Q3 DYNAMOE PROGRAMME
BIOLOGICAL SCIENCE DIVISION
BRITISH ANTARCTIC SURVEY

LARGE SCALE DISTRIBUTION IN THE SCOTIA SEA

JR82 SCIENTIFIC CRUISE
JANUARY & FEBURARY 2003

CRUISE REPORT

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INTRODUCTION

BACKGROUND

In order to achieve an understanding of ecosystems well enough to make predictions (for example how they might respond to climate change), their key interactions need to be identified and examined. To make this objective tractable, research programmes have selected central species for study, or specific systems, or both. Within the Southern Ocean, Antarctic krill (*Euphausia superba*) are an obvious target species, and BAS's DYNAMOE programme focuses on the South Georgia-Scotia Sea system. Previous work has shown that the South Georgia system depends on large scale inputs of energy from the Antarctic Circumpolar Current as well as local production. JR82 forms part of DYNAMOE, to help understand this large scale distribution and transport of material within the Scotia Sea. It also forms part of the UK GLOBEC programme as a component to SO-GLOBEC, to understand the physical-biological factors dictating the distribution, survival, and population size of krill. SO-GLOBEC emphasizes the study of key, yet poorly known processes dictating krill recruitment, for example the role of sea ice in overwintering.

Sea ice is not a feature of theSouth Georgia system, yet krill thrive here, well north of their main habitat in the seasonal ice zone. However, there are some peculiarities of the krill at South Georgia. First, given that it is packed with hungry predators and at the northern fringe of their range, there are a lot of krill here. Second, only a fraction of their size range is found. Larvae are normally noticeable by their absence, and immigrants to the South Georgia system are mainly the older krill, not the 15-25 mm juveniles. Something must be happening somewhere along the supply routes from the ice zone towards South Georgia.

SCIENTIFIC RATIONALE FOR SCOTIA SEA CRUISE

The Scotia Sea cruise aimed to investigate large-scale transport, growth and survival of krill across the Scotia Sea. It was planned around several principles to make the objective more tractable. First, sea ice is hard to sample properly at large scales, so the cruise was in summer when it had retreated furthest. Second, the study links two of the most well studied and krill-rich parts of the Southern Ocean: the Antarctic Peninsula and South Georgia, and the Scotia Sea itself is fairly well known. So we have a good starting point.

The third point is that the Scotia Sea is one of the few places where the currents do not flow broadly parallel to the winter ice zone. Instead they loop far to the north, around South Georgia. There is current uncertainty over the relative roles of oceanfronts and the zone of retreated ice in the generation and transport of blooms or krill aggregations. Therefore the disassociation of the ACC flow from the ice zone here provides the opportunity to tease apart their effects. For example, larval krill seem to rely on ice cover to overwinter to a greater extent than adults. Is the lack of larvae at South Georgia because the 3D circulation retains these vertical migrants in the ice zone well south of South Georgia, but sweeps the non-migrating adults up towards the island? Or have the larvae lower starvation tolerance and simply starve as they are swept across the "desert" of the central Scotia Sea?

Although krill are a central focus of SO-GLOBEC, it recognizes the need for a multidisciplinary approach to understand the key biological and physical interactions governing their survival. The interactions between krill and their food, competitors and predators dictate growth and mortality. These processes are reflected in behavioural patterns, such as schooling and diel vertical migration, which in turn link with the flow field to determine large-scale distribution. Therefore, central to this study is a quantification of nutrient availability, the factors leading to Scotia Sea blooms, and how these relate to condition and growth of krill. These factors were also studied in relation to copepod condition and egg production, and this provides further insights into the secondary production process. It is beyond the scope of this cruise to quantify krill mortality from predation. However the cruise includes 4 cetacean scientists who will also observe seals.

OBJECTIVES OF JR82 CRUISE

Our interdisciplinary team will address two central questions:

1. What controls the growth, development and survival of krill in the Scotia Sea?

2. How important are these processes in determining the distribution and abundance of krill?

The cruise also includes a section at South Georgia. In addition to sampling in the same way as in the Scotia Sea component to increase geographical coverage, there were two further objectives:

1. To sample the Western Core Box as part of an ongoing monitoring programme

2. To lift and check two moorings as part of an AFI grant.

SUMMARY OF SCIENCE ACTIVITIES

SCOTIA SEA PHASE

The cruise was planned to encompass 3 elements. Firstly we aimed to do a 6 long transects across the Scotia Sea from north of the Southern Antarctic Circumpolar Current Front (SACCF) to about 63°S. This would comprise underway observations of the environment with oceanlogger, nutrient autoanalyser, towed UOR with mounted Fast Repetition Rate Fluorometer (FRFF) and visual observations of cetaceans and seals. Along these transects XBTs would be deployed every 20 miles and water samples filtered every hour for chlorophyll *a*.

The second planned element was a series of 40 "rapid stations". These comprised a period of acoustic searching and target fishing for krill with the RMT. Then at the station a 0-2000m CTD drop with water samples analysed at fixed depths, a shallow CTD for water for particulate filtration, lugols preservation and primary production deck incubations. Bongo nets to 400 m were planned for mesozooplankton abundance and copepods for condition factor analysis and egg production rate. Sonobouys for cetacean acoustics were deployed in the vicinity of the stations. At 11 stations we deployed a pair of Argos drifters drogued at 20 and 100m to measure current velocity in the Eastern Scotia Sea. At 7 stations we released ARGO floats for Jon Turton at the Met Office, and at 1 station deployed an Acoustic Recording Package for cetacean monitoring.

The third planned element was a series of 24-hour process stations to be based at stations with high abundance of krill larvae. These stations were aimed to provide a detailed picture of the diel vertical migration cycle of krill larvae as well as animals for experiments on growth rate and starvation tolerance.

As described in the cruise narrative below, the rarity of krill larvae where we had expected them in the central Scotia Sea precluded the 3rd element. This, and the exceptionally good weather freed up time that we used to:

1. Add an extra transect pair to make 8 not 6 transects,

2. Extend our transect coverage further east to the South Sandwich Islands,

3. Lengthen some transect lines so that they all spanned from north of the SACCF to the ice edge,

4. Increase the amount of target fishing, as postlarval krill were abundant and the growth experiments were going well,

5. Add a series of 6 LHPR hauls to 1000m. This was prompted by the surprising observation that major copepod species were at over wintering depths in parts of the Scotia Sea during summer.

We thus ended up with a very nice set of 56 stations, most of which had a full suite of measurements, including rate processes on primary production, copepod egg production and krill growth rate. These spanned the whole Scotia Sea along 4300 miles of transects.

SOUTH GEORGIA PHASE

WESTERN CORE BOX (WCB).

This is a more or less standardized survey repeated annually and interannually at South Georgia to monitor the shelf and oceanic region to the north of Bird Island. This comprises 4 pairs of acoustic transects 80 km long, with a pair of stations (shelf and oceanic) on the first 3 of these. The stations are worked at night and the acoustic transects to monitor krill biomass are during daytime. We completed all in good weather, although a huge iceberg half the size of South Georgia was hanging around the NE corner, which meant truncating the northern sections of the last two transects (see Figure on Cruise track).

I admit that this was the worst planned part of the cruise. I had thought there was a groove in the sea for the ship to follow; this WCB has been done so much. There were several versions of both the cruise track and sampling protocol floating around, and none of us seemed sure what we were meant to be doing. More worryingly, many people didn't really understand *why* we were doing it, and simply used it as an exercise to continue the measurements they had made so consistently through the Scotia Sea. It is my personal view, but one echoed by many of the people on this cruise, that we should take this WCB back to the drawing board.

MOORINGS

Two upwards-looking moorings, anchored 200m from the surface, had been anchored within the WCB earlier in the season. One was in oceanic water and the other over the shelf. These were retrieved, their data downloaded and the shelf one was redeployed.

YEAR-CLASS SUCCESS OF MACKEREL ICEFISH AND HUMPHEAD.

A pair of RMT8 net hauls was made off Stromness Bay, Cumberland Bay and near Shag Rocks to capture fish larvae for subsequent determination of age structure and abundance.

TIMETABLE

7 Jan	Depart Stanley
9-23 Jan	First half of Scotia Sea phase
24 Jan	Signy: acoustic calibration, pick up John Blunn, R and R
25 Jan-9 Feb	Second half of Scotia Sea phase
10-11 Feb	Grytviken: cargo, pick up Mark Belchier and Martin Collins, R and R
12 Feb	Lift moorings
13-16 Feb	Western Core Box, then return to Grytviken for moorings floats
17 Feb	Acoustic calibration in Stromness, R and R, test moorings instrument
18 Feb	Bird Island. Pick up Richard Phillips and Keith Reid. LHPR in WCB
19 Feb	Bad weather, redeployed a mooring that night
Passage to Stanley, via fishing, swath bathymetry, XBT transect	

CRUISE NARRATIVE WITH RESULTS SUMMARY

Below are a selection from the e-mails sent back to BAS, narrating cruise progress, key events and modifications to our itinerary as dictated by conditions in the field. These give a flavour of the results, detailed in the individual sections of this cruise report.

13 JANUARY 2003

Dear Jon, Eugene,

Its yet another flat calm day here-we've been blessed with very calm weather ever since the bumpy first couple of hours at sea. We are near the top of our second zig-zag and making excellent progress.

We couldn't quite get down to our southernmost station at 63°S, not for sea ice but for numerous bergs and bergy bit making it difficult to work. A couple of huge bergs also in the vicinity. Hopefully it will have cleared a bit more from south of the South Orkneys by the time we get there.

There has been very little phytoplankton in the water, even in the classic bloom locations like the shelf west of Powell basin. This is borne out by the satellite images and nutrients.....it does not seem to have got going yet down here, although it looks like a bloom is starting to take off south of Signy. We have been catching masses of krill for moulting experiments, and as Volker et al have been saying for years, the small juvs furthest south and adults offshore. So the krill moulting team, acoustics and target netters have been very happy. Most of today we have been sailing through 2 layers of adult krill near the surface, with occasional schools of what look like juvs underneath. This, and the rarity of copepods have prompted the usual discussions of whether krill feeding has anything to do with it.

First Argo float was deployed just south of Burdwood bank and the ARP went in without trouble at 60°S last night. Whale visual and acoustics teams are happy with their data, and everything except UOR is working. Doug is making great efforts to get a functioning system, and so till now the FRRF has gone in through flow with vertical profiles at stations with UOR dangled over stern. Doug thinks he might have found what's wrong so fingers crossed for next transect.

We haven't found any larvae yet and we should soon be coming into region where they are most abundant. Hopefully there hasn't been a spawning failure this year.

I hope all is going well back at base.

With best wishes,

Angus and the JR82 team.

27TH JANUARY 2003

Dear Eugene and Jon**,**

Thanks for the feedback on the drifters and transecting. We have made good progress so far and are well on schedule. The satellite images showed a bloom south of Signy and we sampled that, and the krill feeding on it, to get a better diversity of growth environments in a region of otherwise low primary production. Perhaps because of this, few krill larvae or copepods were

present in the central Scotia Sea, but we were able to locate postlarvae easily at almost every station, and set up growth experiments.

Oceanography, nutrients and primary production, zooplankton and krill work, as well as whale observations are all going well.

We broke off transect 5 for a day at Signy which provided a cold water calibration of the acoustics, a welcome day off for the scientists and allowed us to pick up John Blunn, before resuming transect 5 southwards to the ice edge.

We are currently heading north on the 6th transect at 59.44'S, 41.50'W, approaching station 6.2.

All the best,

Angus

10TH FEBRUARY 2003

Dear Jon and Eugene,

We have just finished the Scotia Sea section and are heading back to Cumberland Bay for Tony's icefishing tonight before a welcome break at KEP. Clerke Rocks are now to starboard, gleaming in the sun among the grounded icebergs.

Well, the Scotia Sea section was a bit of a slog, but we did 56 stations with CTDs, Bongos and RMT fishing, interspersed with 4332 miles of transect, much with UOR and FRRF. Equivalent to one and a half times across the Atlantic with stations every 60 miles.....no wonder it seemed to go on a bit.

We have seldom seen weather this settled for so long; we only lost a few hours due to weather in a whole month. But despite being lucky both with weather and equipment, it was a fine effort by all.

We crossed the SACCF and Southern Boundary 8 times with good profiles from XBTs and deep CTDs. Along the last few we towed consistently the UOR with the FRRF. Along all transects except the last one through the South Sandwich Islands, the most southerly station was at the ice edge.

Both the 7 ARGO and the 22 Argos drifters have been deployed successfully, and the latter are already showing interesting and sometimes surprising trajectories. It looks as if we will have them going both sides of South Georgia: something that we particularly wanted from the transect 7 drifters.

Primary production values were obtained from nearly every station, which is the first time that such a good coverage has been obtained for the Scotia Sea. There seems reasonable SeaWiFS coverage as well for January, and together with the FRRF data, hourly chlorophylls, nutrient and physical data, this should make a good story.

The zooplankton team have built up a solid picture of mesozooplankton which, like the other components of this cruise, will make a nice comparison to the Synoptic Survey of 2000, where conditions were clearly different. Seven LHPR hauls to 1000m will lend the necessary vertical context to the seasonal cycles of copepod production. After a start with few animals in the top 400m they obtained egg production rates at a large number of the stations. Copepods were

picked out at each station for future elemental analysis of condition factor. This, with egg production rates, will form a valuable extension of copepod production data from previous years.

A surprising finding was the lack of blooms in the Antarctic Peninsula area, and across a large part of the western and central Scotia Sea, a low abundance of krill larvae and large copepod species. Deep hauls with the LHPR showed that these copepods were at over wintering depths even in mid summer. The absence of gravid female krill and krill larvae further suggests a late spawning and production cycle or an unsuccessful one in this area.

The rarity of krill larvae, on which we were to base a series of 24 h process stations, freed up several days to redirect towards extending the transecting and extra work on the copepods and postlarval krill.

We managed to find enough krill for IGR experiments at 21 of the 56 stations, and 4320 individuals were incubated. Growth rates ranged roughly 20 fold. However, in contrast to recent models in low chlorophyll areas of the Scotia Sea, mean rates were all positive, ranging from 0.5-10% per intermoult period, from data plotted so far. A large number of krill were preserved from a wide range of latitudes for future biochemical genetic, isotopic and dietary analysis in the UK.

The EK60 worked very well, and was a substantial improvement on the old system, particularly at 200kHz. Not only were there clear gradients in krill biomass along the transects, but we found also regional changes in delta mvbs values of the krill, broadly in accordance with the length frequencies from net catches. Swarm and layer structure also varied noticeably with latitude.

The Acoustic Recording Package for cetaceans was deployed successfully at ~60°S and the whale acoustic team used sonobouys to make a good comparison with the visual observations. The visual team recorded about 175 recording hours, in comparison with ~120 hours for the 2000 Synoptic Survey. The long periods of calm weather with good visibility have contributed to this.

So, we have had a good Scotia Sea section, and hope that the variety of activities planned for South Georgia go as smoothly.

One question concerns the Western Core Box. There have been various versions of this over the years, so I just want to confirm that we will be doing that which we did on JR70, the coordinates of which we have. If this is indeed correct as I suspect, there is no need to reply to this query.

I hope all is going well in Cambridge.

With best wishes from the JR82 team,

Angus

20TH FEBRUARY 2003

Dear Eugene, Jon, Phil,

We have just put the inshore mooring in, in what may have been our last chance, in a moderation in the weather tonight. It was still blowing force 6 with fair swell and a good effort by all. The big iceberg was over the offshore site, covering it by a good 2 miles and moving south, so we had to give that a miss and head home.

I am sure Peter and Doug will update with details of the moorings but these have been dogged by bad luck. We spent over 3 days shiptime on these, rather than the allotted 2, and Peter and

Doug really gave it a good effort. We returned to KEP to collect more floats and tested the Water Column Profiler both in Stromness before the calibration and at Bird Island. But as I understand, the Water Column Profiler just isn't sensitive enough to see krill, even at max gain setting.

The WCB was completed in good weather so we have some high quality acoustics, which, with the RMT8 hauls, revealed plenty of krill around, in contrast to indications from BI preds rather earlier in the season. The "inconvenient iceberg" precluded northern quarter of 3rd and 4th transects but we got most of it done.

Significant numbers of *Euphausia superba* larvae here were a surprise, given their usual rarity here and their absence where we expected them. We investigated this more fully with the LHPR.

The weather then started to break down, precluding BI pickup as planned for 17th Feb. Instead we detoured back to KEP to collect the moorings floats (used by Martin Collins) then calibrated next day at Stromness, rather than Rosita Harbour as originally planned. This also provided a further 6 h test on WCP. In rapidly freshening weather we managed to do BI pickup of Keith Reid and Richard Phillips on 18th Feb. Very relieved by that....if we had arrived 2 hours later we might still be waiting.

Tony North got a nice series of hauls at mouth of Stromness and Cumberland Bays to assess ice fish abundance/age structure. Also Martin Collins and Mark Belchier from KEP managed to complete, on the JCR, some of their fish work which they had planned to do in KEP..... our picking them up on 11 Feb was earlier than the impression they had been given from BAS before they left.

Anyway..... We are now on the road home via more icefish fishing at Shag Rocks weather permitting, a swath bathymetry profile along Scotia Ridge, XBT transect for Pablo towards the Falklands shelf, and finally warm water testing of the new UOR.

All the best from the JR82 team, knackered after a long cruise and keen to get home!

Angus

NAVIGATION DATA

Navigational data were logged routinely into Pstar on JR82 from 120000 07 January 2003 until 235959 22 February 2003 [excluding the 24 hour period from 1200 10 February 2003 (jday 41a—42p) while we were tied up at KEP]. Data from midnight 23 Feb till arrival at the Falklands shelf were logged but have not been processed yet because of the ITS backup. The four datastreams processed came from the Trimble 4000 GPS receiver, the Sperry Mk 37 Model D Gyrocompass, the Ashtech ADU-2 GPS receiver and the GLONASS GPS (Ashtech GG24) receiver. These datastreams were used regularly in processing other oceanographic datasets.

The navigation data were processed twice daily using a set of unix scripts detailed below.

TRIMBLE 4000

The Trimble 4000 in differential mode was the primary source of positional information on JR82. The data were processed using the unix script gpsexec0. This first calls datapup to transfer the data from the RVS SCS data stream to Pstar binary files. It then executes pcopya, which resets the raw data flag, and pheadr, which sets up the Pstar dataname and header. Finally a datpik command is performed to remove data with a dilution of precision (hdop) greater than 5. The two twice-daily output files are called 82gps[jday][a/p].raw and 82gps[jday][a/p], these being written before and after the datpik stage respectively. The processed data were then appended to a master file called 82gps01.

GYROCOMPASS

The data stream from the gyrocompass constitutes the most continuous information available on ship's heading. It is involved in processing data from meteorological instrumentation (so as to derive information on true wind velocity), and in processing the Acoustic Doppler Current Profiler (ADCP) data. It is also drawn into the bestnav stream (see below) to derive positional information by dead reckoning during periods of no GPS data coverage. Twice daily processing was performed using the unix script gyroexec0. This uses datapup, pcopya and pheadr in a similar manner to gpsexec0 to retrieve the information from the RVS data stream and set the header information; followed by datpik to force all the heading data to lie between 0 and 360 degrees. The output file is called 82gyr[jday][a/p].raw. The data were also appended to a master file called 82gyr01. The Pstar routine pcopym was run within gyroexec0 to exclude duplicate time stamps from the processed data.

ASHTEC ADU-2

The ship's gyrocompass is subject to an inherent error and can oscillate for several minutes after a turn. Consequently, the Ashtec ADU-2 is used to correct errors in the gyrocompass heading prior to input of the data to the ADCP processing. The data were processed using the four unix scripts ashexec0, ashexec1, ashexec2, and ashedit.exec.

ashexec0 uses datapup, pcopya and pheadr to read in the data from the RVS data stream, reset the raw data flag, and set the header information. The output filename is 82ash[jday][a/p].raw.

ashexec1 uses pmerge to merge in data from the master gyro file (see below), followed by parith and prange to calculate the difference between the gyro and Ashtech heading, and force it to lie in the range +/- 180 degrees. The output file is 82ash[jday][a/p].mrg.

ashexec2 edits the merged data file, using the following Pstar programmes:

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

heading difference ("a-ghdg") outside –5° to 5°

pmdian - remove outliers in a-ghdg of greater than 1° from a 5 point mean.

pavrge - set the data file to 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 - reset the data file to a 2 minute time base.

pmerge - remerge in the heading data from the master gyro file.

pcopya - change the order of the variables.

The output files are 82ash[jday][a/p].edit and 82ash[jday][a/p].ave.

Finally, ashedit.exec was used to manually remove obvious outliers from a-ghdg and interpolate any gaps in the data, producing the output file 82ash[jday][a/p].ave.dspk. Data were also appended to a master file called 82ash01.int.

GLONASS

The Ashtech GG24 receiver works by accepting data from both American GPS and the Russian GLONASS satellites. This increases accessibility to satellite fixes, and hence should provide more accurate navigation data than standard GPS coverage allows. However, previous experimentation revealed disappointing performance from the instrument (accuracy approximately 15 m on JR47; see also analysis on JR67). Data were logged routinely using ggexec0, but were not used in the processing of other data streams. Filenames were of the form 82glo[jday][a/p].raw**.** Some basic quality control is performed on this file, with the resulting data stored in 82glo[jday][a/p].

BESTNAV

Bestnav is a processed data stream, which contains 30-second interval position data. It uses the best available data source: GPS when available, dead reckoning from the ship's gyrocompass and speed otherwise. On JR82, the script navexec0 was called to read 12 hours of data at a time, and append them to a master file called abnv821. The script first runs datapup, pcopya and pheadr to retrieve the data and set its header information. posspd calculates east and north velocities, after which papend is used to append the data to the master file. pdist calculates the distance run, after which pcopya is used to remove the RVS calculated distance variable. A second script navexec1 was then run to average and filter the navigation data. This takes a straight copy of the unsmoothed navigation and smooths and despikes it, putting the data in abnv821.av. This file (abnv821.av) was used to produce the cruise track plots during JR82.

CONDUCTIVITY-TEMPERATURE-DEPTH (CTD) PROFILING

At each station on the Scotia Sea transects the CTD was deployed to 2000 m, or full depth if shallower (-10 m from the seafloor in most cases), to profile the physical properties of the water column. At the deep CTD stations of the Western Core Box (WCB), the maximum depth of CTD deployment was 1000 m. Bottles were fired on all CTDs at standard depths (see Table CTD 1). In addition, a shallow CTD was deployed at each station to sample the water column at specific light levels as determined by Dr R. Korb and to collect water at 20 m for analysis by the biochemists on board. At recovery of the acoustic moorings from the WCB, the CTD was deployed to 200 m and water samples taken at 50 m intervals rather than the standard depths. Further shallow CTD casts were carried out to profile the water column before the acoustic calibrations performed at Signy and at Stromness. No bottles were fired on these casts. The positions of the CTD deployments can be found in the JR82 event log; details of the depth of each cast and the levels at which the bottles were fired are given in Table CTD 2.

CONFIGURATION AND PROCEDURE

The BAS SeaBird (SBE) 911plus CTD was used for station-based profiling of the water column on JR82. The BAS SBE 911plus system consists of dual temperature and conductivity sensors and a pressure transducer connected to an SBE 32 twelve-position carousel water sampler, with each position having a 10-litre Niskin bottle fitted. For JR82, an altimeter, a fluorometer, a photosynthetically active radiation (PAR) sensor and an oxygen sensor were also mounted to the system. In addition, the SBE35 deep ocean standards thermometer was fitted. Sensor serial numbers and calibration coefficients are given in the Appendix, while the configuration of the CTD sensors on JR82 (stored in file jr82ctd.CON) is listed in Table CTD 2. The CTD PC that logs the data is now networked (so data can be transferred to the central Unix system via Samba rather than having to ftp) and synched to the ship's clock. The Seasave module of the new Windows version of Seasoft was used to log the CTD data. Calibration data can be entered through the Configure menu on Seasave.

The CTD package was deployed from the mid-ships gantry and hauled/veered on the CTD/hydro winch. The BAS swivel was used to prevent rotation of the package and twisting of the cable. The general procedure was to power up the deck unit before deployment and commence logging, then lower the package to about 10 metres depth, where it was left to soak for 3 minutes (this procedure was not followed for casts to collect water from specific light levels conducted for Dr. R. Korb). The pumps are saltwater activated after 60 seconds using a conductivity switch, and so do not operate until the CTD is in the water. With the word display on the deck unit set to "E", the least significant digit on the display denotes pumps active (1) or pumps inactive (0). The soaking ensures the pumps are running when the cast starts and that the CTD system has had some time to adjust to the water temperature from the atmospheric temperature. After soaking the CTD was brought to the surface and then lowered to its given maximum depth (either 2000 m, 1000 m or about 10 metres above the seabed using the altimeter to judge the approach; see Table CTD 2 for details of the maximum depth of each JR82 CTD).

DISCRETE SALINITY SAMPLES

Discrete water sampling was conducted on the upcast of the CTD, with the exception of the stations conducted at Signy and Stromness for the calibration of the EK60 echosounder (Events 287 and 678) where no bottles were fired. The winch was stopped at each desired bottle level, and a 10-15 second interval left before firing the Niskin. After closing the bottle, a 24 second interval was left before continuing to the next bottle depth. These intervals are needed since the data from each side of the firing time are averaged to create the CTD data comparable to the bottle data. 24 seconds is required after the bottle closes for the SBE35 thermometer to capture data. If more than one bottle was fired at one level, 30 seconds was left between each bottle.

The primary purpose of discrete salinity sampling is to calibrate the salinity measurements made by the CTD sensors. Samples were drawn into 200 ml medicine flats, each having been rinsed thoroughly (3 times) prior to filling. The bottles were filled to about an inch below maximum, to allow expansion of the (cold) samples, and to allow effective mixing upon shaking of the samples prior to analysis. The rim of each bottle was wiped with a tissue to prevent salt crystals forming upon evaporation, and a plastic seal inserted into the bottle neck to prevent salinification through evaporative loss of sample. A bakelite cap was screwed down to keep the insert in place. The bottles and crates were numbered and colour coded for reference. Twelve samples were taken from all of the Scotia Sea transect casts and the deep WCB casts; this was reduced to nine for the shallower WCB casts and six for the mooring-associated casts. Stations conducted for discrete sampling at specific light levels had varying numbers of Niskins closed, but none were sampled for salinity analysis.

Once a crate of samples was full, the crate was moved into the *James Clark Ross*'s Bio Lab, where the BAS Guildline Autosal model 8400B serial number 65763 was sited for JR82. The samples were left for a minimum of 24 hours to allow their temperatures to equalise with the laboratory temperature (around 19.5°C). The samples were then analysed on the 8400B, with measurements being made using Ocean Scientific standards P141 (K15 = 0.99993, S = 34.997, date of preparation = 12-Jun-2002). One bottle of standard was used per twelve samples (once a misunderstanding had been cleared!). The 8400B cell temperature was set to 21°C for the duration of JR82. Once conductivity measurements had been made for each sample, they were manually entered into an Excel spreadsheet for conversion to salinity, with the resultant data being written out as ASCII and transferred (via Samba) to JRUF for subsequent processing in Pstar.

CTD DATA PROCESSING (SEASAVE)

BAS now use a new version of the Seabird software called Seasoft-Win32 which includes several stand-alone programs for subsequent data processing. CTD data files were named within the SBE Seasave software as 82ctdNNN.dat, where NNN was the event number of the station in question. The Seasave software also writes out files 82ctdNNN.HDR containing the information inputted by the user prior to the cast (e.g. Ship, cruise, station, position), 82ctdNNN.BL that logs the bottle sequence number, position, date, time and beginning and ending scan numbers for each bottle file, and file 82ctdNNN.CON, a configuration file for the cast. Once logging was terminated, the SBE35 data were downloaded with the SeaTerm software to a file named 82ctdNNN.cap and the time in the software reset before switching off the deck unit. The .dat file was then converted to an ASCII format file (82ctdNNN.cnv) using the Data Conversion tool in the SBE Data Processing software. The .cnv file contains the calibrated data. The Data Conversion tool also creates a file 82ctdNNN.ros (containing the data for each scan associated with a bottle using the file 82ctdNNN.BL).

The effect of the thermal mass of the conductivity cells was removed from the data using the Cell Thermal Mass tool in the SBE Data Processing software. The ASCII input file 82ctdNNN.cnv was converted to 82ctdNNN_ctm.cnv. The formula used and details are given in the software. Both conductivity sensor datastreams were corrected using values of 0.03 for the thermal anomaly amplitude (a) and 7 for the thermal anomaly time constant ($1/\beta$). The software states that in areas with steep temperature gradients the thermal mass correction is on the order of 0.005 PSU but is negligible in other areas.

CTD DATA PROCESSING (UNIX)

After correcting for cell thermal mass, all data pertaining to the CTD in question were transferred to the Unix system using Samba, where they were further processed using Unix scripts that called

Pstar routines. The execs we used on JR82 are mainly copied from the SOC execs used on JR81, in some instances modified with bits from the JR70 execs. ***The data have not been calibrated as yet***, this is to follow back in Cambridge. The execs and procedure followed this far are detailed next.

82seactd0: reads in the ASCII file to Pstar format using pascin. The start time is extracted from the ASCII file and will be the PC clock time. The header time was set to the start of the CTD cast, with the time variable being seconds thereafter (this modification was brought in on JR67 to avoid the extraordinarily large values for the time variable being generated previously). The water depth is extracted from the Simrad EA500 SCS file, and latitude and longitude from the SCS Trimble navigation file and inserted into the Pstar header. The output file is 82ctdNNN.raw.

82seactd1: applies shifts to the timings of the conductivity readings. These corrections are needed because the temperature and conductivity sensors are separated in space within the pumped system, and the seawater first passes the temperature sensor and then the conductivity sensor. The default time separation of the temperature and conductivity measurements is 0.073 seconds (1.75/24 seconds). The Deck Unit is set up to advance the primary conductivity by this amount but the secondary conductivity is not shifted in time. Whilst different sensor configurations may need different values for the time shifts, the temperature and conductivity sensors were configured the same on JR82 as on JR81, hence the JR81 derived values were adopted unaltered on JR82. Thus, the primary conductivity was advanced by 1 cycle (1/24 sec) and the secondary conductivity by –1 cycle (-1/24 sec). The time shifts were performed by using pcopya to copy time and the conductivity variable into another file, pcalib to adjust the time base and pmerg2 to combine the files again. This was done for each conductivity variable separately. The salinity and potential temperature were recalculated from the adjusted conductivities using peos83. The output file is 82ctdNNN.tsh.

82seactd2: extracts data from 82ctdNNN.raw corresponding to the bottle firing times taken from the ASCII file 82ctdNNN.BL. Data are extracted for 3 seconds before the bottle close start datacycle and 5 seconds after the bottle close end datacycle. The bottle closing time is about 1.5 seconds meaning that just less than 10 seconds of data are extracted. These 10 seconds of data are averaged within 82seactd1 using pbins to give a file containing a single datacycle for each bottle firing. These are appended using papend to give a Pstar file of CTD data corresponding to each bottle firing. As 12 datacycles were required, absent data were appended to the end of the file if fewer than 12 bottles were fired. The output file is 82ctdNNN.btl.

82seactd3: reads in the SBE35 digital thermometer data and merges with the CTD temperature sensor data. The ascii data from the *.cap file is read in with pascin, information on the bottle firings is extracted from the *.BL file and then the corresponding data from the *.tsh file are extracted using mlist and pascin. The CTD data are then averaged for each bottle using pbins and merged with the SBE35 data using pmerge. The difference between the SBE35 data and the two temperature sensors is calculated with parith and plotted using plotxy. Finally the differences are listed to the screen with plist. The merged CTD and SBE35 data, along with the calculated differences, are written out to 82ctdNNN.sbe35. I made a note on JR82 of the bottles with a temperature difference greater than 0.01ºC but have done nothing more with these data yet (see the calibration section later in the report).

82seactd4: identifies when the CTD was put in the water using the standard deviation of the salinity as a measure. Data for the period when the CTD was out of the water is excluded by considering the first 20 minutes and last 5 minutes of each cast: these periods of data were compressed (pbins) into 10 second bins, with the start (end) of good data being taken as the first (last) bin in which the standard deviation of conductivity is less than 0.5 mS cm^{-1}. These times were identified using datpik and conductivity and salinity data outside these times removed using peditc. The data are outputted to file 82ctdNNN.ed1.

82seactd5: further automatically edits the CTD data using noise levels of the data (these functions were combined with the seactd4 exec---forming 70seactd3---on JR70). The differences of salinity and potential temperature from their 1 second filtered values were calculated for both the primary and secondary sensors. pcopya was used to duplicate these four variables, pfiltr to apply a 25 point running mean and parith to take the difference of the instantaneous and filtered quantities. peditc was then used to remove conductivity and salinity values where the absolute difference from the filtered salinity value was greater than 0.01 and to remove temperature and potential temperature where the absolute difference from the filtered temperature value was greater than 0.05ºC. At this stage, an output file called 82ctdNNN.ed2 is created. A final step is to exclude any remaining negative pressures; a file of form 82ctdNNN.ed3 is then written. If needed, manual editing can then be performed on the 82ctdNNN.ed3 file using the large-buffer interactive editor plxyedlots. ***Casts requiring further editing were noted on JR82 but the editing has not been performed yet.***

Thus far, the scripts described have been used for processing the SBE CTD data. At this stage, comparison with the discrete salinity samples is needed. The processing of the salinity sample data within Unix, to bring it into a useable state, is conducted as follows:

A) At the start of the cruise, an ASCII file sam82.names was created. This contained 2 columns, specifically variable name and variable units. All variables required in subsequent processing were included. A blank Pstar sample file called sam82.blank was created from this using the script pblankexec. This contained 12 data cycles, corresponding to the 12 positions on the rosette.

B) After each cast, samblank.exec was run. This created an empty copy of sam82.blank called sam82NNN. Date, time, position and depth information is written into the header.

C) samfir was then run, to paste variables from CTD file 82ctdNNN.btl into sam82NNN.

D) importsalts.exec was then run, to convert the text file samp82NNN.txt (the ASCII file written out from the Excel spreadsheet) into a Pstar file sal82NNN.bot. The exec has been written to expect 12 lines in the text file so if not all 12 bottles were fired, extra lines need to be added to the file to make it up to 12. (Or else the script needs making a bit more sophisticated!)

E) passal was then run, to paste sample salinity data from file sal82NNN.bot into sam82NNN.

F) botcond was then run, to calculate sample conductivity from bottle salinity, CTD pressure and (primary) temperature. Bottle minus CTD conductivity was calculated for each sample and for both CTD conductivity sensors. These operations all pertain to file sam82NNN.

G) bottlecond.offset was then run. This uses mlist to create quick plots of conductivity offset (bottle minus CTD) versus conductivity for each of the primary and secondary conductivity sensors. Desired conductivity offset ranges are then requested (the typical maximum value used on JR82 was 0.01), and summary statistics for all the bottles with conductivity offsets within these ranges are calculated (no. of bottles, mean offset, standard deviation of offset). This provides a useful check on the bottle/CTD discrepancy of each station. It could also be used to derive a conductivity calibration on a station-by-station basis, if such a thing were desired (this was the procedure used on previous BSD cruises, although only the primary conductivity was then considered).

