp. When net fired	Temperature recorded when the net vasriable changes value
cond	Conductivity recorded when the net vasriable changes value
light	PAR recorded when the net vasriable changes value
flour	Chlorophyll - a
salinity	Salinity recorded when the net vasriable changes value
distrun	Horizontal distance from time net launched to time net fired
Time net fired	Time net fired
Event Number	Bridge assigned ID
action	description of what the net is doing
length of time net open	time between current net and following net being opened
avr_ang	Average angle of tilt for the net monitor
volume of water filtered	How much water has moved through the net given an effective mouth area of 8 m^2 and angle of 45 degrees to the vertical.

Table 3: Description of rmt net summary fields.

Fnet Information:

There was no physical oceanographic data collected about the fnet unlike the nets controlled by the downwire net monitor, and details about time of deployment was generally collected after the event from the bridge science log book. Catch details were recorded in a similar manner to those from the RMT 8 and can be obtained from members of the plankton dynamics team.

Recommendations:

There has also been highlighted, a need for a standardised net monitor procedure, whereby logging of operations and event details are systematic. Ideally, event numbers would be electronically recorded on the bridge and immediately available to all scientists over the network. It is also proprietious, for the purposes of trouble shooting, for mishaps and accidents to be logged in a detailed manner.

DWNM Appendix I: Net summary information

Event number	Date	Time	latitude	longitude	depth (m)	net number
122	980124	19:54:09	-53.8781	-35.372	35.6	1
	980124	20:10:15	-53.866	-35.3845	75.6	2
	980124	20:48:32	-53.8359	-35.4134	53.8	3
128	980125	1:20:54	-53.8808	-35.434	0	1
	980125	1:50:05	-53.8646	-35.406	271.3	2
	980125	2:20:03	-53.8514	-35.3841	0	3
136	980125	6:19:02	-54.0828	-35.9157	4.4	1
	980125	6:50:03	-54.1049	-35.9086	175.6	2
	980125	7:13:59	-54.1218	-35.9096	2.5	3
140	980125	19:13:11	-54.2966	-35.8158	11.9	1
	980125	19:20:14	-54.2934	-35.8219	65.6	2
	980125	19:22:29	-54.2923	-35.8239	66.2	3
145	980125	23:20:50	-54.2375	-35.7403	3.1	1
	980125	23:50:04	-54.2188	-35.7534	197.5	2
	980126	0:20:05	-54.203	-35.7662	4.4	3
154	980126	6:01:02	-54.0414	-35.2425	1.2	1
	980126	6:32:33	-54.0438	-35.2819	250	2
	980126	7:00:13	-54.046	-35.3166	1.9	3
158	980126	19:22:39	-54.1693	-34.9695	155	1
	980126	19:25:48	-54.1686	-34.9744	135.6	2
	980126	19:34:05	-54.1669	-34.9873	105	3
159	980126	20:12:00	-54.1607	-35.0366	75	1
	980126	20:36:18	-54.1594	-35.0671	61.9	2
	980126	20:41:05	-54.1592	-35.0733	36.9	3
164	980126	23:37:15	-54.1846	-35.0597	2.5	1
	980127	0:07:16	-54.1732	-35.0989	241.9	2
	980127	0:37:05	-54.1624	-35.1341	0.6	3
173	980127	4:49:56	-54.3953	-35.5425	4.4	1

	980127	5:21:08	-54.4002	-35.574	250.6	2
	980127	5:51:57	-54.4066	-35.6076	2.5	3
177	980127	18:38:32	-54.5983	-35.5013	65.6	1
	980127	18:46:50	-54.5925	-35.5013	76.2	2
	980127	18:55:14	-54.5869	-35.5002	78.7	3
178	980127	20:06:47	-54.5572	-35.3728	0.6	1
	980127	20:37:10	-54.5355	-35.3884	151.3	2
	980127	21:07:06	-54.5186	-35.3981	13.1	3
193	980128	5:04:00	-54.3196	-34.8896	3.1	1
	980128	5:32:38	-54.3007	-34.8761	251.3	2
	980128	6:04:48	-54.2821	-34.8629	2.5	3
203	980130	19:30:44	-53.8011	-38.8554	98.8	1
	980130	19:59:25	-53.799	-38.8925	50	2
	980130	20:23:32	-53.7992	-38.9231	98.8	3
208	980130	23:10:21	-53.8228	-38.8923	1.9	1
	980130	23:40:07	-53.8162	-38.9309	193.1	2
	980131	0:09:56	-53.8079	-38.9677	1.2	3
217	980131	5:12:56	-53.4657	-39.0105	12.5	1
	980131	5:14:02	-53.4654	-39.0117	6.2	2
	980131	5:41:37	-53.4561	-39.0478	251.3	3
221	980131	23:36:56	-53.4332	-38.7123	5.6	1
	980201	0:04:53	-53.4375	-38.752	250.6	2
	980201	0:34:50	-53.4423	-38.7948	4.4	3
234	980201	4:55:24	-53.7946	-38.5958	1.2	1
	980201	5:14:11	-53.8034	-38.6109	180	2
	980201	5:34:17	-53.8132	-38.6276	3.7	3
240	980201	19:54:56	-53.68	-38.2697	65	1
	980201	20:16:36	-53.6826	-38.2977	25.6	2
	980201	20:50:03	-53.6873	-38.3427	90	3
245	980201	23:21:26	-53.7464	-38.2875	3.7	1
	980201	23:51:15	-53.7391	-38.3287	180	2

	980202	0:20:11	-53.731	-38.3666	0.6	3
254	980202	5:27:44	-53.3976	-38.4156	4.4	1
	980202	5:54:34	-53.4043	-38.4488	250	2
	980202	6:23:41	-53.4109	-38.4825	1.9	3
259	980202	19:14:04	-53.3484	-38.0599	55	1
	980202	19:44:13	-53.3507	-38.1022	157.5	2
	980202	20:14:04	-53.3541	-38.1439	22.5	3
264	980202	23:03:56	-53.3641	-38.0934	1.2	1
	980202	23:34:50	-53.3735	-38.138	250	2
	980203	0:03:57	-53.3827	-38.18	0.6	3
272	980203	4:18:48	-53.7088	-37.9734	1.2	1
	980203	4:34:00	-53.7031	-37.987	118.8	2
	980203	4:52:32	-53.6972	-38.0022	0.6	3

DWNM Appendix II:

RMT.PGM

SAS script invoked by the C-Shell script rmt_info.

```
                /* SAS SCRIPT : RMT.PGM */
/************************************************************** /
/* Date of creation: December 1997                             */
/* Input: Ascii file containing netmonitor variables           */
/* Ouput: text summary file called cruiseRMTevent              */
/*************************************************************/

/************************/
/* Input Variables      */
/************************/
/* Time HMS      */
/* Depth metres  */
/* temp degrees C */
/* cond          */
/* light mV      */
/* flow1 m/sec   */
/* flow2 m/sec   */
/* flow3 m/sec   */
/* flour         */
/* sal ppt       */
/* net           */
/* type          */
/* net angle     */
/*****************/


/*********************************************************************/
/*              SETS UP VARIABLES AND FILENAMES                      */
/*          nb: you should only have to change things up here        */
/*********************************************************************/

%let netarea = 8;

data RMT(drop=timex);

 infile SASFILE firstobs=24;

 input N datex:$6. timex:$6. LAT LON DEPTH TEMP COND LIGHT
      FLOW1 FLUOR SAL NET TYPE DISTRUN;


 if SAL < 30 then SAL = .;
 if (NET = 1 OR NET = 2 OR NET = 3) AND DEPTH = 0 then DEPTH = .;

 timex = RIGHT(timex);
 TIME = HMS(input(substr(timex,1,2),2.),
       input(substr(timex,3,2),2.),
       input(substr(timex,5,2),2.));

 format TIME time8. ;

 E_NUM = sysget("EVENT");
run;

/* Use sas means procedure to calculate the min max and average depth and flow */
/* Then save to a file called rmtstat */

proc means min max mean;
  class net;
  var depth flow1 temp cond sal;
  output out=rmtstat
```

```
        min=min_dep min_flow min_temp min_cond min_sal
        max=max_dep max_flow max_temp max_cond max_sal
        mean=avr_dep avr_flow avr_temp avr_cond avr_sal;
run;

/* Pick out information at the point when each net is opened/closed */
/* Save to a file called rmtinfo */


data rmtinfo;

  set rmt;

  if _n_ = 1 then
    counter = 0;

  if NET = counter AND SAL ne . then

  do;
    select (NET);
      when(0) action = 'downcast';
      when(1) action = 'open 1';
      when(2) action = 'open 2';
      when(3) action = 'open 3';
      when(4) action = 'upcast';
      otherwise action = 'Error';
    end;

    counter + 1;
    output;

  end;

run;

/* shift time one place up to get net end times */

data time(drop=time);

  set rmtinfo(keep=net time);

  net = net - 1;

  endtime=time;

  format ENDTIME time8. ;

run;

/* Calculate Length of time that net is open */

data rmttime(keep=endtime time duration tot_sec net);

  merge rmtinfo(keep=time net ) time;

  imtime = '235959';
  ST1   = HMS(input(substr(imtime,1,2),2.),
         input(substr(imtime,3,2),2.),
         input(substr(imtime,5,2),2.));

  format ST1 time8. ;

  format hour24 time8. ;

  if endtime < time then
  do;
    duration = (ST1 - time) + endtime;
    sec  = second(duration) + 1;
```

```
  end;

  else

  do;
    duration = endtime - time;
    sec  = second(duration);
  end;

  hour = hour(duration);
  min  = minute(duration);

  tot_sec = sec + (min * 60) + (hour * 60 * 60);

  DURATION = HMS(hour,min,sec);

  format DURATION time8. ;

  by NET;
  where NET <= 4 AND NET >= 0;

run;

data rmtevent(drop = N TYPE COUNTER
                min_dep min_flow min_temp min_cond min_sal
                max_dep max_flow max_temp max_cond max_sal
                avr_dep avr_flow avr_temp avr_cond avr_sal
                endtime tot_sec);

  merge rmtinfo rmttime rmtstat;

  by net;

  volume = &netarea * tot_sec *  avr_flow;

  where net ne .;

run;

proc print
  data=rmtevent(drop=_type_ _freq_) split='\';

  by net;

  label datex ='Date of haul'
  depth ='Depth net fired (m)'
  temp  ='Temp. when net fired'
  flow1 ='Flow when net fired (m/s)'
  sal   ='Salinity\(ppt)'
  time  = 'Time net fired'
  e_num  = 'Event number'
  duration = 'Length of time\net open'
  lat = 'Start\Latitude'
  lon = 'Start\Longitude'
  volume = 'Volume of\water\filtered';

  title 'Details of RMT haul';

run;
```

RMT_INFO

C-Shell script which creates a summary table for an RMT net haul by running the SAS script RMT.PGM

```
###############################################################################
#!/bin/csh
###############################################################################
#
#  Filename: rmt_info
#
#  Description:
#  This script creates a text file containing summary information about rmt
#  net hauls from a pstar file containing netmonitor information and position
#  information from one of the GPS.
#
#  Processing steps:
#  STEP_01  Check the relevant pstar file exists in the correct directory
#           as set by the environment variable P_RMT and using the pstar
#           command mlist create an ascii file of data.
#
#  STEP_02  Using SAS to run the batch file rmt.pgm create a text file of
#           summary information.
#
#  History:
#  Version Date     Author      Description
#  01      04/12/97 SAGR        Copied from uorexec2 by MABRA and amended for
#                               net monitor
#  NEXT    ??/??/?? ???         Please make a note of your changes here
#                               - using as many lines as necessary.  If
#                               the  changes are  substantial perhaps a
#                               new exec might be better?
#
###############################################################################
########## Initialisation #####################################
setup sas
# change to the correct directory

   if ($?P_RMT) then
     echo " "
     echo " Changing directory to P_RMT: $P_RMT"
     cd $P_RMT
   endif

# RMT event number
  echo -n " Enter the RMT event number please  "
  set Enum = $<

# Check pstar file exists
  if (! -e ${CRUISE}rmt${Enum}.dis ) then
     echo " The file ${CRUISE}rmt${Enum}.dis does not exist."
     echo " Have you run rmtexec1 and rmtexec2 yet? "
     exit
  endif
echo $Enum

 mlist >! rmt.talk << !
${CRUISE}rmt${Enum}.dis
fmt time HMS
vars time lat lon depth temp cond light flow1 fluor sal net type distrun
ascii ${CRUISE}rmt${Enum}.asc
list
q
!

# Setup SAS filename and event number variables.
setenv SASFILE ${P_RMT}/${CRUISE}rmt${Enum}.asc
setenv EVENT $Enum
echo $EVENT
```

```
echo $SASFILE

# Run the SAS script rmt_info.pgm and put the pint statements
# into the print statements into the file ${CRUISE}rmt${Enum}.info
# and the log statements into rmt.log

sas /users/mlsd/pstar/data/rmt/rmt.pgm -print ${P_RMT}/${CRUISE}rmt${Enum}.info -log ~/data/rmt/rmt.log
unsetup sas


# Tidy up  bit

rm rmt.talk
echo "...all done"
```