The bottle salinity data are now in a useable state (in the form of the file sam82NNN), and examination of the data alongside the CTD data is required. Two Unix scripts were written for investigating the performance of the CTD conductivity (also temperature) sensors. Both of these

consider solely the data below 500 m, and hence can only be applied to deeper casts. There are a number of reasons for this restriction, namely that (1) the sampling policy on BSD cruises strongly favours the upper part of the water column, since this is the region of most interest to colleagues involved in nutrient and chlorophyll analyses. In itself, this poses no problem, except (2) the region heavily sampled is also the region of the halocline, where vertical gradients in salinity are greatest. These strong gradients, combined with (3) the offset levels between the Niskins and CTD conductivity sensors and (4) the "wake effects" noted in both CTD and SBE35 data, lead to significantly more noise in the conductivity offset data in the upper part of the water column. Thus, for the most accurate possible assessment of the performance of the CTD conductivity sensors, we restrict our analysis here to the waters deeper than 500 m. The aim here is to understand the relative and absolute behaviour of the conductivity sensors for the duration of the cruise: once these are determined (using data from deeper than 500 m), corrections can be applied to all data irrespective of their depth. The Unix scripts used at this stage were:

1. offsets.ctd.below500: runs through a list of specified CTD stations (those containing data from deeper than 500 m), extracts the portions deeper than 500 m, then calculates the offsets between primary and secondary conductivity, primary and secondary temperature, and salinity derived from paired primary and secondary sensors. Although not useable to create a conductivity (or temperature) calibration in their own right, these numbers do provide information on the relative drift of the sensors, i.e. the performance of the primary sensors with respect to the secondary ones.

2. offsets.sam.below500: runs through a list of specified stations (those containing bottle firing depths deeper than 500 m), extracts the portions deeper than 500 m, and calculates the offsets between (a) bottle conductivity and CTD primary conductivity, and (b) bottle conductivity and CTD secondary conductivity. These data invariably seem noisier than the primary-minus-secondary CTD conductivity offsets – this is only to be expected, since they are based on far fewer data (a handful of bottles, as opposed to several hundred or thousand metres of high-resolution data), and also contain additional noise signals from the bottle measurements that will not be correlated with the noise in the CTD measurements and hence will not disappear upon subtraction.

These three data series (primary-minus-secondary CTD conductivity, bottle-minus-primary conductivity, and bottle-minus-secondary conductivity) provide the desired information on the behaviour of the CTD conductivity sensors throughout the duration of the cruise, and form the basis of the calibration. However, ***the JR82 CTD data have not been calibrated yet*** mainly because I am unsure of how to incorporate the SBE35 data. Details of the salinity calibration method are given in the JR70 cruise report but I need to talk to someone who knows how to do the temperature calibration. I've had a trial look at the two Matlab scripts used to fit polynomials to these series (fit_to_botoffset.m and fit_to_condoffset.m) but the data are going to need splitting into separate groups to properly analyse, as in JR70. This is another job for back in Cambridge.

SUMMARY

The SeaBird CTD has performed well over the cruise, although until the data are calibrated we cannot say just how well. We had the same trouble this cruise as we did on JR70 with altimeter spikes causing the pumps to cut out resulting in a loss of data. However, this happened on only a small fraction of the casts that we did. The 8400B salinometer performed well but by the end of the trip the tubing leading into and out of the peristaltic pump was very dirty. The pump was changed with a spare that came complete with new tubing.

CTD TABLES

TABLE CTD 1: STANDARD BOTTLE DEPTHS USED ON JR82 FOR SALINITY AND NUTRIENT SAMPLES

Water depth	Bottle... 1	2	3	4	5	6	7	8	9	10	11	12
~200 m	Bottom	175	150	125	100	80	60	50	40	30	20	10
~400 m	Bottom	300	250	200	150	125	100	80	60	40	20	10
~600 m	Bottom	500	400	200	150	125	100	80	60	40	20	10
~800 m	Bottom	600	400	200	150	125	100	80	60	40	20	10
~1000 m	Bottom	800	600	400	200	150	125	100	80	60	40	20
~1600 m	Bottom	1000	600	400	200	150	125	100	80	60	40	20
>1600 m	Bottom/2000	1500	1000	600	200	150	125	100	80	60	40	20

TABLE CTD 2: CTD WATER DEPTH

Event	Station	Date	Water depth (m)	Cast depth (m wire out)	Bottomcast press (dbar)	B1(m)	B2 (m)	B3 (m)	B4 (m)	B5 (m)	B6 (m)	B7 (m)	B8 (m)	B9 (m)	B10 (m)	B11 (m)	B12 (m)	Comments
3	Test	08.01.03	2517	200	202	200	175	150	125	100	80	60	50	40	30	20	10	
7	1.1	09.01.03	4124	2000	2033	2000	1500	1000	600	200	150	125	100	80	60	40	20	
9	1.1	09.01.03	4130	95	97	95	64	44	27	20	20	20	20	11	5	2	2	Beki's CTD
17	1.2	10.01.03	3816	2000	2034	2000	1500	1000	600	200	150	125	100	80	60	40	20	
19	1.2	10.01.03	3820	95	97	95	64	44	27	20	20	20	20	11	5	2	2	Beki's CTD
24	1.3	10.01.03	3538	2000	2025	2000	1500	1000	600	200	150	125	100	80	60	40	20	
26	1.3	10.01.03	3442	138	142	138	92	65	39	20	20	20	20	16	8	3	3	Beki's CTD
34	1.4	11.01.03	615	593	601	593	500	400	200	150	125	100	80	60	40	20	10	
37	1.4	11.01.03	636	20	20	20	20	20										Water collection
45	1.5	11.01.03	408	389	394	389	300	250	200	150	125	100	80	60	40	20	10	
48	1.5	11.01.03	406	98	99	98	65	46	28	20	20	20	20	12	6	3	3	Beki's CTD
50	2.2	12.01.03	1691	1650	1676	1650	1000	600	400	200	150	125	100	80	60	40	20	
53	2.2	12.01.03	1746	98	99	98	65	46	28	20	20	20	20	12	6	3	3	Beki's CTD
58	2.3	12.01.03	514	482	488	482	300	250	200	150	125	100	80	60	40	20	10	
61	2.3	12.01.03	511	116	118	116	77	54	33	20	20	20	20	14	7	3	3	Beki's CTD
70	2.4	12.01.03	683	655	662	655	500	400	200	150	125	100	80	60	40	20	10	
74	2.4	12.01.03	116	119	116	116	77	54	33	20	20	20	20	14	7	3	3	Beki's CTD
79	2.5	13.01.03	3097	2000	2036	2000	1500	1000	600	200	150	125	100	80	60	40	20	
83	2.5	13.01.03	3094	79	81	79	53	37	22	20	20	20	20	9	5	3	3	Beki's CTD
92	2.6	14.01.03	3311	2000	2040	2000	1500	1000	600	200	150	125	100	80	60	40	20	

96	2.6	14.01.03	3317	79	81	79	53	37	22	20	20	20	20	9	5	3	3	Beki's CTD
103	2.7	14.01.03	3236	2000	2035	2000	1500	1000	600	200	150	125	100	80	60	40	20	
107	2.7	14.01.03	3128	109	111	109	73	51	31	20	20	20	20	13	6	3	3	Beki's CTD
112	3.1	15.01.03	4211	2000	2032	2000	1500	1000	600	200	150	125	100	80	60	40	20	
116	3.1	15.01.03	4649	109	111	109	73	51	31	20	20	20	20	13	6	3	3	Beki's CTD
122	3.2	15.01.03	3657	2000	2006?	2000	1500	1000	600	200	150	125	100	80	60	40	20	
126	3.2	15.01.03	3962	142	145	142	95	66	40	20	20	20	20	20	17	8	3	Beki's CTD
134	3.3	16.01.03	3802	2000	2035	2000	1500	1000	600	200	150	125	100	80	60	40	20	
138	3.3	16.01.03	3804	142	142	142	95	66	40	20	20	20	20	20	17	8	3	Beki's CTD
145	3.4	16.01.03	3695	2000	2034	2000	1500	1000	600	200	150	125	100	80	60	40	20	
148	3.4	16.01.03	3714	72	76	72	48	33	20	20	20	20	20	8	5	3	3	Beki's CTD
154	3.5	17.01.03	1505	1454	1478	1454	1000	600	400	200	150	125	100	80	60	40	20	
158	3.5	17.01.03	1507	72	74	72	48	33	20	20	20	20	20	8	5	3	3	Beki's CTD
165	3.6	17.01.03	3071	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
169	3.6	17.01.03	3073	116	118	116	77	59	33	20	20	20	20	14	7	3	3	Beki's CTD
170	3.7	17.01.03	3152	2000	2033	2000	1500	1000	600	200	150	125	100	80	60	40	20	
174	3.7	18.01.03	3155	116	117	116	77	59	33	20	20	20	20	14	7	3	3	Beki's CTD
177	4.1	18.01.03	335	300	304	300	250	200	150	125	100	80	60	40	20	10	0	
181	4.1	18.01.03	336	82	83	82	55	38	24	20	20	20	20	10	5	0	0	Beki's CTD
187	4.2	18.01.03	326	307	311	307	300	250	200	150	125	100	80	60	40	20	10	
191	4.2	18.01.03	305	58	60	58	38	27	20	20	20	20	16	7	3	0	0	Beki's CTD
196	4.3	19.01.03	1946	1927	1945	1927	1500	1000	600	200	150	125	100	80	60	40	20	
200	4.3	19.01.03	1657	70	72	70	47	33	20	20	20	20	20	8	4	0	0	Beki's CTD
206	4.4	20.01.03	2163	2000	2035	2000	1500	1000	600	200	150	125	100	80	60	40	20	

210	4.4	20.01.03	2187	70	72	70	47	33	20	20	20	20	20	8	4	0	0	Beki's CTD
217	4.5	20.01.03	1965	1925	1959	1925	1500	1000	600	200	150	125	100	80	60	40	20	
221	4.5	20.01.03	1977	104	106	104	69	49	30	20	20	20	20	12	6	1	1	Beki's CTD
228	4.6	21.01.03	2783	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
232	4.6	21.01.03	2912	104	107	104	69	49	30	20	20	20	20	12	6	1	1	Beki's CTD
237	5.1	21.01.03	3905	2000	2029	2000	1500	1000	600	200	150	125	100	80	60	40	20	
240	5.1	21.01.03	3914	68	70	68	45	32	20	20	20	20	19	8	4	2	2	Beki's CTD
244	5.2	22.01.03	3567	2000	2033	2000	1500	1000	600	200	150	125	100	80	60	40	20	
248	5.2	22.01.03	3577	68	71	68	43	32	20	20	20	20	19	8	4	0	0	Beki's CTD
258	5.3	22.01.03	2858	2000	2035	2000	1500	1000	600	200	150	125	100	80	60	40	20	
262	5.3	22.01.03	2840	83	86	83	55	39	24	20	20	20	20	10	5	0	0	Beki's CTD
267	5.4	23.01.03	1278	1227	1247	1227	900	600	400	200	150	125	100	80	60	40	20	
271	5.4	23.01.03	1278	83	85	83	55	39	24	20	20	20	20	10	5	0	0	Beki's CTD
278	5.5	23.01.03	4789	2000	2038	2000	1500	1000	600	200	150	125	100	80	60	40	20	
282	5.5	23.01.03	4785	20	22	20	20	20	20									water collection
287	Signy	24.01.03	38	31	33	No bottles												EK60 calibration
293	5.6	26.01.03	331	300	305	300	250	200	150	125	100	80	60	40	30	20	10	
297	5.6	26.01.03	332	83	86	83	55	39	24	20	20	20	20	10	5	0	0	Beki's CTD
302	6.1	26.01.03	2691	2000	2036	2000	1500	1000	600	200	150	125	100	80	60	40	20	
306	6.1	26.01.03	2703	94	96	94	63	44	27	20	20	20	20	11	6	0	0	Beki's CTD
311	6.2	27.01.03	3865	2000	2038	2000	1500	1000	600	200	150	125	100	80	60	40	20	
315	6.2	27.01.03	3865	94	97	94	63	44	27	20	20	20	20	11	6	0	0	Beki's CTD
326	6.3	27.01.03	3055	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
330	6.3	27.01.03	3055	82	85	82	54	38	23	20	20	20	20	10	5	0	0	Beki's CTD

336	6.4	28.01.03	3464	2000	2038	2000	1500	1000	600	200	150	125	100	80	60	40	20	
340	6.4	28.01.03	3463	101	104	101	68	47	29	20	20	20	20	12	6	0	0	Beki's CTD
351	6.5	28.01.03	3732	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
355	6.5	29.01.03	3732	20	22	20	20	20	20									Water collection
359	6.6	29.01.03	3550	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
363	6.6	29.01.03	3548	44	46	44	29	20	20	20	20	20	13	5	3	0	0	Beki's CTD
374	6.7	30.01.03	3163	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
378	6.7	30.01.03	3165	44	48	44	29	20	20	20	20	20	13	5	3	0	0	Beki's CTD
381	6.7	30.01.03	3216			No bottles												CTD for light
382	6.7	30.01.03	3240	43	45	43	29	20	20	20	20	20	12	5	3	0	0	Beki's CTD
391	7.1	30.01.03	2666	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
395	7.1	30.01.03	2664	38	40	38	25	20	20	20	20	18	11	5	2	0	0	Beki's CTD
402	7.2	31.01.03	3000	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
406	7.2	31.01.03	2978	42	44	42	28	20	20	20	20	20	12	5	2	0	0	Beki's CTD
417	7.3	31.01.03	2768	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
421	7.3	31.01.03	2808	95	98	95	63	44	27	20	20	20	20	11	6	0	0	Beki's CTD
428	7.4	01.02.03	3057	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
432	7.4	01.02.03	3058	98	100	98	65	46	28	20	20	20	20	12	6	0	0	Beki's CTD
441	7.5	01.02.03	2967	2000	2036	2000	1500	1000	600	200	150	125	100	80	60	40	20	
445	7.5	02.02.03	2967	98	102	98	65	46	28	20	20	20	20	12	6	0	0	Beki's CTD
451	7.6	02.02.03	2873	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
455	7.6	02.02.03	2884	102	105	102	68	48	29	20	20	20	20	12	6	0	0	Beki's CTD
464	7.7	02.02.03	2900	2000	2038	2000	1500	1000	600	200	150	125	100	80	60	40	20	
468	7.7	03.02.03	2900	102	105	102	68	48	29	20	20	20	20	12	6	0	0	Beki's CTD

477	7.8	03.02.03	1230	1214	1233	1214	800	600	400	200	150	125	100	80	60	40	20	
481	7.8	03.02.03	1089	43	45	43	29	20	20	20	20	20	12	5	3	0	0	Beki's CTD
487	7.9	03.02.03	2946	2000	2040	2000	1500	1000	600	200	150	125	100	80	60	40	20	
491	7.9	04.02.03	2925	43	45	43	29	20	20	20	20	20	12	5	3	0	0	Beki's CTD
499	7.10'	04.02.03	3760	2000	2033	2000	1500	1000	600	200	150	125	100	80	60	40	20	
503	7.10'	04.02.03	3831	61	63	61	40	28	20	20	20	20	17	7	4	0	0	Beki's CTD
516	7.11	05.02.03	3514	2000	2039	2000	1500	1000	600	200	150	125	100	80	60	40	20	
520	7.11	05.02.03	3511	48	50	48	32	22	20	20	20	20	14	6	3	0	0	Beki's CTD
522	8.1	06.02.03	2527	2000	2036	2000	1500	1000	600	200	150	125	100	80	60	40	20	
526	8.1	06.02.03	2540	40	42	40	27	20	20	20	20	20	11	5	2	0	0	Beki's CTD
533	8.2	06.02.03	3060	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
537	8.2	06.02.03	3061	40	42	40	27	20	20	20	20	20	11	5	2	0	0	Beki's CTD
539	8.3	07.02.03	3388	2000	2038	2000	1500	1000	600	200	150	125	100	80	60	40	20	
543	8.3	07.02.03	3394	37	42	37	25	20	20	20	20	20	17	11	4	4	4	Beki's CTD
552	8.4	07.02.03	3137	2000	2037	2000	1500	1000	600	200	150	125	100	80	60	40	20	
556	8.4	08.02.03	3129	20	22	20	20	20	20									Water collection
562	8.5	08.02.03	3230	2000	2036	2000	1500	1000	600	200	150	125	100	80	60	40	20	
566	8.5	08.02.03	3367	68	70	68	45	32	20	20	20	20	20	8	4	0	0	Beki's CTD
573	8.6	09.02.03	3244	2000	2038	2000	1500	1000	600	200	150	125	100	80	60	40	20	
577	8.6	09.02.03	3245	68	71	68	45	32	20	20	20	20	20	8	4	0	0	Beki's CTD
582	8.7	09.02.03	2175	2000	2038	2000	1500	1000	600	200	150	125	100	80	60	40	20	
586	8.7	09.02.03	2175	42	44	42	28	20	20	20	20	20	12	5	2	0	0	Beki's CTD
596	Moornig	12.02.03	306	200	204	200	150	100	50	25	0							Shallow mooring
600	Mooring	12.02.03	1334	200	203	200	150	100	50	25	0							Deep mooring

611	W1.2S	13.02.03	294	272	276	272	175	150	125	100	80	60	50	40	30	20	10	
614	W1.2S	13.02.03	294	28	30	28	20	20	20	20	20	13	8	2	2	2	2	Beki's CTD
622	W1.2N	14.02.03	~1700	1000	1016	1000	800	600	400	200	150	125	100	80	60	40	20	
625	W1.2N	14.02.03	1454	28	32	28	20	20	20	20	20	13	8	2	2	2	2	Beki's CTD
630	W2.2N	14.02.03	3264	1000	1013	1000	800	600	400	200	150	125	100	80	60	40	20	
633	W2.2N	14.02.03	3512	39	41	39	26	20	20	20	20	18	11	5	2	0	0	Beki's CTD
640	W2.2S	15.02.03	214	195	199	195	175	150	125	100	80	60	50	40	30	20	10	
643	W2.2S	15.02.03	208	39	41	39	26	20	20	20	20	18	11	5	2	0	0	Beki's CTD
651	W3.2S	15.02.03	139	123	126	123	123	100	80	80	60	60	50	40	30	20	10	
654	W3.2S	15.02.03	139	34	37	34	23	20	20	20	20	16	10	4	2	0	0	Beki's CTD
661	W3.2N	16.02.03	1979	1000	1015	1000	800	600	400	200	150	125	100	80	60	40	20	
664	W3.2N	16.02.03	1980	34	36	34	23	20	20	20	20	16	10	4	2	0	0	Beki's CTD
678	Stromness	17.02.03	65	54	55	No bottles												EK60 calibration

TABLE CTD 3: DETAILS OF THE CTD CONFIGURATION ON JR82

No of frequency channels to suppress	0
No of voltage words to suppress	0
Computer interface	RS-232C
Scans to average	1
Frequency 0	Primary temperature
Frequency 1	Primary conductivity
Frequency 2	Pressure
Frequency 3	Secondary temperature
Frequency 4	Secondary conductivity
External voltage 0	Altimeter
External voltage 1	spare
External voltage 2	PAR/Irradiance
External voltage 3	spare
External voltage 4	"Fluorometer, Chelsea"
External voltage 5	spare
External voltage 6	"Oxygen, SBE 43"
External voltage 7	spare

APPENDIX: CALIBRATION COEFFICIENTS FOR THE CTD SENSORS USED ON JR82

TEMPERATURE, ITS-90 SCALE

Coefficient	Primary (03P2366)	Secondary (03P2191)
	19-Jul-02	19-Jul-02
g	4.31950826e-03	4.31967419e-03
h	6.43754128e-04	6.38837657e-04
i	2.32220252e-05	2.27990979e-05
j	2.19161783e-06	2.17976156e-06
f_0	1000.0	1000.0

CONDUCTIVITY

Coefficient	Primary (042289)	Secondary (041912)
	19-Jul-02	19-Jul-02
g	-1.04108582e+01	-4.16212062e+00
h	1.38996218e+00	5.36713913e-01
i	-3.42550982e-03	-7.86598365e-04
j	3.12641143e-04	6.80295512-05
CTcor(nominal)	3.25e-06	3.25e-06
Cpcor(nominal)	-9.57e-08	-9.57e-08

PRESSURE

Sensor model: Digiquartz 410K-105

Sensor serial number: 67241

Calibrated: 30-Jun-00

Digiquartz Coefficients

C1 = -4.461418e+04 [psia]

C2 = 3.038286e-02 [psia $^{\circ}C^{-1}$]

C3 = 1.224130e-02 [psia $^{\circ}C^{-2}$]

D1 = 3.645500e-02

D2 = 0.000000e+00

T1 = 2.999608e+01 [µs]

T2 = -3.512191e-04 [µs $^{\circ}C^{-1}$]

T3 = 3.729240e-06 [µs $^{\circ}C^{-2}$]

T4 = 4.918760e-09 [µs $^{\circ}C^{-3}$]

T5 = 0.000000e+00

Calibration correction: Slope = 0.99992 Offset = -0.8815

AD590M = 1.283280e-02

AD590B = -9.474491e+00

IRRADIANCE (PAR)

Serial number 7235

Calibrated: 18-Jun-01

M = 1

B = 0

Calibration constant, $C = 10^5/C_W$

where C_W = calibration constant from calibration sheet (wet calibration factor in μEinsteins/cm².sec; 1.88E-06 in the present case). Hence,

C = 5.3191489361e+10

Note that although the Biospherical calibration sheet gives the wet calibration factor in μEinsteins/cm².sec, SEASOFT scales this and outputs values in μEinsteins/m².sec.

FLUORESCENCE

Serial number 088216

Calibrated: 11-Jun-01

VB = 0.2607

V1 = 2.0350

Vacetone = 0.3263

Scale factor = 1.00

Slope factor = 1.00

Offset = 0.00

OXYGEN

Serial number 242

Calibrated: 27-08-02

Soc = 4.5920e-01

Boc = 0.0000

Voffset = -4.597e-01

Tcor = 1.00e-04

Pcor = 1.35e-04

Tau = 0.0

EXPENDABLE BATHYTHERMOGRAPHS (XBTS)

To supplement the CTD data collected on JR82 XBTs were dropped throughout the Scotia Sea transecting phase of JR82, nominally at the third and two-thirds point (20 and 40 nm) of each transect. They were also dropped on the way back from South Georgia to the Falklands at a 15 nm interval.

Sippican T5 (1830 m maximum depth) and T7 (760 m maximum depth) probes were used, bought from the UK Hydrographic Office. Since we had to pay for the probes this season, we assume that we do not have to send the data back to the HO. The XBT launcher was used unattached to the ship in handheld mode to allow us to choose the best side of the ship to deploy the probes from depending on the wind direction when the UOR was in the water. A total of 107 T5 probes and 4 T7 probes were launched during the Scotia Sea transecting phase of JR82, of which 19 of the T5 probes failed (18%) and one of the T7 probes gave bad data. A further 2 T5 probes did not respond when loaded into the launcher and therefore were not used. See the JR82 event log for deployment positions of the XBTs.

When not towing the UOR, the ship decreased its speed to 6 knots for deploying the T5 probes (T7 probes can be deployed up to 15 knots) otherwise we deployed the XBTs at the transect speed. The only detrimental factor of this was that the XBTs do not reach their full depth; at 10 knots most of the XBTs reached a depth of about 1400 m thereby losing a potential 300 m of data. Some early XBTs failed due to coming into contact with the UOR wire (typically at about a depth of 300 m); however we counteracted this by flicking the XBTs to the side of the ship from aft (with an optional ninja jump!) and pinching the wire lightly between our fingers to stop the wind blowing the XBT wire into that of the UOR. This was successful in almost all instances.

Data were logged by a networked PC running the Sippican WinMk12 software. The PC synchs its clock to the ship clock (GMT; although to start with the PC was set to a different time zone). Position data are acquired across the network so that the software logs accurate time and position of probe deployment. At the end of the XBT drop data were transferred to the Q drive and then to the central unix system (JRUF) for processing. Two Unix scripts were used to process the data:

1. xbtexec0 - This reads the data from ASCII into Pstar format, sets up header information, and extracts navigation and water depth from the RVS data streams appropriate for the time of the drop. Creates the file 82xbtNNN.raw, where NNN is the event number of the XBT drop in question.

2. xbtexec.edit - This runs a median despiking routine on the data, and launches the Pstar program plxyed, which enables interactive editing of the XBT profile. This was used to remove any remaining spurious spikes, and also remove the noise recorded after the probe had reached its terminal depth. The file 82xbtNNN.edt was created.

VESSEL-MOUNTED ACOUSTIC DOPPLER CURRENT PROFILER (VMADCP)

INSTRUMENT CONFIGURATION

The acoustic Doppler current profiler (ADCP) on the RRS *James Clark Ross* is used to collect data on absolute water velocity. It is an RD Instruments 153.6 kHz unit sited in a sea chest that is recessed within the hull to afford protection from sea ice. The fluid in the sea chest is a mixture of 90% deionised water and 10% ethylene glycol, and is closed to the sea by a 33 mm thick window of Low Density PolyEthylene (LDPE). The orientation of the transducer head is offset by approximately 45° to the fore-aft direction.

For JR82, as with cruise JR70, the VMADCP was configured to record data in 64 x 8 m bins, in ensembles of 2 minute duration. The 'blank beyond transmit' was set to 4 m such that the centre depth of the first bin was 14 m, given the approximate transducer depth of 6 m. The system uses 17.07 firmware and version 2.48 of RDI Data Acquisition Software (DAS). The two minute ensembles of data are passed via a printer buffer directly to the Level C. Data can be recovered from the PC PINGDATA files in the instance of any problems with the ship's Level C system.

The VMADCP was operated almost continuously on JR82, in two modes (the ADCP must be turned off when calibrating the EK60 acoustic echosounder). Data in bottom tracking mode were collected in shallow waters (shallower than approximately 500 m). Data in water track mode were collected where water depth was sufficient to preclude useful bottom tracking, typically in depths greater than 500 m. The command FH0004 was used to set the instrument to make one bottom track ping for every four water track pings.

DATA PROCESSING

VMADCP data were processed in 12 hour sections, specifically 0000 to 1159 hrs and 1200 to 2359 hrs of each day. On JR82 data were collected and processed over the time period 0000 08 January 2003 to 0000 22 February 2003 continuously, apart from times of EK60 calibration (2053 24 January—1220 25 January, and 1129 17 February—1201 18 February). Data from midnight 23 Feb till arrival at the Falklands shelf were logged but have not been processed yet because of the ITS backup. ***The data have not yet been calibrated***, this is to follow back in Cambridge. A sequence of Unix scripts calling Pstar routines were used for the data processing:

1. Read data into PSTAR 82adpexec0

Data were read from the RVS Level C system into Pstar creating two output files 82adp[jday][a/p] and 82bot[jday][a/p], containing water track and bottom track data respectively. When the ADCP was configured to record water track information the bottom track file contained engineering data.

2. Temperature correction 82adpexec0.1

The VMADCP DAS software assumes that the fluid surrounding the transducers is ambient seawater. A speed of sound is derived using the temperature measured at the transducer head and an assumed salinity of 35. A correction must be made to this to take into consideration the difference between the speed of sound in seawater and the mixture of 90% deionised water and 10% ethylene glycol.

The required modification was derived on JR55 by Meredith and King, and has been employed on subsequent cruises. Measurements of the variation in sound speed versus

temperature were obtained from RDI and used to derive an equation for the speed of sound through the mixture as a function of temperature,

$c = 1484 + 3.6095 \times T - 0.0352 \times T^2$, (1)

Where the individual velocity measurements were given to an accuracy of 0.01%, and the environmental conditions were known to within 35 kPa pressure and 0.5 C temperature.

This equation was used to derive a correction term to adjust the assumed speed of sound such that it was appropriate for the fluid mixture within the sea chest,

$(1484 + 3.6095\ T - 0.0352\ T^2) / (1449.2 + 4.6\ T - 0.055\ T^2 + 0.00029\ T^3)$. (2)

This correction term was applied to both the raw water and bottom tracked velocities measured on JR82.

On JR55, a residual dependence of A on temperature was also found, due probably to the speed of sound in the fluid in the sea chest not being perfectly known. Following estimates using bottom track data on JR55 a residual correction of

$1 - 0.00152\ T$ (3)

Was also applied.

The output files created were 82adp[jday][a/p].t and 82bot[jday][a/p].t.

3. Clock Correction 82adpexec1

The VMADCP data stream was time stamped by the 286 PC clock running the DAS software. The PC clock drifts from the ship's master clock at an approximate rate of one second per hour. This results in there being a timing error associated with the raw data. The time difference was measured at approximately 4 hour intervals, and a correction applied to the data. This created the files 82adp[jday][a/p].corr, 82bot[jday][a/p].corr and clock[jday][a/p].

4. Gyrocompass error correction 82adpexec2

The VMADCP measures the water velocity relative to the ship. To calculate true east and north water velocities over ground, we need to include information on the ship's heading and speed. The ship's gyrocompass provides near-continuous measurements of heading, however it can oscillate for several minutes after a manoeuvre, due to an inherent error. The gyro heading can be corrected using data from the Ashtech ADU-2. However, the Ashtech system does not provide continuous data, and hence a correction can only be applied on an ensemble by ensemble basis. The two-minute averaged Ashtech-minus-gyro heading correction ("a-ghdg") was manually despiked and interpolated. The required correction was then applied to the data creating the output files 82adp[jday][a/p].true and 82bot[jday][a/p].true.

5. Calibration 82adpexec3

Two further corrections are applied to the VMADCP data:-

A an inherent scaling factor associated with the VMADCP velocities

- ϕ a compensation for the misalignment of the Ashtech antenna array relative to the VMADCP transducers.

During routine (pre-calibration) processing, bottom tracked velocities were adjusted using a nominal scaling of A=1 (scaling factor) and □□ = 0 (misalignment angle) (a dummy calibration). True values of A and □ still need to be calculated to calibrate the data (details of the method to use are given in the JR70 cruise report).

6. **Derivation of absolute velocities 82adpexec4**

Ship's velocities between ensembles were derived by merging in position information from the RVS navigation data. The absolute water velocities were then derived by removing the ship's velocities from the VMADCP data. These final velocities were output to the files 82adp[jday][a/p].abs and 82bot[jday][a/p].abs. These dummy absolute velocity files are needed in the calibration process but will eventually be rewritten with the calibrated data.

SUMMARY

The VMADCP performed well for the duration of the cruise. It occasionally lost communication and restarted itself—when this happens it is worth checking the configuration file that the system is running from as it doesn't always restart with the same one it was using when it crashed. No instances of data loss associated with switching from bottom-tracking to water-tracking mode and vice versa as recorded on JR70 occurred on JR82.

The ADCP clock still drifts substantially. ITS have suggested a way to synch the PC with the ship's clock now that the ADCP PC is networked. I had discussions with Brian King and Mike Meredith about this and its validity (see separate document of the emails). Brian says that the time drift has been fixed on Discovery and knows the method to do it, however it has not been implemented on this cruise as I don't fully understand it all so have left it for someone who does!

ADCP CLOCK CORRECTION EMAILS….

While on JR82, we started a discussion about whether we could fix the clock drift in the ADCP software. This is as far as we got:

>>> Sally Thorpe <seth@south.nerc-bas.ac.uk> 01/13/03 04:02am >>>

Dear Mikey and Brian,

hello from the foggy and icebergy south! I have a quick question about the ADCP. Our computer technician says that now that the ADCP PC is networked onboard the JCR, he can get the software to use the ship's time so that we do not need to do the clock corrections. Is this worth doing? If so, are you happy for me to ask it to be done on this trip and then sort out the execs accordingly? What do you think? I thought I would pass the decision-making northwards!

Thanks!

Sally

Subject: Re: Official: ADCP clock

Date: Mon, 13 Jan 2003 09:45:07 +0000

From: "Michael Meredith" <mmm@pol.ac.uk>

To: <mmm@pol.ac.uk>, <BAK@soc.soton.ac.uk>, <seth@south.nerc-bas.ac.uk>

Hello Sal (and Brian)

Brian - in case you are wondering what this is about - the 286 ADCP PC on the JCR has been replaced with a Pentium. Still runs DAS, but is networked, and now connects to ADCP box through serial port (therefore .cnf files are a tad different - I gave copies of the new ones to Sheldon). The disk is partitioned into small chunks (D: and G:, G: is networked) to fool the software into thinking it can write to them. Performance of the ADCP seemed as good as ever on JR81, however good that is.

Re taking a clock feed from the network... we tried this on the last cruise (JR81) - or rather Jim Fox did - but it didnt seem to work quite right. Basically the PC clock was synched to network (GPS time) everytime the PC was booted, but it drifted thereafter. Surprisingly (for a Pentium) the drift was comparable to that of the old 286, which made us think it might be a software thing rather than a hardware thing. What it needs is a DOS program to sit in the background and continuously (or, rather, repetitively) take a feed from the network - Im guessing this is the sort of program your ITS guy has? Would be worth a go, certainly, but ....

1. Please make sure it is removable, i.e. if it goes wrong we can go back to the old way of doing it!

2. if it works, please log the times as per usual anyway for now, in case it hiccups orresets at funny intervals. That way we can at least keep track of how well the synch program works, and can make a decision downstream about whether we believe the times or not.

3. if you are logging the times as per usual, the execs wont need changing just yet. I guess this will only need doing if the synch program works so well that the times are deemed

perfect, in which case XXadpexec1 will become defunct. That is something to worry about once we have seen how the clock program performs.

Okay, hope this helps a wee bit, and that things are ticketyboo down there!

Cheers

mmm

Subject: Re: Official: ADCP clock

Date: Wed, 15 Jan 2003 09:25:30 +0000 (GMT)

From: Brian King <bak@soc.soton.ac.uk>

To: mmm@pol.ac.uk, bak@soc.soton.ac.uk, seth@south.nerc-bas.ac.uk

Sally,

ADCP clock:

When I was on Charles Darwin in March, they had the ADCP interfaced to accurate time signal. This is highly desirable ! I suggest you get it implemented if you can.

On that cruise, I didn't mess about with the execs. Since I wasn't sure that I would always be on ships with accurate clock, I didn't want to remove the clock correction part of the loop.

Therefore I left things as they were, but the time correction was always simply zero.

But at least it was always accurate and didn't need to be recorded. But that didn't stop me checking from time to time that the clock was indeed accurate ! Suspicious, me, and you never knew when the ADCP might lost synch ! (At least until we've run in that mode long enough to have confidence. Actually, the thing ran perfectly for the whole of that cruise.)

Regards

Brian.

Subject: Re: Official: ADCP clock

Date: Wed, 15 Jan 2003 09:33:15 +0000 (GMT)

From: Brian King <bak@soc.soton.ac.uk>

To: mmm@pol.ac.uk, BAK@soc.soton.ac.uk, seth@south.nerc-bas.ac.uk

Ah,

Now I've got further down email, and seen Mike's.

It will be an issue of configuration!

The time signal doesn't automatically keep the time correct in the ADCP data.

What happens is that time is made available on a serial port.

An extra bit of code is needed, a 'user exit' program in RDI's DAS speak.

The DAS needs to be configured to run this user-exit program at specified intervals. eg once per (2-minute) enemble. The user exit program, checks the clock against external time and adjusts if necessary.

If you don't have the UE code present on disk and enabled in DAS, the clock will drift exactly as before.

Now without DAS in front of me, I couldn't tell you exactly how to configure DAS.

But the program will be called something like ue4.exe (version 4 of the userexit code) and the DAS screen will be one of the screens near the end of the options.

John Wynar here at SOC set it up on Darwin 139 for us.

Let me know how you get on.

Brian.

Subject: Re: Official: ADCP clock

Date: Wed, 15 Jan 2003 10:39:51 +0000

From: "Michael Meredith" <mmm@pol.ac.uk>

To: <mmm.POL.NERC@pol.ac.uk>, <bak@soc.soton.ac.uk>, <seth@south.nerc-bas.ac.uk>

Aha! That sounds like the extra bit of info that we were lacking on JR81.... so Sal, if you could get the ITS/ETS chaps to have a go at configuring the ADCP along the lines that bak suggests, that would be great. I may tinker some more myself in April at the start of ShagEx, which is almost guaranteed to break the thing.

mmm

Subject: NTP client

Date: Fri, 17 Jan 2003 02:25:06 +0000

From: "Pete Lens" <pcdl@pcmail.jcross>

To: "Sally Thorpe" <seth@pcmail.jcross>

CC: <helpdesk@bas.ac.uk>

Hi Sally,

What I propose is this:

The JCR has an NTP server. This is an Intel computer that takes an input of the trimble GPS serial data and sends out time synchronization information using TCPIP on the ships LAN. Any computer running the NTP client, be it Sun, Intel, Solaris, Windows or Linux can receive NTP time synchronization packets which corrects the local hardware clock.

All we have to do is find a DOS NTP client because the ADCP software is now running on a PC connected to the network (since the hardware upgrade). The NTP client will constantly (once every few seconds) adjust the hardware clock.

I will contact Cambridge to see if they can send me a DOS NTP client. (Hi guys, search for K9 or Tardis first, then anything else)

Cheers, Pete

For details on it look at http://www.eecis.udel.edu/~ntp/ on the World Wide Web.

Q. What is broadcast NTP?

A. NTP includes an option to broadcast a time signal that other computers on the same LAN can listen for.

Subject: Re: Official: ADCP clock continued

Date: Sat, 18 Jan 2003 19:16:41 +0000

From: "Michael Meredith" <mmm@pol.ac.uk>

To: <seth@south.nerc-bas.ac.uk>

CC: <bak@soc.soton.ac.uk>

Hi Sal

Sounds like that NTP time fix is a good idea... so if Pete can implement it, then go for it. However, I suspect that the DAS will need to be configured along the lines Brian described in his previous email as well- on JR81 the drift with the Pentium was as bad as ever, and Pentiums have much better clocks than 286s! So the reconfiguration will probably be needed to make the software actually read the time properly (at which point the GPS-synched time will be really useful).

Let me know how it goes

Mike

Subject: Re: Official: ADCP clock continued

Date: Fri, 24 Jan 2003 10:34:54 +0000 (GMT)

From: Brian King <bak@soc.soton.ac.uk>

To: seth@south.nerc-bas.ac.uk, mmm@pol.ac.uk

CC: bak@soc.soton.ac.uk

Back in action:

I'm not sure the proposal from Pete Lens will work. My understanding from a few years back was there are two issues: a hardware clock, and a DOS software clock. Back in the old days, I looked at this a bit. On one PC I tried, the hardware clock was actually quite good. But the DOS clock, which is what ADCP DAS sees, drifted much worse, especially when under heavy computational load. So keeping the hardware real-time clock honest isn't the solution.

In any case, there needs to be a means of forcing the DAS, which is a DOS program, to check the clocks and update the DOS clock if needed. Otherwise, the operating system just runs DAS and doesn't do anything else. Unless your NTP tool manages to run in the background, even while DAS is running, and keep all the times synchronised, incluidng the DOS clock.

My advice, since kind international colleagues have handed a solution to us on a plate, would be to implement the known solution, which I believe requires feeding an NMEA message to a serial port, rather than inventing a new one.

Regards to all

Brian.

Subject: PERSONAL

Date: Mon, 27 Jan 2003 15:40:07 +0000

From: "Michael Meredith" <mmm@pol.ac.uk>

To: <seth@south.nerc-bas.ac.uk>

Hey Sal!

What did you decide to do re the ADCP clock in the end? Did Pete's program make any improvement? Or Brian's user exit thingy? If you didn't get chance to play with it, no worries - we can get Brian to give us step-by-step instructions, and I'll have a go on ShagEx.

Mmm

OCEANLOGGER (UNDERWAY MEASUREMENTS)

Throughout JR82, underway measurements were made with the ship's oceanlogger. The oceanlogger system is comprised of a thermosalinograph and fluorometer connected to the ship's non-toxic pumped seawater supply, plus meteorological sensors measuring air pressure, air temperature, humidity, total incident radiation (TIR) and photosynthetically available radiation (PAR). Data are time-stamped using the ship's master clock. Data were logged and processed for the period 120000 07 January to 235959 22 February 2003 (with exception of the data over the period 1200 10 Feb to 1200 11 Feb that were not processed because we were tied up at KEP). Data from midnight 23 Feb until arrival at the Falklands shelf were logged but have not been processed yet because of the ITS backup.

DATA PROCESSING

Oceanlogger data were processed in 12 hour segments throughout the course of JR82. Three Unix scripts calling PSTAR software routines were used for this processing:

1. 82oclexec0: Reads the oceanlogger data streams into a PSTAR format and merges in relative wind speed and direction from the anemometer data stream. Output files are 82ocl[jday][a/p].raw and ocl821. The former of these is the 12-hour data segment for morning (a) or afternoon (p) of Julian day jday. The latter is the master file to which successive 12-hour sections are appended.

2. 82oclexec1: Divides the data into ocean data and meteorological data files, writing meteorological data to a separate file. Output file is 82met[jday][a/p].raw (containing the meteorological data).

3. twvelexec: Merges the met data file with gyrocompass and navigation data streams in order to calculate ship motion and true wind velocity. Output file is 82met[jday][a/p].true.

These execs were modified on JR81 to take command line arguments (year, jday and am or pm) which speeds up the processing time. In addition to these standard execs, we ran an additional one on JR82, 82whaleexec0, that extracted various parameters from the oceanlogger and met files and binned them into 5 minute intervals for our whale observers. Output files were named 82uwayNNN.txt.

SALINITY CALIBRATION

During JR82, discrete salinity samples were taken from the ship's non-toxic supply at approximately 4 hour intervals (a total of 162 samples). These were drawn into a 200 ml sample bottle that had been thoroughly rinsed, with the neck of the bottle dried and an air tight seal inserted after sample collection. Samples were left to acclimatise in the ship's Bio laboratory (where the salinometer was sited) for at least 24 hrs prior to analysis. Measurement procedure was identical to that followed for the CTD salinity samples. ***The resulting data will be used for calibration of the thermosalinograph conductivity although this remains to be completed back in Cambridge.*** See the JR57 and JR70 cruise reports for details on the calibration procedure.

PROBLEMS

There were no real problems with the oceanlogger on JR82. Hourly checking of the flow rate meant that times of low flow were quickly picked up and sorted out.

SIMRAD EA500 BATHYMETRIC ECHO SOUNDER

The RRS *James Clark Ross* is equipped with a Simrad EA500 echo sounder, which was run virtually continuously to record ocean depth during cruise JR82 (it was turned off for the two EK60 calibrations on 24 January 2003 and 17 February 2003). The EA500 transducer is mounted on the hull just to starboard, with the primary visual display and controls located on the bridge.

DATA PROCESSING

EA500 data were logged by the SCS into the simulated level C data stream SIM500 and retrieved into twice-daily Pstar files using the script jr82_sim (copied from jr70_sim). This ran the Pstar routine datapup, taking the jday and am or pm as the requisite inputs. This data stream features uncorrected depth, i.e. it produces bottom depth calculated assuming a mean vertical sound velocity of 1500 m s^{-1}. The unix script jr82_sim ran pedita on the uncorrected depths, since the EA500 data often features spurious zeroes; these were replaced with absent data markers. Since the data are often very spiky, pmdian was run from within jr82_sim, whereby each successive value was replaced with the median of a moving window of five adjacent data cycles. Navigation data were merged in from the RVS Bestnav stream. Corrected depths were calculated using pcarter, which feeds the ship's position into a set of reference tables to correct for the assumption that vertical sound velocity averages to 1500 m s^{-1}. The output files created by jr82_sim were 82sim[jday][a/p].raw (containing the raw data from the SCS), 82sim[jday][a/p] (containing the cleaned data), 82sim[jday][a/p].mrg (the cleaned data plus merged navigation), and 82sim[jday][a/p].corr (the above data corrected using a more representative speed of sound).

Following jr82_sim, plxyed was run on the data, so as to enable manual despiking to be performed to remove any remaining obvious spurious data. This routine marks any data cycles identified as missing; to create continuous data, pintrp was run to linearly interpolate across the gaps. Final cleaned data were stored in files named as 82sim[jday][a/p].corr.dspk. These despiked files were appended to a master file, 82sim. All data for the period 120000 07 January—235959 22 February 2003 were processed, except for the 24 hour period covering 1200 10 February—1200 11 February when we were tied up at KEP. Data from midnight 23 Feb till arrival at the Falklands shelf were logged but have not been processed yet because of the ITS backup.

PROBLEMS

The problem reported on JR70 of the EA500 locking onto a depth range outside the true depth was less common on JR82. I noticed it only twice, one of which times was when the instrument was set in passive mode by the bridge and lost the bottom as we came off the shelf. Fortunately, it did not cause problems with the CTD as it did on JR70.

ARGO FLOATS

Seven Argo profiling floats were deployed for the Met. Office on the Scotia Sea transects as part of the UK contribution to the Argo programme (see JR82 event log for deployment positions). Full deployment instructions, reactivation magnets and a transmission detector were supplied with the floats. The floats were activated 40—60 minutes prior to deployment, sensor caps removed, transmission checked and inflation of the bladder verified (by removing an awkward black plug from the base of the float, then replacing the plug). The floats were then deployed, by lowering on a rope over the aft end of the ship, within the 40—60 minute time window while making slight headway. Real-time data from the floats are available from http://www.metoffice.gov.uk/research/ocean/argo/ukfloats.html or (with full-depth salinity resolution) via ftp from ftp://ftp.pol.ac.uk/pub/bodc/argo/floats/.

NEAR-SURFACE DRIFTERS

22 holey sock drifters were deployed on JR82 on transects 6 and 7. The drifters were deployed in pairs, with one drifter drogued at 20 m and the other drogued at 100 m (the deeper drifters were originally drogued at 50 m but the depth was increased by splicing in extra rope by Doug). Deployment positions and depths of the drifters can be found in Table drif 1. The drifters were activated before deployment and transmission checked using the device supplied with the Argo floats. All packaging was removed (although the wood and cardboard can be left on if desired) and the buoy lowered into the water from the aft deck. With the ship making slight headway, the wire (and rope for the deeper drifters) was paid out and finally the drifter thrown overboard.

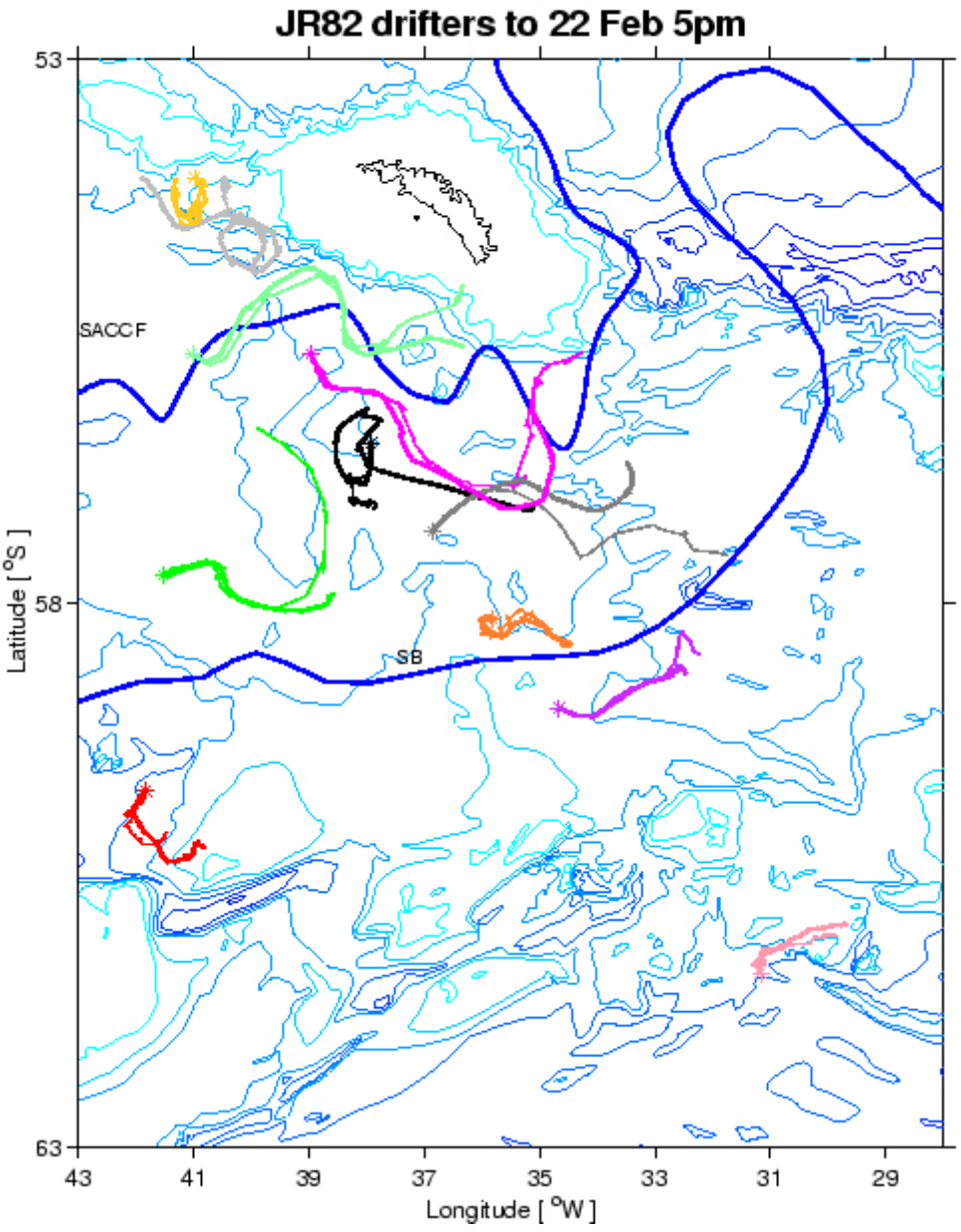
The drifters are tracked solely by the Argos satellite communication system (rather than onboard GPS and Argos triangulation as on JR70). Positions are reported up to 12 times daily and were outputted to an ascii file and forwarded down to the ship during the cruise via Andy Wood's pre-processing drifter program. No data processing was carried out on the cruise apart from removing duplicate values. As of 18 Feb '03, all 22 drifters were still being tracked (see figure 1).

TABLE DRIFTERS 1: DRIFTERS DEPLOYED IN THE SCOTIA SEA

Event Number	Argos Ptt	Depth	JDAY	Date	Time	Latitude	Longitude	Location
320	37644	20m	027	27-Jan-03	12:01	-59.7346	-41.8393	Station 6.2
321	37655	100m	027	27-Jan-03	12:03	-59.7348	-41.8366	Station 6.2
343	37643	20m	028	28-Jan-03	14:04	-57.7477	-41.5245	Station 6.4
344	37654	100m	028	28-Jan-03	14:06	-57.7475	-41.5223	Station 6.4
366	37647	20m	029	29-Jan-03	16:26	-55.7173	-41.0185	Station 6.6
367	37658	100m	029	29-Jan-03	16:29	-55.7187	-41.0220	Station 6.6
397	37648	20m	030	30-Jan-03	23:05	-54.0956	-40.9761	Station 7.1
398	37661	100m	030	30-Jan-03	23:09	-54.0943	-40.9738	Station 7.1
407	37649	20m	031	31-Jan-03	11:29	-54.9055	-39.9815	Station 7.2
408	37659	100m	031	31-Jan-03	11:30	-54.9048	-39.9805	Station 7.2
422	37650	20m	031	31-Jan-03	22:43	-55.7208	-38.9582	Station 7.3
423	37660	100m	031	31-Jan-03	22:45	-55.7198	-38.9576	Station 7.3
433	37646	20m	032	01-Feb-03	12:11	-56.5354	-37.9282	Station 7.4
434	37656	100m	032	01-Feb-03	12:13	-56.5344	-37.9264	Station 7.4
446	37645	20m	033	02-Feb-03	03:03	-57.3479	-36.8660	Station 7.5
447	37657	100m	033	02-Feb-03	03:06	-57.3458	-36.8643	Station 7.5
456	37651	20m	033	02-Feb-03	15:44	-58.1543	-35.8012	Station 7.6
457	37662	100m	033	02-Feb-03	15:47	-58.1545	-35.7997	Station 7.6
470	37652	20m	034	03-Feb-03	03:02	-58.9692	-34.6603	Station 7.7
471	37663	100m	034	03-Feb-03	03:04	-58.9679	-34.6587	Station 7.7
506	37653	20m	035	04-Feb-03	18:48	-61.3190	-31.3028	Station 7.10
507	37664	100m	035	04-Feb-03	18:50	-61.3201	-31.3009	Station 7.10

DRIFTERS FIGURE 1: DRIFTER TRACKS

PF



MOORINGS TO INVESTIGATE INTRA-ANNUAL VARIABILITY IN KRILL ABUNDANCE AND WATER-MASS PHYSICAL CHARACTERISTICS OF SOUTH GEORGIA

INTRODUCTION

Antarctic krill (*Euphausia superba*) is of vital importance to the South Georgia marine ecosystem. It provides food for a high proportion of Antarctic wildlife, and is eaten by most animals (seals, whales, birds, fish, squid, penguins). It is the key link in the Antarctic food web. Krill abundance has a major influence into higher and lower trophic levels and knowledge about factors controlling krill abundance is therefore vital to understand the South Georgia ecosystem.

The Island of South Georgia is important in the Southern Ocean because many creatures breed on it (seals, birds, penguins) or live near by in the shallow seas (fish and squid). The krill biomass has a direct effect on all other animals in the ecosystem.

To measure krill biomass acoustic surveys have been done by BAS scientists at least once a year for the last 6 years. But these krill acoustic surveys provide only a snap-shot measurement each year of the biomass of krill. It was discovered that krill abundance changes from year to year presumably mainly driven by population dynamics.

But what is happening to the krill biomass for the rest of the year? So far we have only very limited data on the scale of within-year variability. We do not know to what extend the observed year to year variability actually is inter-annual, or whether any of the apparent variability is simply an artefact resulting from our discrete, widely-spaced sampling of a system with high-frequency, short-term variability.

Krill abundance at South Georgia is probably influenced most strongly by immigration. On an inter-annual scale we have shown that krill abundance at South Georgia varies in phase with variation at the Antarctic Peninsula, one region that is thought to be a possible source for krill at South Georgia. Whatever their origin, krill must be transported to South Georgia by ocean currents, and it has been suggested that the Southern Antarctic Circumpolar Current Front (SACCF) is key to the transport process. This seasonal variability renders it unlikely that the single snap-shot appraisals of the pelagic environment obtained from short research vessel studies reveal the full picture of variability at the island.

AIM

The aim of the project is to:

1. Quantify the magnitude and timing of short-term, ecologically-significant, intra-annual variability in krill abundance at South Georgia;

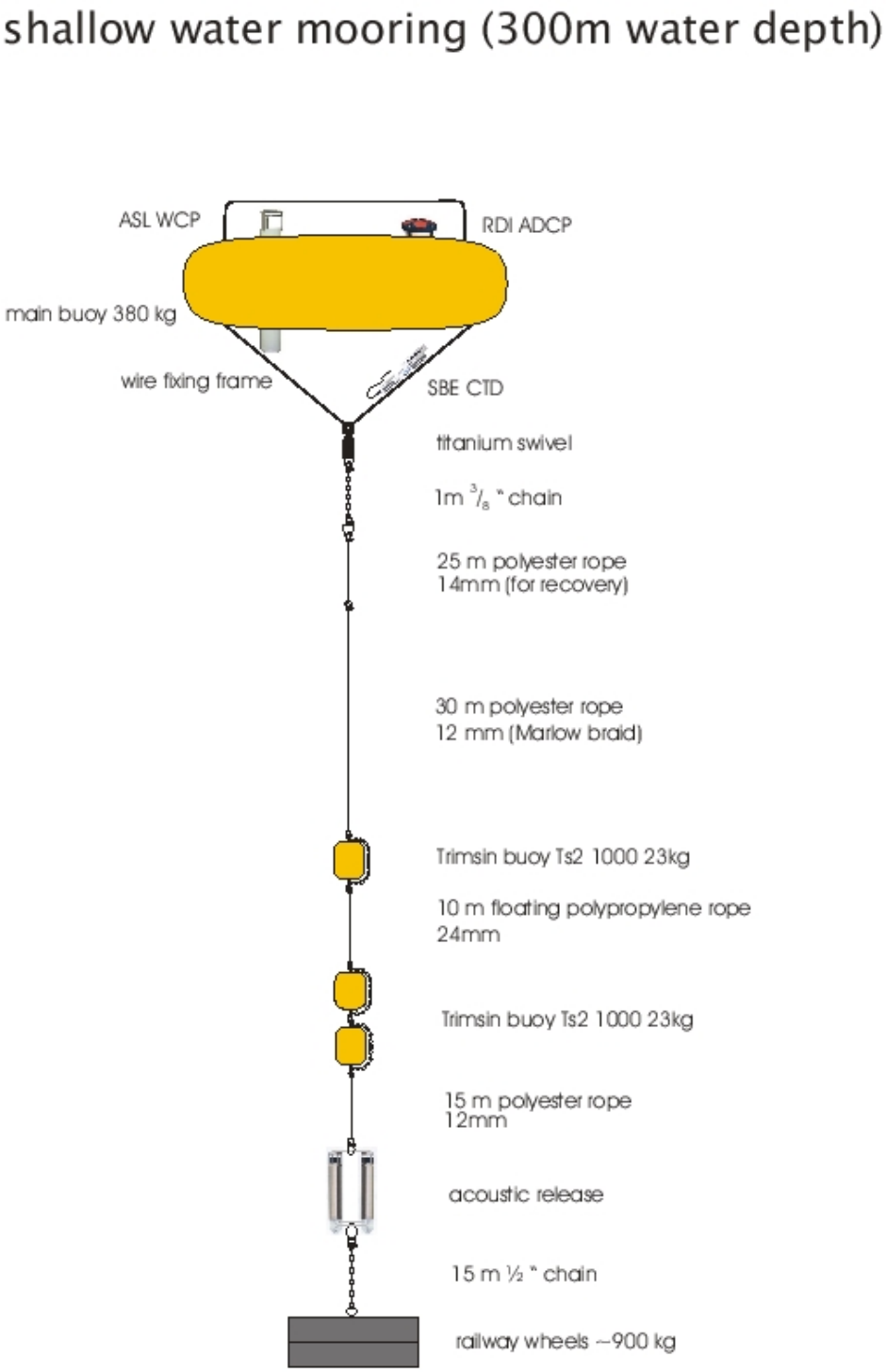
2. Describe the effect of oceanic tides at the two locations;

3. Test the hypothesis that krill immigration to, and hence abundance at, South Georgia is mediated by influx of cold waters; and

4. Determine functional responses of predators to short term variations in prey (krill) abundance.

METHOD/SYSTEM SPECIFICATION

Each mooring consists of a bottom weight of railway-wheels, followed by a few meters of chain, two acoustic releases, three subsurface buoys (to bring the releases back to the surface), the required length of rope for the specific water depth, a swivel which allows the buoy to rotate in the water and finally the big buoy with the instruments (see pic 1).



To minimise iceberg impacts the buoys are 200 m below the surface with the instruments looking up at the water above. These moorings are unique and are the first in the South Georgia area.

Each mooring has 3 monitoring systems on-board:

1. Water Column Profiler,
2. Acoustic Doppler Current Profiler
3. CTD (Conductivity/Temperature/Depth recorder)

Water Column Profiler – used to estimate the krill biomass using sound waves of 120kHz.

Acoustic Doppler Current Profiler - measures speed and direction of the water currents at different levels of the water column as well as recording the backscatter from zooplankton, (it uses sound waves of 300kHz)

Conductivity/Temperature/Depth (CTD) - It measures the conductivity of the water (equals salinity), temperature and depth of the buoy in the water.

MOORING RECOVERY AND REDEPLOYMENT

The moorings were first deployed on the 14th October 2002. The shallow water mooring was deployed in 300 m water depth, the deep water mooring in 1300 m water depth near South Georgia. Both buoys with the instruments are sitting at 200 m below the surface.

The first recovery took place at the 12th of February. We had some problems recovering the moorings, principally because the secondary buoyancy, although adequate in theory proved to be far from adequate in practice. The principal task of this is to bring the release gears up and to provide a grappling point for recovery. Recovery was achieved through some magnificent ship handling and really 'salty' deck work under far from ideal conditions. The shallow mooring was recovered by grappling from the starboard side, followed by lifting first the secondary buoyancy and release gears through the stern gantry followed by the main buoy. The deep mooring was recovered after "catching" it with a lasso from the starboard 'Effer' crane. Then the main buoy was recovered first, then the top 700m of rope was recovered onto the starboard mooring winch. The secondary buoyancy was disconnected and the final 300m of rope with the releases at the end hauled in, again onto the mooring winch.

The unknown position of the bight of rope between the secondary and main floatation hampered the recovery. The problem was made worse by the inadequacy of the secondary buoyancy.

Due to the failure of the shallow water WCP (see below) and the problems during recovery, redeployment was delayed for several days. We were able to borrow some additional floats which had to be collected from King Edward Point. One extra float was attached to the shallow water mooring, and two extra to the deep water one. Also the secondary buoyancy was moved closer to the main buoy to make recovery easier. Now they are only 25 m below the main buoy. On the planned day of redeployment the weather conditions were to bad (force 10) and after a long day of waiting the shallow water mooring was finally redeployed under far from optimal conditions (force 6) in the evening of the 19th of February. Deployment took place over the stern of the ship. The main buoy was deployed first followed by the secondary buoyancy, these are streamed out in the water astern of the ship and the railway wheels are hung over the stern secured by

sacrificial rope. The ship steams slowly toward the mooring position and the rope is cut with an axe when the position is reached.

The deep-water mooring could not be redeployed because a mega ice-berg was sitting on the position.

PRELIMINARY RESULTS

OVERALL PERFORMANCE OF THE MOORINGS AND THE INSTRUMENTS:

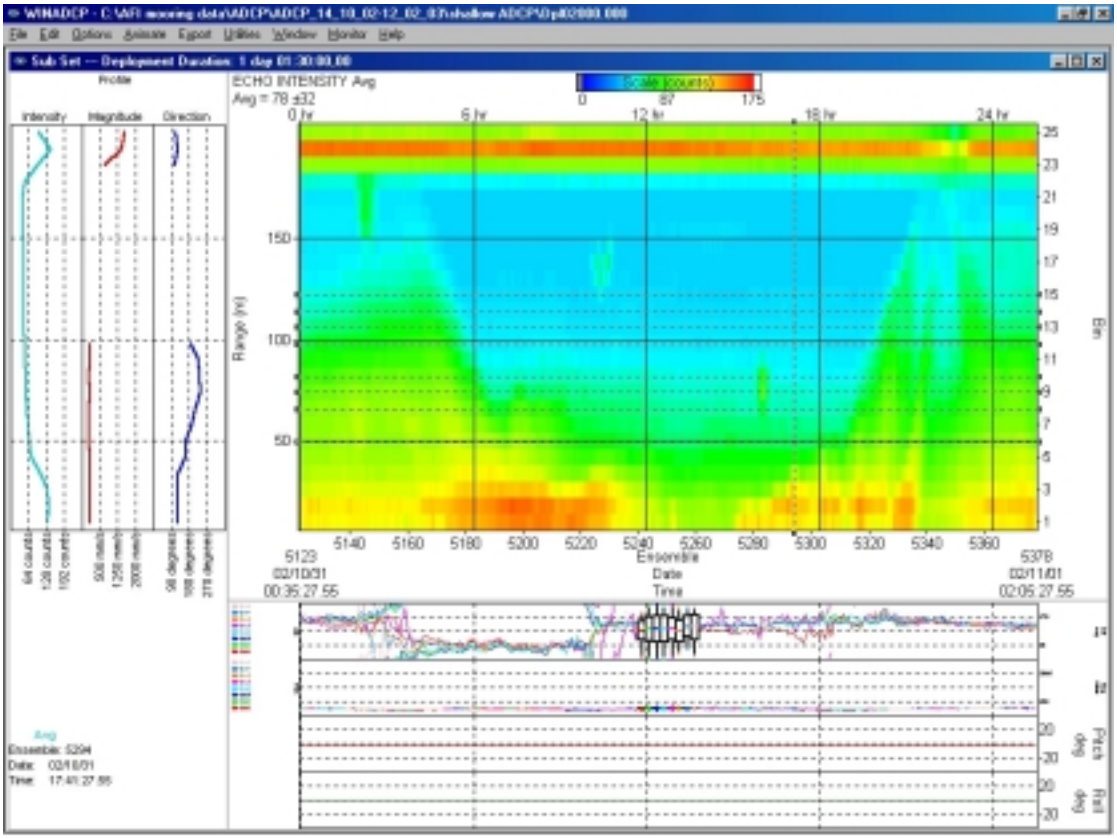
The **shallow water mooring** showed no damage at all from icebergs, or fishing gear. The mooring was at exactly 198 m water depth. That's an excellent achievement for a completely new system. All instruments came back in very good working conditions except the WCP, which has suffered major electrolytic corrosion to the transducer head. The damage is so severe that its needs to be repaired by the manufacturer. Further, it has not gathered any data.

The **deep water mooring** did not show any damage either. The instrument buoy was at about 203 m water depth. That's something we didn't expect with the first deployment, because the overall length of the mooring could only be theoretically calculated by the stretch of the rope under tension. From the CTD and ADCP data it looks as though the mooring was hit by an iceberg at least twice. All instruments came back in very good working conditions showing no damage or corrosion. Because there is no damage visible on the moorings or the instruments, it looks as though we were right with the design of our moorings. They seem to be to be able to bend over under the influence of a berg and then just pop back into position.

ADCP

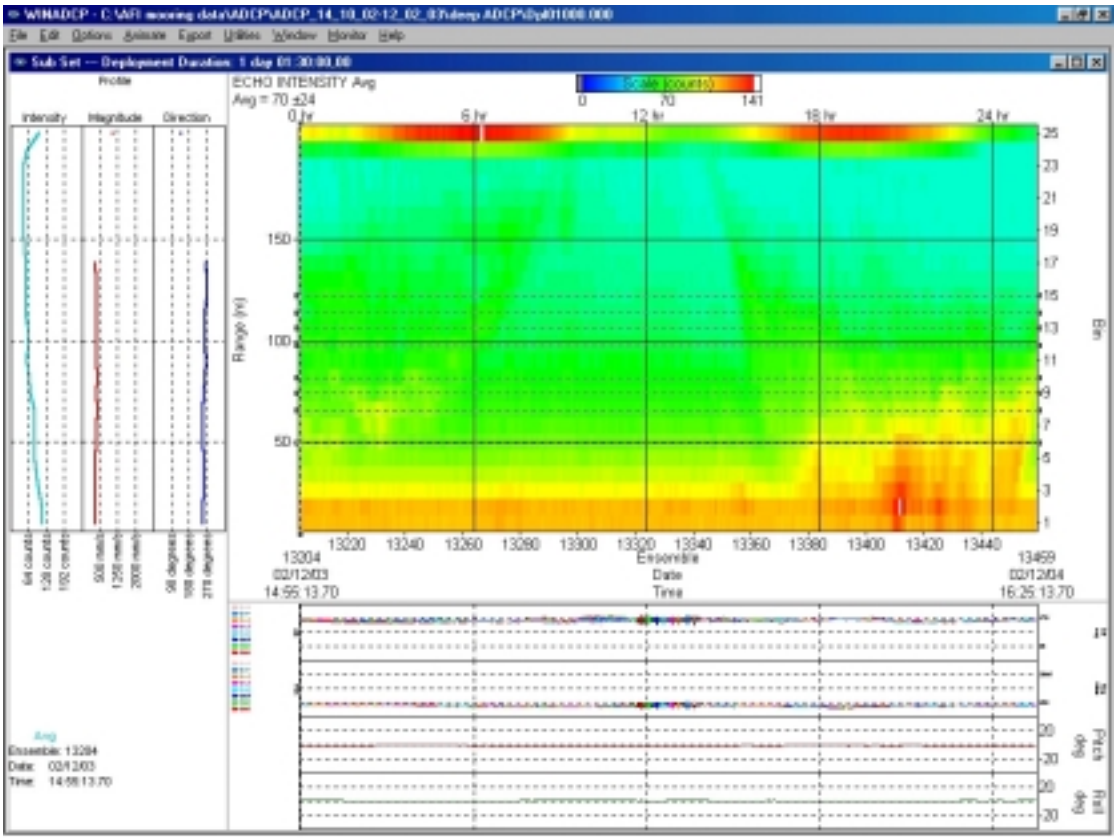
SHALLOW WATER MOORING:

The instrument has worked during the whole time of the deployment and sampled data every 4 minutes. It seems that the instrument looked at at least two bins above the surface, so we have sampled the whole water column. On the oceanography side all data look good, except that there are not enough particles in the top layer to get velocity data over the whole period (see below left side). On the biological side we still get good migration data on a daily pattern (below right graph). So overall we have a very nice set of data!!