RMTEXEC0

PSTAR exec which reads in net monitor data from RVS Level C using datapup and converts it a pstar format file called *cruise*RMT*event.*

```
###############################################################################
#
#  rmtexec0
#
#  Description:
#  This is an exec to read in data from the James C Ross
#  net monitor into pstar format
#
#  It sets up the dataname ( 3 letter instrument id, followed by 3 figure
#  cruise number) and file name ( dataname followed by the 3 figure file
#  sequence number) and other header details.
#
#  Files produced:
#  $nam$CRUISE$num.raw        Pstar format of RVS data; variables still in
#  raw form.
#
#  Main processing steps:
#  STEP_01Read in RVS data using datapup
#  STEP_02 If dataname is new: create new file, reset raw flag
#             using pcopya, and setup dataname and other header
#             details using pheadr
#  STEP_03      NOW just a datpik to tidy the data somewhat
#
#  History:
#  Version Date     Author      Description
#  00      01/12/97 MAB/SG    Just read in the netmonitor data
#
#  NEXT    ??/??/?? ???         Please make a note of your changes here
#                          - using as many lines as necessary.  If
#                          the  changes are  substantial perhaps a
#                          new exec might be better?
#
###############################################################################

########## Check these variables ####################
#  These variables should be checked when setting up this    #
#  exec for the first time at sea.                                    #

#  RVS file to read.
#  No checks made for their existence. exec will bomb out if they don't exist.
   set rvs = netmon

#  Instrument type (for header)
   set inst = netmon

########## Initialisation ###################################
   touch rmt.talk
```

```
################################################################

########## Get information from the user ###################
  echo " "
  echo " "

  echo "> This exec reads in data for the netmonitor."
  echo "> It requires the following information:"
  echo "> 1)   The start time and end time "
  echo -n "> Continue (y/n)? "
  set ans = $<
  if ($ans != "y") exit
#
  echo " "
  echo -n " Enter Event number : "
  set Enum = $<
  echo " "
  echo -n " Enter start time in format yydddhhmm(ss) (0=start of file): "
  set start = $<
  echo -n " Enter stop  time in format yydddhhmm(ss) (0=end   of file): "
  set stop  = $<

  set start = "-s"$start
  set stop  = '-e'$stop

################################################################
########## Main processing steps ###########################
################################################################
#  STEP_01 - Read in data from RVS format
#

  echo ""
  echo "> Running datapup"
  datapup $start $stop $rvs ./${CRUISE}rmt$Enum   -
  if ($status != 0) then
    echo "problem running datapup - "
    exit
  endif

#  Reset raw data flag
  pcopya >> rmt.talk << !
${CRUISE}rmt$Enum
y
/
/
/
!
  if ($status != 0) then
    echo "problem running pcopya - see rmt.talk"
    exit
  endif

#########################################################################
# STEP 02
# Update the dataname and other header details.
#
  echo "> Running pheadr"
  pheadr >> rmt.talk << !
${CRUISE}rmt$Enum
y
1
${CRUISE}rmt$Enum
2
$inst
ship
$SHIPNAME
$CRUISE
/
```

```
/
/
y
!
  if ($status != 0) then
    echo "problem running pheadr - see rmt.talk"
    exit
  endif

 echo " "
 echo " The file created is called ${CRUISE}rmt$Enum at version "
 pinq -FD ${CRUISE}rmt$Enum
 echo " "

########## Keep directories tidy ############################

  /bin/rm -f rmt.talk

echo "*** THE END ***"
```

RMTEXEC1

PSTAR exec which take the file created by RMTEXEC0 and adds position information by time to produce a file called *cruise*RMT*event*.dis.

```
###############################################################################
#
#  rmtexec1
#
#  Description:
#  This exec is part of a series of execs (0-1) for processing net monitor data
#  This exec merges in a navigation file and calculates distance run.
#
#  Processing steps:
#  STEP_01  Merge in the navigation data
#          pmerge - merge in the lat and lon to the file.
#
#  STEP_02  Construct a distance run variable
#          pdist - copy out an extra variable.
#
#  History:
#  Version Date     Author     Description
#  01      04/12/97 SAGR       Copied from uorexec2 by MABRA and amended for
#                               net monitor
#  NEXT    ??/??/?? ???        Please make a note of your changes here
#                          - using as many lines as necessary.  If
#                          the  changes are  substantial perhaps a
#                          new exec might be better?
#
###############################################################################
########## Initialisation ######################################
#  This exec looks at P_RMT for a directory to run from

  if ($?P_RMT) then
    echo " "
    echo " Changing directory to P_RMT: $P_RMT"
    cd $P_RMT
  endif

#  set up variables and files
  /bin/rm -f rmtexec1.talk
  touch rmtexec1.talk

########## Get information from the user ###################
#  STEP_00  Do we want to run this exec ?
```

```
  echo " "
  echo " This exec merges the navigation for the haul with info from the net monitor."
  echo " It will require the event number for the rmt haul,"
  echo " the jday of the haul, "
  echo " and the origin of the distrun variable."
  echo -n " Continue (y/n)? "
  set ans = $<
  if ($ans != "y") exit

# RMT event number
  echo -n " Enter the RMT event number please  "
  set num = $<

  if (! -e ${CRUISE}rmt$num ) then
    echo " The file ${CRUISE}rmt$num does not exist."
    exit
  endif

#################################################################
# Main processing steps

# Julian day of deployment
  echo -n " Enter the jday of the deployment (3 figure number eg. 013) "
  set nav_day_1 = $<
  if (! -e $P_GPS/${CRUISE}gps$nav_day_1 ) then
    echo " The file $nav_day_1 doesn't exist,"
    echo " are you sure it has been processed."
    exit
  endif
  cp $P_GPS/${CRUISE}gps$nav_day_1 $P_UOR/nav_file_1
  set nav_file_1 = $P_UOR/nav_file_1
  echo " running pheadr - "
 pheadr > ! rmtexec1.talk << !
$nav_file_1
y
1
RMT_nav
-1
-1
y
!
  if ($status != 0) then
    echo "problem running pheadr during navigation file generation"
    echo " see rmtexec1.talk"
    exit
  endif

  pinq -FD $nav_file_1

  echo -n " Does the RMT haul cross into the following jday ? "
  set ans = $<
  if ( $ans == "y" ) then
    echo -n " Enter the next jday of the deployment (3 figure number eg. 014) "
    set nav_day_2 = $<
     if (! -e $P_GPS/${CRUISE}gps$nav_day_2 ) then
       echo " The file $nav_day_2 doesn't exist,"
       echo " are you sure it has been processed."
       exit
     endif
     echo " running papend - "
     papend > ! rmtexec1.talk << !
$nav_file_1
y
n
$P_GPS/${CRUISE}gps$nav_day_2
none
!
     if ($status != 0) then
```

```
      echo "problem running papend during navigation file generation"
      echo " see rmtexec1.talk"
      exit
    endif
    pinq -FD $nav_file_1
  endif

# Distance origin
  echo -n " Please give the origin for dist run now  "
  set dist = $<

#############################################################
# STEP_01 Merge in the navigation

  echo " Merging in navigation data. "
  echo " "
  echo -n " running pmerge - "
 pmerge >! rmtexec1.talk << !
${CRUISE}rmt$num
${CRUISE}rmt$num.nav
/
$nav_file_1
time lat lon /
!
  if ($status != 0) then
    echo "problem running pmerge"
    echo " see rmtexec1.talk"
    exit
  endif

 pinq -FD ${CRUISE}rmt$num.nav

  echo -n " running pdist -  "
 pdist >! rmtexec1.talk << !
${CRUISE}rmt$num.nav
${CRUISE}rmt$num.dis
$dist
!
  if ($status != 0) then
    echo "problem running pdist"
    echo " see rmtexec1.talk"
    exit
  endif

 pinq -FD ${CRUISE}rmt$num.dis

########## Keep directories tidy ############################

  /bin/rm -f UORwork
  /bin/rm -f rmtexec1.talk
  /bin/rm -f ${CRUISE}rmt$num.nav
  /bin/rm -f $nav_file_1

########## The End ##########################################

   echo " "
   echo "        file created - ${CRUISE}rmt$num.dis "
   echo " "
   echo -n "     at version - "

   pinq -FD ${CRUISE}rmt$num.dis

   echo " "
   echo "  End of rmtexec2  for event $num"
   echo " "

   the_end:
   exit
```

Start date (JDAY): **End date (JDAY):**

Time logging started: **Water depth at start:**

Time in water: **Net Type:**

Time on deck:

Time logging stopped:

Time (GMT)	Net depth (m)	Wire out (m)	Ship speed (knots)	Net no.	Activity (e.g. Net 1 fired)

10.5 Fore-deck Net

The Fore-deck net was designed by Doug Bone (Gear Development, BAS) in 1980. It has a square net mouth of 1m2 area and is fitted with a 5mm mesh tapering over 3m to a solid conical cod end. The Fore-deck net is towed from the Hydrolic Crane at the break of the fo'csl at a depth near to the sea surface.

Deployment

This net was deployed twice at each station within the two Core Boxes. Deployments were timed to coincide with the opening of each of the two Rectangular Midwater Trawl nets also fished at these stations, and lasted approximately 20 minutes. These deployments aimed to provide macrozooplankton and micronekton samples for the characterisation of Core Box communities. An extra deployment was undertaken at station E12N to provide samples of live Euphausia supeba for faecal pellet and dietary experiments.

Problems

This net was originally designed for use aboard the RRS John Biscoe. Consequently, the net's behaviour when towed from the RRS James Clark Ross is unpredictable and an even flight path just below the water's surface is difficult to maintain. Erratic movement of the net through the water means that the net mouth actually presented to the water flow is very variable.

10.6 Bongo Net

The bongo net was designed and built by Doug Bone (BAS, Gear Development) and comprises a rigid frame with a pair of nets attached , each with a mouth opening of 62 cm diameter. Net mesh sizes of 200 and 100 microns are routinely used. Each is fitted with a solid cod-end of ca. 15 l capacity from which the catch is drained via a tap into a bucket half filled with seawater at ambient temperature.. In this way experimental animals are caught and maintained in good condition. The catch residue is preserved in 4% (V/V) seawater formalin for analysis in UK.

Deployment

Nets were deployed at all 22 Maurice Ewing Bank stations from 200m and hauled vertically to the surface. All eight station in each of the Core Boxes were routinely sampled with the bongo net for zooplankton community composition. Deployments were again from 200m (or near bottom). An additional net was fished at the second station occupied each night primarily for additional animals with which to set up egg production and moulting rate experiments.

11. Chemistry, Phytoplankton and Biochemistry

11.1 Inorganic nutrient pools and cycling

Andrew Rees (PML) and Julian Priddle (BAS)

Objectives

To make a comprehensive measurement of nutrient chemicals (silicate, nitrate, nitrite, ammonium and phosphate) in order to enable comparison of JR28 conditions with those on other Core Programme cruises (JR11 and JR17) and those on the earlier Spring Processes cruise (JR25).

To further develop models of nitrogen cycling in the South Georgia pelagic ecosystem.

To support physiological measurements made during the cruise.

Methods

Following mobilisation of the PML's Technicon auto analyser system in the ships main laboratory, analyses were made of dissolved nutrients according to adaptations of the methods of; Brewer and Riley (1965) for nitrate, Grasshoff (1976) for nitrite, Mantoura and Woodward (1983) for ammonium, and Kirkwood (1989) for silicate and phosphate. Initial problems with the failing of the nitrite colorimeter were solved with the replacement of a controlling circuit board. This channel remained noisy for about ten days, with a small regular but gradually declining interference superimposed onto a steady baseline. This is not considered to have resulted in the loss of any data.

A drastic decline in the quality of deionized water provided by the Elgastat UHP unit during the Western Core Box caused difficulties with ammonium analyses. The deionized water eventually returned to an acceptable quality for ammonium determination following renewal of the cartridges in the Elgastat and continued flushing of the unit. For the three days when water quality was poor, reference was made to low nutrient seawater blanks and standards.

Sampling was by one of two modes; 1) discrete samples were collected from the CTD bottle rosette into a 60 ml syringe and filtered through acid washed (10% HCl) 0.45 µm pore-size mixed ester filters, into 125 ml sample pots. 2) surface (6 m depth) samples were taken from the ships non-toxic seawater by means of a continual supply to the autoanalyser from a tangential flow filter block fitted with 0.45 µm filters (Morris *et al.* 1978). Data were recorded to paper chart, and will be digitized by Mick Whitehouse in Cambridge. Any preliminary results presented must be regarded with caution.

Calibration of the system was undertaken at least twice a day using standards prepared onboard in a deionized water matrix. These were compared in terms of their salinity effect on the response of the instrumentation with standards prepared in a commercially available low nutrient seawater matrix (Ocean Scientific International) on a weekly basis. This provided a measure of the refractive index offset across the full range of sensitivities used.