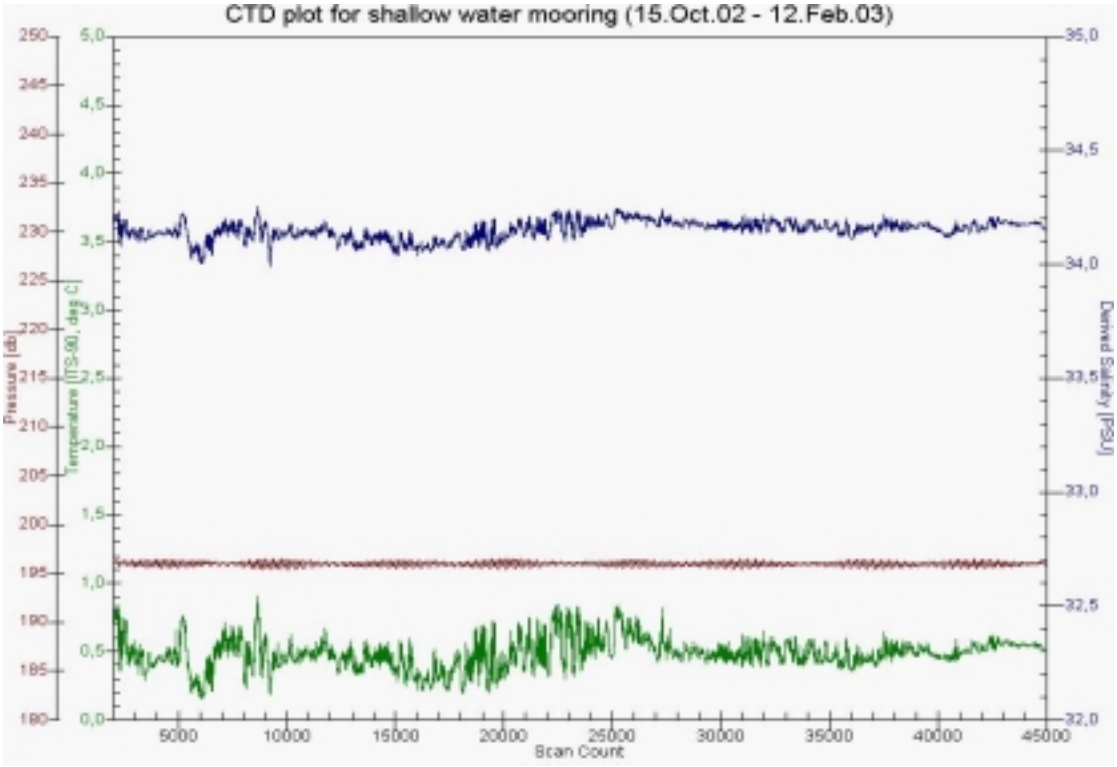
DEEP WATER MOORING

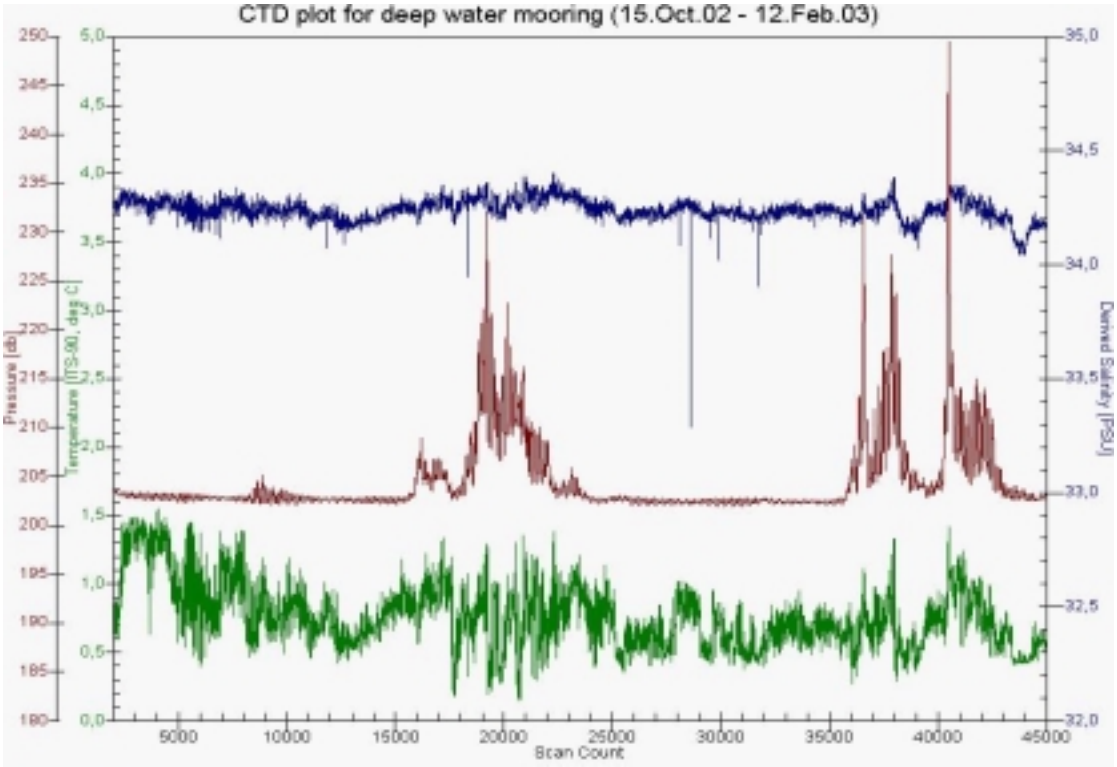
As on the shallow water mooring, the ADCP has worked throughout the deployment. The data are very similar to those from the shallow site: it also looked at bins above the surface. Again a good data set for both oceanography and biology. With clear migration patterns only slightly weaker than on the shallow site. (see pic below). Again it looks as though there were not enough particles in the water to get velocity data in the top layers. The ADCP data support our findings from the CTD data that the mooring was hit by icebergs at least twice. Good data are still gathered during these episodes but it does not reach the surface. So again overall a very nice set of data!!



CTD

Both instrument worked during the whole time of the deployment and sampled data every 4 minutes. The shallow water mooring shows a clear daily and monthly tide cycle. The average temperature was 0.5°C and the average salinity 34.2 psu. The deep water mooring shows three events, which look like the impact of ice-bergs. So the tide cycles are not as clear as on the shallow water mooring. The average temperature was with 1.0°C marginally higher compared with the shallow water site, also the oscillations are greater in comparison with the shallow water data. The salinity has an average of 34.2 psu; comparable with the shallow water site.


CTD plot for shallow water mooring (15.Oct.02 - 12.Feb.03)
Pressure [db]
Temperature [ITS-90], deg C
Derived Salinity [PSU]
Scan Count


CTD plot for deep water mooring (15.Oct.02 - 12.Feb.03)
Pressure [db]
Temperature [ITS-90], deg C
Derived Salinity [PSU]
Scan Count

PROBLEMS ENCOUNTERED

WCP

The Water Column Profiler on the shallow station did not work at all and suffered major electrolytic corrosion to the transducer head. The damage is so severe that it needs repairs to be carried out by the manufacturer.

The WCP on the deep station was OK and it had worked. However, the data were very sparse and we suspected that the gain setting used was too low. To test the performance of the WCP we carried out tests while the ship was stationary, first at Stromness and then Bird Island.

On both occasions we lowered the WCP into the water with the 120 kHz std sphere suspended approximately 5 m below it. Due to high winds the conditions were not ideal at BI and we lost the target sphere to drifting kelp. But we still got enough data to come to some conclusions about the performance of the WCP.

The test in Stromness was to find out more about the gain settings, we tested gain 1 to 4 at a pulse length of 300 ms. At gain 1 the target sphere can only be seen as a very week "shadow". At gain 4 the sphere scores 14 to 15 out of a possible 255.

In BI we tested different pulse lengths at gain levels 3 and 4. Due to movement of the ship and the loss of the sphere the data are not as good as those from Stromness. However they are good enough for some interpretation: pic 3 shows gain 4 at 600 ms and pic 4 is with gain 4 at 900 ms. Both pics show clearly that an increase in pulse length only results in a decrease in resolution and an increase of noise and not in any increased sensitivity.

From the tests results, we feel that only an increase in gain will would give more useful data.

From the backscatter scores of the 120 kHz std sphere with known ts we came to the following (disappointing) conclusion about the performance of the WCP:

Having the 120 kHz std sphere scoring only 14 out of a possible 255 (at gain 4) with a known ts of ~-40dB and krill having a mean ts of -65 - -85dB (from the EK60 and Ecoview data) means that krill will score probably something like 1 to 5 out of 255. That means, with the noise background, it will be more or less impossible to detect krill properly with the WCP.

The only resolution to that problem would, from our point of view, a further increase in gain to make the instrument more sensitive for the data we are looking for. This should not be too difficult for ASL or us because there is a special gain circuit board on the back of the WCP with the 4 Resistors clearly visible. A change of Resistors or a proper test with a potentiometer should dramatically increase the performance of the WCP.


WcpLink Version 1.1.2 (Build 020724) (c) ASL Environmental Sciences Inc. 1998-2002 all rights reserved
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Kb 33
Percent Read
Date and Time of the Last Ping Read 2003 02 17 09 59 53
Number of Bins 40
Bins
Load File (Shift F1)
Next (PgDn)
Close (Esc)
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Interpolate Colors
Reverse Axis
Max Profiles 300
Min Color Range 0
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Color 1
Panels
Utility (F1)
Deploy (F2)
Recover (F3)
Decode (F4)
Coefficients (F5)
Sensor (F6)
Date/Time (F7)
Playback (F8)
Help (F9)
About (F10)
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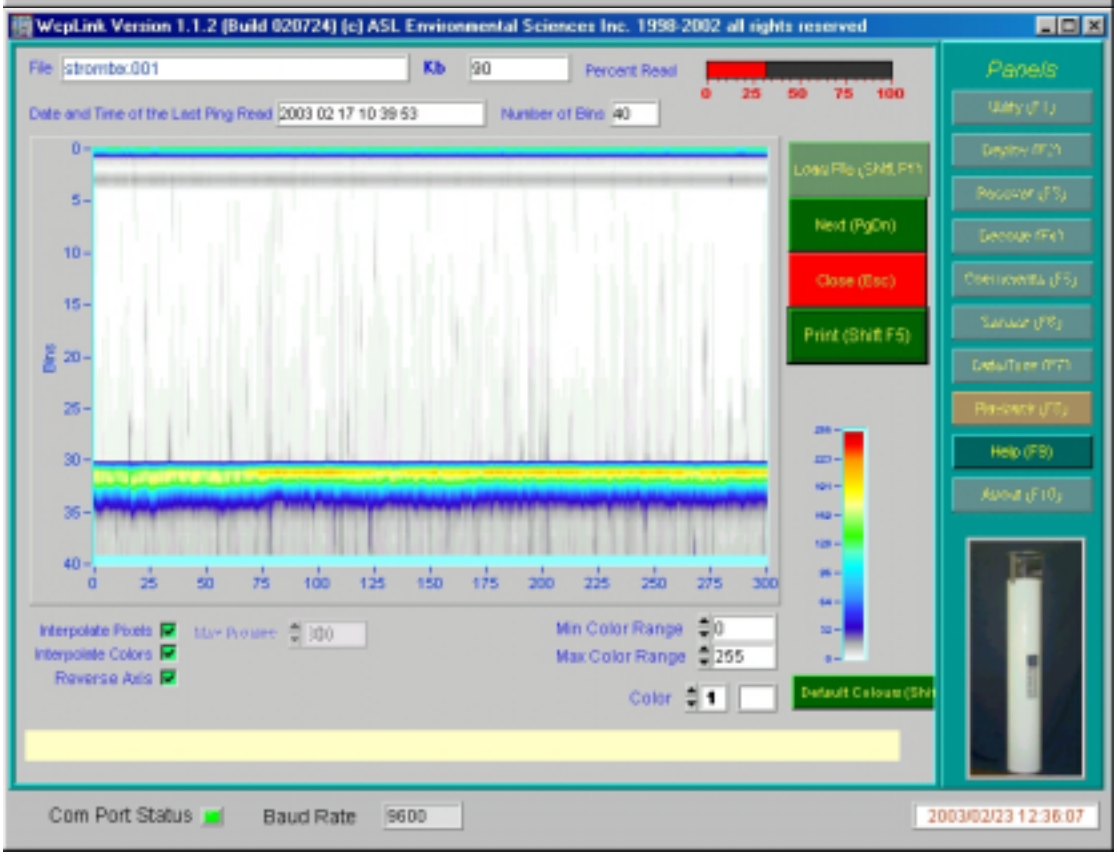
WcpLink Version 1.1.2 (Build 020724) (c) ASL Environmental Sciences Inc. 1998-2002 all rights reserved
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Number of Bins 40
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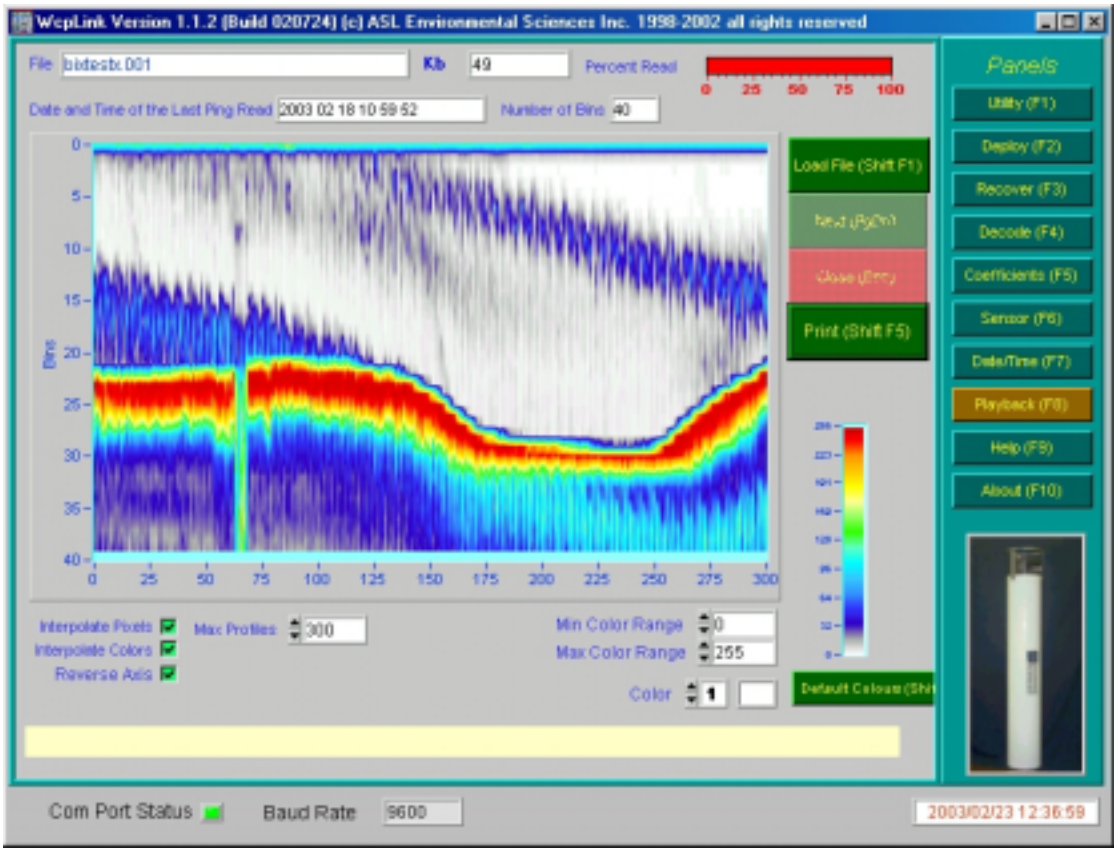
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Percent Read
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Date and Time of the Last Ping Read 2003 02 18 10 59 52
Number of Bins 40
Bins
Load File (Shift F1)
Print (Shift F5)
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Deploy (F2)
Recover (F3)
Decode (F4)
Coefficients (F5)
Sensor (F6)
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Playback (F8)
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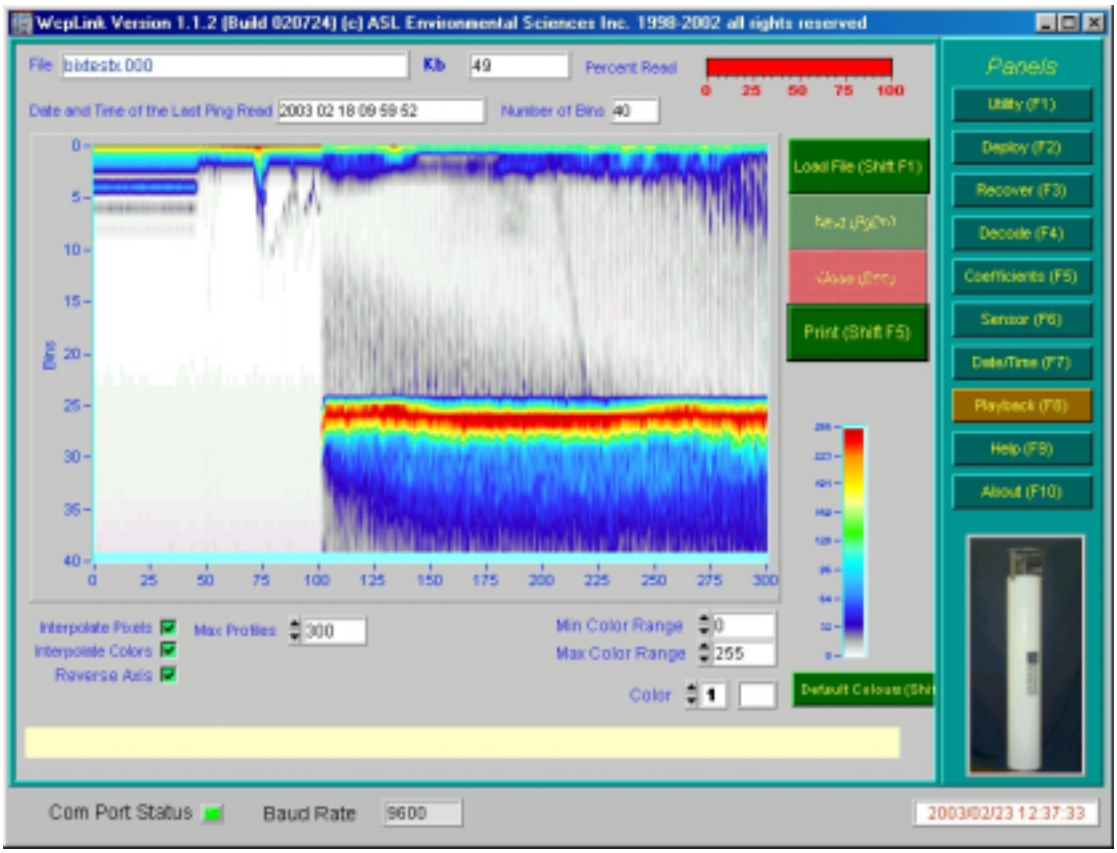
WcpLink Version 1.1.2 (Build 020724) (c) ASL Environmental Sciences Inc. 1998-2002 all rights reserved
File bidestx.000
Kb 49
Percent Read
0 25 50 75 100
Date and Time of the Last Ping Read 2003 02 18 09 59 52
Number of Bins 40
Bins
Load File (Shift F1)
Print (Shift F5)
Interpolate Pixels
Interpolate Colors
Reverse Axis
Max Profiles 300
Min Color Range 0
Max Color Range 255
Color 1
Panels
Utility (F1)
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CRUISE JR82 NUTRIENT ANALYSIS

MICK WHITEHOUSE & MIN GORDON

INTRODUCTION

Nutrients were measured contemporaneously with direct assessments of primary production (eg. phytoplankton standing stock and growth rate - see Korb, this report). Generally speaking, depletions of nutrients such as silicic acid, nitrate and phosphate give an indirect indication of the recent (weeks to months) extent of phytoplankton growth. Ammonium is a product of nitrogen remineralisation (eg. due to microbial break-down of sinking organic material at the pycnocline), and as a reduced nitrogen source it is frequently used by phytoplankton in preference to oxidised nitrogen sources such as nitrate. Given that the magnitude of phytoplankton growth is a major control on secondary production, an assessment of its variability across the Scotia Sea is a prerequisite for examining the condition of krill that may be transported through the region. Although nutrient stocks are abundant in the Scotia Sea, their availability for primary production varies for a number of reasons. For instance, a paucity of micronutrients such as iron to facilitate nitrate uptake, and there is also a marked north-south silicic acid gradient across the Scotia Sea that as the growing season progresses can lead to diatom growth-limitation in the north of the region.

JR82 AIMS

During cruise JR82 nutrient concentrations were monitored with the following objectives:

1. In conjunction with primary production measurements to assess phytoplankton dynamics and their relationship to krill.

2. To ascertain the extent of nutrient use across the major water masses and frontal systems in the Scotia Sea.

3. To examine the north-south silicic acid gradient in relation to the physical environment.

4. Again in conjunction with primary production measurements, to examine the regularly occurring mega-phytoplankton bloom that is partially sampled by the Core Programme's Western Core Box to the northwest of South Georgia.

DATA COLLECTION AND ANALYTICAL METHODS

Water bottle sub-samples for nutrient analysis were collected at all standard CTD casts throughout the Scotia Sea transects and the Western Core Box. In addition to standard CTD sample depths (approximately 20, 40, 60, 80, 100, 125, 150 and 200 m, and a further four depths sampled between 200 m and the bottom of the cast), a near-surface sample (6-7 m) was taken from the ship=s non-toxic seawater supply. Between stations along the eight Scotia Sea transects and the four transect pairs within the Western Core Box, the ship=s non-toxic seawater supply was continuously monitored for nutrient levels, and the analyser outputs were logged to a PC once every ten seconds.

Discrete water bottle samples and the continuously monitored non-toxic supply were filtered through a cellulose nitrate membrane (Whatman WCN, pore size 0.45 μm), and the filtrate was analysed colorimetrically for dissolved nitrate+nitrite (NO_3+NO_2-N), nitrite (NO_2-N), ammonium (NH_4-N), silicic acid ($Si(OH)_4$-Si) and phosphate (PO_4-P) using a Technicon-based segmented-flow analyser (Whitehouse 1997). Data were logged using LabVIEW 6i (National

instruments) and an acquisition programme developed by Mark Preston, and a Kipp and Zonen BD300 data acquisition recorder.

DATA ANALYSIS

Full data analysis and verification will be undertaken with subsidiary programmes (Whitehouse and Preston 1997) on our return to the UK. The data are subject to a variety of analytical corrections (eg. saline-freshwater RI adjustments), and the underway data requires the application of time-lags to individual chemistry lines. Additionally the data will need to be examined alongside the physical oceanography to enable a reasonable assessment of nutrient dynamics within the range of water masses sampled. Therefore a preliminary assessment of the data is not practical. A full evaluation of the data should be completed during summer 2003.

REFERENCES

Whitehouse, M. J. (1997) *Automated seawater nutrient chemistry*. British Antarctic Survey, Cambridge, 14 pp.

Whitehouse, M. J., Preston, M. (1997) A flexible computer-based technique for the analysis of data from a sea-going nutrient autoanalyser. Analytica chimica Acta **345**: 197-202.

CRUISE REPORT FOR JR82 – PHYTOPLANKTON BIOMASS AND PRIMARY PRODUCTION

REBECCA KORB, MIN GORDAN, RENUKA BADHE

INTRODUCTION

While we can currently obtain information from the SeaWiFS satellite on the distribution of phytoplankton blooms throughout the Scotia Sea, ship based experiments are required to indicate the magnitude of growth and examine the factors controlling phytoplankton stocks. On this BAS science cruise we examined chlorophyll *a* distribution and primary production in relation to seawater chemistry (e.g. nitrate, phosphate and silicate) and physical oceanography (light and mixing depths) to establish the environmental controls on phytoplankton. In addition, we will compare standard methods of measuring primary production with novel technology in the form of the Fast Repetition Rate Fluorometer (FRRF). The data we are collecting will also be useful to the zooplankton group who will be interested in the amount and type of food available to krill or copepods being transported through the Scotia Sea.

JR82 AIMS

During cruise JR82, phytoplankton biomass and primary production were measured throughout the Scotia Sea with the following objectives:

1. Characterise the amount and type of phytoplankton available to secondary producers.

2. To examine the physical and chemical factors affecting phytoplankton growth.

3. To scale up and relate localised measurements (e.g. from CTDs) of primary production and chlorophyll biomass to the basin scale (i.e. the Scotia Sea).

4. To use the field data on chlorophyll biomass and primary production rates to calibrate modelled estimates from satellite data.

DATA COLLECTION AND METHODS

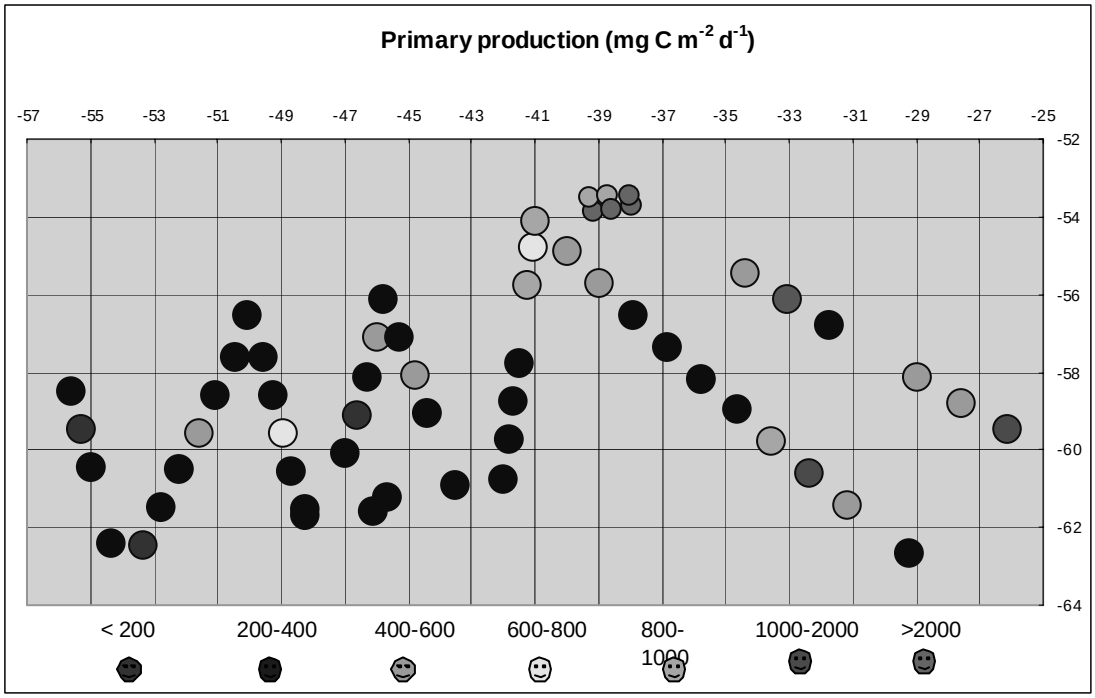
At each station, water samples for chlorophyll *a* concentration were collected from the standard CTD casts and will be used to calibrate the CTD fluorometer. Whenever possible, PAR profiles were obtained from the standard cast and used to estimate water depths for a separate primary production CTD carried out after bongo nets. Four water bottles were fired at 20m on the production CTD and this water was sampled for species composition, fatty acid analysis and POC (see table attached), size fractionated chlorophyll and occasionally for dissolved inorganic carbon. Primary production was measured at almost every station with the following exceptions: Stations 1.4, 5.5, 6.5, 8.5. Primary production was measured by ^{14}C uptake. Water samples were incubated for 24 hours using an on-deck incubator. A number of production rates were also measured on the phtotosynthetron, although the overall numbers of these experiments was low due to a limited stock of ^{14}C isotope.

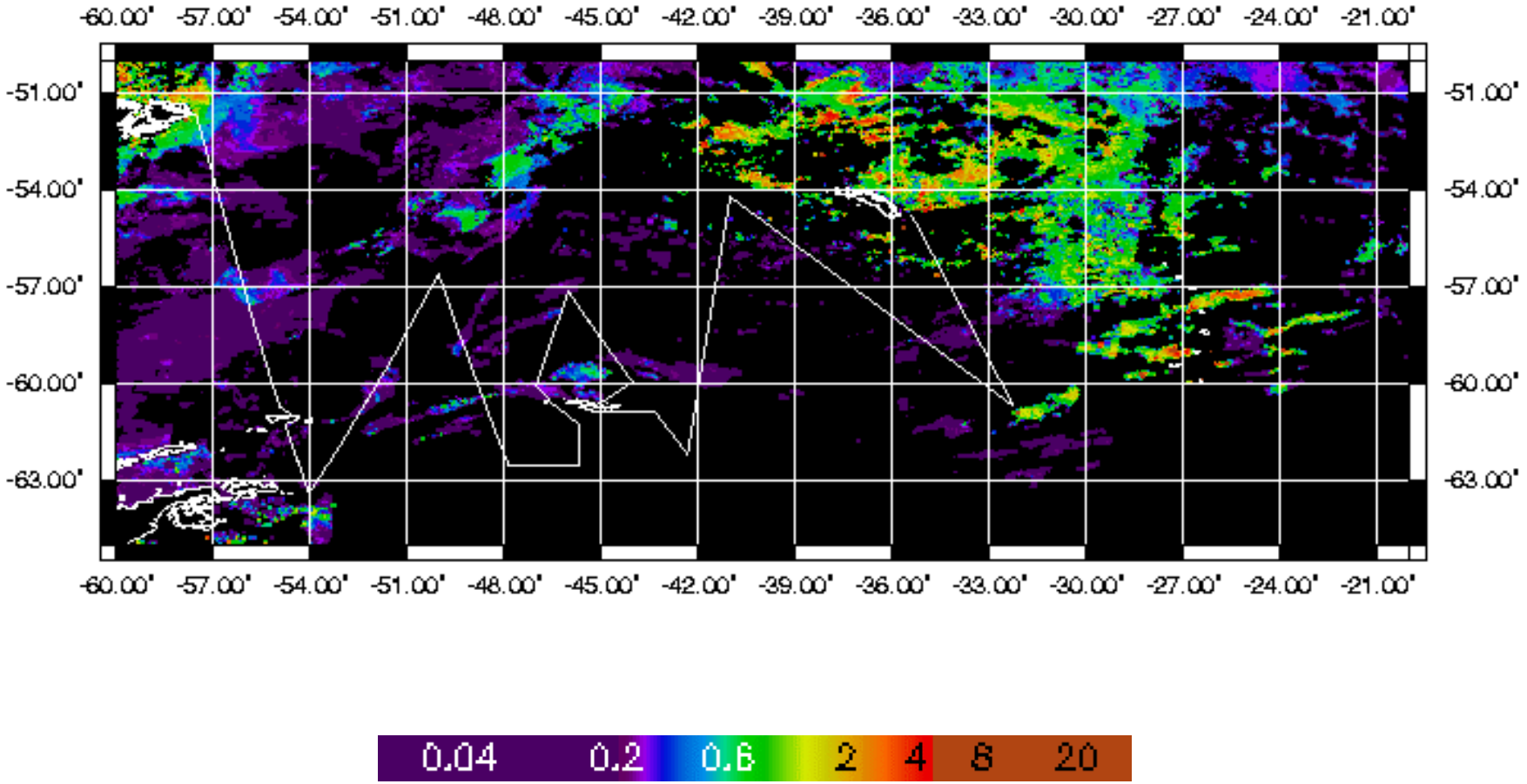
The ships non-toxic seawater supply was continuously monitored for chlorophyll fluorescence and the output logged to the Oceanlogger. To calibrate this data set, hourly seawater samples were collected along transects. All chlorophyll samples, including those from the CTD casts, were frozen at –20 ºC and stored for analysis back at BAS HQ. Throughout the cruise, near real time satellite data on chlorophyll *a* concentration and sea surface temperature were provided to the ship from the Remote Sensing Group at Plymouth.

RESULTS

Chlorophyll *a* concentrations are not known at present as samples were frozen and will be analysed upon the ships return to the UK. From the SeaWiFS satellite (for an example see Figure 1 of the 21-27th January 2003), chlorophyll *a* concentrations could be seen to be low throughout much of the Scotia Sea. Blooms appeared to be associated with the Scotia Ridge, in particular high biomass was evident near the South Orkneys and South Shetlands. As in previous years, a large and dense bloom was also seen to the northwest of South Georgia over the Georgia Basin.

Primary production rates largely reflected the patterns found with chlorophyll biomass with low rates throughout much of the Scotia Sea (< 200 mg C m^{-2} d^{-1}) and higher rates occurring around the islands. Full data analysis and verification of the primary production data set will be undertaken on our return to Cambridge. A preliminary map of production rates can be seen in Figure 2.




-60.00' -57.00' -54.00' -51.00' -48.00' -45.00' -42.00' -39.00' -36.00' -33.00' -30.00' -27.00' -24.00' -21.00'
-51.00'
-54.00'
-57.00'
-60.00'
-63.00'
0.04 0.2 0.6 2 4 8 20

Station	Event	Date	Sample	Lugols?	POC rep 1	POC rep 2	Fatty acid	comments
		(2003)	depth (m)		vol (L)	vol (L)	vol (L)	
1.1	9	9.1	20	yes	3.6	3.6	3.6	
1.2	19	10.1	20	no	3.6	3.6	3.6	
1.3	26	10.1	20	yes	3.6	3.6	3.6	
1.4	37	11.1	20	yes	3.6	3.6	3.6	
1.5	48	11.1	20	yes	3.6	3.6	3.6	
2.3	61	12.1	20	yes	3.6	3.6	3.6	
2.4	74	13.1	20	yes	3.6	3.6	3.6	
2.5	83	13.1	20	yes	3.6	3.6	3.6	
2.6	96	14.1	20	yes	3.6	3.6	3.6	
2.7	107	15.1	20	yes	3.6	3.6	3.6	
3.1	116	15.1	20	yes	3.6	3.6	3.6	
3.2	126	15.1	20	yes	3.6	3.6	3.6	
3.3	138	16.1	20	yes	3.6	3.6	3.6	
3.4	149	16.1	20	yes	3.6	3.6	3.6	
3.5	158	17.1	20	yes	3.6	3.6	3.6	
3.6	169	17.1	20	yes	3.6	3.6	3.6	
3.7	174	18.1	20	yes	3.6	3.6	3.6	
4.1	181	18.1	20	yes	3.6	3.6	3.6	
4.2	191	18.1	20	yes	3.6	3.6	3.6	
4.3	200	19.1	20	yes	3.6	3.6	3.6	
4.4	210	20.1	20	yes	3.6	3.6	3.6	
4.5	221	20.1	20	yes	3.6	3.6	3.6	
4.6	232	21.1	20	yes	3.6	3.6	3.6	
5.1	240	21.1	20	yes	3.6	3.6	3.6	

5.2	248	22.1	20	yes	3.6	3.6	3.6	
5.3	262	22.1	20	yes	3.6	3.6	3.6	
5.4	271	23.1	20	yes	3.6	3.6	3.6	
5.5	282	23.1	20	yes	3.6	3.6	3.6	
5.6	297	26.1	20	yes	3.6	3.6	3.6	
6.1	306	26.1	20	yes	3.6	3.6	3.6	
6.2	315	27.1	20	yes	3.6	3.6	3.6	
6.3	330	27.1	20	yes	3.6	3.6	3.6	
6.4	340	28.1	20	yes	3.6	3.6	3.6	
6.5	355	28.1	20	yes	3.6	3.6	3.6	
6.6	363	29.1	20	yes	3.6	3.6	3.6	
6.7	378	30.1	20	yes	3.6	3.6	3.6	
7.1	395	30.1	20	yes	3.6	3.6	3.6	lots small copes. I medium one picked off
7.2	406	31.1	20	yes	3.6	3.6	3.6	1 medium size cope and small euph picked off
7.3	421	31.1	20	yes	3.6	3.6	3.6	
7.4	432	1.2	20	yes	3.6	3.6	3.6	
7.5	445	1.2	20	yes	3.6	3.6	3.6	
7.6	455	2.2	20	yes	3.6	3.6	3.6	
7.7	468	3.2	20	yes	3.6	3.6	3.6	
7.8	481	3.2	20	yes	3.6	3.6	3.6	
7.9	491	4.2	20	yes	3.6	3.6	3.6	
7.10	503	4.2	20	yes	3.6	3.6	3.6	
7.11	520	5.2	20	yes	3.6	3.6	3.6	
8.1	526	6.2	20	yes	3.6	3.6	3.6	
8.2	537	6.2	20	yes	2.4	2.4	3.6	
8.3	543	7.2	20	yes	3.6	3.6	3.6	

8.4	556	7.2	20	yes	3.6	3.6	3.6	labelled as e555
8.5	566	8.2	20	yes	3.6	3.6	3.6	
8.6	577	8.2	20	yes	3.6	3.6	3.6	
8.7	586	9.2	20	yes	3.6	3.6	3.6	lots small copes
W1.2S	614	13.2	20	yes	3.6	3.6	3.6	
W1.2N	625	14.2	20	yes	2.4	2.4	2.4	
W2.2N	633	14.2	20	yes	2.4	2.4	3.6	copes picked off
W2.2S	643	15.2	20	yes	2.4	2.4	2.4	
W3.2S	651	15.2	20	yes	3.6	3.6	3.6	lots small copepods
W3.2N	664	16.2	20	yes	2.4	2.4	2.4	
Strom	677	17.2	20	yes	3.6	3.6	3.6	"at Stromness target RMT Min did chl filtration"

UNDERWAY NON-CONTAMINATED WATER SUPPLY

Date	Time Local	Time GMT	Filter Put In Use	Pump In Use	Probe Position	Event	Remarks
7th Jan	1500	1800	Fwd	Fwd	Mid	Water On	DEPARTURE STANLEY
8th Jan	16.56	17.56	Aft	Fwd	Mid	Filter C/O	ALGAE & FEW SMALL LAVAE
9th Jan	17.35	20.35	Fwd	Fwd	Down	Filter C/O	A small amount of algae & a few fish lavae.
10th Jan	16.20	19.20	Aft	Fwd	Down	Filter C/O	A few animals, but very little really
10th Jan	16.35	19.35	Aft	Aft	Down	Pumps Changed over as the aft pump was motoring.	Sudden rise in system pressure then stablised after about five minutes.
11th Jan	12.00	15.00	Aft	Aft	Mid	Probe lifted to Mid due to ice	
11th Jan	15.40	18.40	Fwd	Aft	Mid	Filter C/O	Filter basket approx half full with one jellyfish.
12th Jan	14.25	17.25	Aft	Aft	Mid	Filter C/O	One large krill and several small otherwise clean.
13th Jan	18.00	21.00	Fwd	Aft	Mid	Filter C/O	Almost Clean
14th Jan	14.32	17.32	Aft	Aft	Mid	Filter C/O	About Five Krill, otherwise clean
15th Jan	15.55	18.55	Fwd	Aft	Mid	Filter C/O	Two Large krill and about six small, otherwise clean.
16th Jan	16.24	19.24	Aft	Aft	Mid	Filter C/O	Several small dead krill.
17th Jan	17.10	20.10	Fwd	Aft	Mid	Filter C/O	Some Algae and a few small krill.
18th Jan	16.00	19.00	Aft	Aft	Mid	Filter C/O	Few small animals otherwise clean.

Date	Time Local	Time GMT	Filter Put In Use	Pump In Use	Probe Position	Event	Remarks
19th Jan	02.04	05.04	Fwd	Aft	Mid	Filter C/O	Called out due to low Oceanlogger flow alarm. Filter contained some small krill, but problem was air locking of instrumentation line.
19th Jan.	14.06	17.06	Aft	Aft	Mid	Filter C/O	Filter Clean.
20th Jan	16.09	19.09	Fwd	Aft	Mid	Filter C/O	Various animals and some penguin feathers.
21st Jan	15.44	18.44	Aft	Aft	Mid	Filter C/O	Approx ¼ of bottom of filter screen covered with dead krill.
21st Jan	15.55	18.55	Aft	Aft	Mid ↓ Down	Probe lowered and instrument line purged.	Water supply reported stopped, but only through the underway instruments. Line was purged and probe lowered as experiencing heavy weather.
22nd Jan	16.05	19.05	Fwd	Aft	Down	Filter C/O	Some Algae.
23rd Jan	17.27	20.27	Aft	Fwd	Down	Filter C/O	Some Krill in filter base.
23rd Jan	22.00	01.00 (24th)	Aft	Fwd	Down ↓ Mid	Probe to mid position.	In preparation for ice.
24th Jan	≈06.00	≈09.00	Aft	Fwd	Mid	Pump Stopped	In Ice
24th Jan	15.05	18.05	Fwd	Aft	Mid	Pump Restarted & Filter C/O	Pump run at Signy. Filter Clean.
25th Jan	16.40	19.40	Aft	Aft	Mid	System fully underway.	Reasonable expectation of keeping system running after sea ice exit.
26th Jan	16.24	19.24	Fwd	Aft	Mid	Filter C/O	One fish and a couple of krill
27th Jan	14.50	17.50	Aft	Aft	Mid	Filter C/O	Approximately 20 krill.
28th Jan	16.45	19.45	Fwd	Aft	Mid	Filter C/O	Small quantity of krill found.
29th Jan	14:52	17:52	Aft	Aft	Mid	Filter C/O	One krill some small animals and approximately one-sixth algae.
30th Jan	15.40	18.40	Fwd	Aft	Mid	Filter C/O	Approximately □ of filter covered with algae & animal debris.
31st Jan	16.35	19.35	Aft	Aft	Mid	Filter C/O	Small amount of animal debris.

Date	Time Local	Time GMT	Filter Put In Use	Pump In Use	Probe Position	Event	Remarks
1st Feb	16.43	19.43	Fwd	Aft	Mid	Filter C/O	Almost Clean
2nd Feb	16.11	19.11	Aft	Aft	Mid	Filter C/O	Just a few animals, almost clean
3rd Feb	15.40	18.40	Fwd	Aft	Mid	Filter C/O	Three krill and some algae
4th Feb	15.37	18.37	Aft	Aft	Mid	Filter C/O	Approximately of filter covered with algae & animal debris.
5th Feb	15.40	18.40	Fwd	Aft	Mid	Filter C/O	Practically clean.
6th Feb	15.40	18.40	Aft	Aft	Mid	Filter C/O	Approximately ¼ of basket covered with algae and a few krill.
6th Feb	23.05	02.05	Aft	Aft	Mid ↓ Down	Probe lowered and instrument line purged.	Water supply reported stopped, but only through the underway instruments. Line was purged and probe lowered as experiencing heavy weather.
7th Feb	15.46	18.46	Fwd	Aft	Down	Filter C/O	Basket covered with some algae.
8th Feb	15.35	18.35	Aft	Aft	Down	Filter C/O	Almost Clean
9th Feb	14.00	17.00	Fwd	Aft	Down	Filter C/O	Almost Clean
9th Feb	17.00	20.00	Fwd	Aft	Down ↓ Mid	Probe Raised	
10th Feb	07.30	09.30	Fwd	Aft	Mid	Water Off	Arrival KEP (Now GMT-2)
10th Feb	09.00	11.00	Fwd	Aft	Mid	Water On	Run after arrival to cool incubators until processed. High Water alongside, so ok.
10th Feb	14.00	16.00	Fwd	Aft	Mid	Water Off	
11th Feb	20.45	20.45	Fwd	Aft	Mid	Water On	Departure KEP
12th Feb	17.10	19.10	Aft	Aft	Mid	Filter C/O	Approximately of filter covered with animal debris.
13th Feb	14.20	16.20	Fwd	Aft	Mid	Filter C/O	One small fish, two krill & approx of filter covered with other animals.
14th Feb	14.45	16.45	Aft	Aft	Mid	Filter C/O	Small quantity of animals present.

Date	Time Local	Time GMT	Filter Put In Use	Pump In Use	Probe Position	Event	Remarks
15th Feb	15.39	17.39	Fwd	Aft	Mid	Filter C/O	One small fish, & approx of filter covered with other animals.
16th Feb	15.10	17.10	Fwd	Aft	Mid ↓ Down	Probe lowered and instrument line purged.	Water supply stopped, but only through the underway instruments. Line was purged and probe lowered as experiencing heavy weather.
16th Feb	15.52	17.52	Aft	Aft	Down	Filter C/O	A few small animals and feathers.
17th Feb	--.--	--.--	Aft	Aft	Down		Water off twice for about 30 minutes while workboat deployed and recovered.
18th Feb	15.49	17.49	Fwd	Aft	Down	Filter C/O	A few small animals and penguin feathers.
19th Feb	16.37	18.37	Aft	Aft	Down	Filter C/O	A small quantity of small animals.
20th Feb	14.26	16.26	Fwd	Aft	Down	Filter C/O	A small quantity of small animals.
20th Feb	14.30	15.50	Fwd	Aft	Down	Probe being worked on	Probe being worked on for approximately 20 minutes.
21st Feb	08.15	10.15	Fwd	Aft	Down	Probe being worked on	Probe being worked on for approximately 30 minutes.
21st Feb	08.45	10.45	Fwd	Aft	Down ↓ Mid	Probe Raised to Mid Position	
21st Feb	15.58	17.58	Aft	Aft	Mid	Filter C/O	Approximately ¼ for filter area covered in algae & a few small animals.
22nd Feb	14.26	17.26	Fwd	Aft	Mid	Filter C/O	Almost Clean just a few animals. (Clox GMT-3)
23rd Feb	08.30	11.30	---	---	---	Pumps Off	Inside Port William, just a few small animals. Cruise End.

Information compiled by; Simon Wright (Deck Engineer) [Email - Jrdeng@south.nerc-bas.ac.uk]

FRRF

RENUKA BADHE

INTRODUCTION

Primary Production has been measured, classically by one or more of the experimental methods, such as C14, Oxygen production, etc, which require the sample of water to be taken out of its surroundings and thus induce the so called "Bottle Effect". The FRRF has been a development in the field of fluorescence, which manages to measure primary production insitu, thus removing a lot of the drawbacks of the earlier methods. Its placement in the UOR makes it a very good tool for large scale coverage of area.

The other aspect of the placement of the FRRF in the UOR meant that the FRRF could run only if the UOR was in running in good order. Thus, the FRRF could not run at all till the station 2.7 as the UOR was not working. The decision was then taken to run the FRRF on the uncontaminated seawater supply while keeping it on deck during the transect if the UOR did not work. So, from station 2.7 onwards, an almost continuous dataset has been built from the FRRF, either running it on the uncontaminated seawater supply on deck or undulating. Table 2 provides a summary of the data collected with the FRRF during the cruise. On return to BAS HQ, the data will be analysed for primary production values and compared to the values obtained by the classical ways. (See Korb, this report)

ON DECK AND VERTICAL DEPLOYMENT

During the transect, when the UOR was not working, the uncontaminated sea water supply was plugged directly into the dark chamber. The UOR was placed on deck to maintain temperature conditions. At stations, vertical deployment was done as soon as possible after the CTD for Primary Production had been deployed. The UOR was let down straight to the deepest depth attained by the Primary Production CTD, and raised slowly.

DURING TRANSECTS

During the transect, the UOR was towed from the aft deck after the ship had attained a speed of 10 knots. It was towed through the station, and then removed onto the deck. The data was downloaded and the blanks were performed. Uncontaminated seawater filtered thorough GF/F filters was used for performing the blank. The blank was performed on deck, to maintain the temperature conditions. For the dark adapted measurement, sample was taken from the uncontaminated water supply and put in the dark chamber which was the secured with black plastic sheet.

ABSORPTION AND HPLC SAMPLES:

Samples for absorption measurement and HPLC were taken from the uncontaminated water supply at approximately halfway between a transect as well as from depths of 100m, 60m and 20m from the CTD. They were filtered onto a GF/F filter, and stored in petridish at –80° C, in the dark.

TABLE 1: PROTOCOL USED FOR FRRF

Parameter	Boot Setting	Vertical run	Transect
No of acquisitions	0	64000	64000
Flash sequences per acquisition	1	16	16
Saturation flashes per sequence	100	100	100
Saturation flash duration	4	4	4
Saturation interflash delay	0	0	0
Relaxation flashes	Enabled	Enabled	Disabled
Relaxation flashes per sequence	20	20	--
Relaxation flash duration	4	4	--
Relaxation interflash delay	61	61	--
Sleeptime between aquisitions	1000	100	100-1200
PMT Gain (Autogain) lower signal limit	3	3	--
PMT Gain normal mode	0	--	x1 – x16
Analogue output	Disabled	Disabled	Disabled
Desktop verbose mode	Disabled	Disabled	Disabled
Light Chamber	Active	Active	Active
Dark Chamber	Inactive	Active	Active
Logging mode to internal flashcard	Disabled	Enabled	Enabled
Upper limit autoranging threshold value	90	85	85
Lower limit autoranging threshold value	15	15	15

TABLE 2: DEPLOYMENT OF FRRF

Location	Event No	Jday	FRRF	Absorption (Sample No)	HPLC (Sample No)
Station 1.1	11, 12	009	F		
Transect					
Station 1.2	20	010	F		
Transect					
Station 1.3	28	010	F		
Transect			NU		
Station 1.4					
Transect			NU		
Station 1.5					
Transect			NU		
Station 2.2					
Transect	55	012	T		
Station 2.3					
Transect			NU		
Station 2.4	75	013	V		
Transect		013	U		
Station 2.5	84	013	V		
Transect			NU		
Station 2.6					
Transect			NU		
Station 2.7					
Transect	108	014	T	1	
Station 3.1					
Transect	118	015	T	2	
Station 3.2					
Transect	128	015	F, U		
Station 3.3					
Transect		016	U	3	
Station 3.4					
Transect	150	016	T	4	
Station 3.5					
Transect	159	017	T, U	5, 6	
Station 3.6				7, 8, 9	
Transect		017-018	U		
Station 3.7	175	018	V	11, 12, 13	
Transect		018	U	10	

Station 4.1	182	019	V	14, 15, 16	
Transect			U	17	
Station 4.2	192	019	V x3times	18, 19, 20	
Transect		019	U	21	
Station 4.3					
Transect	202	019	T		
Station 4.4				23, 24, 25	
Transect	211	020	T	22	
Station 4.5				26-28	
Transect	222	020	T	29	
Station 4.6					
Transect		021	U	30	
Station 5.1				31-33	
Transect		021	U	34	
Station 5.2					
Transect		022	U	35	
Station 5.3				36-38	
Transect	263	022	T	39	
Station 5.4				40-41	
Transect	272	023	T	43	
Station 5.5				44-46	
Transect		023	U		
Signy					
Transect		025	U		
Station 5.6					
Transect		026	U	47	
Station 6.1				48-50	
Transect	307	026	T		
Station 6.2				51-53	1-4
Transect	322	027	T	54	5
Station 6.3				55-57	6-8
Transect	332	027	T	58	
Station 6.4				59-61	9-11
Transect	345	028	T	62	12
Station 6.5				64-66	13-15
Transect	356	029	T	63	
Station 6.6					
Transect	368	029	T	67	16
Station 6.7				68-70	17-19
Transect	386	030	T	71	20

Station 7.1				72-74	21-23
Transect	399	030	T		
Station 7.2				75-77	24-26
Transect	410, 411	031	T	78	27
Station 7.3				79-81	28-30
Transect	424	031	T	82	
Station 7.4				83-85	31-33
Transect	435	032	T	86	34
Station 7.5				91-93	38-40
Transect	448	033	T	87	
Station 7.6				88-90	35-37
Transect	458	033	T	94	41
Station 7.7				96-98	42-44
Transect	472	034	T	95	
Station 7.8	482	034	V	99-101	45-47
Transect	483	034	T	102	48
Station 7.9				104-106	49-51
Transect	493	035	T	103	
Station 7.10				107-109	52-54
Transect	508, 513	035, 036	T	110	
Station 7.11				111-113	55-57
Transect					
Station 8.1				114-116	58-60
Transect	527	037	T	117	
Station 8.2					
Transect			U	118	
Station 8.3				120-122	61-63
Transect	545	038	T	123	64
Station 8.4				125-127	65-67
Transect	557	039	T	124	
Station 8.5				128-130	68-70
Transect	567		T	131	71
Station 8.6				132-134	72-74
Transect	578	040	T	135	75
Station 8.7				136-138	76-78
Transect	588	040	T	139	79
South Georgia					
Western Core Box					
Transect 1	606	044	T	140	80
Station 1.2S				--	--

Station 1.2N				--	--
Transect 2	626	045	T	141	81
Station 2.2 N				142-144	82-84
Station 2.2S				145-147	85-87
Transect 3	644	046	T	148	88
Station 3.2S				149-151	89
Station 3.2N				152-154	90-92
Transect 4	665	047	T	155	93

F UOR Trial Failed

U On Underway Water Supply

T Undulating in Transect

NU Not Used

V Vertical Deployment

MESOZOOPLANKTON STUDIES

PETER WARD, RACHAEL SHREEVE & DAVID POND

CRUISE OBJECTIVES

Were to examine the spatial distribution of the mesozooplankton community across the Scotia Sea in relation to changing environmental conditions and to make measurements of egg production rates (EPR) on selected large calanoid species of copepod (*Rhincalanus gigas, Calanoides acutus* and *Calanus propinquus*) and of condition (DM and C:N) on copepodite stages CIV and CV of *Calanoides acutus*. Seven deep (0-1000 m) hauls were made with the Longhurst Hardy plankton recorder in the eastern part of the survey area to ascertain the vertical distribution of the plankton in relation to latitude and water mass. Another haul was made in the vicinity of station W2.2N in the western core box to the north of South Georgia to examine the vertical distribution of krill larvae which unusually were present in significant numbers in the oceanic parts of the survey area.

METHODS

Mesozooplankton samples were collected with the motion compensated paired bongo net (200 μm and 100 μm mesh) which were hauled vertically from 400 m to the surface at each of the 56 stations. As a rule on previous cruises only the top 200 m has been sampled but because of the uncertainties surrounding the vertical distribution of krill larvae it was decided to extend the nets depth range. A single haul to 400 m was carried out followed by two hauls to 200 m, the latter to provide material for experimental work (see objectives). The 0-400 m haul was preserved in 10% (v:v) formalin for analysis in the UK.

Females were randomly sorted from the catch and batches of 10 were placed inside perspex tubes closed off at the bottom end by 800 μm mesh netting. These were then suspended inside 1.5 l jars containing filtered sea water and incubated at ambient sea water temperature in the cold room for 24 hrs. At the end of this females were removed and retained for C:N analysis and the number of eggs laid counted. Ideally 30 females (3*10) of each species were sought but this was very often not possible as they were not very abundant in certain parts of the survey area. Thirty stage CIV and CV *C. acutus* were removed from the samples and placed in foil capsules in batches of either 10 (CIV) or 5 (CV) for C:N determination in the UK.

The LHPR deployments consisted of a single upward oblique profile at each station. The net was rapidly deployed to 1000 m (veering rate of 60-80 m min^{-1}) and then switched on and hauled to the surface at 30 m min^{-1}. The gauze advance was set to 90 seconds. In this way each profile consisted of around 50-60 patches with a depth resolution of around 20 m.

PRELIMINARY RESULTS

As in previous years much of the sample analysis will take place back in the UK upon return of the samples. However preliminary observations are as follows:

COMMUNITY COMPOSITION AND GEOGRAPHICAL CHANGE.

Over much of the western part of the Scotia Sea the plankton was very sparse, particularly in the vicinity of the Antarctic Peninsula and in waters that were influenced by the Weddell Scotia Confluence. A lack of younger stages implied that the recruitment of the new generation of many of the large Calanoids had not yet happened, although the smaller Cyclopoid species were generally abundant. In the eastern parts of the survey area, particularly at the northern ends of

the transects, phytoplankton blooms were occurring and the summer generation was present.

How typical this situation is has yet to be resolved but will be looked at in relation to watermass, chlorophyll and primary production measurements as well as SeaWiFS data. A comparable survey in Jan/Feb 2000 (CCAMLR 2000) indicated somewhat similar conditions and the existence of a single zooplankton community despite latitudinal differences in population structure and abundance. A cold water overwintering community was seen during both surveys in the vicinity of the South Sandwich Islands, in waters that derive directly from the Weddell Sea. It was noticeable that bloom conditions had generally stimulated zooplankton population development, indicating once again that food limitation is an important factor underpinning zooplankton population dynamics in the Southern Ocean. This year ice extended more into the southern part of the proposed survey region than during 2000. Its influence on community development remains to be determined.

EGG PRODUCTION RATES (EPR) AND CONDITION

EPR for selected species were, as expected, extremely variable. Not all species were present at each station and at some, none were present at all. General patterns of presence/absence fitted in with what is generally understood about species distributions: *Rhincalanus gigas* having a more northerly distribution, *Calanus propinquus* generally restricted to the south and *Calanoides acutus* somewhat intermediate. Numbers of females incubated and stations with highest EPRs are given in Table Zoop1 below.

Table Zoop 1. Total number of each species of copepod incubated. Numbers of eggs per female and station at which highest egg production was recorded. NP not producing eggs.

Species	Nos fems inc	Nos eggs fem d^{-1}	Station
Calanoides acutus	707	46	7.10
Rhincalanus gigas	871	29	8.3, W1.2S, W2.2N
Calanus propinquus	128	157	7.10
Metridia sp.	115	NP	

Generally EPRs for all species were low on the first three transects and variable to low on the fourth and fifth. On the latter two transects elevated rates were coincident with a small bloom found to the south of the South Orkneys. Higher rates were evident at the top of transects six and seven north of the SACCF closer to South Georgia. At the southern end of transect 7 (Stns 7.10 and 7.11) and again at the first few stations on transect 8 EPR for most species was maximal. Overall rates were highest on transect 8. Rhicalanus gigas females were the only ones found in the WCB and here EPRs were comparable to previous years with the offshore regions supporting highest rates.

First impressions are that there was a good correlation between EPRs and patterns of production inferred from SeaWiFS images. This will be explored later once samples relating to food quality and species composition are analysed.

VERTICAL PROFILES

Observations during the course of the cruise indicated that at many of the more southerly stations plankton in the 0-400 m bongo hauls was more abundant than in the 0-200 m hauls. This suggested that there might be differences in the depth distribution of populations across the survey area. Accordingly hauls were carried out, primarily on transects 6 and 7, to investigate this. Stations worked were chosen in relation to their position in relation to the mean climatological positions of the SACCF and the SACCB such that 2 hauls were carried out in each water type. A subjective evaluation of species distribution indicated that at the northern end of the transects (Stns 6.6 and 7.1) in waters north of the SACCF, R. gigas and C. acutus were concentrated in the upper 200 m despite being present throughout the water column. At the southern ends (Stns 5.5 and 6.2) below the SACCB, C. acutus in particular was most abundant between 300-450 m. Stations lying between the SACCF and the SACCB (Stns 6.4 and 7.5) showed an intermediate distribution. These samples will be worked up in the UK and will be used to set near-surface observations in context, particularly in relation to physical observations as seasonal changes in depth distribution will have important implications in terms of mass transport.

The final LHPR at Stn W2.2N, to the north of South Georgia, was carried out in response to the presence of significant numbers of krill larvae in the near-surface bongo net hauls. This very unusual finding is at odds with the fact that, despite many years of sampling in the region, we have not detected larval krill so close to the island before. Successful development was not thought to take place although the reasons for this were unclear. These samples in conjunction with the oceanographic observations may shed light on this unusual occurrence. During this single daytime haul, krill larvae were centered in a distinct layer from 90-120 m, although it was not possible to see from the gauzes whether eggs or newly hatching naupliar stages were present further down the water column.

LIPID BIOSYNTHESIS

Marine copepods require large quantities of polyunsaturated fatty acids for growth and reproductive processes and generally obtain substantial amounts of these 'essential' dietary nutrients from their microplanktonic diet. However, the ability or otherwise of marine copepods to themselves produce PUFA, particularly 20:5(n-3) and 22:6(n-3), has not been established. To definitively address this issue a method has been developed whereby the precursor to long chain PUFA i.e.,18:3(n-3) has been labeled with a stable isotope of hydrogen (deuterium). Any elongation and desaturation of deuterated 18:3(n-3) into 20:5(n-3) and 22:6(n-3) can then be tracked quantitatively.

Experiments were conducted on Oithona similis during the Scotia Sea phase of the cruise and on Calanoides acutus obtained during the western corebox sampling campaign off South Georgia.

Copepods were incubated for 24 hours with an emulsion of the deuterated 18:3(n-3) tracer. The emulsion also contained a lipid specific stain (Nile Red) to provide a visual conformation of ingestion of the liposomes by the copepods. Copepods readily ingested the liposomes, as evidenced by pink vesicles in the gut, and uptake of the Nile Red stain by the lipid vacuole. A series of experiments were run for 96 hours with samples being taken at intervals of 24 hours to provide a time course of lipid biosynthesis.

Samples will be analysed by gas chromatography mass spectrometry (GC-MS) in conjunction with Dr Michael Bell at the institute of Aquaculture at the University of Stirling. These Southern Ocean studies will complement similar investigations on Calanus finmarchichus that were undertaken in the Irminger Sea, N Atlantic during the spring of 2002.

ANCILLARY MATTERS

Equipment as usual functioned extremely well again this year. The modification to the LHPR cod-end box involving the inclusion of a mechanism to allow venting of the plankton until ready to fish, thus conserving gauze, was a great success. Many thanks to Doug Bone for designing and building this useful add on. Similarly the bongo nets were very heavily used again this year but performed faultlessly.

ADDITIONAL SAMPLING

Seawater samples were collected for Mike Zubkov (SOC) for analysis of bacterial numbers. Twelve samples (a complete CTD rosette profile) were taken at selected stations. Initially the first 14 stations were sampled and thereafter at every other station until completion of the transecting. Additionally all 6 stations in the western core box were sampled. Samples were treated according to defined protocols and frozen at –80°C.

POST LARVAL KRILL STUDIES.

RACHAEL SHREEVE, GERAINT TARLING, ANDREW HIRST,

ANGUS ATKINSON, DAVID POND, KATE ARNOLD.

INTRODUCTION

Growth rates of post larval krill have been reported to be much higher around South Georgia than for comparable sized krill within the Scotia Sea. To investigate this, growth rates were measured over a wide spatial scale, ranging from Elephant Island in the Scotia Sea to an area to the north of South Georgia. The methodology employed was the same as that used on the previous seasons cruise JR70, which was undertaken in an area to the north of South Georgia. The data from both the current cruise and the previous years will be examined in relation to temperature as well as feeding, diet, food quantity and quality. The data will allow us to obtain a more mechanistic understanding of the factors affecting growth, and are aimed towards the generation of first-stage predictive models for krill growth rate. The method employed for growth rate studies is described below, with a summary of the growth rates obtained for each swarm of krill sampled.

In conjunction with growth rate experiments, we incubated and preserved krill for a wide suite of measurements that enable a more in-depth examination of how the food environment translates to krill growth and reproduction. A detailed breakdown of the net hauls that collected krill, and the sites of krill experimentation and preservation, are in Appendix krill 1 and krill 2.

FEEDING, DIET AND BIOCHEMICAL COMPOSITION.

Freshly caught krill were frozen at –80°C immediately on capture (T0 animals) from 48 contrasting sites at South Georgia and in the Scotia Sea. These will be dissected for gut content analysis to examine diet and the importance of alternative food items to diatoms. Faecal pellets were collected from 26 of these sites for similar analysis. The distribution of sites where T0 animals were collected and where feeding experiments were carried out is plotted in Fig 1 (top and bottom left respectively). To examine throughput rates of phytoplankton we measured gut evacuation rates at 15 sites. Freshly caught krill were placed in filtered seawater to evacuate their guts, while samples of ~15 individuals were frozen at 15 min intervals for ~1.5 h to trace the rate of emptying of the gut.

Lipid and elemental analysis of the krill in the U.K. will provide further insights, over longer timescales than gut analysis, of the nutritional condition of the krill in relation to transport across the Scotia Sea. Krill were also starved for 24 h before preservation, to allow potential isotopic analysis of their trophic level, in relation to regional change in the food environment.

ENERGETICS

Freshly caught krill were measured and sexual maturity stage determined following the method of Makarov and Denys (1981). Animals were preserved immediately at -80 °C. A total of 810 animals were preserved from 30 swarms, summarised below (Table 1). Mean length and modal sexual maturity stage are presented, but caution must be used in comparing these results with those obtained from the IGR experiments as only small sample sizes were used and the selection of animals for preservation was not necessarily strictly random, (however mean lengths are similar).

Event	Net	Number of Samples	Mean length	Modal Sex_stage
27	2	30	34	MS1
43	2	30	32	MS1
49	1 and 2	20	32	FS
67	2	20	28	J
85	2	30	49	FA3
90	2	20	49	FA3
121	2	8	48	FA2
144	2	30	44	FA2
153	1	30	41	FA1
186	1	20	27	J
195	1	30	46	FA2
205	2	30	49	FA3
215	1	30	41	FA2, J
255	2	10	46	MA2
255	1	20	42	MA2
277	2	20	37	J
292	2	20	33	J
292	1	20	32	J
300	1	30	42	J
318	2	30	46	FA3
331	1	20	49	FA3
335	2	20	51	MA2
350	2	30	42	J
440	2	10	53	FA3, FA4
476	2	30	55	FA5
498	1	30	35	J
551	2	20	51	FA5
571	2	10	54	FA5, MA2
603	2	30	52	FA4

TABLE 1

A number of animals from a selection of events were also dissected and muscle tissue, digestive gland and ovaries preserved at – 80 °C. Preserved samples will be analysed on return to Cambridge for elemental (C, H, N and P) and proximate composition (protein, carbohydrate, lipid, chitin and nucleic acid). These data will be used to further inform work started on samples from JR70 to produce a stoichiometrically consistent composition of krill. The temporal and spatial variability of these data will also be examined and the results incorporated into work developing an energy budget for krill and energetic models of krill transport.

GENETICS

Krill samples were frozen and preserved in 95% ethanol for a genetics study by Simon Jarman at Australian Antarctic Division. He will combine their krill caught from the Indian Ocean with the regional coverage of the Scotia and Northern Weddell Sea from this cruise, to examine evidence for genetically distinct sub-populations. The method will examine microsattelites DNA to look at variation within and between swarms as well as between areas. This is a more sensitive approach than mitochondrial DNA methods applied during the "Gene-flow" experiments.

OVARIAN MATURATION

In the majority of instances, a random fraction of the catch was preserved in formalin for analysis of the ovaries. The distribution of sites where this procedure was performed is plotted in Fig 1. This will be carried out at BAS HQ following the protocol of Cuzin-Roudy and Amsler (1991). This method is superior to that of the Makarov and Denys scale because it takes in to account the potential for females to enter repeated ovarian cycles. It also will give an insight in to whether the females were at the start or end of the reproduction period. These patterns will be of much interest in determining the factors behind the lack of the normally abundant larvae in the Scotia Sea during this cruise.

SPERM

Sperm sacks were obtained from mature male krill and preserved for future C:N and lipid analysis. Previous evidence has suggested that the reproductive costs incurred by male krill may be high and that this could be attributed to energy intensive mating behaviour. However, the biochemical content and composition of krill sperm has yet to be determined and given the continuous nature of krill mating behaviour, sperm production could potentially constitute a significant energetic cost for male animals.

INSTANTANEOUS GROWTH RATE

METHOD

The method used for determining krill growth rate is known as the Instantaneous Growth Rate (IGR) method. This involves incubating freshly caught animals individually for several days and recording the fraction that moult. The inverse of this moulting frequency is the inter-moult period. If krill are growing, the new body is larger than the moulted exoskeleton, by a fraction known as the percentage growth per inter-moult period. If a krill is shrinking then once again the change can be expressed in a similar way, but in this instance the value is negative. The average daily percentage growth rate in length is a product of the moulting frequency and the percentage growth per inter-moult period.

Krill were caught with the RMT 8, the two nets of which were used to target separate swarms, where possible. The krill were transferred to 500 ml perforated pots maintained in three tanks of ~0.5 m^3 in the cold room. Filtered seawater was pumped through these tanks at ~1-2 L min^{-1}, at ambient seawater temperature. At daily intervals, usually for a total period of 5 days each animal was checked to ascertain whether it had moulted. Those that had were removed and both

uropods on the moult and the new animal were measured to determine the percentage

growth per inter-moult period. The first ~120 animals in the experiment, both moulters and non-moulters, were also measured and ascribed to sex and maturity staged according to the Makarov and Denys scale.

PRELIMINARY RESULTS

A total of 5443 krill were incubated. These were from 29 separate swarms across 25 stations. Krill Growth (percentage increase in length per inter-moult period) was highly variable, both between individuals in an experiment, and between experiments, means growth rates for swarms varied from 0.2 to 2.84% per inter-moult period. Mean growth per inter-moult period was slightly less than that for the previous cruise (2% compared to 3.57 %). Whilst krill in the Scotia Sea gave the highest recorded levels of growth from either of the two cruises, negative growth was also recorded for some individuals in this region. Numbers of individuals incubated from each swarm, their mean length, and average growth rate are reported in table krill 1.

TABLE KRIL 1. *EUPHAUSIA SUPERBA*. DETAILS OF THE 24 IGR EXPERIMENTS. THE FINAL TWO EXPERIMENTS (EVENTS 648 AND 676) ARE ONGOING AT TIME OF WRITING AND ARE NOT INCLUDED HERE.

Event	Mean length (mm)	% growth per inter-moult period			Inter-moult period (days)	Number of krill incubated
		Mean	Minimum	Maximum		
27	35	0.65	-2	5	25	300
43	31	1.98	-1	7	23	240
49	33	2.09	-2	8	20	150
67	30	3.7	0	10	18	168
90	50	2	-1	8	75	90
144	42	2.4	0	8	17	300
153	40	3	0	8	30	304
186	30	10	0	18	11	229
195	44	0.6	-1	3	74	360
255	42	0.6	-1	4	32	210
277	40	2	-1	9	19	360
292	32	1	-4	7	16	258
300	38	2	-1	12	18	90
331	48	0.5	-1	5	53	138
350	42	2.6	-4	13	19	150
440	48	0.2	-3.6	7.3	31	306
443	51	0.15	-2.5	7.3	30	300
498	36	11	5	28	14	186

550	50	1.9	-1.4	7.3	31	298
571	53	0.3	-2.4	3.2	41	282
605	47	2.8	-1.2	7.5	40	390
637	46	2.84	0	5.7	23	156

MOULT AND MATURITY STAGING

Following to 5-6 day incubation for IGR, the total length, maturity and moult stage of the animals that did not moult during the experiment were carried out following the same protocol as JR70. Rachael always performed the measurement of length and followed the Makarov and Denys scheme to stage maturity whilst Geraint moult staged the same animals following the field-guide provided by Janine Cuzin-Roudy. For future reference, the categories in this field-guide were the following.

Stage	Animal	Lappet or Uropod
A	Soft	New cuticle thin and soft; epidermal tissue vacuolised; blood lacunae invading setae
B	Soft	Cuticle still flexible; lacunae withdraw from setae and condense into one large blood lacunae
C	Hard	Cuticle thick; epidermal tissue dense with organised setal matrices ("stripe pattern")
D0	Hard	Epidermis retracted from cuticle
D1	Hard	Invaginations developed between setal matrices
D2	Hard	New cuticle conspicuous on epidermis and inside invaginations
D3	Soft	Two cuticle layers; old cuticle thin; new setae folded inside the appendage
E	Flaccid	Old cuticle detached; new setae unfolded

Note: Any animal that moulted on the day the experiment was taken down was staged as A. Category B were rare because even the most recently moulted individuals should have progressed to stage C after the 5 days of incubation. The presence of category B suggested that the animal had moulted during the experiment and either the moult had been missed during the checks or the animal had ingested it.

Note 2: Determining whether the animal was at an early, middle or late stage in their respective category added further detail to the above scheme.

At least 120 animals from the IGR experiment were examined in the majority of instances where numbers were sufficient. Around 25 experiments were carried out (See Table Kril_1), making the total number of measured animals more than 3000.

ANALYSIS OF MOULT STAGING

The rationale for carrying out the moult staging is to determine whether the distribution of stages was random in each experiment. This assumption is relied upon by the IGR method and its violation results in the estimate of inter-moult period (IMP) being biased. Detailed statistical analyses to determine this will be carried out at BAS HQ.