1. Maurice Ewing Bank (MEB) transect

Following a shakedown station on the 16th January, the MEB transect comprising 22 stations took place between 17th and 21st January. At each of these stations 12 samples were collected from the CTD at selected depths throughout the water column. Analysis was completed within 2.5 hours. Water samples for iron analysis by Andrew Bowie (Plymouth University and PML) were collected for the entire profile from MEB stations 12, 13, 16 and 20. On-deck incubations of water from the 20 m water bottle to measure uptake of nitrate and ammonium using ^{15}N tracers were carried out at stations 1, 5, 11, 15 and 20.

Nutrient concentrations in near-surface waters (ie shallower than the pycnocline) were relatively low north of the Polar Front (Table 1). Nitrate concentrations at the first two stations were especially low, reflecting the more southerly position of the Subantarctic Front than had been seen previously on this section. The single high silicate concentration (station 10) also conforms with physical oceanographic observations. Otherwise nutrient concentrations were comparable to those found on JR11 and JR17.

Table 1. Summary data for the Maurice Ewing Bank transect, divided into sections north and south of the Polar Front. Data from the previous Core Programme cruises JR11 and JR17 are presented for comparison (available data sources incomplete).

Section and cruise	Near-surface $Si(OH)_4$*	Near-surface NO_3*	Near-surface NH_4*	Pycnocline NH_4*
North of PF (1-11) JR28	4-6 (20)†	(3) 15-22	0.5-1.2	0.5-2.0
North of PF (1-11) JR11	2-6	15	no data	no data
South of PF (12-22) JR28	(4-14)22-33(58)	19-24	0.6-1.25	(1.1)1.7-2.4
South of PF (12-22) JR17	5-25	16-20	0.2-1	1.2-2
South of PF (12-22) JR11	5-25	18-20	0.4-0.8	0.8-1.8

*All concentrations are mmol m^{-3} (= μM), †Concentration ranges shown for JR28, extreme values in parentheses

South of the Polar Front, silicate concentrations were higher than observed typically along the section, and significantly higher than seen in JR11. Low concentrations were found only in association with blooms at the Polar Front (stations 12 and 13) and on the South Georgia shelf (station 22). Nitrate concentration appeared markedly uniform along the section, with very slight depletion at the shelf. Ammonium concentrations in both near surface water and at the pycnocline were higher than in the northern part of the transect.

When the section was studied during cruise JR06, prior to the Core Programme, extensive nutrient drawdown was observed in the middle of the southern section of the transect. This coincided with a dense mid-ocean bloom (Whitehouse *et al.* 1996). Absence of grazing pressure associated with the very low biomass of krill in 1994 was implicated in the development and supposed eventual sedimentation of this bloom. No such feature was seen in the present cruise, despite the likelihood that krill densities may have been low in the vicinity of the western end of South Georgia earlier in the season.

On completing the MEB transect and *en route* to Stromness for the first calibration, the vessel passed close to Bird Island. Surface-water ammonium concentrations were monitored continously, and showed an increase from 0.2 to 0.9 mmol m^{-3} as we passed the island.

2. Eastern Core Box

Nutrient concentrations in the surface water were monitored continuously along all ten transects by sampling the ship's non-toxic seawater supply. Samples were also analysed for all depths from the eight CTD-rosette casts carried out in the box. On-deck incubations of water from the 20 m water bottle to measure uptake of nitrate and ammonium using ^{15}N tracers were carried out for all stations, the bulk samples being drawn off into carboys and kept in the dark in the CT room until incubation the following midday.

Silicate and nitrate concentrations in the Eastern Box were high, although slightly lower than winter values (Table 2). High silicate in JR11 was associated with the north-eastern corner of the box and attributed to influence of Weddell Sea water. Slightly higher surface silicate concentrations were again found on the more eastward of the transects during JR28. Overall, the relatively high nutrient concentrations may be correlated with the comparatively low phytoplankton abundance over most of the box.

Table 2. Summary data for the Eastern Core Box transects and profiles. Data from the earlier Core Programme cruises JR11 and JR17 are presented for comparison.

Cruise	Near-surface $Si(OH)_4$*	Near-surface NO_3*	Near-surface NH_4*	Pycnocline NH_4*
JR28	30-35	22-26	0.4-2.6	1.7-2.6
JR17 (off, on)†	20, 20	25, 23	1.2, 1.7	1.2, 1.7
JR11 (off, on)	35, 25	25, 23	1, 1.5	1, 1.6

*All concentrations are mmol m^{-3} (= μM), †Concentrations for JR11 and JR17 are average values for off-shelf and on-shelf stations

The ammonium data appear to confirm earlier findings. Concentrations were high, and typically values in near-surface water from the night-time profiles, and in the single night-time transect across the box at the end of the study, were slightly higher than in the daytime acoustic transects. The daytime transects typically had higher ammonium concentrations over the shelf than in deeper water. Diurnal variability in ammonium concentration has been ascribed to excretion by zooplankton grazers, especially krill (Priddle *et al.* 1997), and is consistent with the apparently

large biomass of krill in the Eastern Box during JR28. High levels found in the pycnocline at all stations are a typical feature of the area, and are ascribed to intense microbial remineralisation of organic matter (Priddle *et al.* 1995).

3. Western Core Box

Nutrient concentrations in the surface water were monitored continuously along all ten transects by sampling the ship's non-toxic seawater supply. Samples were also analysed for all depths from the eight CTD-rosette casts carried out in the box. On-deck incubations of water from the 20 m water bottle to measure uptake of nitrate and ammonium using ^{15}N tracers were carried out for all stations, the bulk samples being drawn off into carboys and kept in the dark in the CT room until incubation the following midday.

Table 3. Summary data for the Western Core Box transects and profiles. Data from earlier Core Programme cruises JR11 and JR17 are presented for comparison.

Cruise	Near-surface $Si(OH)_4$*	Near-surface NO_3*	Near-surface NH_4*	Pycnocline NH_4*
JR28	4-36	12-26	0.4-2.2	1.9-3.4
JR17 (off, on)†	<1, 20	22, 25	0.5, 1	3, 1.5
JR11 (off, on)	10, 20	23, 22	0.5, 1.5	2, 1.2

*All concentrations are mmol m^{-3} (= μM), †Concentrations for JR11 and JR17 are average values for off-shelf and on-shelf stations

The transects showed very much more structure than the eastern box. Overall, silicate and, to a lesser extent, nitrate concentrations were higher off-shelf than on-shelf. This pattern is similar to that seen in JR17. Ammonium concentration varied markedly along the transects, but typically most high values occurred at the nearshore end of the transects. Nutrient concentrations appeared to be slightly lower at the western edge of the box than at the eastern side - this was particularly marked in the case of silicate where very low values (down to 4 mmol m^{-3}) were only found at the offshore ends of transect pairs W1, W2 and W3.

An interesting feature of some of the transects (principally W2.2, W3.1, 3.2 and W4.1) was the presence of 'green holes'. Regions of the transect of the order of 10 km showed significant decrease in silicate, phosphate and nitrate concentration. In most cases, these regions appeared to be colocated with areas of high chlorophyll fluorescence as indicated by the underway fluorometer. The nutrient drawdown appeared to be of a magnitude (eg NO_3 reduced by 5 mmol m^{-3}) which suggested that these features had been established for some time, and probably indicated some stable mesoscale feature. The location of the holes along adjacent transects suggests that they represent a single contiguous feature, located on the shelf close to the shelf break.

The area of the Western Core Box was also visited earlier in the season during the Spring Processes cruise JR25, with work being undertaken at two stations corresponding to MEB19 and MEB 22 (just inside the core box). Nutrient concentrations varied little over the time period of

the study or between the two sites that were occupied. Generally near-surface nitrate, silicate and phosphate concentrations were similar to what might be expected in winter ie. 25-30, ~25, and 1.5-2.0 mmol m^{-3} respectively. Ammonium concentrations were also generally low (0.1-0.2 mmol m^{-3}). During the last occupation of the on-shelf station (MEB 22), there was some evidence that both silicate and nitrate concentrations had both declined to ~20 mmol m^{-3}, and there was more structure in the ammonium profiles with surface levels remaining low, while a peak around the bottom of the surface mixed layer reached ~0.6-0.7 mmol m^{-3}. The phytoplankton bloom had started during the spring cruise, and the decrease in nutrient concentrations appears consistent with this. However, whilst silicate utilisation had clearly proceeded to further deplete the nutrient pool between the two cruises, rather less nitrate had been removed than might have been expected. High concentrations of reduced nitrogen sources (ammonium, nitrite) may have been used in preference.

4. The 'middle' transects and Bird Island survey

The two transects undertaken in the gap between the two core boxes were sampled for nutrient concentrations from the ship's non-toxic seawater supply. The traverse between the two transects was not sampled.

Following the call into Right Whale Bay on JD035, the underway system was again sampled for nutrients as the vessel steamed towards Bird Island, thence through Stewart Strait between Bird Island and the Willis Islands. The aim of the transect was to test the hypothesis that high reduced nitrogen loadings would be associated with bird and seal colonies (Whitehouse *et al.* in prep). The approach to the islands was very much closer than that achieved at the end of the MEB transect.

As the vessel drew level with the northern side of Bird Island, ammonium concentrations rose to *c.* 2.2 mmol m^{-3}. Concentrations in Stewart Strait were slightly higher, at *c.* 2.6 mmol m^{-3}, reaching a maximum of 2.8 mmol m^{-3} on leaving the southern end of the strait. Phosphate concentrations were also high within the strait, rising to 1.7 mmol m^{-3}. On reaching open water south of the islands ammonium concentrations declined dramatically. Within 5 km of the strait, ammonium concentrations were back to *c.* 0.3 mmol m^{-3}, the concentration seen earlier along the northern South Georgia coast between Right Whale Bay and Bird Island.

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11.2 Phytoplankton biomass and bio-optics

Julian Priddle, Alistair Murray and Phil Trathan

Objectives

To provide routine measurements of phytoplankton biomass, based on chlorophyll *a* concentration in samples from the scientific pumped seawater supply and from the water bottle rosette

To develop calibration procedures for *in situ* measurements of chlorophyll fluorescence

To explore the utility of fluorescence quenching as a proxy for photoautotrophic production

Introduction

The measurement of chlorophyll as a proxy for phytoplankton biomass is a routine procedure. On cruise JR28, chlorophyll was measured *in vivo* on the scientific pumped seawater supply and with fluorometers mounted on the Aquapack and Nv-shuttle undulator (see separate report chapter). These sensors were calibrated using extraction of chlorophyll from water samples, followed by fluorometric estimation of chlorophyll. Discrete samples from water bottle profiles and experiments were also analysed in the same way.

1. Measurements of extractable particulate chlorophyll

Water samples for chlorophyll analysis were taken from the scientific pumped seawater supply and from water bottles mounted on the CTD-rosette. Samples for whole-community chlorophyll were filtered under moderate vacuum onto fine glass-fibre filters (Whatman GF/F - nominal retention 0.7 μm). Samples were extracted in 10 ml of 90% acetone (HPLC grade: Rathburn Chemicals) in the dark at approx 2°C for 24 hours. Fluorescence was measured using a benchtop fluorometer, before and after acidification of the extract with dilute hydrochloric acid.

Benchtop fluorometer This is a high sensitivity instrument, built originally to measure gut fluorescence in large zooplankton such as krill. It is modular in design, and uses fibre optics to enable the sample holder to be separated from the electronics.

The light source during JR28 is a Schott KL 1500 'cool light' microscope illuminator, using a 150 W low voltage projection lamp. The unit was fitted with an OB-10 excitation filter with peak transmission at 430-440 nm. The light source used originally with this system failed during an earlier cruise.

The detector is a Hamamatsu R446 photomultiplier in a fibre optics housing fitted with RG665 and infra-red suppression filters. The photomultiplier is interfaced to an Oriel model 7070

detection system.

Samples for measurement are placed in a one-centimetre pathlength fluorescence cuvette in a fibre optics cuvette holder. Fibre optics are 5 mm 'liquid light guide' throughout.

Calibration and calculation. The benchtop fluorometer was calibrated against a standard prepared from chlorophyll *a* extracted from the cyanobacterium *Anacystis nidulans* (Sigma Chemicals). The standard solution was itself calibrated using HPLC. Fluorescence before and after acidification was used to derive calibration curves, using least-squares linear regression for both chlorophyll and phaeopigment. These calibrations were used subsequently to calculate chlorophyll and phaeopigment concentrations from pre- and post-acidification values using the solution of simultaneous linear equations. The initial fluorescence of the sample, F_B, is a mix of fluorescence from unknown proportions of chlorophyll and phaeopigments, where 'chl' and 'phaeo' are unknown.

$$F_B = F_c + F_p = \text{slope}_c\ \text{chl} + \text{const}_c + \text{slope}_p\ \text{phaeo} + \text{const}_p$$

The subscripts c and p indicate the parameters of the chlorophyll and phaeopigment regressions respectively. Acidification converts the chlorophyll to a known amount of phaeopigment which is 0.975 original chlorophyll mass (Marker, 1972). Thus the fluorescence after acidification can be considered as the combination of two phaeopigment fluorescences as follows

$$F_A = (\text{slope}_p.0.975)\text{chl} + \text{slope}_p\ \text{phaeo} + \text{const}_p$$

Subtraction of the two equations allows us to solve for chlorophyll, because the contribution from the original phaeopigment in the sample remains constant and cancels out. Thus

$$F_B - F_A = \text{slope}_c\ \text{chl} - (\text{slope}_p.0.975)\text{chl} + \text{const}_c$$

Rearranging, this gives

$$\text{chl} = (F_B - F_A - \text{const}_c)/\ (\text{slope}_c - (\text{slope}_p.0.975))$$

Phaeopigment is then calculated by substituting the value of chlorophyll concentration in the extract into the equation for F_B -

$$\text{phaeo} = (F_B - (\text{slope}_c\ \text{chl} + \text{const}_c + \text{const}_p))\ /\text{slope}_p$$

Data processing and preliminary results

Data were entered to a specially designed QuattroPro spreadsheet during the cruise. The following summary is restricted to the vertical profiles derived from CTD-rosette casts.

Maurice Ewing Bank transect. North of the Polar Front, phytoplankton biomass tended to be relatively low, typically 1-1.5 mg m^{-3}. Higher biomass was found at MEB8, MEB10 and MEB 11, reaching 4 mg m^{-3} at maxima slightly deeper in the water column at 40-60 m. Presence of deep chlorophyll maxima has been observed on this section in previous cruises. A moderate

bloom of around 3.5 mg m^{-3} was associated with the Polar Front (MEB12-13), with biomass declining gradually southwards. A dense bloom was found at the shelf station MEB22, with biomass approaching 10 mg m^{-3} close to the surface.

Eastern Core Box. Phytoplankton biomass was low over all of the box, with chlorophyll concentrations *c.* 1 mg m^{-3}.

Western Core Box. Overall, phytoplankton biomass was higher in the western box, especially at on-shelf sites where biomass reached 20 mg m^{-3} at one station. Off-shelf, biomass tended to be $\leq$ 5 mg m^{-3}.

2. Measurement of in vivo *fluorescence on the ship's pumped seawater supply*

A Turner Designs Model 10 through-flow fluorometer is connected to the ship's scientific pumped seawater supply in series with, and downstream from, a Sea Bird Electronics thermosalinograph and a LitreMeter flowmeter. Flow rate through this suite of instruments is of the order of 4 litres per minute, dependent on the ship's motion and the degree of aeration of the water. The thermosalinograph contains a dead space of approx 5 litres, so tends to damp very small scale variability. The fluorometer, thermosalinograph and flowmeter data are logged at 5 second intervals to a dedicated microcomputer using LabWindows software, and thence to the ship's data acquisition system. The intake for the seawater supply is in the bottom of the ship's hull, at a nominal depth of 6 m. Under normal circumstances, the supply is drawn through an extensible probe which projects 40 cm from the hull, avoiding turbulence and entrapped bubbles.
Discrete samples (n = 324) for calibration were taken from the outflow from the fluorometer. When the ship was on passage, especially during transect legs, these samples were at approximately hourly intervals. On station, samples would be taken less frequently, but one would usually be taken to coincide with the recovery of the CTD-rosette to provide an additional depth in the water bottle chlorophyll profile.

Processing the data from the underway fluorometer is the subject of continuing development. The ratio of *in vivo* chlorophyll fluorescence to the concentration measured on extracted samples (termed 'fluorescence yield') varies in response to a number of factors. The major influences are changes in phytoplankton community composition (typically over large distance scales), the ambient light experienced by the phytoplankton immediately prior to the fluorescence measurement, and presence of other fluorescent compounds in the sample. We are applying a model of light-induced fluorescence quenching to correct data to 'dark' values, and then classifying survey areas into coherent regions where fluorescence yield, and by inference community characteristics, are more or less uniform.

3. In situ *measurements of* in vivo *chlorophyll fluorescence*

In vivo chlorophyll fluorescence was measured using Chelsea Instruments flashlamp fluorometers deployed in an Aquapack vertical profiler and in the Nv-shuttle undulator. These instruments have a pulsed light source which is split to provide a measurement of sample fluorescence and a reference beam to compensate for changes in lamp output. The detector is a photodiode. Details of filter characteristics are not supplied.

The manufacturer provides an instrument calibration which converts fluorescence measurements into chlorophyll *a* concentration. However, this is based on measurements of fluorescence of

extracted chlorophyll, and makes no allowance for variation in fluorescence yield due to light and to changes in community composition. During JR28, we have attempted to collect calibration samples from the ship's pumped seawater supply to coincide with the water sampled by the undulator fluorometer at the top of its cycle. In addition to this, we have undertaken three high resolution calibration runs, taking between 15 and 24 samples coincident with every undulation or with alternate undulations (4-8 minute, 1-3 km resolution). These series were accomplished in the dark, to remove the problem of light quenching of fluorescence. The Aquapack has been deployed at most stations immediately following the recovery of the CTD-rosette, providing a chlorophyll fluorescence and PAR profile more or less coincident with samples for extracted chlorophyll from the top six water bottles and a seventh sample from the pumped supply.

Calibration of the Aquapack is relatively simple, because it is easy to relate the *in vivo* measurements to concentrations measured on water samples, and use PAR data from the same profile to estimate quenching. For the undulator, the problem of obtaining calibration samples is more complex. As noted above, we have taken samples from the pumped seawater supply to coincide with water sampled by the undulator at the top of its cycle where possible. We are also exploring the use of the transmissometer on the undulator as a means of providing a second estimator of phytoplankton biomass. The transmissometer is fitted with a filter which has a peak transmission at 660 nm - approximately the blue absorption maximum for chlorophyll. Whereas *in vivo* fluorescence measurements are subject to light quenching, absorption measurements will not be affected by ambient light. Preliminary analysis for one transect pair from the Western Core Box indicates that the ratio of fluorescence to absorbance varies with PAR in a very similar way to fluorescence yield measured for the pumped supply. The behaviour is characterised as a negative exponential, and we even saw what appeared to be two separate curves which coincides with observation of differing yield characteristics for shelf and offshore communities in the same box during JR17.

Thus fluorescence-absorbance ratio may provide a useful proxy for fluorescence yield. This opens up exciting possibilities for the use of undulator data to estimate primary production. Light quenching arises because chlorophyll is only 'available' for fluorescence in its unexcited state. Although the photochemistry and physiology are complex, it is reasonable to assume that the degree of quenching in the light will be related to the rate of photosynthesis. If we can use the fluorescence-absorbance ratio as a proxy for quenching, and thereby compute a 'dark' fluorescence to correspond to the *in vivo* measurement, then the magnitude of the difference between the two should be proportional to photosynthetic production.

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11.3 Log of Filter Cleaning

Pump Changes for the Uncontaminated Sea Water supply on JR28

Information Supplied By
Doug Trevett (Deck Engineer)
R.R.S. James Clark Ross

Date	Time (GMT)	Pump In Use	Comments
15/1/98	1130	2	
16/1/98	1423	2	
17/1/98	1130	2	
18/1/98	1115	2	
19/1/98	1119	2	
20/1/98	1115	2	
21/1/98	1110	2	
22/1/98			StromnessWater Off 0900 Water On 2330
23/1/98	1126	1	
24/1/98	1122	1	
25/1/98	1118	1	
26/1/98	1130	1	
27/2/98	1126	1	
28/1/98	1130	1	time approx.
29/1/98	1120	2	Stromness
30/1/98	1114	2	
31/1/98	1104	2	
1/2/98	1109	2	
1/2/98	2035	2	Special Request
2/2/98	1116	2	
3/2/98	1114	2	
4/2/98	1118	2	
5/2/98	1114	2	
6/2/98	1118	2	
7/2/98	1000	2	Water Off End of cruise

11.4 Organic biochemistry

Geof Cripps

The characterisation of the standing phytoplankton crop, the investigation of the impact of grazing zooplankton on the algae and the study of biochemical changes in zooplankton related to variability in diet.

1. The characterisation of particulate material (essentially phytoplankton) by pigment and fatty acid analysis (Core programme).
2. Analysis of the fatty acid composition of krill, copepods (core) and other zooplankton compared to varying quantity and quality of food supply.
3. The analysis of fatty acids and pigment content of krill faecal compared to quality and quantity of food.

CTD samples - Samples were taken from stations 1,5,11,19 and 22 from the MEB transect plus two offshore sites and two inshore sites from each box survey (also additional water samples were taken from the non-toxic inlet). Sampling was from seawater collected by CTD casts to 30m and 140 or 200m. Suspended particulate material was obtained by filtration at 0.7 µm, 20 µm with prefilteration at 200 µm. The filter membranes were extracted on ship and analysed for their algal carotenoid profiles, chloropigments and fatty acid content. The analysis of carotenoid and chloro-pigments was by HPLC and fatty acids was by capillary gas chromatography. The results identified the variation in diatom biomass compared to the a background consisting mainly of flagellates.

RMT net hauls - E. superba and other zooplankton were sampled from the Bongo nets (MEB only), RMT and FNET deployed at each inshore and offshore station from both core boxes (depending on availability). Animals were frozen for later analysis in the U.K. The fatty acid content will be related to the changing dietary environment, age and population structures. Time and facilities preclude analysis of macro-zooplankton at Sea.

FNET hauls using a solid cod end for live specimens of E. superba - Live krill were collected for faecal pellet and dietary experiments in the controlled temperature facility. Due to lack of time no FNET could be deployed until the beginning of the EBOX which restricted the time available for experiments. The experimental animals were all collected at the first station of the EBOX .
Faecal pellet production experiments were carried out on captive krill separated into juvenile, sub-adult, male-adult and gravid females. The animals were held in a tank supplied by the non-toxic seawater supply and the faecal pellets collected every second day. The gravid females laid a large number of eggs which made it impossible to separate a 'clean' sample of faecal pellets. The efficiency of assimilation and dietary preferences were observed through the fatty acid and pigment profiles and proportion of phaeopigments in the faecal pellets.

Krill held in aquaria and fed different types of food, i.e. no food, small algae (<20 µm) (flagellates and small diatoms), large algae (predominantly large diatoms), a selection of small zooplankton (mainly the copepod Drepanopus collected from Stromness Bay). At the end of the cruise the animals were frozen for analysis in the UK to test the impact of the different diets on their fatty acid content. The impact of the krill on the quality of a food supply of known quality (i.e. that

which corresponded to CTD samples) was investigated by incubating animals for 24 hours in seawater of known content and filtering the remaining material, which was then analysed for chloropigments and fatty acids.

Working problems and ideas for improvement (and refit [sic!])
1. Walk-in CT room - this is fine unless there is no more than one person using the facility at time - two people using the facility regularly per cruise is an maximum. This is not helped by the amount of cargo stowed in the CT room. There must be cool stow available somewhere else on the ship. This would be advantageous to both CT room users and the owners of the cargo - especially those with unsealed and cardboard containers. Even if no water got spilt - using water makes the atmosphere very humid and every surface becomes damp. Working facilities could be improved with a sink which was moved away from the corner of the room, had a double drainer and twin outlet (or double spigot) to the seawater supply. More shelving would help to keep gear off the floor (I have suggested this before!).

2. Fire doors to the labs continue to be hazardous due to their heavy nature - even when alongside and the ship is not rolling they can be difficult to move gear through.

3. ELGA pure water system is in need of extensive refit or replacement by a Millipore® system.

4. Downward communications/interactions between UIC room and the labs is getting better (due to one or two people) but generally still poor. Some sort of info transmission device would be useful - like a small vdu in each lab conveying essential info of the day, events, times, lat, long, heading, etc. or a even a NOBO board in the main lab!

5. Some lab coats were being worn and virtually no safety specs have been used. Personally I find difficult when frequently moving from the labs to other parts of the ship where labs should not be worn or are not appropriate, such as working on deck, going to the UIC room to find out what is going on or the CT room (a 'chemical free' area). Generally the lab coats do not fit over warm clothing for working outdoors or in the CT room. Likewise it is difficult to persuade people to come and see what is going on in the labs if access is restrictive. Some drinking still occurring in the labs!

6. Gas Lines - (I have suggested this before !) - it would be useful to install some kind of ducting so that gas lines could be laid, as per requirement of the cruise, from the existing gas cylinder cages to the labs via the cable glands, rather than have the cylinders lashed to the side of the ship - and not spoiling the view of people in the UIC room.