If any experiment is found to contain a non-random distribution of animals, it can be used to make an alternative estimate of IMP. The non-random distribution implies that there is some degree of synchrony in the population, which would be apparent as a concentration of individuals in a small number of stages. The stages in which the population is concentrated after 5 days of incubation can be compared to that at the start of the experiment, using the animals frozen straight after capture (the T0 animals – see above). Each of the moult stages lasts for a known percentage of the entire IMP (Buchholz, 1991). Comparing the incubated animals to the T0 animals will indicate what percentage of the full IMP was covered during the 5 days of incubation. The inverse of this value will give an estimate of IMP. T0 samples will be examined for moult status at BAS HQ to allow this calculation to be carried out.

LARVAL KRILL GROWTH

There are major uncertainties about whether the adult krill at South Georgia are advected there from the Peninsula, or if they are a self-sustaining population there. Krill larvae have been reported near South Georgia during the austral winter, but are only observed in small numbers during summer months. It was hypothesised that the lack of larvae in abundance at South Georgia was due either to them starving on the way from the Peninsula across the Scotia sea, or that 3D ocean currents deflected the larvae to the south. To investigate their ability to cross vast areas of open ocean one of the primary objectives on the cruise was to look at the growth rate of larval krill, their diurnal vertical migration (DVM) and their tolerance to starvation. However, no krill larvae were found around Elephant Island and the South Orkneys as we had anticipated. Calyptopis were first encountered to the south of South Georgia, by which time it was deemed too late in the cruise to begin detailed work on the larvae. More larvae were found to the north of South Georgia, at the northwestern end of the western core box. This is a very interesting observation, as krill larvae have never been reported in any great numbers at this time of year in the South Georgia area. LHPR hauls were carried out in the vicinity of these larval patches (see Mesozooplankton section). Furthermore, two moulting and growth rate studies were undertaken, which showed very rapid development of the calyptopis stages CI and CII, and concur with similar experiments which were undertaken during the synoptic survey conducted across the Scotia sea in 2000. Given the moulting rates estimated (see below) for the calyptopis stages, these larvae would have to have been spawned in the vicinity of South Georgia.

METHODS.

Two methods were employed to estimate the moulting rate of larval krill. The pros and cons of each will be discussed below.

Method 1. Individual krill larvae, un-staged, were transferred to 25 ml vials full of filtered sea-water. These were incubated at ambient sea-surface temperature for 48 hours, and the preserved by the addition of 40% formaldehyde solution. This method proved very labour intensive, but will allow us to look at the reported incidence of intermediate stages of development between calyptopis stages. Individuals were taken at time 0 for dry and carbon mass determinations.

Method 2. Krill larvae were identified to stage at the beginning of the experiment, and groups of 30 individuals of like stages were incubated for 48 hours in filtered sea-water, at ambient sea-surface temperature. Individuals were then staged again, and the number of moulters and non-moulters counted. Individuals were then placed in pre-weighed tin foil capsules for dry and carbon mass determinations, with moulters and non-moulters preserved separately. This

method is more efficient for handling larger numbers of krill larvae, but will not allow us to look at intermediate stages of development as method 1 will.

Stage durations for larvae were calculated as the reciprocal of the number of individuals moulting, divided by the total number incubated, divided by the length of time of incubation (in days). Results are given in table Kril_2.

TABLE KRIL_2. *EUPHAUSIA SUPERBA*. NUMBER OF INDIVIDUALS INCUBATED AND NUMBER MOULTING, IN MOULTING RATE EXPERIMENTS. STAGE DURATION GIVEN IN DAYS. NM NOT MOULTING.

Stage	Stage I incubated	Stage i +1	Stage duration (d)
ci	161	85	3.78
cii	88	46	3.79
ciii	23	0	NM

EFFECTS OF LONG TERM FREEZING AND STORAGE ON THE CARBON AND NITROGEN CONTENTS OF MARINE INVERTEBRATES.

INTRODUCTION.

It has been well documented in the literature over the last 20 years, that the method of initial handling and preservation of copepods may change their chemical composition. In remote locations, such as the Southern Ocean, immediate analysis of samples is made logistically difficult, and so preservation is a necessary procedure. Freezing samples at –80°C has become a common method to preserve samples for further biochemical analysis. However, nitrogen in particular has been shown to be lost from frozen samples, whilst carbon does not appear to change significantly. This results in an increase in the C:N mass ratio. Preliminary results have shown that nitrogen loss may increase with the amount of time that samples remain frozen. In order to investigate this further, samples of krill and copepods were collected and kept in the freezer for varying lengths of time before being dried and analysed for their CHN content.

MATERIALS AND METHODS

Individual *Calanoides acutus* stage CV was sorted from bongo net hauls, rinsed in ammonium formate and blotted dry before being transfer in pairs to pre-weighed tin foil capsules. Seven batches of 30 copepods were treated in this way with the process being carried out at three stations. Similarly, at three locations 7 groups of 30 krill were isolated from hauls, blotted dry and laid in plastic trays. For each experiment one batch of copepods or krill were dried immediately at 60°C for 24 hours. The six other batches were frozen at –80 °C and were then left in the freezer for either 1 day, 1 week, 2 weeks, 1 month, 2 months, or 3 months, before being dried. These samples will be analysed for their carbon and nitrogen content back in the UK. Below is the drying schedule for each event.

Krill Trays Event 49

Time interval	Day of drying
T = 0	12/01/03
T = 1 day	13/01/03
T = 1 week	19/01/03
T = 2 weeks	26/01/03
T = 1 month	12/02/03
T = 2 months	**12/03/03**

Krill Trays Event 498

Time interval	Day of drying
T = 0	04/02/03
T = 1 day	05/02/03
T = 1 week	11/02/03
T = 2 weeks	18/02/03
T = 1 month	**04/03/03**
T = 2 months	**04/04/03**
T = 3 months	**04/05/03**

Krill Trays Event 605

Time interval	Day of drying
T = 0	13/02/03
T = 1 day	14/02/03
T = 1 week	20/02/03
T = 2 weeks	**27/02/03**

T = 1 month	**13/03/03**
T = 2 months	**13/04/03**

Copepod trays event 403 (experiment A)

Time interval	Day of drying	Amendments?
T = 0	31/01/03	
T = 1 day	01/02/03	
T = 1 week	08/02/03	12/02/03
T = 2 weeks	14/02/03	
T = 1 month	**28/02/03**	
T = 2 months	**31/03/03**	

Copepod tray event 612 (Experiment C)

Time interval	Day of drying	Amendments?
T = 0	13/02/03	
T = 1 day	14/02/03	
T = 1 week	20/02/03	
T = 2 weeks	**27/02/03**	
T = 1 month	**13/03/03**	
T = 2 months	**13/04/03**	

Copepod tray event 623 (Experiment B)

Time interval	Day of drying	Amendments?
T = 0	14/02/03	
T = 1 day	15/02/03	
T = 1 week	21/02/03	
T = 2 weeks	**28/02/03**	

T = 1 month	**14/03/03**	
T = 2 months	**14/04/03**	

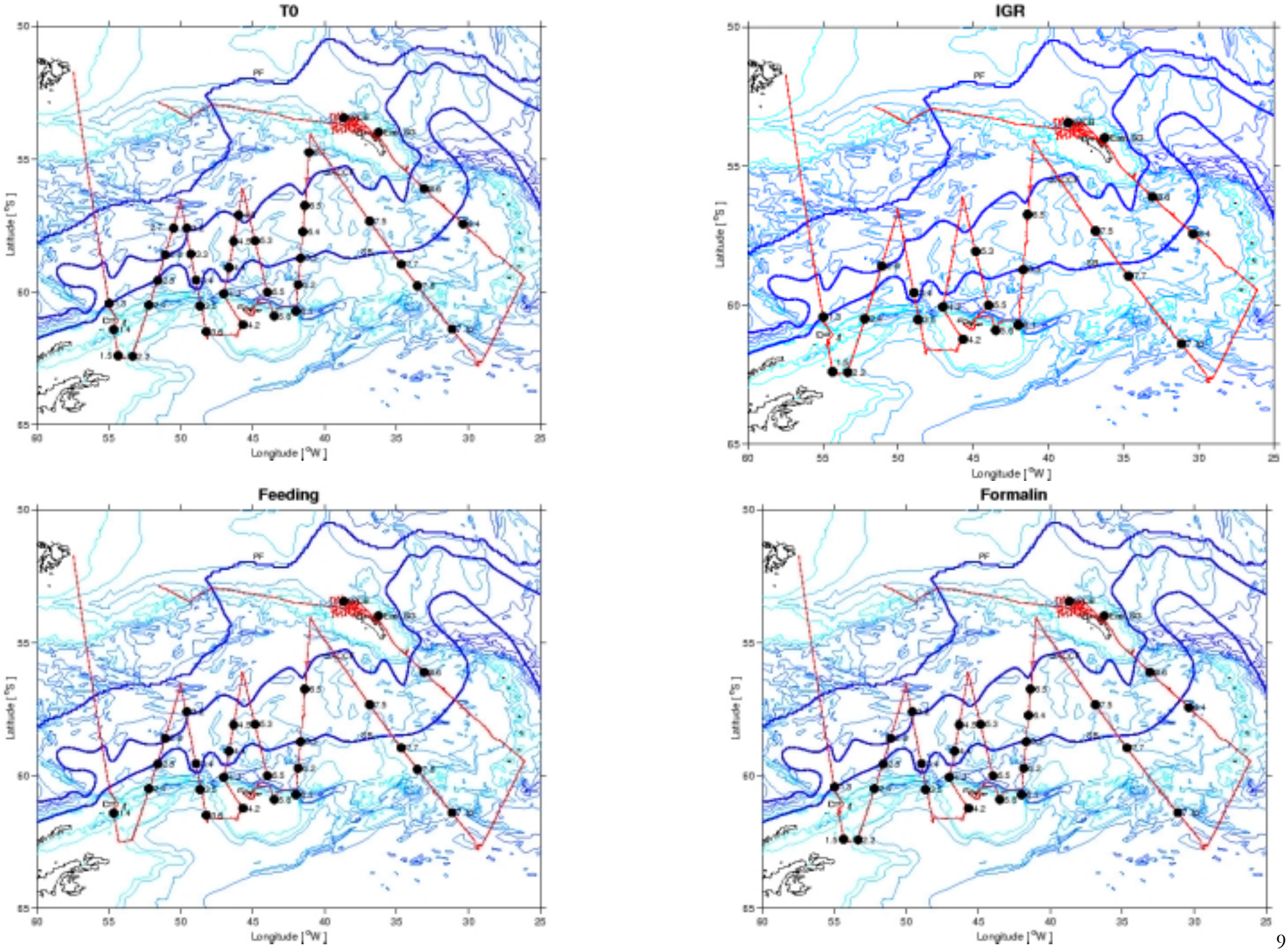


Fig 1: Experimental and preservation station distribution (T0 – random animals frozen immediately after capture; IGR – incubations of 100-200 animals to determine growth; Feeding – gut clearance and fecal pellet investigations; Formalin – 50 to 200 random animals preserved for ovarian analysis

Appendix 1:

JR82: KRILL 'TARGET FISHING_1' (UNTIL STN 6.5), PLUS PRESERVATION OF FROZEN MATERIAL

Red text shows which minus 80 box the sample was put in

Stn	Event	Date (03)	Time inboard	Net 1					Net 2					Gut evac/faecal pellet experiment Preservation after 24 h gut clearance	Moulting expt settup
				Target depth	Krill size	T_o sample	Genetic sample	Form' sample	Target depth	Krill size	T_o sample	Genetic sample	Form' sample		
1.3	25 Bongo	10.1	(Bongo)	Bongo	-	1 krill in box 19 30 salps in box 6									
1.3	27	10.1	1445	100m?	40-45	30 (1 tray in box 16)	-	Yes	40m	20-40 2 sizes	1 tray says it a t_o in 16 5 trays, prob t_o in 16 1 tray "selected small k" in 6 1 bag in 19	?	?	-	Tubes1-50 @1515 Random krill (net 2) incl smaller ones
1.4	33	11.1	~0100	?	~20	60 in petri dishes in 19	none?	none?	-	-	-	-	-	Excess krill from moulting in 9	51-65 poor condn. Expt terminated next day
1.5	43	11.1	1255	?	small	5 trays (labelled as e41?) in 16	100 in 4	Yes	?		4 trays (labelled as e41?) in 16	?	?	-	Net 2 in tubes 70-109
2.2	49	11.1	2150	Sep swarm to net2	small	5 trays in 16	100 in 4	Yes	Sep swarm to net1	Small	5 trays in 16	30 in 4 80 in 25	?	-	Net1 in tubes110-134 @2200
2.3	60													Krill pellets collected from Bongo bucket event 60, purified and frozen in 2 tubes	
2.4	67	12.1	2120	Sep	Large	"60 krill frozen"	none	none	Sep	20-35	3 trays in 16	200 krill	~200	From net 2, fp's collected	Net 2 in tubes

				swarm to net2	~40	2 trays in 16			swarm to net 1			in a bag in 21	krill	after 3 h, ans preserved after24 h of clearing guts in 9	200-227
2.5	80 Bongo					Salps in 100 micron net in 6									
2.5	81 (0-200m Bongo	13.1.	?		Adult males	3 krill in 16	-	-	-	-	-	-	-	-	-
2.5	85	13.1	1345	2 shallow layers	>40	4 trays in 6 ~15 salps (net 1 or 2) in 6	100 in bags in 21	Yes	2 shallow layers	>40	1 trays in 5 2 trays in 6	100 in bags in 21	yes	Net 2 fp's collected after2.5 h, and ~40 krill frozen after 23h in 15	None
2.6	90	13.1	~2130	?	>40	-	-	Yes	?	>40	2 trays presumably net 2 in 6 1 tray in 7 1 tray no to label in 5 5-6 salps in 19	Yes in 21	yes	Net 2 expt settup for faecal pellets and 60 krill starved for 24h in 15	Net 2 in tubes 51-65 @2200
2.6	91 (neuston)	13.1	~2130!!!!			16 salps frozen not located									
2.7	101	14.1	?	?	Juvs and adults	30-4o in tray in 5 1 bag of 10 krill (says it's a to) in 6 "plus another~30 krill 1 h later" 2 fish in Tony's box	20 in 4 (could be those frozen 1 h later)	-		-	30-40 krill in bag in 6	-	-	-	-
3.1	No record of fishing														
3.2	121	15.1	1115	?	40-50 Small catch incl	20	-	Yes	?	40-50	2 trays in 5 1 tray in 15	40 krill (not in great condn) in	50 krill (not in great condn)	15 krill from net 2 after ?24h? gut clearance in 8 (NB its in wrong box)	-

					Themisto							21			
3.3	133	15-16.1	Night	No krill, caught big Themis and salps?	?	200 salps preserved don't know which net Not sure if it's a t_o, Kate preserved these In 6	-	-	-	-	200 salps preserved don't know which net Kate preserved these in 6	-	-	-	-
3.4	144	16.1	1115	Both nets through single big swarm/ layer	20-45 Most >30	2 trays (and probably another with no label) in 5	~100 krill? (not sure if just 1 net preserved)	~300 krill? (not sure if just 1 net preserved)		20-45 Most >30	4 trays in 5	~100 krill in 21	~300 krill	Faecal pellets collected and froze 100 krill in 2 bags after 37 h gut clearance Net 1 gut clearance in 15 Presumably net 2 in 2 bags in 9	Net 2 in tubes 1-50 at 1230 Last 20 krill on takedown in bags not trays
3.5	153	16.1	2315	Both nets big catches from ~7m depth	25-40	4 trays (~200 krill) in 5	100 in bag	200 krill	Both nets big catches from ~7m depth	25-40	none	none	none	Faecal pellets collected and froze ~100 live krill after 24 h in 15 and 9	Net 1 in tubes 70-119 at 0015 on 17.1
3.6	164	17.1	Daytime I think	?	?	1 tray in 6	Some?	none	Not many krill	?	2 trays, 1 is unlabelled, in 5	~100 in 4	none	Faecal pellets collected and froze ~15 live krill "net 2" after 24 h in 15	
4.2 bloom	184	18.1	1700	?	40 (1 krill)	-	-	-	-	-	-1 bag with 1 krill, 2 fish larvae Not located: maybe in	-	-	-	-

											Tony's box				
4.2 (bloom)	185	18.1	~1730	?	-No krill, lots Thyss	2 fish larvae and ~20 adult Thysanoessa in bag Not located, maybe in Tony's box	-	-	-	-	-	-	-	-	-
4.2 (bloom)	186	18.1	~1800	Big catch of krill in net 1	25-30	2 trays and 1 bag together, in 5	Yes in 21	Yes	-	-	-	-	-	Faecal pellets picked 2.5 h later, pres on 200 micron gauze in petrislide	Net 1 settup in tubes 120-134 and 200-227
4.3	195	19.1	~1200	Bigger catch in net1, from deeper layer	~40	1 tray in 5 2 bags in 6	Yes in 4	Yes	Some	?	2 trays in 5 1 bag in 7	?	?	Prob net 1. All faecal pellets collected after 3 h, but 24 h starved animals were chucked by mistake	Net 1 settup 1300 in tubes 51-65
4.4	205	19-20.1	Nightshift!	?	?	3 trays, prob t_o, doesn't say which net, in 6 a to, not said which net in 19	**?**	**Yes**	**?**	**?**	**?**	**?**	**?**	Gut evac set up, and frozen in trays/bags for first 12 h and at 24 h (at 15, 30 45,60,75 min and 1 h later) 12 h sample in 8, but other timepoints in14 faecal pellets collected 50 krill frozen after 24h gut clearance, 2 bags in 15	-
4.5	215	20.1	1130	Both nets in a	25-50	2 trays in 7	Bag in 4	~100 krill	-	-	-	-	-	Gut evac net 1 settup at 1145 (T=1.3^{O}C) 15 variable size k per	-

				continuous layer										timepoint. T1 at 1150 T2 at 1200 T3 at1210 T4 at1220 T5 at1230 T6 at1240 T7 at1250 These in 11 Too few fps to collect (green hepatos but empty guts), krill frozen after 26 h (2 bags in 15) 1st of 100, 2nd bag of 8	
4.6	227	20.1	2315	6m	45	14 krill in 5 20 salps in 6 1 h later	-	-	17m	45 mm	22 in 5 green hepatos 30 salps in 19 1 h later, random sizes, poor condn.	-	-	-	-
5.3	255	22.1	1400	Shallow	40-50 lots males, this event krill not in brill condn	2 trays in 7	~100 in 21	~100	shallow	Same as net1	2 trays in 5 and 1 bag, frozen 1412. I think it was mislabelled as 225, in 7	-	-	From net 2 settup1408 T1 at 1423 T2 at 1438 T3 at 1453 T4 at 1508 T5 at 1523 All these in 11 15-20 per timepoint plus small no of faecal pellets at 1730 60 (net 1 plus 2) krill	22.1.03 at 1425 net 1 tubes 14-25 net 2 tubes26-36

														pres together after 26 h gut clearance "net 1 after28h" in 15	
5.4	266	23.1	~0230	31 m	none	-	-	-	10 m	None Only Thys in net2	-	-	-	-	-
5.5	277	23.1	1600	Swarms at 50 m	35-45	2 trays in 5	~200	~200	Different swarms to net1 at 50 m	35-45	2 trays , 1 bag in 5	50 in 21	-	Net 2 settup at 1610 T1 at1616 T2 at 1631 T3 at 1646 T4 at 1701 T5 at 1715 T6 at 1731	Net 1 tubes 37-59 Net 2 tubes 70-119 At 1630 on 23.1

														T7 at 1746 These all in 3 15 k per timepoint T=-0.5 °C All their fp's collected 2300 on 23.1 Extra fp's from net 2 also collected then on "unquantified" petrislide 24 h starved krill (~60?) prob in 9 or 15, in 2 bags 50 krill from moulting takedown (untrayed) in 9	
5.6	292	26.1	0220	43-28 m	~20	2 trays in 6	100 in 4	Yes (net 2)	38 m	~30	2 trays in 6	100 in 4 100 ethanol	200	T1 at 0245 T2 at 0300 T3 at 0315 T4 at 0330 T5 at 0345 T6 at 0400 T7 at 0415 These all in 3 but 1 marked "endtime" is in 15 Plus faecal pellets Collected 24 h gut clearance is in 15	Net 1:205-227 Net 2: 200-204 Set up 0300 on 26.1.03
6.1	299	26.1	1330	60 m	~40	20-30 in bag in 6	-	-	60m	?	20-30 in bag in 6	-	-	-	-

6.1	300	26.1	1430	60m similar layer to net 2	~30-40	1 tray (~100) in 5	~100	~50	60m similar layer to net 1	~40	1 tray (~100) in 5 1 bag (~40) in 6 (poss a genetics sample?)	Bag of ~50, maybe the bag can be used	~50	Net 2 Set up 1440 T1 at 1455 T2 at 1510 T3 at 1525 T4 at 1540 T5 at 1555 These all in 3 (15 krill per timepoint) fp's from 17 remaining krill all collected at 2030 on 26.1.03 100 net 1 krill frozen after 30 h gut clearance in 9 Ditto for net 2 in 9	Net 1: tubes 51-65 At 1500 on 26.1
6.2	318	27.1	0825	20-30m	30-40	1 tray in 7 1 bag 100 ?	~60 in 4	Yes (net 2)	15-20 m	40	2 trays in 5	100 in 4 plus 50 in ethanol	yes	To's at 0835 Net 2 Set up T1 at 0850 T2 at 0905 T3 at 0920 T4 at 0935 These all in 3 Lots fp's collected, at 1530 on 27.1 40 krill frozen from net 2 after 28 h gut clearance in 9	-

6.3	331	27.1	~1920	Shallow?	40-50	2 trays and 1 bag Not found/recorded	(the t_o bag could be used)	- (too few) (see net 2)	shallow	40-50	2 trays. Pale hepatos,fairly empty guts Not found/recorded	1 bag (~100?) done at t_o time Not found/recorded	~200	No gut evac, just faecal pellet collection at 2300 on 27.1	Net 2: tubes 1-23 at 1930 on 27.1
6.4	335	28.1	0415	30 m	40-50	3 trays Not found/recorded	-	50	40 m	None, no rec of catch					
6.5	350	28.1	1850	Sev swarms, diff ones in net 1 and 2	30-50	1-2 trays Not found/recorded **NB "e355 stn 6.5 net 1 I tray in 7"**	1 bag (also usable as a t_0	~300	See net 1	30-50	2 trays Not found/recorded	Bag also usable as a t_0	None (all were dead)	T_o's done at 1900 Net 2 Settup at 1900 T1 at 1915 T2 at 1930 T3 at 1950 T4 at2000 T5 at 2015 T6 at 2030 faecal pellets collected at 2330 on28.1. More possibly collected at 0030 on 29.1? These all in 11 Net2: froze ~100 after 27 h gut clearnce Not found/recorded 40 mm krill, dark green hepatos	Net 2 tubes 24-48 settup 1900-1927 on 28.1

														Not found/recorded	

Stn	Event	Date (03)	Time inboard	Net 1					Net 2					Gut evac/faecal pellet experiment	Moulting expt settup
				Target depth	Krill size	T_o (freshly frozen) sample	Genetic sample	Formalin sample	Target depth	Krill size	T_o(freshly frozen) sample	Genetic sample	Formalin sample		
6.6.	-					No fishing done, no swarms seen									
6.7	373	29.1	~2100	~40 to 10 m	30-50 mm grav female	9 in bag in 6, no event label Big catch of small Themisto	-	-	10-0	30-50 grav female	2 krill (squashed so not pres) Big catch of small Themisto 10 salps in 6 (labelled wrongly as e370)	-	-	-	-
7.1	396	30.1	1550	~110m	None caught	-	-	-	~110	None caught	4 myctophids and 8 salps frozen sample not located: maybe all in Tony's box	-	-	-	-
7.2						Net not fished									
7.3						Net not fished									
7.4	427	1.2	0530	131-106 (no target	5	Kate preserved these in her boxes	-	-	117-surface, no target	None caught prob	-	-	-	-	-
7.5	440	1.2	1930	~40 m sev	Mainly large,	I tray plus 1 bag all in 7	Could use a t_0 bag	-	~40 m sev swarms	Mainly large,	I tray plus 1 bag all in 7	Could use a t_0 bag for	~100 dying	T_o frozen at 1940 Settup from net 2 at 1940	Net 1 tubes 61-65 and 70-80 at 2025

				swarms within same cluster as net2	incl grav females, also ~30mm size class		for genetics		within same cluster as n	incl grav females, also ~30mm size class		genetics	krill	T1 at 1955 in 3 T2 at 2010 in 8 T3 at 2025 in 3 T4 at 2040 in 3 T5 at 2055 in 3 15 krill per timepoint Faecal pellets collected at 2359 50 net 2 krill frozen in 2 bags after 24 h gut clearance in 9 ~30 krill frozen from net 1 after 26 h gut clearance in 9	Net 2 tubes 1-23 and 49-60 at 1940 on 1.2
7.6	No event no. in event log??	2.2.	~0500?	No targets seen		About 2 krill caught? Preserved by Kate in her boxes					About 2 krill Preserved By Kate in her boxes				
7.7	463 mislabelled 443	2.2	2005	Horiz layer at ~20m	Most >50, many grav fems	-	-	~ 50-80 krill from net 1 and 2 combined	Same horiz layer as net 1	Most >50, many grav fems	1 tray and 2 bags in 7, (mislabelled as event 443)	1 of bags usable for genetics	~ 50-80 krill from net 1 and 2 combined	Too few for gut evac. Faecal pellets collection from net 2 harvested to 200 mesh at 2300 on 2.2.03 in 10 V pale fp's: diff diet?? Too few krill for 24 h gut clearance	Net 1: tubes 81-123 at 2030 Net 2: tubes124-130 at 2140 Excess krill at takedown not trayed up are in bag (minus 2 that got away) in 26
7.8	476	3.2	0823	30-59m Single layer in both nets	40	4 trays in 7 Dark hepatos	1 bag ~50 inds, **not** a t₀ in 4	No rec of one	60-39 m Single layer in both nets	40	2 trays in 7	-	No rec of one	Net 2 to's frozen at 0833 T1 at 0848 T2 at 0903 T3 at 0918 T4 at 0933 T5 at0948 All in 8 Faecal pellets (lots, not clean sample), collected on 200 micron at 1200 on 3.2 In 10	None set up, too few krill

														Plus remaining 15 large krill frozen after 27 h in 9	
7.9						Net not fished.									
7.10	498	4.2	0912	30m Huge swarm sampled by both nets	25-30	2 trays in 7	Frozen in 4 and ethanol	yes	20m nets 1 and 2 fished for only a few mins	25-30	2 trays in 7	~50	-	**Which net used????** To at 0920 in ? T1 at 0935 in ? T2 at0950 in ? T3 at 1005 in 8 T4 at1020 in 11 T5 at 1035 in ?	Net 1 and 2 tubes 24-48 and 200-205
8.1	525 0-200m Bongo	6.2	Last Bongo on the stn											Faecal pellets, not necessarily of krill were prominent in net. Those from 100 micron net in 22	
8.2	Net not fished														
8.3	Net not fished														
8.4	550	7.2.	1810	25-30m sampled a continuous layer	30-50 including some grav fems	No to of net 1 Both nets caught fair few Themisto, only ~50 krill in each net.	-	Net 1 and 2 combined: dying krill and rest of catch in 2 pots (~100 krill)		30-50 including some grav fems	3 bags in 27		Net 1 and 2 combined: dying krill and rest of catch in 2 pots (~100 krill)	-	550 nets 1 and 2 combined settup in 53-64 at 1930 on 7.2 Moulters not traed up on takedown in 22
8.4	551	7.2	1850	15-31 same continuous layer as	30-50 including some grav	-	-	-		30-50 including some grav	3 bags in 27 Net 2 contained lots			Too few krill for gut evac Faecal pellets collected at 2230 on 7.2.02, in 1 Guts were v.pale-	551 net 1 in 1-23,49-52,65-76 at 1930 on

				e550	fems some Themis to as well					fems	Thysanoesssa as well as themisto			white. Prob difff diet to normal Krill from net 1 and from e 550 net 1 and 2 pooled and ~30 krill with cleared guts for 20 h in 26	7.2.03 Moulters not traed up on takedown in 22
8.5	560	8.2	~1015	No krill caught											
8.6	571	8.2	2015	~15 m	~40 a few grav fems	~40 krill in 1 bag in 27	-	yes	15-5 m	~40	5 krill in 1 bag in 27	-	-	-	Settup net 1 at 2115 tubes 77-100 Moulders not trayed up on takedown in 22
8.6	572	8.2	2100	15-30m	-	No krill, poss net didn't fish properly	-	-	15-30m	Same as e571	3 bags of 30-40 krill each in 27 plus 2 bags of salps, 880 per bag in 27	-	-	Settup net 2 at 2115 (tos frozen at 2110) T1 at 2135 T2 at 2155 T3 at 2210 T4 at 2225 T5 at 2240 (15 krill per timepoint, in 2 lots faecal pellets onto a petrislide at 2245 in 1 krill preserved after clearing guts for 24 h	Settup net 2 at 2140 Tubes101-123 Moulders not trayed up on takedown in 22
SG	603 SW corner of WCB	13.2	0156 note clocks forward 1 h at SG to GMT –2h	54 m	A few lge krill, themisto, Euchaeta	Krill for Kate Arnold for analysis	-	-	15 m	A few large krill, Themisto	Krill for Kate for analysis	-	-	-	-
SG	604 SW	13.2	0246	35 m same	Mainly Themis	1 bag of 100 frozen at 0315 (combined	-	-	25 m same swarm as	Mainly Themis	1 bag frozen at 0315	-	-	-	-

	corner of WCB			swarm as net 2 so catches combined	to ~50 krill	with net 2) in 27			net 1 so catches combined	to ~50 krill	(combined with net 2)				
SG	605 SW corner of WCB	13.2	0324	40 m Same swarm caught in net 1 and net 2	Sev hundered krill	-	-	-	20 m Same swarm caught in net 1 and net 2	Sev hundered krill	To (100 krill) frozen at 0355? In 27	100 frozen, in 22 100 in ethanol	200 in formalin	Settup net 2 for gut evac T1 at 0410 T2 at 0425 T3 at 0440 T4 at 0455 T5 at 0510 T6 at 0525 T7 at 0540 T8 at 0555 All in 2 and left aninals to clear guts for 36 h: 7 krill in 22 V few faecal pellets in 1	Net 1 and net 2 settup at in tubes 1-65
SG W2.2S	635	?	? (see WCB logsheets?	Nesuston standard haul 1 at stn	? (see WCB logsheets	10 in a bag in 27	-	-	-	-	-	-	-	-	-
SG W2.2S	636	14.2	? ? (see WCB logsheets	Nesuston , stn. standard haul	? (see WCB logsheets	17 in a bag in 27	-	-	-	-	-	-	-	-	-
SG w2.2S	637	15.2	0221	0-250 m standard stn. haul	? (see WCB logsheets)	-	-	-	0-250 standard stn. haul	40-50	250 krill (frozen how long after capture?)	-	yes	No gut evac or faecal pellets	Net 2 set up at 0500 Tubes 70-95
SG Near W3.2S	648	15.2	1512	150-170m Different swarms in net 1 and 2	~40	2 bags in 1/27 NB in ALL labelling, including that here (except for net depths), net 1 and net 2 are actuall transposed and it should be e 649 not 648	-	-	2 bags frozen at 1525	40	2 bags in 1/27 NB in ALL labelling, including that here (except for net depths), net 1 and net 2 are actually	~100 in ethanol	~200	Net 2 set up at 1525 T1 at 1540 T2 at 1555 T3 at 1610 T4 at 1625 T5 at 1653 T6 at 1715 15 sim size krill per timepoint in 2	Net 2 into tubes 96-116 at 1530 on 15.2 Net 1 into tubes 117-130 at 1545 on 15.2

											transposed and it should be e 649 not 648			A few fecal pellets (very dark) on petrislide at 2000 on 15.2 in 1 ~100 krill after 24 h gut clearance in 1/27	
SG just N of shelf break on W3.2	650	15.2	~1745	120-90m	No krill Some Themisto and Thys	-	-	-	162-195m	No krill Large nos of E. triacantha	-	-	-	-	-
SG 3.2N	659	15.2	? see WCB net logsheets	Standard neuston haul 1	? see WCB net logsheets	55 krill in 1	-	-	-	-	-	-	-	-	-
SG 3.2N	660	?	? see WCB net logsheets	Standard neuston haul 2	? see WCB net logsheets	55 krill in 1	-	-	-	-	-	-	-	-	--
N of Stromness	676	17.2	~0215	27-25m	25-40	100 krill in 1	100 frozen in 25 100 ethanol	100 krill	29-5m	25-40	100 krill (plus 20 for Kate's dissection) in 1	-	-	Gut evac from net 1 (not net 2) T1 after 15 min T2 after 30 min T3 after 45 min T5 after 1 hour In 2 Very few fp's At 1100 added more krill from net 1 and 2 for fp's (in 1) and 24 h gut clearance (100 krill in 26)	Net 1 settup ~0300 on 17.2.03 Tubes 200-227
SG W2.2N	684	18.2	1720	95-107m	none	-	-	-	83-62m	30-45mm	32 krill in 1	-	-	-	-
SG W2.2N	685	18.2	~1800	20-10m	None, a few Themisto	-	-	-	10-13 m	None, a few Themisto	-	-	-	-	-

NET SAMPLING IN THE WESTERN CORE BOX

GERAINT TARLING AND TONY NORTH

RMT8 and Neuston nets were deployed along transects 1.2, 2.2 and 3.2 between 13th and 15th February 2003. It was not possible to sample transect 4 because it was occupied by a megaberg. As in previous years, two stations were sampled along each transect, labelled North and South. The RMT was deployed in a double oblique fashion between the surface and either 250 m or to within 10 m of bottom. Net 1 was open during the descent, net 2 open during the ascent. The neuston net was deployed simultaneously from the foredeck for two periods of fifteen minutes.

Both the RMT and neuston catches were sorted in a semi-quantitative fashion immediately after capture. Both sets of catches were volumised and then sorted to species for all larval fish and most macrozooplankton. Abundances of the most common species were estimated from various sub-sampling techniques. A known fraction of all RMT catches was preserved in 10% Formalin (4% Formaldehyde). Larval fish were removed and either frozen or preserved in 95% ethanol by Tony North. Where abundances were sufficient, 200 adult krill were removed and frozen for length-frequency analysis by J. Watkins back at HQ. Further adult krill were sometimes frozen to complement the growth study work. Notes were made on sample labels if these removals affected quantities in the preserved sub-sample.

Table 1 shows the deployment information for each net. Details of the semi-quantitative sorting are given in the filenames in the last column of this table. These files are stored under the directory ***WCB_Nets***. Files containing a more thorough breakdown of the physical and geographical information of the RMT deployments are also stored in this directory. Those deployments where krill were frozen for length-frequency measurements are indicated.

PERSPECTIVE ON SORTING

Those involved in the sorting of catches showed had varying degrees of taxonomic knowledge and grouped things differently. Mistakes in identification were also frequently made meaning that these records were not reliable. It is recommended that future sorting of these catches be limited to the following taxa: *Euphausia superba*, *Themisto gaudichaudii*, Salps and Myctpohids. These four make up the majority of biomass in each catch and are rarely misidentified. A suggested protocol for sorting of core box RMT nets from now on is given below.