Summary of initial results - Prymnesiophytes dominated the algal population north of the polar front on the MEB transect . The diatom biomass increased southwards of the front and grazing activity was at a maximum nearest to Bird Island. The particulate matter below at 140m and 200m showed high phaeopigment content at stations on the shelf in the WBOX where grazing was occurring but fatty acid analysis showed that dietary useful compounds had been removed. All material the 140/200m samples was heavily degraded (MEB, EBOX and WBOX). Krill produced large quantities of faecal pellets when the diatom biomass was high which still contained dietary useful unsaturated fatty acids (PUFAs). Removal of these PUFAs from the 140/200m particulate samples indicates some recycling/regrazing in the upper water column. In the EBOX the low algal biomass was predominately prymnesiophytes and small diatoms. There was only a small signal indicating grazing activity and faecal pellet production indicated this was only by small/juvenile

krill. Pigment profiles of faeces suggested that younger krill showed a preference for smaller phytoplankton and were more likely to include flagellates in their diet.

12. Experimental Zooplankton Studies

12.1 Zooplankton studies

Peter Ward & Rachael Shreeve

The bongo net comprises a rigid frame with a pair of nets attached , each with a mouth opening of 62 cm diameter. Net mesh sizes of 200 and 100 microns are routinely used. Each is fitted with a solid cod-end of ca. 15 l capacity from which the catch is drained via a tap into a bucket half filled with seawater at ambient temperature.. In this way experimental animals are caught and maintained in good condition. The catch residue is preserved in 4% (V/V) seawater formalin for analysis in UK.

Analysis

Egg production

Studies involve the isolation of adult female copepods in groups of 10 in a perspex cylinder closed at one end with 800 micron mesh netting suspended in a jar of chilled filtered seawater. In this way eggs laid by the copepods drop through the mesh into the jar and are not cannibalized by the females. Jars are maintained for 24 h in the CT room at which time the females are removed and routinely preserved for dry mass and or lipid analysis and the eggs are filtered out and backwashed into a sorting dish and counted under a microscope.

Moulting rates

Copepodites of the same stage are isolated from the samples usually in groups of 30 and maintained for 48 hours in filtered seawater. At the end of this period the jar contents are examined under a microscope and the number of animals moulted to the next stage counted.. Stage duration is calculated as the reciprocal of the moulting rate which is the proportion of the population that has moulted to the next stage during the incubation. Individuals in each jar are subsequently preserved , according to stage, either deep frozen in foill capsules for drying and subsequent dry mass and CHN analysis in UK or in a 2:1 chloroform/ methanol mixture in which lipid is extracted . Weight specific growth rates can then be calculated once these analyses have been performed.

MEB Transect

Our third annual pilgrimage down the MEB transect was, from the point of view of bongo netting, entirely successful, with all 22 stations being sampled. Nets were deployed from 200 m and hauled vertically to the surface and as in previous years major changes in zooplankton composition were strikingly related to differences in water masses. On this occasion the first three stations on the northern side of the Sub Antarctic Front (SAF) were relatively impoverished in terms of plankton. This is in stark contrast to 1996/7 when *Calanus tonsus* was a very conspicuous species in these waters but this year was largely absent. South of the SAF, within the Polar Frontal Zone (PFZ), varying proportions of *Calanus simillimus* and *Rhincalanus gigas* tended to dominate the catches,

although at one or two stations in the northern part of this region, chains of aggregate salps were commonly seen in the surface waters. A typically cold water plankton (*Calanoides acutus* dominant) was encountered at station 11 in the southern part of the PFZ, at which it transpired a cold feature was present. South of the Polar Front (PF) *C. acutus* and *R. gigas* were abundant through to the end of the transect. Bloom conditions were met with at a number of stations, particularly south of the PF, and this year the addition of a TSK flow meter to the 200 m net has allowed us to quantify their effect on filtration. Provisionally flow was reduced by up to around 30% in the densest blooms.
As in previous years representative species/stages of the dominant copepods were taken for lipid, dry mass and CHN determinations at stations 1, 5, 11, 19 and 22 along with particulate material at 30 m and 200 m depth. At the latter two stations, (Z1 and Z2 in recent process studies) egg production and moulting experiments were set up. At station 19 *R. gigas* females averaged 17 eggs female d^{-1} and at station 22 slightly higher, at 23 eggs female d^{-1}. Only a few *C. acutus* females were present at station 22 and these produced no eggs. Moulting rate data indicated that for both species rates were higher offshelf at station 19.

Core boxes

All eight stations in each of the core boxes were routinely sampled with the bongo net for community composition. Deployments were from 200 m (or near bottom if, 200 m) to surface. An additional net was fished at the second station occupied each night primarily for additional animals with which to set up egg production and moulting experiments. Provisional observations were comparable to those made during last years core programme (JR17), with the eastern box being relatively poor in zooplankton, egg production being low and moulting rates higher in the offshore sector. In the western box animal densities were higher as were egg production rates although again higher offshelf. Moulting rates didn't appear to differ between boxes but a fuller analysis of growth will be undertaken in UK when experimental animals will be subjected to dry mass, CHN and lipid analysis.

Equipment and facilities

For much of our work the motion compensated bongo net, designed and built inhouse by Doug Bone has proved to be an extremely valuable sampler over the past few years. Its spring recoil system ensures that snatch on the net due to the ships rolling whilst stationary is kept to a minimum and the resulting catches are in good condition for experimental purposes. It is easily deployed from the mid-ships gantry the wire being spooled onto one of the small auxillary drums and let outboard over a small block. However there are severe limitations to this system. Firstly the drum only has the capacity to take some 350 m of non cored 6 mm wire, second, there is no way of metering wire out other than is done at present which involves flaking the wire out on deck prior to loading the drum and marking off the depth intervals with tape and third no record of deployment details can be passed to the ABC system. Thus the net is restricted in practice to near surface deployments and any instrumented package that is lowered on the same wire has to have its own power supply and data storage memory. Further, its control position alongside the gantry involves the winch driver standing for long periods on the open deck. At this time when it is understood that a replacement for the present winch system is under consideration it seems sensible to re-emphasise the need for a more satisfactory arrangement for vertical deployments that are routinely undertaken from this region of the ship. However to incorporate a suitable electro-mechanical cable into the new winch fit would carry with it the key requirement that two wires, (normally for MLSD cruise, CTD and vertical netting cables) could be led up the gantry

at the same time (to separate blocks). Even with a much simpler winch system than at present, the time and potential damage penalties imposed by the need to withdraw one wire before leading up another, would be unacceptable. CTD casts and vertical net hauls need to be carried out within a few minutes of each other to avoid major delays in a busy schedule. We look forward to the time when our netting activities are brought into line with other deployments carried out onboard and remotely logged to the main computer system.

The use of a TSK flow meter on the net this season has further highlighted the problem of relying on a purely mechanical technology, this time to estimate flow. A number of these old flow meters in various states of disrepair were kindly donated to us by Steve Coombs from PML as they were surplus to their requirements. Unfortunately the original working instrument lost a vane from its impellor due to wind damage during a storm. A second one was pieced together by cannibalizing others but gave erratic readings. Sufficient spares were available to construct a third which appears to be working well although flow data are absent for a number of hauls made in the eastern core box. Interestingly at stations where the bongo net caught krill the 100 micron net (no flowmeter) invariably caught more. It seems that the presence in the mouth of the TSK was sufficient to cause an effective escape response.

Constant Temperature Room
On biological cruises such as this where rate process measurements are routinely carried out space was once again at a premium in the CT room. On this occasion four people were regularly using these facilities which were often congested, particularly as krill were being studied involving their maintainance in large volumes of water. Similar problems were also experienced on the spring process cruise (JR25). Lack of space does not allow for the expansion of experimental design. A contributing factor is the use of the room to store samples collected on previous cruises. An alternative cool storage facility would certainly help ease congestion and free up space for experimental science in progress. Additional benching and better use of available space (see report by GCC) would also improve matters. From our perspective the present size of the scientific -20°C is well in excess of what is required at least for the volumes of material collected on biological cruise and an increase in CT facility at the expense of freezer space would ultimately seem a sensible trade off. This is particularly so in view of the projected program structure within MLSD for the next quinquenium, within which ecophysiological studies, at Rothera and on JCR, are seen as a significant contribution.

12.2 Excretion by *Euphausia superba*
A. Atkinson, M.J. Whitehouse

This study was prompted by a recent paper suggesting that excretion by krill was important in supplying ammonia, the preferred nitrogen source for phytoplankton growth around South Georgia. Most previous estimates of krill excretion rate have been too low to support this, but they been derived mainly from krill incubated in small containers with nothing to feed on. For a mobile species with high energy requirements these are very unnatural conditions. I therefore tried to measure how much ammonia krill excrete when they are actively swimming and feeding. Batches of 10-20 krill (mean length 36 mm) were incubated in 40-70 l of water for alternating 24 h periods of feeding (on freeze killed phytoplankton and zooplankton in excess quantities) and non feeding (in filtered seawater). Both their ammonia excretion and feeding rates were monitored at 3-12 h intervals for 9 d. Ammonia concentrations in the incubation water were measured on the autoanalyser with the help of Andy Rees. The table below summarises the comparable excretion rates when feeding and not feeding. Feeding rates will be measured in

Cambridge. Each value for an experiment represents the mean of two krill containers, compared to a control container with no krill.

Experiment number (Date, 1998)	Ammonia excretion rate (micro mols per ind. per h)	
	During feeding	In filtered seawater
1 (28 Jan)	0.23	
2 (29 Jan)		0.15
3 (30 Jan)	0.29	
4 (31 Jan)		0.21
5 (1 Feb)	0.30	
6 (2 Feb)		0.21
7 (3 Feb)	0.30	
Mean	**0.28**	**0.19**

These excretion rates can be compared with values of ~0.16 micro mols ammonia per individual per hour, for krill of similar length, based on a recent review (Quetin et al. 1994). So this value (based on incubations in filtered seawater) is slightly lower than ours with filtered seawater. As expected, krill excreted more when feeding. With excess food the krill clearly fed rapidly, as shown by numerous faecal pellets, yet daily excretion rates were only ~50% higher than when they were not feeding. A similar result was found with smaller krill on JR25, so we may be measuring their maximum daily excretion rates. This would imply that previous studies, based on smaller volume incubations without food, probably represent roughly half of the maximum daily excretion rate of krill.

Diets of major copepod species based on stable isotope ratios (D. Pond, A. Atkinson)

Diets of the large, biomass dominant copepods *Calanoides acutus*, *Rhincalanus gigas*, *Calanus simillimus* and *Calanus propinquus* have been studied extensively recently. Although their feeding habits are now known broadly, *R. gigas* remains enigmatic. Its low ration of algal carbon plus the fact that it can grow before the main primary production season suggest that it is not strictly herbivorous, but no evidence for an alternative food source has appeared. This study aims to use ratios of stable isotopes in the lipid stores of the copepods (CVs, adult males, adult females) and in the microplankton food assemblages to provide further insights into the diet of *R. gigas* compared to the other three species. At various sations on the MEB transect and at the core boxes these four large species were preserved in chloroform/methanol for analysis by D. Pond in Stirling. To characterise the food assemblage, 10 l water samples from the surface were filtered onto GF/F and preserved in 1% Lugol's iodine solution.

Diets of major copepod species based on incubations (A. Atkinson)

This study, started on JR11, links to two others. First it forms a "cross check" on the novel approach to diet using stable isotope ratios. Second, it is part of a project examining the role of predation in copepod population dynamics. The four above-mentioned copepods plus the predatory *Euchaeta antarctica*, were incubated for 24 h. Uneaten food items remaining at the end of the experiments will be counted in Cambridge, allowing feeding rates to be gauged by

comparison with ungrazed contols. I used large volume (11 liter) containers of natural seawater which allows an assessment of the dietary importance of eggs, nauplii and small copepods to the larger species. Four experiments were done, three on the MEB transect, and one in the Western Core Box.

General comments on the cruise and facilities

As usual for the JCR, there was excellent cooperation from all ships personnel in my work. There were some hitches with the autoanalyser and with the deionised water supply, but thanks to the perseverence of Andy Rees and Julian Priddle these were solved. I would like to point out that there is a chronic lack of space in the cold room to do experimental work. On this, a mainly non-experimental cruise, there were 4 people trying to run experiments in this small room; on the Spring Processes Cruise the situation was worse.

I think fairly small and cheap alterations would greatly improve the quality of experimental science that can be done on this ship.

1) The room needs more storage space. Eighteen inch shelves with retaining lips around available wall space would help enormously. Also cruises late in the season have the burden of scientific cool stow from earlier cruises cluttering up the cool room. Some other (even temporary) location for this could be found?

2) The placing of the sink in the corner of the room makes it accessible to only one person at a time. Ideally two sinks placed near the middle of adjoining walls would ease congestion. Failing this, moving the sink to the middle of a wall would let two people work in it simultaneously.

13. Higher Trophic Level Studies

13.1 At-sea distribution of marine predators near South Georgia

Gabrielle Nevitt and Keith Reid

We conducted systematic observations of the at-sea distribution of seabirds and marine mammals along the Maurice Ewing Bank (MEB) transect and in both core boxes. Our aims were:

1) To examine the determinants of the at-sea distribution of seabirds and marine mammals across the Polar Frontal Zone along the Maurice Ewing Bank transect.

2) To examine the relationship between variability in predator distributions and physical oceanographic, chemical or other biological parameters such as krill abundance in the two core boxes.

3) To characterize inter-annual variability in predator distributions in the two core boxes.

Methods

All data were collected using identical methods to the JR17 Core Programme cruise. Observations were restricted to a 100 x 100 m "box" positioned 100 m directly ahead of the ship complying to the same transect area over which other ship-board data were collected. The dimensions of the viewing box were adapted from the methods of the SCAR BIOMASS working party on seabird ecology (*Marine Ornithology* 20, 51-59).

Constructing the viewing box: The positions of the horizontal lines at 100 and 200 m from the front of the ship were calculated using the following expression:

$$Xn = h\,l/(di + s)$$

where:

Xn = length from horizon on bridge window corresponding to distance n
h = height of observers eye above sea level (15.6 m)
l = distance of observers eye to window (90 cm)
di = distance from front of ship to edge of box
i.e., A= 100 m B = 200 m
s = distance from observer to front of ship (36 m)

With the eye at distance l, points X_{100} and X_{200} below the horizon were marked on the window. These two points corresponded to distances of 100 and 200 meters from the front of the ship, respectively. The width of the viewing box was then calculated using similar triangles. Once these measurements were determined, the box was outlined with opaque tape so that is was visible when looking through binoculars. A separate viewing box was used for each observer to account for differences in height.

Predator observations: During each transect, one person continually scanned the observation box with binoculars and dictated observations to a second person. Once a predator was spotted in the box, the species, number, behavior and direction of movement were entered directly into a HP 200SX palmtop computer. Each observation was automatically given a time-stamp synchronized to the ships clock as it was entered. Incidental observations of unusual species or behaviors observed outside of the viewing box were noted as incidental comments and given a time-stamp. Roles were switched at 30 min intervals to balance for any inter-observer differences and to avoid observer or recorder fatigue. In addition, the same two people (Nevitt and Reid) conducted all observations.

Predator observations were completed on twelve transects along the MEB transect approaching stations 2, 3, 6. 7, 11, 12, 13, 16, 7, 20, 21 and 22, and on all ten transects in both Core Boxes. For each of the transect pairs in the core boxes, observations were conducted for the entire duration of the first transect and for all but the first and last 30 min of the second. Observations were temporarily suspended on the East box 3.2 and 4.1 and West box 1.1 and 4.1 transects due to either excessive glare or fog.

13.2 Squid Jigging

Cairistiona I. H. Anderson

Cruise objectives

1. To sample the distribution of *Martialia hyadesi* across the Antarctic Polar Frontal Zone in relation to the mesoscale oceanographic features present.
2. To ascertain whether *M. hyadesi* is present south of the Polar Front in the vicinity of South Georgia at this time of year.

Summary

Full details of the set-up and use of the squid jigging machine are given in the technical notes at the end of this section. The machine was left set-up on the sidedeck at the end of the Geneflow cruise (JR26) with the length of the headline on each reel increased from 200m to 350m. The machine was stowed during JR27 bolted onto the 1m. deck matrix facing inboard against the side of the main lab. The electrical connections and the light bulbs were left in place, whilst the jig traces, weights and fish boxes were removed. This arrangement appeared satisfactory as no problems were reported at the end of the cruise.

At the start of JR28 the machine was returned to its operating position bolted onto the outboard edge of the 1m deck matrix immediately aft of the midships scientific hydraulics manifold. It was deployed from this position throughout the cruise.

The machine was deployed at most of the stations on the MEB transect and all of the Core Box stations. The exceptions were Stations MEB1 and MEB9 where the weather conditions were considered too rough. It was also deployed at the gear trial station preceding the MEB transect (Event 002) and at an extra station in the vicinity of the Polar Front on the journey back to Stanley (Event 293).

The only major technical problem encountered was that the reel onto which the forward line is wound began to warp at the start of the MEB transect. It seems likely that it had initially been slightly deformed by the force of a wave hitting it during JR26, and that the extra pressure of deploying up to 350m of line caused it to buckle further. Attempts were made to straighten it at station MEB3, but it immediately began to warp again. This caused problems in recovering the forward line when the lines were streaming aft and so hindered the effective deployment of the machine.

At the end of the MEB transect, it was decided that no more than 250m of line should be deployed at a time and a piece of angle iron was attached to the outer side of the reel to act as a brace. This approach was successful and the problem did not reoccur.

Under normal conditions there appeared to be no conflict between the use of the jigging machine and the deployment of the CTD, as long as the manoeuvres carried out by the ship to maintain station over the CTD were performed slowly. Unfortunately, this was not always possible and on some occasions there were problems with the jig lines streaming fore or aft of the machine. When this became extreme, the lines would skip off the rollers during recovery and the jigs would catch on the rollers and cause them to flip inwards. Even under less extreme circumstances, the angle

of the lines reduced the fishing depth and increased the strain on the equipment due to the friction against the side of the rollers.

The lines only got snagged on the CTD on two occasions. On the first occasion, the forward line caught the CTD wire briefly and was washed free when the line movement was halted. On the second occasion, the aft line snagged on the CTD wire and broke just above the fourth jig from the bottom. The missing gear was recovered when the CTD was brought back onboard as the weight had landed on top of the CTD rosette. No damage to the CTD was reported and the broken trace was quickly replaced with the spare set. The effect of these problems on the fishing efficiency of the machine cannot be assessed as no squids were caught at any of the stations.

The acoustics record for the sites where the machine was deployed suggests that this lack of success probably had more to do with a lack of potential targets than any major deficiencies in the machine or the fishing techniques used. However, this means that the various techniques used can not be properly assessed for their suitability to catch *Martialia hyadesi* on future cruises. In the longer term, if specimens of *M. hyadesi* are subsequently caught using similar techniques, this cruise will have provided useful negative data on the distribution of this species at this time of year and so fulfilled the second cruise objective.

As stated in the cruise report for JR26, no major modifications appear to be required for future use of the machine, but several small improvements could be made. The forward reel should be replaced as it has obviously become weakened as it has been warped. The lamp covers provided are not really strong enough to withstand continued use in rough weather. After only a short period of strong winds and waves, the forward most cover was significantly warped and the others were also affected to some degree. The heavy nylon line that makes up the top section of the jig lines and the net used to cover the outrigger are of poor quality. The net should be replaced as a priority as it is brittle and has already started to break under the pressure of waves breaking against it. A softer woven net is likely to be more durable and easier to repair if it does give way. It may be more cost effective, and certainly more reliable, to replace the nylon line with fine wire rope such as that used on Japanese commercial jiggers. This would reduce the likelihood of failure due to damage during storage, as well as that caused by general wear and tear. The provision of at least one spare light bulb and spare net for the 'trampoline' would also be sensible given the working conditions experienced.

Deployment Log

1.Maurice Ewing Bank Transect

Event Number	**Station**	**Depth(s) Fished**	**Catch**
002	(gear trial)	100m, 200m, 350m	none
MEB Transect			
013	MEB 2	50m, 150m	none
017	MEB 3	50m, 250m	none
022	MEB 4	200m	none
029	MEB 5	150m	none
034	MEB 6	200m	none
039	MEB 7	300m	none
044	MEB 8	250m	none
053	MEB 10	200m, 300m	none
060	MEB 11	290m, 350m	none
065	MEB 12	350m	none
070	MEB 13	200m	none
075	MEB 14	100m, 130m, 150m	none
079	MEB 15	300m	none
085	MEB 16	300m	none
091	MEB 17	250m, 300m	none
095	MEB 18	150m	none
102	MEB 19	250m	none
107	MEB 20	150m	none
112	MEB 21	150	none

2. Eastern Core Box

Event Number	**Station**	**Depth(s) Fished**	**Catch**
126	E1.2N	75m, 100m	none
134	E1.2S	150m	none
142	E2.2S	200m	none
152	E2.2N	60m	none
162	E3.2N	100m	none
171	E3.2S	50m	none
181	E4.2S	75m	none
191	E4.2N	75m	none
198	(E5.2)	225m, 250m	none

3. Western Core Box

Event Number	**Station**	**Depth(s) Fished**	**Catch**
206	W1.2S	200m	none
215	W1.2N	60m	none
224	W2.2N	150m	none
232	W2.2S	180m	none
243	W3.2S	190m	none
252	W3.2N	250m	none
262	W4.2N	250m	none
270	W4.2S	120m	none
277	(W5.2)	125m	none
Extra station			
293	na	350m	none

Data recorded during each event.

For the whole event:

Event number
Station number
Date
Target Depth (with notes)
Time lights on (hh:mm, GMT)
Time lights off (hh:mm, GMT)

For each set of casts:

Power (inc. Manual or Automatic setting)
Lifting speed
Descent speed
Fishing depth
Shakuri (Y/N, with stop depth below surface if yes)
Start time (hh:mm:ss, GMT)
End time (hh:mm:ss, GMT)
Time jig not running during cast set (total mins/ start & stop times)
Catch (no. of animals)

Note: A new cast set was started whenever the motor settings were changed or after approximately 20 mins fishing.

Technical notes on the set-up and use of the squid jigging machine.
These notes are adapted from those given in the cruise report for the Geneflow cruise (JR26).

Set-up

On arriving on the ship, on 15th January 1997, the jigging machine was assembled on the side deck according to the plans provided by Andy Tait. The details of its assembly are given below.

- The frame (without the outrigger) was initially assembled facing inwards against the side of the main lab, so that the light fittings were accessible from the walkway above.
- The upright pieces of the frame were inserted into their sockets and then the crosspieces were dropped down onto them. The upper crosspiece was fixed in place initially, and the lower crosspiece was fixed after being lined up under the lamp covers.
- The lamp covers and light fittings were attached to the brackets on the crosspieces and then the bulbs were inserted after they had all been fixed in place.
- The net trampoline was attached to the outrigger using flat net twine before the outrigger was attached to the frame. Initially, mainly single fixing points were used but these broke easily. It was then retied so that the sides and the outboard edge were connected with continuous lashings and the rest of the net was left free to flex under any impacts.
- The rollers were assembled and attached to the outrigger. The position of the supports holding the rollers prevented the supplied nuts being used as spacers. Instead, the same size nuts with the threads drilled out and extra washers were used as spacers, and the supplied nuts and wing nuts were used on the outside of the supports to fix the rollers in position.
- The main frame was swung into position using the crane and the outrigger was attached. It was later discovered that the outrigger can easily be removed and re-hung without the use of a crane even at sea.
- The base of the machine was bolted onto the outboard edge of the 1m. deck matrix immediately aft of the midships scientific hydraulics manifold. It was successfully used in this position throughout the cruise and did not appear to interfere with any other on-deck activities.
- The electric cables were led off the top of the frame along a rope to the walkway outside the UIC room and then along the edge of the walkway to the water bottle annex. The light cables were strung behind the CTD crane, and then through a cable port to the ballast located on a bracket by the power outlets at the forward end of the annex. The motor cable was strung inside the crane (above deck level) as it was shorter, and then lead directly to the power outlet through the cable port.
- The lifting rope was tied to the front edge of the outrigger and passed through a block attached to the bracket on the lower crosspiece of the frame. A second block was attached to the base of the walkway guard-rail and the rope was passed through this and tied off on the handrail below.
- 200m of heavy nylon fishing line was wound onto each reel using the lifting action of machine. The jig traces were then tied to the end of this line and wound on by hand.
- Each jig trace comprised of 20 jigs separated by 1m. lengths of fine nylon fishing line with a swivel clip at each end of the trace, and an extra pair of swivel clips separated by 1m. of fine line at the head end.
- Pieces of heavy nylon line, approximately 2m long, with clips on the lower end were then added to each reel to attach the weights to. The weights were only attached when the jigging machine was in use.
- Two fish boxes were found to sit in the wells at the base of the frame to collect the catch when the machine was in use.

Stowing between stations:
When not in use, the machine was left as outlined below:

- The lines were taken off the rollers and the outrigger raised with the rollers folded in. The rope was tied to the handrail on the main lab wall.
- The weights were removed from the jig lines and the free ends of the lines were coiled and tied to stanchions. The control box flex was also coiled and tied below motor unit using a short piece of rope.
- The cover was placed on the motor unit, and the fish boxes and the weights were removed.
- The power supplies to the light ballast and the motor unit were turned off at the outlets.

Use:
On arriving at a station the process of stowing the machine was reversed and the machine was deployed according to the notes given below.