RECOMMENDED FUTURE PROTOCOL FOR SORTING OF RMT CATCH

1. Take total displacement volume of catch.

2. Subsample to estimate numbers of individuals and volumes of *E. superba*; *T. gaudichaudii*; salps and myctophids.

3. Preserve sample or a known fraction thereof in no more than one 1.5 litre Le Parfait jar.

Event number	Profile	Net type	Station	Target depth (m)	Start day	Start date (GMT)	Start time (GMT)	Start Lat Decimal	Start Long. Decimal	Filenames	Krill frozen for L-F
616	Double oblique	RMT	1.2S	0-250	44	13-Feb-03	22:47:16	-53.8221	-39.146	82RMT616N1; 82RMT616N2; 82rmt616	Yes
617	surface	NEU	1.2S	0	44	13-Feb-03	22:55:00	-53.8221	-39.146	82NEU_617	
618	surface	NEU	1.2S	0	44	13-Feb-03	23:20:00	-53.8221	-39.146	82NEU_618	
619	Double oblique	RMT	1.2N	0-250	45	14-Feb-03	2:30:00	-53.5093	-39.2122	82RMT619N1; 82RMT619N2; 82rmt619	
620	surface	NEU	1.2N	0	45	14-Feb-03	2:35:00	-53.5093	-39.2122	82NEU_620	
621	surface	NEU	1.2N	0	45	14-Feb-03	2:45:00	-53.5093	-39.2122	82NEU_621	
634	Double oblique	RMT	2.2N	0-250	45	14-Feb-03	22:53:49	-53.4621	-38.6264	82RMT634N1; 82RMT634N2; 82rmt634	
635	surface	NEU	2.2N	0	45	14-Feb-03	23:05:00	-53.4621	-38.6264	82NEU_635	
636	surface	NEU	2.2N	0	45	14-Feb-03	23:20:00	-53.4621	-38.6264	82NEU_636	
637	Double oblique	RMT	2.2S	0-180	46	15-Feb-03	3:22:11	-53.8027	-38.5294	82RMT637N1; 82RMT637N2; 82rmt637	Yes
638	surface	NEU	2.2S	0	46	15-Feb-03	3:29:00	-53.8027	-38.5294	82NEU_638	
639	surface	NEU	2.2S	0	46	15-Feb-03	3:44:00	-53.8027	-38.5294	82NEU_639	
655	Double oblique	RMT	3.2S	0-151	46	15-Feb-03	22:53:28	-53.7185	-37.9713	82RMT655N1; 82RMT655N2; 82rmt655	
656	surface	NEU	3.2S	0	46	15-Feb-03	23:05:00	-53.7185	-37.9713	82NEU_656	
657	surface	NEU	3.2S	0	46	15-Feb-03	23:20:00	-53.7185	-37.9713	82NEU_657	
658	Double oblique	RMT	3.2N	0-250	47	15-Feb-03	3:06:42	-53.4528	-37.9367	82RMT658N1; 82RMT658N2; 82rmt658	Yes
659	surface	NEU	3.2N	0	47	15-Feb-03	3:12	-53.4528	-37.9367	82NEU_659	
660	surface	NEU	3.2N	0	47	15-Feb-03	3:23	-53.4528	-37.9367	82NEU_660	

TABLE 1: RMT AND NEUSTON NET DEPLOYMENTS IN THE WESTERN CORE BOX, FEBRUARY, 2003

FISH – MACROZOOPLANKTON/NEKTON

TONY NORTH 22 FEB 2003

INTRODUCTION

There is a regular fishery for mackerel icefish, *Champsocephalus gunnari,* at South Georgia and Shag Rocks. The humphead notothen, *Gobionotothen gibberifrons*, is a by-catch species. Both fishes are found in the diet of fur seals and gentoo penguins. Monitoring larval fish growth and abundance may provide insights into the factors affecting their year-class success and recruitment to the fishable stock.

The growth of larval mackerel icefish and humphead notothen depends on the abundance of their main prey, which is copepods, and other factors, such as temperature. The early growth rate of the humphead is greater in colder years. Larval humphead occur over the shelf and the data on them has been derived from Core Box sampling. Mackerel icefish occur inshore and are thus poorly sampled in the Core Box, although in some years they have been taken by additional sampling. Information on larval *C. gunnari* will complement that provided by regular sampling from the fisheries research base at KEP. The abundance and size of larval humphead and icefish contributes to an index of interannual ecosystem variability at South Georgia.

There is evidence that the mackerel icefish at Shag Rocks hatch earlier than at South Georgia. However, the larvae/early juveniles have only been sampled twice previously.

AIM

The aim of sampling fish during JR82 was to estimate the year-class success of mackerel icefish (*C. gunnari*) and humphead (*G. gibberifrons*) from their larval abundance and mean size.

METHODS

Fish larvae were sampled by RMT8 net and Neuston sledge at night. Larval humphead occur in greatest abundance off the coast and were sampled at the standard Core Box stations. However, the results from previous cruises have shown that mackerel icefish larvae are most abundant inshore. Consequently, they were inside the entrance of Cumberland East Bay and just off Stromness Bay at South Georgia where they have been consistently found at high abundances. Shag Rocks was also sampled opportunistically using the RMT8 net for larval/juvenile fish but unfortunately this was during daylight when net avoidance is likely to be large.

Larval fish shrink soon after death. Consequently, fish larvae were measured fresh, generally within 30 minutes of net retrieval and any specimens that seemed to have begun shrinking were not measured

Larval *C. gunnari* and *G. gibberifrons* and some *Notothenia rossii* and *Notothenia coriiceps* were preserved frozen at –20°C and in ethanol (95%) for potential work on age determination, diet and genetics. A few of the more common myctophids were also frozen at –20°C for potential work on diet and/or genetics.

Otoliths were taken from a few of the common mytophids to add to data on fish otolith identification and otolith to body size relationships.

RESULTS

Fish sampled by Neuston sledge included, in order of abundance, larval *G. gibberifrons*, fingerling, *N. coriiceps* and *N. rossii*. The RMT8 nets inshore contained many larval *C. gunnari*, *Trematomus*

hansoni and *Lepidonotothen larseni*. Inshore samples also contained many *Themisto* from the surface to 100 m depth, and Mysids between 5 and 100 m depth.

Offshore the RMT8 nets caught lanternfishes (Myctophidae) and some deep water smelt (Bathylagidae) which together comprised a substantial portion of the total macrozooplankton/nekton biomass. These species, in order of abundance were, *Gymnoscopelus braueri, Gymnoscopelus microlampas, Protomyctophum choriodon, Electrona antarctica*, *Protomyctophum bolini* and *Bathylagus* spp., and a few other species.

Samples off Cumberland East Bay and off Stromness Bay indicate that this is a year of relatively high larval mackerel icefish abundance compared to previous years Samples of larval humphead at Core Box stations indicate that this is a year of medium-low abundance. Compared to previous years, the Core Box RMT8 net hauls contained generally more *Protomyctophum choriodon* and *Gymnoscopelus microlampas* and less *Protomyctophum bolini* and *Bathylagus* spp.

No mackerel icefish were caught during sampling at Shag Rocks although a few larval *L. larseni* and *T. hansoni* and 2 adult *Patagonotothen guntheri* were caught. Although sampling was limited this indicates that it is probably a poor year for the recruitment of mackerel icefish at Shag Rocks.

ACOUSTICS JR82 CRUISE REPORT

CATHY GOSS, PETER ENDERLEIN AND GERAINT TARLING, 21 FEBRUARY 2003

INTRODUCTION

JR82 has been the first major cruise on *James Clark Ross* to use the new fisheries echosounder Simrad EK60. This was installed at the 2002 refit, and followed by a calibration in Uggdalseidet fjord, Norway, and a four-day survey at South Georgia in October 2002. No serious setbacks were experienced up to this point.

JR82 has provided an opportunity to carry out two calibration exercises at cold-water sites and extensive field-testing of the system. The sounder has some important advantages over the EK500 system that it replaced. All frequencies are considerably more sensitive than with the EK500, probably due to the improved layout of the equipment; the transceiver units (GPTs) are sited in the beer store, close to the transducers. The 38kHz shows noise-free soundings down to 500m, and the 120kHz 7-degree-beam transducer is a marked improvement on the 9-degree-beam transducer that it has replaced. These two frequencies are now operating with lower background noise than any of the other three vessels used for the CCAMLR 2000 Synoptic Survey. The 200kHz transducer was not replaced with a split beam model, as had been planned, but produced the most dramatic advance of all. Usable data are now recorded down to 250m, and these provide the potential for a range of new analyses that will improve target discrimination identification. The opportunity exists to extend the capability of the EK60 further by increasing the number of frequencies to include a lower frequency, e.g. 12 or 18 kHz and an intermediate one, e.g. 70 kHz.

One negative aspect of the improvements in sensitivity is that interference by other acoustic equipment and ship noise is more visible. The EK60 suffered regular crashes, not experienced before JR82; these are described below, along with steps taken to remedy the problem. Sonardata's Echoview, previously trouble-free, also crashed repeatedly, possibly because of uneven gaps in the data generated by the EK60 problem. A remedy for this is also being sought. Because of these outstanding difficulties, only short runs of data have been processed to generate useful measures of biomass. A description of some of these is included below, together with information on the data that can be generated once our software difficulties are resolved.

Scotia Sea transects were run through day and night covering over 3200 nautical miles, providing extremely interesting contrasting datasets.

The survey carried out at South Georgia over an area north of Bird Island, was the seventh repeat in a series of combined oceanographic/acoustic surveys in the austral summer (See Trathan et al, in press). The surveys provide an annual acoustic stock assessment of krill to CCAMLR in sub-area 48.3, the most important fishery zone in the Southern Ocean. Eight transects were run in the Western Core Box area, but four were cut short because of the presence of a 50-mile long iceberg covering the north-eastern corner of the box. This reduced the transect length by 19%.

AIMS

1. Familiarisation with the new sounder.

2. Calibration of the equipment at appropriate sites for the acoustic surveys.

3. Collection of acoustic data to accompany all transects, fishing searches and nets during the Scotia Sea survey period.

4. Acoustic survey in the Western Core Box at South Georgia.

5. Back up and post process acoustic data.

6. Compare data collected with the EK60 with data collected with the EK500 and consider the implications for krill stock assessment.

METHODS/SYSTEM SPECIFICATION

SOFTWARE VERSIONS

- Simrad EK60 v 1.4.4.66

- Sonardata Echolog 60 v 2.25.61

- Sonardata Echoview v 2.25.106

- HASP Dongle BAS2 is licensed for bathymetry, integration, school detection and virtual echogram modes, but not for live viewing.

FILE LOCATIONS

Initial settings and revised settings following Signy and South Georgia Calibrations: Eksettings.xls. Full calibration results signysummary.xls SG summary.xls. Raw files that permit a replay of the calibration are also available with the other data files.

Live viewing template: C:\program files\sonardata\echoview2\Live Viewing Templates\EK500-60-EK6.EV on workstation 2. Also possible to view .raw files, use EK500-60-RAW.EV (EK500 refers to the name of workstation 2).

Scotia Sea transects divided into 30-mile sections, suffix a, b, c etc and summarized in 10-mile blocks or less if part or all of transect in dark. Suffix d, n or t (for transition) used to identify which parts in the day (and thus suitable for processing in more detail). D or n determined by sunrise and sunset with a further 30 minutes of day excluded because of low light levels before sunset and after sunrise at high latitudes.

COMPRESSION WITH ECHOLOG

Echolog allows for a variety of data compression strategies. Averaging samples below the sounder detected bottom+ an offset could be disastrous if bottom detection was triggered by something dense in the water column, and although this can be prevented by setting a deep minimum bottom on the EK60, that too can cause problems if the ship moves into shallow water and the deep minimum has not been changed. Since low backscattering may be of

interest when looking at zooplankton for this cruise, the preferred strategy will probably be to rely on removing angle data with echolog. A comparatively shallow maximum depth, 300m, will be set in Echolog, allowing the possibility of looking deeper with the EK60 say 500m, and keeping the data if deep targets are seen. Disappointingly, the sounder-detected bottom feature of Echolog 'ignore bottom if range less than' only goes up to 10m. Otherwise this feature would be a useful safety aspect.

Final compression settings used in Echolog for all frequencies:

- power data only (angle data is still available from .raw files which are being saved on this occasion)

- from 0m – 300m this should probably be from 10m to 250m for krill studies since the first 10m is normally deleted at processing stage, and deeper data are not used. For fish data collection 38 kHz and 120 kHz data should be logged to 500m, 200 kHz to 250m, if raw data will be deleted

- Average samples where both Sv below –100 and TS below 20 i.e. the latter condition is always met and therefore has no effect

- Maximum number of samples to average: 50

- Ignore bottom detection if range less than 10 metres

Other compression options in Echolog:

- Average samples below sounder detected bottom + offset x metres (sounder detected bottom is not reliable enough to depend on this although it could be used in conjunction with a conservative setting of 'Ignore bottom detection if range less than y metres'

- If keeping angle data too, data will be discarded where TS less than a preset level or when range greater than sounder detected bottom + an offset

The settings are also used by Echozip; this can be run post hoc on .raw files, either singly or in batch mode in a DOS window. From the program file directory where echozip is located type: Echozip_60 –z folder, where folder is the location of .raw and .out files to be compressed.

EK60 .raw data files are just over 25MB; Echolog as set brings this down to around 9 or 10 MB. With 40-50 files being logged per day this represents a reduction from 1.25GB to around 500 MB. Data were collected at a ping interval of 1, or more often, 1.5 seconds which has increased the data collection rate from that encountered on previous cruises, and improved horizontal resolution.

WORKSTATIONS

EK60 software is run on the dedicated machine supplied by Simrad which includes fast CD writer and good CD creation software (Nero). It was linked to GPTs and a pc (called EK500, labelled EK60 Workstation 2) in an isolated network using the hub previously used with the EK500 sounder. It was suggested that the hub might be the cause of a recurrent problem involving the link to the three GPTs so this was replaced during the cruise with a brand new hub that was capable of running at 10 or 100 MB(?). This increased capability could only be utilized by one of the links (EK60 pc to workstation 2), and there was no change in the frequency of the 'GPT' problem. It was suggested that the hub should be replaced with a switch (hub with routing capability, mentioned in an email from Simrad). Workstation 2 was used for Echlog

(compression utility) and Echoview (post processing). Even after compression, the data from the cruise came close to using the entire 15GB available on drive d:. Data had to be deleted from the EK60 machine on a regular basis (after backup CDs had been copied to tape) because the hard drive was too small to contain data from the whole survey. Workstation 1 was networked to the ship's central network and used for maintaining the transect log and acoustic log, as well as general tasks, email, report writing. For future cruises it is recommended that Workstation 1 be switchable between the local acoustic network with the other two machines, and the general network, making its hard drive available for acoustic data, that could then be transferred for backing up, while maintaining its current functions. The daily creation of CDs was time consuming; these were backed up to tape every 10 days or so. In future increased capacity hard drives (>100GB) and a tape drive should be installed in the local acoustic network, as used by the swath workstation.

SETTINGS

EK60 settings are shown in Table acou1; they are listed for the start of the cruise (derived from Norway calibration), revised settings following the calibration at Signy, and further adjustments made after the South Georgia calibration.

Range, bottom discrimination, TS filters, ping interval and pulse length can be altered from the EK60 standard menus. Environmental parameters: salinity, temperature and sound speed, are entered through the Install Environment dialogue, and derived absorption coefficients are calculated for each frequency in the sounder software, these can be inspected by right-clicking on the frequency heading on the main display to see (but not adjust) transceiver settings. All other settings are generated and installed during calibration, and cannot be changed at other times. The EK60 was designed to be used with split-beam transducers, and changes in settings for the single-beam 200 kHz could not be made in the standard software. An email request for help to the Simrad helpdesk - fish.research@simrad.com received the following solution (edited):

All transducer and transceiver parameters are stored in the file TriList.ini. To modify transducer parameters you should use the program tdajust.exe, found in the directory EK60. Start the program, choose TriList.ini and find the transducer you are using/installing in the transducer list. Angle sensitivity should be 0.0 for single beam. There are five Gains and Sa correction values, each pair representing a pulse length. After editing the TriList.ini the transceiver has to be uninstalled and installed again for the new parameters to be loaded (parameters loaded may be inspected in the advanced menu in transceiver settings dialogue)

DATA PROCESSING IN ECHOVIEW

Initial settings for Echoview were based on salinity and temperature recorded at the time of the first XBT of the cruise: 33.8 and 2°C. This yielded sound velocity of 1456 and absorption coefficients:

38 kHz – 10.40dB/km; 120 kHz – 27.93 dB/km; 200 kHz – 41.36 dB/km.

For post processing, an ev file was set up with standard virtual variables that were created following the JR70 example, using Signy calibration settings, 2-16 Sv difference for Scotia Sea, 2-12 for WCB. These have been documented in Anon (2000), and are also described in Echoview help ' about virtual variables' (Higginbottom et al, 2000).

Additionally *range-diff wide* and *mask 120-s-c-wide* using Sv difference range 1-16 (.csv file suffix w), *range diff-fish* and *mask-38-fish* using Sv difference range –10 to 1 (.csv file suffix f). These variables were introduced because examination of Sv difference values from targeted krill swarms showed that these fell below the 2-12 range formerly used, notably for swarms of large krill where there

were many gravid females. This had been predicted by the preferred scattering model used to forecast Sv difference values by Watkins and Brierley (2002). Using 1 or even 0 as a lower boundary for krill discrimination was not expected to overlap with the dominant fish aggregations encountered on this survey (probably myctophiids).

The following procedure was used to repeat processing for additional transect sections:

Using an existing .ev file, save with new file name then delete all raw data files. *Save regularly throughout processing steps*

- Select new data files according times on transect log
- View cruise track, 'process' track data (cruise track menu)
- Review surface noise line and integration stop line (seabed or 250m whichever is deeper)
- Check integrity of integration stop line on *surf-bot* variable
- Mark bad data: start and end, false bottom, interference, drop-out, missed pings
- Set grid on *mask 120s-c* echogram: 1 nautical mile by 250m (or 10 n mi for Scotia Sea transects).
- Export integration by cells to */excel/transects/* sub directory. Variables exported include NASC, midpoint date and time, ping start and end. Latter gives not ping number but bin numbers from first resampling – this should make it obvious where speed changes occur.

SCHOOLS DETECTION WITH ECHOVIEW

During RMT 440 a -87dB threshold used to detect swarms at 120 kHz less than 50m in length. swarms 188-313 were in the vicinity of the net. Bitmaps saved:

rmt440swarms, rmt440deltas (-87), rmt440deltas (-90)

120 kHz variables were exported, and regions moved 3 seconds to make outlines fit on 38kHz

This move was not necessary for 200 kHz (was this because 38 kHz GPT lost some pings at some stage?)

Schools analysis on RMT440 120kHz –87 threshhold, schools parameters in m:

Minimum school length	10
Minimum school height	2
Minimum connected length	5
Minimum connected height	2
Maximum vertical linking distance	2
Maximum horizontal linking distance	2

The schools module was also used to export data from the large krill swam encountered on 4

February 2003. All other potential swarms were excluded from this analysis by using a large minimum swarm length.

Noise measurement

January 17, 2003, 0535h GMT Noise test. See EK60 manual p65. The set-up requires the following changes:

- Operation menu, mode normal, ping rate max
- Transducer settings menu, for each frequency, mode passive
- Colour scales left at –100 (manual suggests using –80)
- Adjust range to see colours on echogram: 38kHz 1500m, 120kHz 500m, 200kHz 300m

Conditions very calm. Start speed 0 knots. EA500 turned off 0540h. 0544h up to 10 knots, 120rpm

Frequency kHz	38	120	200
Pn min	-163	-163	-160.8
Pn max	-157	-151.3	-159.1
Max depth, start of grey band, m	650	140	117

0552h turn

0556h 2.5 knots 40rpm

Frequency kHz	38	120	200
Pn	-161.5	-159.5	-162.0
	-161.4	-157.8	-157.1
	-160.5	-159.2	-160.2
	-160.7	-154.5	-159.0
	-160.4	-160.3	-161.1
Max depth, start of grey band, m	684	147	114

0606h up to 4 knots

0627h operation was returned to normal for transect, ping rate 1 sec. The EA500 was returned to external trigger

CALIBRATION EK60 CALIBRATION AT SIGNY, JANUARY 24, 2003: 60° 42.07'S 45° 34.81'W

Before calibration all discharges were stopped, the EA500, ADCP and any other sounders turned off completely. Walkie talkie radios were used for talking to helpers on deck.

2100h GMT CTD event 287was carried out. The average temperature and salinity for 6-25m and the resulting sound speed were entered into the EK60. The water depth started at 38m, but varied down to 31m as the ship moved in the tidal current. The sea state was almost glassy calm, but drifting ice was a potential hazard, on one occasion one of the lines was paid out and held in close to the hull to free it from a small growler.

2330h Photos of winch locations for the initial calibration in Norway enabled us to reproduce the original line positions. Using marked lines, the sphere was visible on the echogram screen and in ping view, but did not appear in circle view or histogram. It was noted that a boat suspended by crane on starboard aft was causing the ship to list to starboard and to be higher on the bow than during the Norway calibration. The ship's anti-heeling mechanism was brought into play to correct the list, which it did very effectively. The sphere still did not appear. At 0041h it was noted that in the TS detection all filters were set on max, but this needed to be changed because it excluded all echoes because they were too short to exceed the minimum. Thus the minimum length was reset to 0.8, and the sphere appeared in the centre of the beam.

A full calibration of the 38kHz sounder was carried out following the protocol established by P Enderlein and G Tarling for the Norway Calibration earlier in the year. All was successful except for the final step, recording Sa from the Echotrace screen. Values did not appear in the Sa space above the histogram as expected. Also there was no control of the interval between successive data records on the calibration page. This was repeated for the 120kHz sounder, the 23mm sphere, weighted with shackles, moved easily on axis by paying out 2.5m on the port aft line. At the end of the calibration the marks were all beyond the end of their respective booms by the following amounts: Port aft 2.5m, Starboard 0.5m and port forward about 0.8m

0405h saw the start of the 200kHz 13 mm sphere calibration, also weighted with shackles. By using the 120kHz split beam sounder the sphere was placed 1.4 degrees to starboard of 120 axis. The 200kHz sounder was then installed, and all three lines adjusted in turn to see if it was possible to increase the signal but it was not. At 0441h the pulse length was changed to 0.512ms because no theoretical data were available for 1.024 ms. No data were recorded electronically for this calibration due to an oversight. Data from this calibration appear in Table acou1.

EK60 CALIBRATION AT STROMNESS, FEBRUARY 17, 2003: 54° 9.44'S 36° 41.99'W

Before calibration, all discharges were stopped, and all other sounders turned off completely.

1100h GMT CTD event 678 was carried out. Average temperature and salinity for 6-25m were entered into the spreadsheet SVALPHA.xls to generate sound speed and alpha values and transferred to the EK60, see Table acou1.

The water depth started at 51m. The sea state was flat but 'ruffled' by wind increasing from 10 to 30 knots but falling again towards evening. Bow thruster noise was present intermittently.

1300h (GMT) Winch locations established for the initial calibration in Norway were used with marked lines, the sphere was visible on the echogram screen and in ping view in the centre of the beam.

A full calibration of the 38kHz sounder was carried out. After mapping the beam using the line adjuster new values were entered into the sounder using the standard EK60 calibration procedure. Accumulated values that appear in the Sa space above the histogram can be reset to 0

by using the mouse to clear the echogram display.

1600h 120 kHz calibration was begun using the 23mm sphere, weighted with shackles, it was noted that the EK60 alpha is 27.69, our spreadsheet had 28.42. The calibration was repeated with lower power output (500W); differences from 1000W were insignificant. A Simrad News Bulletin dated March 2002 described non-linear effects in EK60 transducers and transceivers. It recommends 500W power output for 120 kHz and 100W for 200 kHz. The former seems possible, and had little visible effect. However any reduction in output power with 200 kHz reduced the usable range significantly. Reduction to 100W lost a lot of the improvement noted from the EK500.

1850h The 200 kHz calibration was begun using a 13 mm copper sphere. The Signy calibration was carried out at pulse length 0.512msec even though 1.024 had been used for the survey because no theoretical data was available for the sphere. The EK60 alpha was 40.86, our spreadsheet had 41.85. Data from this calibration appear in Table acou1.

DATA COVERAGE

SCOTIA SEA TRANSECTS

Scotia Sea transects were run both day and night over all sections between fixed stations, normally 60 nautical miles, details may be found in the Transect Log (Appendix x). Dawn and dusk were calculated each day for each station and these were used to determine which sections will give comparable data to the daytime acoustic survey carried out in the Scotia Sea in 2000 (Anon, 2000).

WESTERN CORE BOX AT SOUTH GEORGIA

Eight transects were run in the Western Core Box, but four were cut short because of the presence of a 50-mile long iceberg covering the north-eastern corner of the box. This reduced the planned 344 miles of transects to 279 miles (19%). (See Appendix x)

The following instructions were prepared for running the transects:

- Two 43 mile transects completed each day for 4 days.
- Switch EA to reduced power
- All other sounders, acoustic devices of any sort to be switched off
- Build up to speed 1 mile before station to launch UOR
- Start transect at least 30 minutes after dawn ~ 5:45 (0745Z)
- Pass through waypoint at 10 knots and on course
- Speed to be maintained at 10 knots or less where conditions dictate
- Pass through transect endpoint at 10 knots and on course
- Turn gradually so that UOR does not need to be recovered
- Complete link between transects at 10 knots for UOR

- Begin gradual turn for start of second transect of the day so that ship will -
- Pass through transect start point at 10 knots and on course
- Pass through transect endpoint at 10 knots and on course

PROBLEMS ENCOUNTERED

INTERFERENCE

Interference at 38 kHz between 17 – 24m was known to be caused by the Simrad EA500 Bridge sounder operating at full power. It disappeared when the EA500 was switched to reduced power as used routinely in shallow water. This interference was mostly below –90, and readily recognizable on dB difference plots. Because EA500 bathymetry is not needed in the South Georgia area, the reduced power option could be used for the whole of the acoustic survey there. For the SSU to function all systems need to be set on external trigger.

The 120 and 200 kHz sounders suffered 'ping' type interference noticeably in shallow water, but not from the ADCP, which was switched off at the end of the cruise. The Doppler Log was also a possible source, but switching this off then on had no effect.

False bottom marks appeared frequently on the 38 kHz echogram when using 1 second ping intervals. Their appearance coincided with a number of different seabed depths; they were calculated to occur when the echo from either the previous ping or the one before must have travelled to the seabed and back. This interference was reduced to an acceptable level by increasing the ping interval to 1.5 seconds. False bottom marks that were not affected by the EK60 ping interval were probably caused by the EK500.

EK60 OPERATION

January 10, 2003 0403h Z saw the first recorded occurrence of a problem that grew progressively worse as the cruise progressed, with the EK60 showing error message: 'Lost some samples from GPT' and lots of white lines appearing on all three frequencies. Switching the GPT link on and off did not cure problem. Stopping SSU and deselecting ext trigger on operations dialogue of EK60 did cure the problem. Subsequently switching the GPT link off and on did cure the problem. A soft alarm from EK60 is just audible when this problem happens. For most of the Scotia Sea transects the system was crashing once every 2 to 4 hours, occasionally more often. At one time it appeared that working on workstation 2, the only other pc on the local network with the EK60, was influencing the occurrence of these crashes, but this was disproved when all programmes, including Echolog were shut down on workstation 2, but the EK60 still crashed. A 'Could not meet ping interval requirement' message also sometimes appeared when the EK60 appeared to lose contact with GPTs. On a few occasions the EK60 froze, there were no 'GPT' messages, but switching GPT off then on could restart it. This differed from other GPT problem in that the entire screen is frozen with a display present in all ping windows. The absence of ping display at one frequency is an obvious sign of the usual GPT problem. The problem has been reported to Simrad (See ETS report for the follow up to this)

ECHOVIEW OPERATION

On two occasions Echoview crashed from live viewing with 'Abnormal program termination' notice for no apparent reason. The same message accompanied crashes while processing data. The latter may be related to the EK60 problem reported above because the three frequencies

may end up with different numbers of pings in a given file. Sonardata have offered to investigate these crashes when I can upload data files and ev files to their ftp site.

FUTURE PLANS

TO DO LIST

- Buy new high capacity hard drives for EK60 pc and Workstation
- Buy suitable tape drive for backup within local network
- Obtain replacement 23mm copper sphere from Simrad
- Obtain theoretical TS value for 13mm sphere at 200 kHz, 1.024ms pulse length
- Obtain replacement UPS, the one presently on loan from ETS is not ideal
- Ensure that the web version of this document and linked files are available on the ship next year
- Pursue Simrad to correct problems with EK60
- Send Sonardata problem files for investigation
- Contact Sonardata about ADCP software

IDEAS FOR ANALYSES

- Analyse krill Sv difference data in the light of results of studies on the condition of krill
- Compare acoustic data from transects with other underway data
- Analyse superswarm data compared with other swarms from the same time of day, also using ADCP to view local velocities in the swarm
- Study superswarm data alongside whale observation data.

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TABLES AND FIGURES

TABLE ACOU1 EK60 SETTINGS AT THE START OF THE SURVEY, AND AFTER EACH CALIBRATION

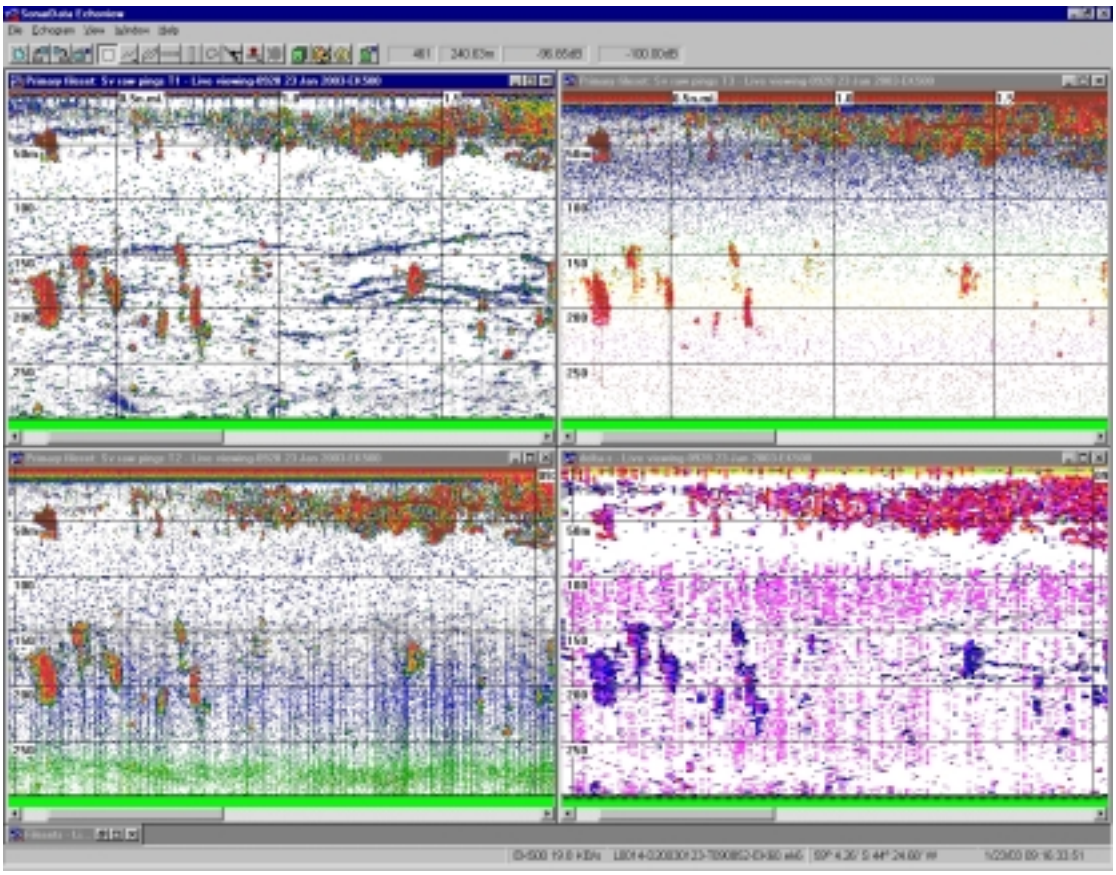
JR82 EK60 settings - recorded under menu items from EK500, new fields in italics changes in bold			
	Start	After Signy Cal.	After Stromness
	090103	240103	
/OPERATION MENU/Ping Mode	Ext.Trig	Ext.Trig	Ext.Trig
/OPERATION MENU/Ping Interval	1.0 sec (SSU)	1.5 sec (SSU)	1.5 sec (SSU)
Salinity		34.08	33.8
Temperature		0.0	2.5
Sound Velocity	1451 m/s	1445.1 m/s	1458.9 m/s
Transceiver-1 Menu/Mode	Active	Active	Active
Transceiver-1 Menu/Transducer Type	ES38	ES38	ES38
Transceiver-1 Menu/Transducer Depth	0.00 m	0.00 m	0.00 m
Transceiver-1 Menu/Absorption Coef.	9.98 dBkm	10.02	10.09
Transceiver-1 Menu/Pulse Length	1.024ms	1.024ms	1.024ms
Transceiver-1 Menu/sample interval	0.1857m	0.1850m	0.1867m
Transceiver-1 Menu/Bandwidth	2425Hz	2425Hz	2425Hz
Transceiver-1 Menu/Max. Power	2000 W	2000 W	2000 W
Transceiver-1 Menu/2-Way Beam Angle	-20.70 dB	-20.70 dB	-20.70 dB

Transceiver-1 Menu/Sa correction	-0.56	-0.56	-0.06
Transceiver-1 Menu/Angle Sens.Along	22	22	22
Transceiver-1 Menu/Angle Sens.Athw.	22	22	22
Transceiver-1 Menu/3 dB Beamw.Along	6.86	7.03	6.87
Transceiver-1 Menu/3 dB Beamw.Athw.	6.73	6.99	6.93
Transceiver-1 Menu/Alongship Offset	0.04 dg	-0.12	-0.15
Transceiver-1 Menu/Athw.ship Offset	0.06 dg	-0.04	-0.02
Transceiver-1 Menu/Frequency	38 kHz	38 kHz	38 kHz
Transceiver-2 Menu/Mode	Active	Active	Active
Transceiver-2 Menu/Transducer Type	ES120-7	ES120-7	ES120-7
Transceiver-2 Menu/Transducer Depth	0.00 m	0.00 m	0.00 m
Transceiver-2 Menu/Absorption Coef.	25.68 dBkm	25.41 dBkm	27.69 dBkm
Transceiver-2 Menu/Pulse Length	1.024ms	1.024ms	1.024ms
Transceiver-2 Menu/sample interval	0.1857m	0.1850m	0.1867m
Transceiver-2 Menu/Bandwidth	3026 Hz	3026 Hz	3026 Hz
Transceiver-2 Menu/Max. Power	1000 W	1000 W	1000 W
Transceiver-2 Menu/2-Way Beam Angle	-20.07 dB	-20.07 dB	-20.07 dB
Transceiver-2 Menu/Sv Transd. Gain	25.03 dB	23.99	22.43
Transceiver-2 Menu/Sa correction	-0.42	-0.47	-0.42
Transceiver-2 Menu/Angle Sens.Along	21	21	21