- The lights were put on as soon as possible on reaching the jigging station. They were always used even during daylight.
- The various controls on the motor unit were set according to the conditions (see Figure ?a.)
  Power
  Lifting speed
  Descent speed
  Fishing depth
  Shakuri
  Automatic lifting
- Lifting speed
  - This was varied with the water temperature to try to match the speed of the lures to the swimming speed of the potential targets i.e. lower speeds were used in colder waters.
  - Setting 6 appears most appropriate for water over 2^0C (i.e. for *Martialia hyadesi*)
- Descent speed
  - This was varied with the fishing depth and the wave conditions to provide the fastest smooth release of the line.
  - Under calm conditions setting 6 appears most appropriate for 200m depth and setting 7 for 100m. At greater speeds the lines go slack towards the bottom of the cast.
  - As the swell increases the descent speed must be slowed to prevent the lines going slack as the ship rolls towards them.
- Fishing depth
  - This was varied depending on the water depth and the depth of the acoustic targets seen.
  - Where no clear targets were seen, the maximum possible fishing depth was used (currently 350m in open water).
  - Where small acoustic targets (i.e. potential squid prey) were seen, the fishing depth was set to fish right through them as squid are more likely to be below prey than above it.
- Shakuri
  - This is not used as it has not been seen in use on commercial squid jiggers.

Appendix 1 JR28 Event Log

Appendix 2 Gear Development

Rectangular Midwater Trawl, (RMT)

The net used throughout the cruise was an RMT 8 x 3, three nets each with a theoretical mouth area of 8 m^2, used in combination with the BAS Down Wire Net Monitor and the 4 Jaw release gear.

The RMT net system has received relatively little use in the past few years, but was adopted as the net for standard hauls on the Core Programme, and has also been used for the majority of targeted fishing during this programme. Much of the RMT equipment is now of great age and in need of replacement. (See below). As a first stage of this replacement two new nets and three new Cod-end tubes were purchased for this season.

The net was originally assembled for JR26, the 'Geneflow' cruise. It was clear that the net had very hard use on this cruise, many very large catches of krill were made, causing considerable wear to take place, necessitating a number of repairs before use on JR28. Many of the wires used in the net do have a finite life however and replacement is routine. The side wires, which take the greatest strain, were renewed at the start of this cruise. One opening bridle needed replacement subsequently.

The net generally worked well throughout the cruise and few problems were experienced. The only major one occurred when the release gear somehow got out of sequence and was opening nets Two and Three before net One, with the result that very small catches were made and were of no quantitative value. The problem was detected as a result of the odd relationship between catch volumes. The cause of the gear going out of sequence is obscure but probably resulted from either an extra release at the end of a haul or possibly radio transmissions triggering the release gear while it was on deck.

Originally the release gear had an indicator to show release cam position but its use was discontinued with the acoustic net monitors on 'John Biscoe', this will now be reinstated.

During the penultimate day of netting a very large and dense Krill swarm was encountered, the net must have been fished through this for some time and collected a large quantity of krill without the operator realising. The haul was not terminated to recover this catch but fished down to some depth before recovery. On recovery the cod-end was found to be full of Krill but the main net had burst, having a hole some 5 metres long. For the few hauls made after this the RMT was fished as a two net rig. This event and the wear and tear that took place on JR26 indicate that net operators should remain alert to the possibility of making unnecessarily large catches.

Two factors contributed to the net damage. Firstly, catches on the new cod-end tubes were prominent and sharp, catching in the meshes of adjoining nets and causing small tears. It is anticipated that this problem can be solved for future seasons by attaching faired plastic blocks ahead of each catch.
Secondly, the surface of the Stern Roller, which does not roll under the influence of an RMT net, and is rusted sufficiently to cause considerable abrasion. This problem would only be solved by chipping and re-painting so long as the roller were not used for any purpose that damaged the paint. A better solution may be to cover the roller in a protective sheet of heavy duty rubber or plastic material.

Recommendation.

As stated above much of the RMT equipment is now up to 20 years old, many of the bar end rollers are insecure in the bar ends and/or of a design that is not very efficient, they are beyond economic repair. A particular problem relates to the practice of shortening or collapsing the rig for deployment and recovery, this involves drawing the side wires up through the ends of the top spreader bar. The mechanism used to do this was developed for use on 'John Biscoe' which had a narrower gantry. The side strain developed on this system by the widely spaced blocks on the 'JCR' gantry is leading to accelerated wear on the components and excessive strain in the side wire. In the interests of safety alone this old system should be replaced with a more appropriate design.

Horizontal Antarctic Multiple Plankton Sampler.

This system has a single fixed net of 1.5 m^2 but takes five separate samples using a cod-end change mechanism. The H-AMPS like the RMT operates with the Down Wire Net Monitor. A major change in the design, made two years ago, caused a backward step in that the cod-end nets tore on opening. Use of this net system for one session of targeted fishing was aimed at testing the remedial action taken. The net did in fact function almost perfectly, the tearing problem did not occur, with some minor adjustments this net should be fully functional for future seasons.

Down Wire Net Monitor.

This net monitor, built in house, has been in use for several years and nominally works very well, but the monitor would not work at the start of JR25 when it was initially set up for the season. The documentation available to the Engineering Technology Group technician on board was minimal but the problems were overcome and the monitor has functioned with little trouble throughout cruises JR25, 26 and 28. When started at the beginning of JR28 a communication problem was experienced, this cleared after the housing was opened and various tests carried out, no particular cause was identified.

The construction of this monitor unit has some vulnerable points when it is considered that it has to operate in a high vibration environment. A second unit, employing different communication and data processing technology was built and given some testing but never brought up to working condition. A promise on the part of Engineering Technology Group to have it ready for this season was not fulfilled. The monitor operates in a very high risk environment and we have been lucky to get through three cruises this season without a major problem. It was not our intention to be in this situation and it would be irresponsible to come South for a further season without an operating spare for this vital item of equipment.

Changes to the software are also required to unable us to call up appropriate calibration files if sensors have to be changed due to damage or malfunction. We have no way of doing this at present without recourse to the software originator who is now unlikely to be on board. Further, we must ensure that the documentation is complete and that there is more than one copy.

Split Beam Transducer Fish.

This item has been under development for two seasons, this development has been handicapped

by difficulties experienced with the cable fairing. The cable is 28 mm diameter and strums very badly when towed at speed. Fairing of the whole submerged section is necessary to prevent this. The fairing originally employed prevented the strumming but became detached from the cable when wound around the winch drum. Last season a simpler, cheaper type of fairing was tried, this had several faults one of which was that it did not stop the strumming!

For this season we returned to the original type but cut it into 150 mm lengths linked together with thin rope and attached to the cable by polycarbonate clips that allow it to rotate freely around the cable. It is supported along the cable length by heavy duty clips that bear on brass clamps.

This arrangement has proved to be largely successful, the addition of rubber bungee links between each section has reduced the tendency of the fairing to enter the sheave upside down. Further work on this fairing, which due to very late delivery, was prepared very hastily, should improve it further.

A vital requirement for this fish is that it is at least as stable as the ships hull in terms of angular excursions from the horizontal. Early design work on this fish was aimed at minimising pitch perturbation induced by the vertical movements induced by the ships roll motion. To this end a tilt sensor was fitted to the fish. Good recordings of tilt have now been obtained. Initial results suggest that pitching of the fish is limited to less than the average roll of the ship. Pitch rate was also recorded and will help considerably in assessing the suitability of this Towfish as a transducer platform.

Appendix 3 ITS Report

ABC Data Logging System and Peripherals

The Level C Ethernet interface failed approximately seven times. This caused the ABC alarm to go off. Setting the status of the Level C Ethernet to "up" with the ifconfig command solved the problem. No data were lost as the backlog accumulated on the Level B. Backward time jumps in data streams are believed to be due to the Level B sending a small amount of old data when the link was restored.

The reason for these failures seems to be due to either the number of collisions on the Ethernet or a fault with the Level C AUI port.

The Level C was moved from the existing AUI wall socket to a 10BASE2 Ethernet socket. It was not possible to bridge the Level C as all the required equipment was already being used to bridge bsumlsb and the Simrad echo sounder. At the time of writing it is planned to switch over to the 10BASET socket on the Level C if the problem happens again - this would at least have the advantage of isolating the Level C AUI socket as the cause of the problems.

The Simrad 500 Level A had to be reset on about four occasions.

The GLONASS GPS needed to be reset on at least six occasions. Sometimes it produced 0 values for all the variables, on other occasions it failed to produce any data at all. It may help to have this unit serviced when the ship returns to the UK if the GLONASS will be logged next season. The Radio Officer plans to use GLONASS port B to provide GLL input to the Dartcom PC on the bridge.

After needing several resets the Ashtec Level A needed to be replaced as it failed to boot up. Also the Ashtec receiver needed to be completely reset. Fortunately these problems occurred during a period of bad weather (08:00 - 21:15 on 23-1-98) when no transecting was possible.

At least five Level As reported master clock jumps on at least ten occasions. The Level As that reported master clock jumps most frequently were WINCH and SIM500.

A table detailing the data streams logged is included at the end of this document.

Antarctic Communications

The Antarctic communications system suffered problems with the sending of message receipts. This was traced back to the removal from the system aliases file of the userid "MailerDaemon", once this was restored the system continued to operate correctly. A slight modification was made to the releasing process so that personal messages could be released by the RO as well as the Master.

BSUMLSB

The external disk on bsumlsb failed early on in the cruise. As no spare disks had been included when the workstation was shipped it was necessary to copy the data from the faulty disk to JRUE and for bsumlsb to access the data via NFS mounts. Fortunately no data were lost but I would

recommend that MLSD send spares for bsumlsb in the future as it plays an important role in data acquisition for the Simrad system.

Consumables

The ship has adequate stocks of consumables apart from Level B tapes and DAT tapes. HQ has been notified of these shortages.

Daily Processing

Part of the daily processing involved extracting data for the "Virtual Data Manager". This required a specific directory structure to be created and unfortunately this structure was not correctly documented. Also the scripts used to extract the data had the current cruise ID hard coded in several places. Apart from this, the scripts ran correctly and without any problems.

ITS Unix Workstations

It was discovered there was no terminator on the Exabyte drive attached to JRUE. It was not known if the Exabyte is terminated internally so a terminator was added.

It was not possible for the AUI cable used by JRUA to be fully plugged into the wall socket. JRUA was moved onto a 10BASE2 Ethernet socket.

Messages on the JRUE console indicated that it was having problems with the state of the network - these were probably caused by the high number of collisions on the network.

There were also messages on the JRUE console reporting write errors to sd0 (the internal hard disk with the root partition) and read errors on sd2 (the external hard disk that stores user data).

JCR Web Pages

A web server was installed on JRUE so that cruise web pages could be developed. The idea being that the web pages could be used as a source of cruise information. An additional set of pages were created which report of the current state of the data logging providing information such as the current latitude, longitude, speed, direction, etc. These pages are created by an automatic job which updates them every sixty seconds.

The overall intention is to create pages which can not only report on the data being logged but which also provide information on the equipment being logged such as make, manufacturer, sample rate, output format, etc. If this is to be pursued then ideally time should be set aside at HQ for a member of ITS staff to work on this in consultation with the science divisions.

Local Area Network

This caused considerable concern. Every device on the network that has a collision indicator appears to be indicating a large number of collisions on the network. As the network use is relatively light the likely causes of this are a faulty network device, faulty network cable or a combination of the two. It is not possible to address this problem while the ship is on a cruise and

it is suggested that solving this problem becomes a priority when the ship is back in the UK.

One of the Anytwist units used to convert between 10BASET and AUI seems to be faulty.

NetWare Servers

JRUB crashed at 03:15 on 3-2-98 and had to be restarted.

PCs

Due to the large number of inconsistencies in the setup of the operating system and applications software on the PCs in the UIC room and the Data Prep room the Principal Scientist requested that the setup be rationalised. The main areas of concern were differences in printer setup (eg some PCs were not configured to print to the DeskJet), differences in Windows desktop setup and differences in applications configurations (eg printing options in Presentations and TCP/IP host file entries).

The solution adopted was to use WINSTART.BAT to overwrite the main Windows INI files with versions that contain the required settings. Two of the PCs hang on exit from Windows when they start Windows from WINSTART.BAT - this is under investigation.

The Principal Scientist requested an upgrade to the PC in his cabin as the existing machine was too slow. The existing machine (486 with 8MB RAM) was replaced with a Pentium with 16MB RAM.

A parallel port card was installed in the PC used by the Radio Officer.

There are currently no spare PC monitors on board - the last one was used to replace a faulty monitor on the PC used by the Catering Officer.

Printers

All the printers functioned well and there were no reported problems.

X Terminals

These seemed to be in continuous use and no problems were reported.

Table detailing data streams logged

Name	Variables	No. of records	Size in bytes	Start Time	Stop Time	Data interval
adcp	ampl, bindepth, bottomew, bottomns, depth, good, heading, pitch, roll, temp, velerr, velew, velfa, velns, velps velvert	1044160	135746944	98 014 19:22:12	98 038 10:14:49	2min
anemom	wind_dir,wind_spd	2227246	35642080	98 013 18:50:43	98 038 12:48:36	1 sec
aqashut	cond, temp, press, chlor, tran, par, wifd1, wifd2, wifd3, wifd4, wifd5, wifu1, wifu2, wifu3, wifu4, wifu5, depth, cdpth, wing, stran	476203	59055316	98 017 16:52:37	98 035 10:14:03	1 sec
bas_ctd	pres, temp, cond, ch1, delstat	212081	7216898	98 016 11:00:24	98 034 14:34:44	1 sec
bestdrf	vn, ve, kvn, kve	71258	2001368	98 013 18:50:30	98 038 12:48:00	1 sec
bestnav	lat, long, vn, ve, cmg, smg, dist_run, heading	71276	3712496	98 013 18:50:30	98 038 12:48:00	1 sec
dop_log	speedfa, speedps	2057346	32923680	98 013 18:50:43	98 038 12:48:32	1 sec
em_log	speedfs	949906	9505204	98 013 18:50:43	98 038 12:48:35	variable
gps_ash	sec, lat, lon, hdg, pitch, roll, mrms, brms, attf	2109797	122374370	98 013 18:48:55	98 038 12:48:34	1 sec
gps_glos	utc, type, svc, lat, lon, alt,cmg, smg, vvel, pdop hdop, bdop, tdop	2504878	205406140	98 013 18:50:43	98 038 12:48:37	1 sec
gps_nmea	lat, lon, gq, svc, hdop, dage, dbase	2138205	98363574	98 013 18:50:43	98 038 12:48:35	1 sec
gyro	heading	2137667	21382814	98 013 18:50:40	98 038 12:48:36	1 sec

netmon	depth, temp, cond, light, flow1, flow2, flow3, angl1, angl2, alt, fluor, sp1, sp2, sp3, sal, net, type	80454	8534268	98 016 18:38:50	98 034 04:56:32	2-3 secs
oceanlog	astemp, mstemp, sstemp, hum, par, tir, fluor, flow, sp1 - sp13, press, cond, tstemp	413829	61252836	98 013 18:50:45	98 038 12:48:35	5 secs
prodep	uncdepth, cordepth, cartarea	420512	9257408	98 014 21:53:47	98 038 10:13:09	1 sec
relmov	vn, ve, pfa, pps, pgyro	71276	2429528	98 013 18:50:30	98 038 12:48:00	1 sec
sim500	uncdepth, rpow, angfa, angph	465057	13027740	98 014 21:53:47	98 038 12:46:05	1 sec
winch	cabltype, cablout, rate, tension, btension comp, angle	21992	1017776	98 016 11:05:26	98 036 11:38:25	1 sec

Appendix 4 Station Positions

Night time station work

The core programme sampling design includes two standard stations on the second transect of each pair for the first four days of each box. These stations are positioned 20 km from the ends of the transect so that one is on- and the other off-shelf. The order of sampling begins alternately on- then off-shelf depending on the direction of the daytime transects. There is a very full programme of sampling during these night time stations and if the first station is begun on time the planned activities only just fit into the time available with a small margin for slippage. Thus, any equipment problems or any weather conditions which prevent the ship steaming at 12.5 knots between stations would either delay the start of the following day's transecting or require some of the intended sampling to be dropped from the programme. On JR28 we were extremely fortunate with the weather, such that sea conditions and visiblility allowed the ship to steam at 12.5 knots between stations.

The first pair of stations in the Eastern box were begun a little late and some time was wasted in repositioning before the standard RMT haul in order that the mid point of the haul would be approximately at the station position. Subsequent station hauls were begun from the position of the ship after accelerating to 2.5 knots following the end of the last vertical wire activity. It is recommended that this become the standard procedure for these stations in order to save time. On the second set of Eastern stations, problems were experienced with the traction winch for the CTD. This resulted in about 45 minutes of lost time while the problem was resolved. A detailed table of the station timings is given below.

The tight schedule and complexity of the station sampling requires good organisation to avoid unneccesary delays. This requires that everyone involved has a clear idea of what to do and that information on the current state of the programme is disemminated at frequent intervals so that people can be ready in time for their sampling activity. The night time watch leaders play an important role in this. After the first couple of nights in the Eastern box, the team had begun to pull together well and operations went very smoothly from then on. For future seasons it would be helpful if a protocol of protocols were prepared which details how all the operations fit together - this would save any initial fumbles and allow the team to get fully up to speed right from the word go.

Station positions

The table below shows the waypoints used on this cruise and the original designed points together with the distance of the current points from the originals (displacement) and also the inter-station distance of the JR28 waypoints.

	JR28 waypoints		Designed waypoints		Displacement	Inter-station
Station	latitude	longitude	latitude	longitude	km	km
MEB1	-47.889019	-43.343533	-47.976667	-43.293333	10.432	0
MEB2	-48.171944	-43.168095	-48.258333	-43.085000	11.402	34.034
MEB3	-48.453632	-42.991997	-48.540000	-42.875000	12.897	33.899
MEB4	-48.738338	-42.793011	-48.821667	-42.665000	13.176	34.853
MEB5	-49.033665	-42.588165	-49.103333	-42.453337	12.501	36.069

Station	latitude	longitude	latitude	longitude	km	km
MEB6	-49.320210	-42.391685	-49.385000	-42.240000	13.129	34.893
MEB7	-49.614609	-42.187759	-49.666667	-42.026667	12.955	35.875
MEB8	-49.904728	-41.967873	-49.948333	-41.811667	12.180	35.895
MEB9	-50.189400	-41.759399	-50.230000	-41.595000	12.531	34.956
MEB10	-50.473099	-41.528099	-50.511667	-41.376667	11.531	35.538
MEB11	-50.763599	-41.292801	-50.793333	-41.156667	10.120	36.294
MEB12	-51.046902	-41.044399	-51.075000	-40.936667	8.146	35.972
MEB13	-51.325802	-40.823898	-51.356667	-40.715000	8.301	34.588
MEB14	-51.614700	-40.607498	-51.638333	-40.491667	8.411	35.425
MEB15	-51.897800	-40.383598	-51.920000	-40.266667	8.387	35.026
MEB16	-52.173599	-40.157501	-52.201667	-40.040000	8.591	34.323
MEB17	-52.463902	-39.894699	-52.483333	-39.811667	6.021	36.868
MEB18	-52.752800	-39.647800	-52.765000	-39.583333	4.542	36.168
MEB19	-53.038601	-39.402802	-53.046667	-39.353333	3.424	35.753
MEB20	-53.319397	-39.148899	-53.328333	-39.121667	2.062	35.489
MEB21	-53.606186	-38.900372	-53.610000	-38.888333	0.900	35.859
MEB22	-53.892601	-38.653816	-53.891667	-38.653333	0.108	35.712

The table below summarises the positions and the displacement of the JR28 waypoints from the original designed points.

	JR17 & JR28		Designed		Displacement
Station	Latitude	Longitude	Latitude	Longitude	km
E1.2.S	-54.0756	-35.9181	-54.0764	-35.9199	0.146
E1.2.N	-53.8673	-35.4017	-53.8778	-35.4117	1.339
E2.2.S	-54.2452	-35.7314	-54.2476	-35.7218	0.676
E2.2.N	-54.0406	-35.2092	-54.0483	-35.2125	0.878
E3.2.S	-54.3908	-35.5489	-54.3928	-35.5547	0.434
E3.2.N	-54.1878	-35.0473	-54.1927	-35.0443	0.582
E4.2.S	-54.5385	-35.3871	-54.5379	-35.3874	0.064
E4.2.N	-54.3359	-34.8702	-54.3372	-34.8761	0.407

The station way points used for the Western core box are the definitive positions from the MLSD WWW pages. The positions were as in the following table.

Station	Latitude	Longitude
W1.2.S	-53.8173	-38.8744
W1.2.N	-53.4638	-38.9839
W2.2.S	-53.7851	-38.5835
W2.2.N	-53.4318	-38.6953
W3.2.S	-53.7504	-38.2781

W3.2.N	-53.3974	-38.3923
W4.2.S	-53.7141	-37.9658
W4.2.N	-53.3614	-38.0825

The methodology of the design and the intermediate calculations together with the definitive waypoints are in the spreadsheet o:\mlsd\event\jr28\design.wb2.

The Eastern box waypoints are shown in the table below:

Way point	Latitude	Longitude
1	-53.693833	-35.250333
2	-54.096500	-36.263333
3	-54.174833	-36.175833
4	-53.772167	-35.161000
5	-54.268000	-36.068833
6	-53.865500	-35.051833
7	-53.943833	-34.959167
8	-54.346500	-35.978333
9	-53.999667	-34.895000
10	-54.402500	-35.915500
11	-54.492000	-35.811667
12	-54.089333	-34.789000
13	-54.559000	-35.736000
14	-54.156500	-34.711667
15	-54.234833	-34.618500
16	-54.637500	-35.644833
17	-54.302000	-34.541000
18	-54.704667	-35.569000
19	-54.779167	-35.481833
20	-54.376667	-34.451833

The Western box waypoints are shown in the table below:

Waypoint	Latitude	Longitude
1	-54.007093	-38.938995
2	-53.299855	-39.156376
3	-53.286988	-39.038308
4	-53.994014	-38.819019
5	-53.264191	-38.831860
6	-53.970843	-38.609241
7	-53.961641	-38.526891
8	-53.255138	-38.750818

Waypoint	Latitude	Longitude
9	-53.937114	-38.309960
10	-53.231008	-38.537319
11	-53.220911	-38.449045
12	-53.926852	-38.220269
13	-53.204792	-38.309365
14	-53.910467	-38.078349
15	-53.890412	-37.906696
16	-53.185061	-38.140417
17	-53.869227	-37.727756
18	-53.164216	-37.964289
19	-53.148413	-37.832307
20	-53.853164	-37.593669

Table of timings for the South Georgia Core Box night time stations on JR28

Station (Events)	Activities	Start Datetime[1] (GMT)	Sampling time[2] (hours:minutes)	Change-over time[3] (hours:minutes)	End Datetime[4] (GMT)	Reposition time[5] (hours:minutes)
E1.2N (123-131)	BNE, BNE, CTD, JIG, PAQ, RMT, FNE, FNE, FNE	24/01/98 21:50	03:13	01:33	25/01/98 02:30	02:10
E1.2S (132-138)	BNE, CTD, JIG, BNE, RMT, FNE, FNE	25/01/98 04:40	02:08	00:31	25/01/98 07:21	01:01
E2.2S (141-147)	BNE, JIG, CTD, PAQ, RMT, FNE, FNE	25/01/98 21:00	02:16	01:13	26/01/98 00:29	02:26
E2.2N (148-156)	BNE, CTD, BNE, CTD, JIG, RMT, FNE, FNE	26/01/98 02:55	03:26	00:51	26/01/98 07:12	01:10
E3.2N (160-167)	BNE, CTD, JIG, PAQ, RMT, FNE, FNE, FNE	26/01/98 21:25	02:49	00:30	27/01/98 00:44	02:03
E3.2S (168-175)	BNE, BNE, CTD, JIG, PAQ, RMT, FNE, FNE	27/01/98 02:47	02:35	00:38	27/01/98 06:00	01:42
E4.2S (178-186)	RMT, BNE, CTD, JIG, PAQ, BNE, BNE, FNE, FNE	27/01/98 19:55	03:04	01:00	28/01/98 00:09	02:06
E4.2N (187-195)	BNE, CTD, BNE, CTD, JIG, PAQ, RMT, FNE, FNE	28/01/98 02:15	03:14	00:44	28/01/98 06:10	01:38
W1.2S (204-210)	BNE, CTD, JIG, PAQ, RMT, FNE, FNE	30/01/98 21:20	02:17	00:41	31/01/98 00:18	02:11
W1.2N (211-219)	BNE, CTD, BNE, CTD, JIG, PAQ, RMT, FNE, FNE	31/01/98 02:29	03:17	00:33	31/01/98 06:18	01:30
W2.2N (222-228)	BNE, CTD, JIG, PAQ, RMT, FNE, FNE	31/01/98 21:25	02:53	00:24	01/02/98 00:42	02:22
W2.2S (229-236)	BNE, BNE, CTD, JIG, PAQ, RMT, FNE, FNE	01/02/98 03:04	01:58	00:39	01/02/98 05:41	02:07
W3.2S (241-247)	BNE, CTD, JIG, PAQ, RMT, FNE, FNE	01/02/98 21:44	02:08	00:33	02/02/98 00:25	02:10
W3.2N (248-256)	BNE, CTD, BNE, CTD, JIG, PAQ, RMT, FNE, FNE	02/02/98 02:35	03:14	00:44	02/02/98 06:32	01:22
W4.2N (260-266)	BNE, CTD, JIG, PAQ, RMT, FNE, FNE	02/02/98 21:05	02:40	00:24	03/02/98 00:10	02:43

Station (Events)	Activities	Start Datetime[1] (GMT)	Sampling time[2] (hours:minutes)	Change-over time[3] (hours:minutes)	End Datetime[4] (GMT)	Reposition time[5] (hours:minutes)
W4.2S (267-274) (125 m)	BNE, BNE, CTD, JIG, PAQ, RMT, FNE, FNE	03/02/98 02:53	01:42	00:28	03/02/98 05:00	02:45

1. Time vessel on station
2. Total time of contiguous activities
3. Total time between activities
4. Time all secure and vessel moves off towards next station
5. Time to commencement of next gear deployment