Transceiver-2 Menu/Angle Sens.Athw.	21	21	21
Transceiver-2 Menu/3 dB Beamw.Along	7.32	7.52	7.92
Transceiver-2 Menu/3 dB Beamw.Athw.	7.25	7.53	7.78
Transceiver-2 Menu/Alongship Offset	-0.2	-0.12	0.05
Transceiver-2 Menu/Athw.ship Offset	0.23	-0.23	0.15
Transceiver-2 Menu/Frequency	120 kHz	120 kHz	120 kHz
JR82 EK60 settings - recorded under menu items from EK500, continued			
	Start	After Signy Cal.	After Stromness
	090103	240103	
Transceiver-3 Menu/Mode	Active	Active	Active
Transceiver-3 Menu/Transducer Type	ES200-7	ES200-7	ES200-7
Transceiver-3 Menu/Transducer Depth	0.00 m	0.00 m	0.00 m
Transceiver-3 Menu/Absorption Coef.	39.37 dBkm	39.30 dBkm	39.30 dBkm
Transceiver-3 Menu/Pulse Length	1.024ms	1.024ms	1.024ms
Transceiver-3 Menu/sample interval	0.1857m	0.1850m	0.1850m
Transceiver-3 Menu/Bandwidth	3088 Hz	3088 Hz	3088 Hz
Transceiver-3 Menu/Max. Power	400 W	400 W	400 W
Transceiver-3 Menu/2-Way Beam Angle	-20.70 dB	-20.70 dB	-20.70 dB
Transceiver-3 Menu/Sv Transd. Gain	26.30 dB	26.30 dB	26.30 dB
Transceiver-2 Menu/Sa correction	0	0	0

Transceiver-3 Menu/Angle Sens.Along	23	23	23
Transceiver-3 Menu/Angle Sens.Athw.	23	23	23
Transceiver-3 Menu/3 dB Beamw.Along	7.2	7.2	7.2
Transceiver-3 Menu/3 dB Beamw.Athw.	7.2	7.2	7.2
Transceiver-3 Menu/Alongship Offset	0	0	0
Transceiver-3 Menu/Athw.ship Offset	0.00 dg	0.00 dg	0.00 dg
Transceiver-3 Menu/Frequency	200 kHz	200 kHz	200 kHz

FIGURE ACOU1KRILL (ORANGE) AND FISH (PURPLE) DISCRIMINATED USING SV DIFFERENCE



FIGRE ACOU2 EFFECT OF SLOWING THE SHIP ON BACKGROUND NOISE

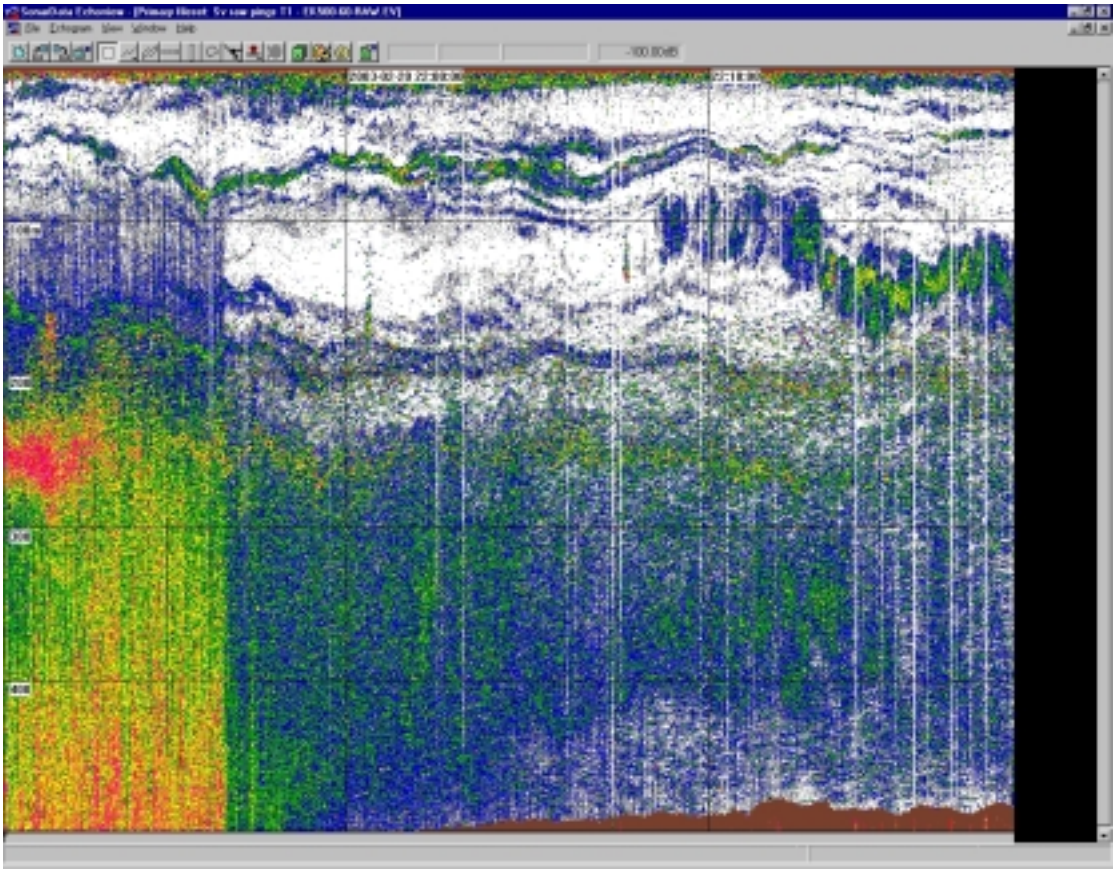


FIGURE ACOU3SUMMARY VIEW OF THE FIRST TRANSECT IN THE SCOTIA SEA SERIES

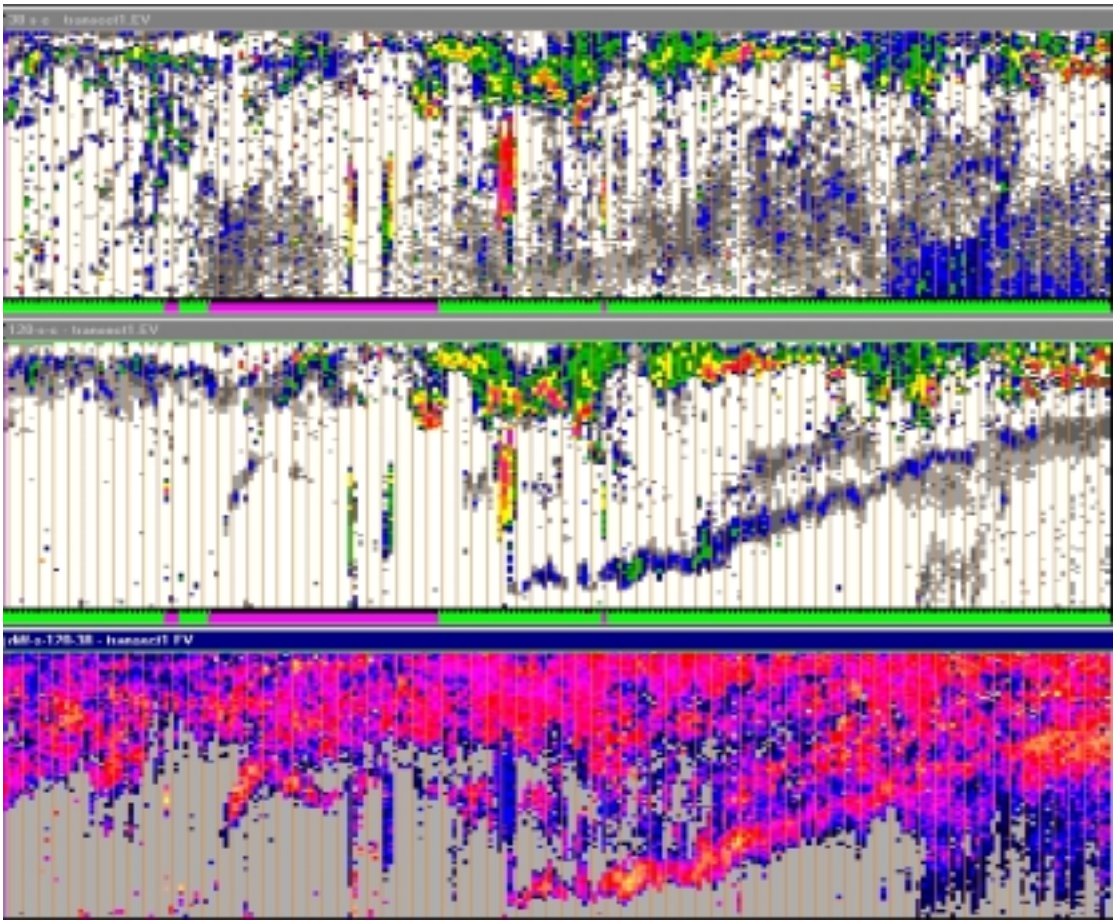


FIGURE ACOU4INTERFERENCE IN SHALLOW WATER

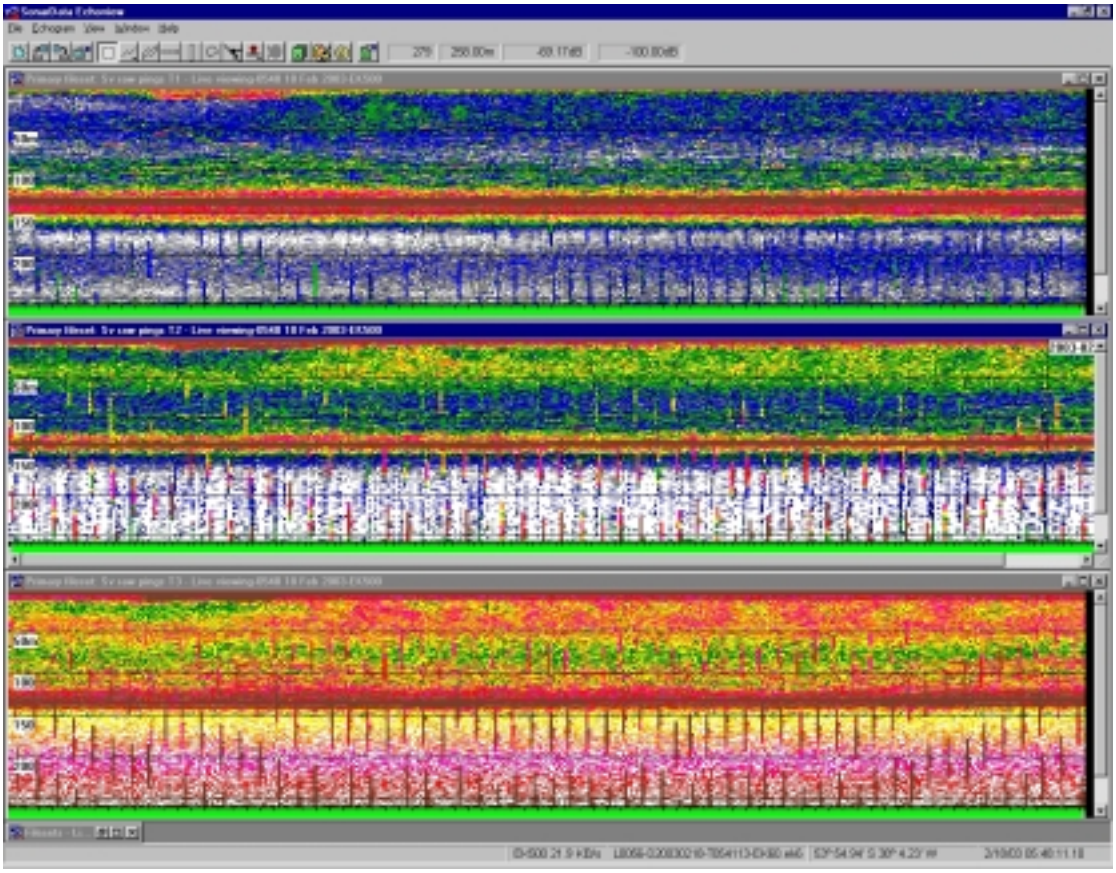
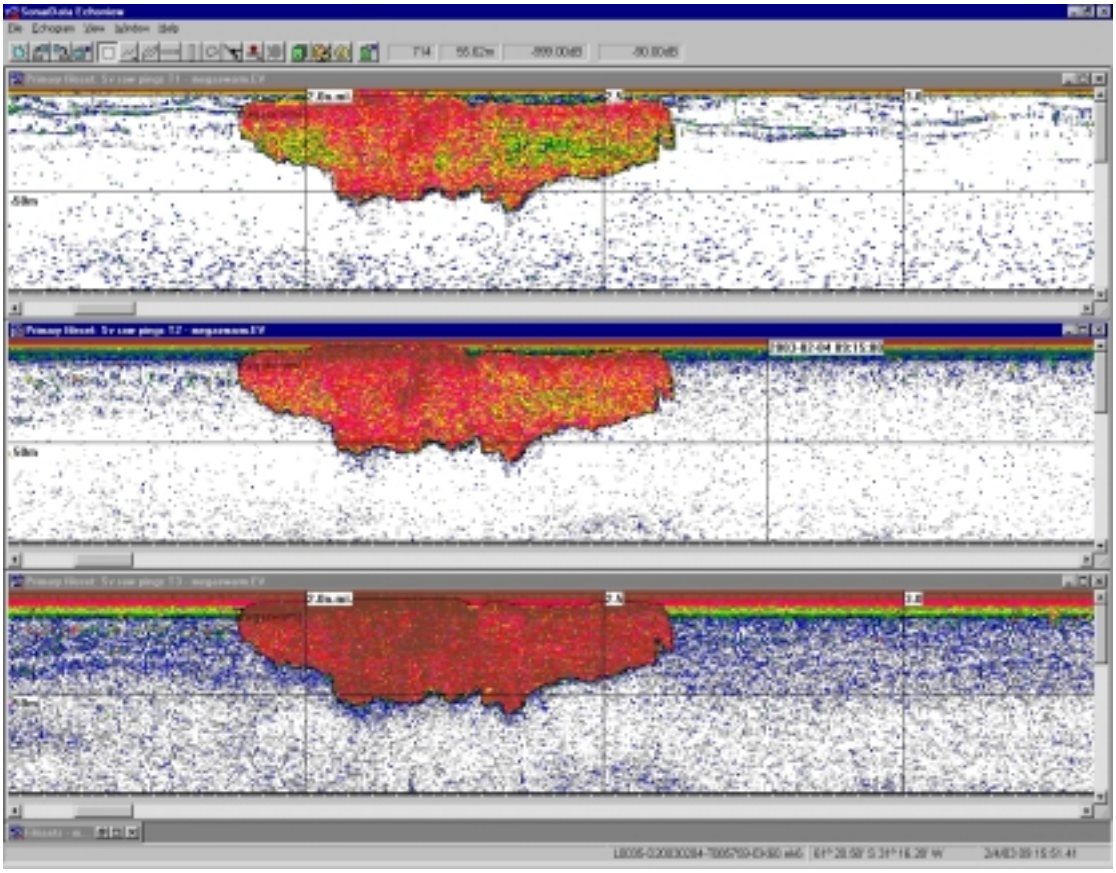


FIGURE ACOU5EXTENSIVE KRILL SWARM SEEN IN THE COMPANY OF WHALES



VISUAL SURVEY FOR CETACEANS BY INTERNATIONAL WHALING COMMISSION OBSERVERS

INTRODUCTION

As part of its SOWER (Southern Ocean Whale and Ecosystem Research) programme, the International Whaling Commission (IWC) has an overall long-term objective to 'Define how spatial and temporal variability in the physical (e.g. sea surface temperature, salinity, mixed layer depth, upwelling, extent of ice cover) and biological (e.g. prey availability) environment influence cetacean species in order to determine those processes which best predict long term changes in cetacean distribution, abundance, stock structure, extent and timings of migrations and fitness'. The cetacean survey on JR82 followed the collaborative, multi-disciplinary, research conducted during the CCAMLR synoptic survey in 2000 (Leaper *et al.*, 2001; Reilly *et al.*, 2000).

AIMS

The objective of the cetacean observations on JR82 were to collect systematic survey data to determine the distribution and abundance of cetaceans. These data may allow investigations of the relationship between cetacean distribution and oceanographic processes or prey abundance.

METHODS

Observations were conducted according to the protocol used for single platform observations during the IWC-CCAMLR survey in 2000. Survey effort was conducted in 'passing mode' (the vessel did not divert to investigate cetacean sightings) along pre-determined transects. Two observers (Russell Leaper and Koen Van Waerebeek) searched a 180° sector ahead o f the vessel with 7x50 binoculars. Observations were made from the roof of the bridge (Monkey Island) behind a wind deflecting screen on the roof of the bridge at an eye height of 18.3m. If rain made observations from the Monkey Island difficult then observations were made from inside the bridge from an eye height of 16m. Sightings and environmental data were entered directly into a computer running the *Wincruz* software. Data from the vessels underway monitoring system were also recorded including wind speed, sea temperature and salinity. Range to each sighting was measured from the angle of dip from the horizon to the whale using Fujinon 7x50 reticle binoculars. Bearings to sightings were recorded by lining up reference marks at 10° intervals in a semicircular pattern of around 1m radius from the observer on the deck, with equivalent 10° marks on the windshield. In addition, one observer used a photogrammetric system for measuring range and bearing. It had been hoped that both observers would be able to use this system but one set of equipment was lost by airline baggage handlers. To ensure consistency between observers and other surveys, priority was given to recording distance and angle using the reticle binoculars and angle reference marks. Higher magnification, Nikon 10x50, binoculars were also used to assist species identification and group size estimation. In addition to the cetacean sightings, data on pinniped and penguin sightings were also recorded. Whenever possible, range and bearing was recorded to all pinniped sightings. However, in areas of high fur seal density, only fur seals within 150m either side of the vessel were recorded. Other seabirds were only noted if any unusual behaviours were observed that might relate to the presence of prey species.

Detailed data on ice conditions were recorded using the ASPeCt (Antarctic Sea Ice Processes and Climate) protocol, whenever the area of sea covered by ice was greater than 5%. If icebergs were present but cover was less than 5% then the number of icebergs in a 180° arc ahead of the vessel were recorded as a comment.

DATA COVERAGE

A total of 220 hours of survey effort were conducted along just over 2000 n.miles of trackline. This resulted in 217 sightings of groups or individuals. Of these, 60% were positively identified to species level.

Most of the survey effort was conducted in deep water with only (10%) in depths of less than 200m. Distribution of effort by depth is shown in table 1a. Sea surface temperatures ranged from –1.6 to 7.7°C with the distribution of effort by sea surface temperature shown in table 1b. A total of 95 n.miles of effort were conducted in estimated ice cover of greater than 5%, amounting to 5% of the total effort.

Environmental variables that could be related to sighting probability included visual estimates of sea state, overall 'sightability' and minke whale visibility. In addition, wind speed and solar radiation were measured by the ship's instrumentation system. Restricting analysis to effort in sightability 'moderate to excellent' and wind speeds of less than 12ms^{-1} results in 1506nm of effort compared to a total effort of 2019nm. This would include 185 out of 194 sightings and only exclude 2 sightings identified to species level.

TABLE 1A. DISTRIBUTION OF EFFORT (IN NAUTICAL MILES) BY DEPTH OF WATER (METRES)

0-999m	1000-1999m	2000-2999m	3000-3999m	4000-4999m	Total
435	188	372	783	240	2019

TABLE 1B. DISTRIBUTION OF EFFORT (IN NAUTICAL MILES) BY SEA SURFACE TEMPERATURE (°C)

-2 to 0	0 to 2	2 to 4	4 to 6	6 to 8	Total
239	664	821	234	60	2019

RESULTS

The sightings on survey effort are shown in table 2. In addition to the listed species, Gray's beaked whale (*Mesoplodon grayi*) and Commerson's dolphin (*Cephalorhynchus commersonii*) were encountered when not on effort.

Table 2. On-effort sightings

Species	Number of sightings	Total individuals
Fin whale (Balaenoptera physalus)	15	36
Sei whale (Balaenoptera borealis)	4	8
Antarctic minke whale (Balaenoptera bonaerensis)	10	24
Undetermined minke whale (Balaenoptera bonaerensis/acutorostrata)	30	48
Sperm whale (Physeter macrocephalus)	6	6
Humpback whale (Megaptera novaeangliae)	12	38
Right whale (Eubalaena australis)	20	33
Southern bottlenose whale (Hyperoodon planifrons)	15	31
Undetermined beaked whale of genus Mesoplodon (Mesoplodon sp.)	4	13
Undetermined beaked whale (Ziphiidae)	9	24
Killer whale (Orcinus orca)	4	33
Pilot whale (Globicephala sp.)	2	85
Hourglass dolphin (Lagenorhynchus cruciger)	9	58
Peale's dolphin (Lagenorhynchus australis)	2	5

One encounter of particular interest to the IWC SOWER objectives was on 4th February 2003. Observation conditions were ideal and a mixed group of 16 humpback and 3 right whales were seen in the vicinity of a large, dense swarm of krill about 0.5nm by 0.3nm and around 60m deep. Apart from this single swarm, acoustic measurements indicated low krill densities in the area. The ship passed through the swarm three times and locations of the whales were measured relative to the ship. This should allow analysis of the locations of the whales in relation to the swarm followed by behavioural observations over a period of several hours.

PROBLEMS ENCOUNTERED

The only major problem was the loss of some equipment due to airline baggage handling. As in previous surveys, James Clark Ross provided an excellent platform from which to conduct cetacean observations. The generally good weather conditions during the survey allowed a greater

amount of survey effort than had been expected. The amount of effort was around 30% greater than that achieved from the James Clark Ross during the CCAMLR synoptic survey in 2000.

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CETACEAN ACOUSTICS DURING JR82

ANA ŠIROVIĆ AND DEBORAH SALMON

INTRODUCTION

Cetaceans spend a large part of their life under water and, as such, they can be difficult to observe and study from the surface. Baleen whales are known to produce low frequency, loud, repetitive calls that propagate well underwater. Since the calls of most baleen whales are unique and easily recognizable, it is possible to distinguish among various species using passive acoustic techniques. Acoustics can be used for a variety of purposes ranging from species identification to determining distribution and seasonality patterns. The main species of interest during this cruise were blue (*Balaenoptera musculus*), fin (*B. physalus*), humpback (*Megaptera novaeangliae*), and southern right (*Eubalaena australis*) whales. Minke (*B. bonaerensis*) and sperm whale (*Physeter macrocephalus* – an odontocete) calls can also be detected and identified to species. Calls produced by other odontocetes are more varied, tend to be higher frequency, and are less readily recognizable and more difficult to attribute to a specific species.

AIM

The acoustic team had two goals during this cruise. The first goal was the deployment of an Acoustic Recording Package (ARP). Data from the ARP can be used to determine distribution and seasonality of mysticete whales within the range of the recordings. The second goal was obtaining acoustic recordings of various species of whales by making opportunistic deployment of sonobuoys from an underway ship. These recordings are helpful in analysis of ARP data, but also enable data acquisition outside of the range of the ARP and provide some insight into spatial distribution of various species of cetaceans.

METHODS

The acoustic recording packages (ARP) that was deployed during this cruise is a bottom-mounted instrument with a hydrophone component floating 10 m above the mooring. The ARP also consists of a data logging and acoustic release systems, batteries, and flotation. It will record continuously at 1000 samples per second for 500 days and the data will be stored on two 18 Gb hard disks. The low frequency calls of blue and fin whales can be recorded from as far as 50 km radius, but somewhat higher frequency minke, humpback, southern right and possibly sperm whale calls should also be detectable.

During the JR82 cruise, sonobuoys were deployed opportunistically in order to supplement the information that will be gathered from the seafloor recorder. Sonobuoys are expendable underwater listening devices. The sonobuoy has 4 main components – a float, a radio transmitter, a saltwater battery, and a hydrophone. The hydrophone is an underwater sensor that converts the pressure waves from underwater sounds into electrical voltages that get amplified and sent up a wire (length of released wire can be set to 90, 400, or 1000 feet) to the radio transmitter that is housed in the surface float. The radio signal is picked up by an aerial and a radio receiver on the ship, then reviewed and simultaneously recorded onto a digital audiotape. Sonobuoy can transmit for a maximum of 8 h before scuttling and sinking.

There are 2 types of sonobuoys. Omnidirectional sonobuoys have hydrophones that can register signals up to 20 kHz, but they cannot determine the location of the sound source. DiFAR (DIrectional Fixing And Ranging) sonobuoys also have an omnidirectional hydrophone for recording sound, but it is limited to frequencies lower than 3.5 kHz. However, DiFARs also have 2 pairs of direction sensors, which along with an internal compass can determine the exact bearing of the sound relative to the sonobuoy. This can then be correlated to visual observations

of the species of marine mammal in that location.

The aerial used during the cruise was a 160 MHz omnidirectional Ringo Ranger. The maximum range for the radio transmission during this cruise was approximately 8 nm, but was variable dependant on weather conditions. We used software controlled ICOM's IC-PCR1000 receiver for reception of sonobuoy signal. Data were recorded on digital audiotapes using Sony PCM-M1 digital audio recorder and reviewed using SpectraPlus software package.

The noise levels from the RRS James C Ross were very low and they did not affect the quality of recordings greatly, except when we were at a station and the bow thrusters were being used.

DATA COVERAGE

Sonobuoys were deployed when marine mammals were visually detected and randomly throughout the cruise, but attempting to provide maximum reception from a single sonobuoy. A total of 107 sonobuoys were deployed: 80 omnidirectional and 27 DiFAR. Four DiFAR and 12 omnidirectional sonobuoys failed (15% failure rate for each type). This relatively high failure rate is probably due to the age of the sonobuoys, which are only given for research after their shelf life in the Navy has passed.

Locations of all the deployments as well as a preliminary summary of the buoys on which calls were heard can be seen in the complete and close-up (Western Core Box detail) maps of the study area. Further analysis of the recordings is needed to double check for calls that were possibly not detected during the preliminary review. Other data noted for each deployment were date and time of deployment, the reason for the deployment, comments on sonobuoy range and reception, and comments on any unusual things heard.

PRELIMINARY RESULTS:

The Acoustic Recording Package was successfully deployed at 60°00' S latitude and 51°54' W longitude.

Several species of baleen whales, as well as odontocetes were recorded from the deployed sonobuoys. Further analyses of the recordings are needed.

DWNM, RMT, LHPR.

DOUG BONE

The Down Wire Net Monitor (DWNM) has worked very well this season, in previous years there has been a problem with noisy temperature, conductivity and depth traces due to eathing problems when then underwater unit was submerged. Paul Woodroffe has eliminated this problem and clear traces for all parameters have been the norm.

The DWNM was used with the RMT and LHPR net

RMT SYSTEM

A total of 62 RMT hauls were made, the majority were target fished hauls to gather krill for experimentation. For the hauls a non-filtering cod-end bucket was used, this results in the captured animals being in better condition.

The configuration used this year was two RMT 8 nets rigged to open/close independently.

There were only two occasions when the net failed to operate correctly; in both cases, this was probably due to accidental miss setting of the release gear.

LHPR

A total of 9 LHPR hauls were made to a depth of 1000m. in anticipation of the requirement to make a number of deep or very deep hauls. An open/close 'valve' was constructed that allowed the net to be veered to the required starting depth without the gauze advance operating. The catch entering the net on descent was vented out through a channel immediately ahead of the recorder box. When the command was sent to start the sampling sequence the channel lined up with the recorder box and directed the catch into it. The O/C valve ignored further advance commands.

UOR CRUISE REPORT

DOUG BONE AND NATHAN CUNNINGHAM

This season we have been using a new Chelsea Technologies Group (CTG) NuShuttle vehicle, (Serial No 029). This is fitted with, Minipack CTD&F, Fastraka (Fast Repetition Rate Fluorometer), PAR sensor, Alphatracka transmissometer, 6 wavelengths of SeaWiFFs sensors for radiance and the same 6 for irradiance. This instrument fit supersedes that of Shuttle Ser No 001.which we have been using for a number of years. The Alphatracka and SeaWiFFs sensors were transferred from 001 to 029.

Operating the shuttle requires two PCs, one to 'fly' the vehicle, the other to control the instrumentation and logging of data. The MINIPACK software was all new, the NSHUTTLE (flight) software was as used previously. However, in the original system NSHUTTLE operated via a Power Line Modem (PLM) using the two conductors supplying power to the instruments. Modem operation was not 100% reliable; breakdown was blamed on noise generated by the flash tube of the Fluorometer. In the new system, the modem has a dedicated pair of conductors, possible because the previously used Optical Plankton Counter is not included in the instrument fit. NSHUTTLE gets its time from the MINIPACK PC.

TESTING

Only very limited testing was carried out on the whole system in UK before shipping South due to late delivery of a full working version of the MINIPACK software.

On setting up on board ship the system seemed to work OK, although there were some problems integrating the MINIPACK output with the SCS.

The first deployment had to be aborted after a few minutes as the PLM ceased to function. Further tests showed that it stopped as soon as the vehicle entered the water but re-started when it was taken out. The problem was traced to bare wires touching the inside of the PLM underwater housing. With this problem cured the PLM worked very well.

With the PLM operating we were able to assess the performance of the vehicle itself and the Minipack instrumentation.

INSTRUMENTATION

It was immediately apparent that the PAR sensor was not working.

Calculated SV was not being given.

Calculated salinity was not being given.

Investigation of the PAR sensor revealed that the fault lay in the sensor itself; initially it was replaced with one from the DWNM. However, it was necessary to make a cable adaptor to use this and the first adaptor developed a depth dependant fault. The fault then became 'permanent' after which a new cable adaptor was moulded. This did not cure the fault. The wiring was thoroughly investigated and it was discovered that the PAR sensor in use was working correctly and the signal was reaching the Minipack. Communication with CTG suggested that there was nothing further we could do.

During one of the early data gathering deployment the Minipack stopped working, testing with the vehicle back on deck revealed that the fault was intermittent but more on than off. CTG were contacted, they suggested a number of possibilities, one of which was that cables could be

pressing on the empty flash card socket causing a fault. This proved the case and a piece of plastic was inserted into the socket to prevent further problems.

VEHICLE FLIGHT

The weight distribution of the 029 instrument fit is very different to that of 001, so we did not expect the new vehicle to have exactly the same flight characteristics as the original. The difference however was much greater than we had anticipated. As the cruise progressed and our experience grew we were able to discern that there were two separate but linked problems. One of these centred around the Primary Flight Parameters used in the PID programme controlling the servo driving the 'wing' which controls depth. An extensive investigation was made into how the N-Shuttle software derived the corrected wing angle for flight, although approximately 75% of the problem was defined using a spreadsheet model, without further assistance or a full engineering/scientific investigation into how exactly the UOR fly's, and how the co-efficient P,I,D are exactly derived, no further progress was made attempting a mathematical solution to our black-box n-shuttle. The other problem was the servo 'stalling' when moved too far in the 'dive' direction. A great deal of time was spent trying to sort these problems out and a considerable volume of email traffic to CTG was generated. There will have to be further discussion with CTG on return to UK but at the end of the day they have not been very helpful.

PRIMARY FLIGHT PARAMETERS

The initial settings led to very chaotic flight with the vehicle going from one extreme to the other, often ignoring the Command Line that it was supposed to be following. After much experimentation, we hit on a set of parameters that gave 'safe' if rather conservative undulations with a fair measure of reliability. From discussions with CTG it is clear that the Primary Servo Parameters that are 'working' for us are rather different to those that they expect to be used. Another aspect of this problem is that the vehicle takes a very long time (circa 15 minutes) to settle on a depth when set to fly level. This also contrasts sharply with 001 which would settle very quickly at a set level flight path. We feel that these factors must be pursued further with CTG.

SERVO STALLS

This takes the form of the wing moving to the physical limit in the dive direction, even when the software is telling it to be elsewhwere. This causes the vehicle to dive as deep as the tow cable will allow. A software limit can be set for both maximum and minimum wing positions. In the case of the maximum it is at a position where there appears to be a powerful hydrodynamic force pushing the wing further. Under certain conditions, normally when the towing speed is slightly more that 10 knots, this force overcomes the software limit and drives the wing to the physical limit of its travel. It is not easy to get the vehicle to recover from this condition, in extreme cases it is necessary to get the ship to slow down. We set the software limit at the minimum that was conducive with the vehicle reaching the depth we wanted (120m). In order to further limit the severity of the problem, and reduce the time taken for recovery, a physical stop was fixed to the wing track.

The limitations on flight trajectory that we had to impose definitely degraded the value of the data gathered. Our normal practice with 001 was to set the top depth at a level that would give a turnover depth between 10 and 6 m (depending on sea state) thus allowing a comparison with the through flow sea water system on the ship. The best we were normally able to achieve with 029 was turnover at around 15m. Similarly we have routinely undulated to 140m with 001, 120 was all that was possible with 029. The lack of depth gained was partly due to the wing position restriction but was also possibly due to the lighter weight of this vehicle.

In spite of the problems experienced the statistics are impressive with 42 data gathering tows were made totalling 230 hours. Assuming an average speed of 10 knots this equates to 2300 nautical miles or 4255 km., in addition 8 verticals profiles were carried out with the FRRF.

POST SCRIPT

From early experience with vehicle 001 we learnt that servo power is significantly affected by low water temperatures. We suspected that the stalling problem that we have experienced with 029 has the same root cause, in spite of the fact that we had overcome the problem with 001. In order to test this theory we carried out a test deployment of 029 in waters outside the polar front. The temperature was around 8°C at the surface and 4°C at 120m.

Employing the same flight parameters as we normally used on transects within the polar front (Top depth –10, Bottom depth 135, climb rate 50) we found a considerable difference in behaviour. Most striking and unexpected was the fact that the vehicle came up and turned over at around 5m depth instead of 15-18. When the bottom depth was progressively lowered to 155, action that would have certainly stimulated a stall in colder water, this did not happen. The maximum dive angle attained by the wing was about 1000 angle units below the software maximum (range 14000-24500). During the 1 hour plus, duration of the trial one stall did occur. This happened when the vehicle was diving very rapidly in the mid depth range. We have noted that 10 knots appears to be a critical speed for the vehicle and that higher towing speeds are more likely to provoke stalls than lower speeds. At the time the stall observed in the trial took place the velocity of the water over the vehicle would have been considerably above 10 knots. We feel that we have gathered significant evidence to support our theory that the stalling problem is temperature based.

ETS CRUISE REPORT

MARK PRESTON

CTD

The CTD was found to be in a good state after the previous cruise (thanks for that Jim). At the request of the scientific party a disolved oxygen sensor was installed (R Bahde), Flurometer & PAR (B Korb).

The serial numbers of all the component parts were recorded, calibration certificates consulted and coeficients verified within the acquisiton softwere by both M Preston and P Glorioso.

A test drop was then fitted into the schedule and verified that the equipment was working correctly.

Little else needs to be said about the operation of the CTD other than one problem (see below) and the small matter of a couple of tap 'o' rings that got too stiff to operate easily in the cold. These were changed and all taps operated much more easily.

One problem did manifest itself to which no solution we ever found. In fact little investigation was done due to its intermittent nature. Occasionally (some 6% of drops), at some point in a drop (either descending or ascending) there would be an apparent break in the power fed to the CTD. The break in power would manifest itself as a spike in the data of all the external sensors (fluorometer, altimeter etc.). The effect was greater than this as it also re-started the pump delay thereby turning the CTD pumps off for about 30 seconds. This was viewed to be trivial, as the problem never happened twice in the same drop and the 'gap' in the data so short. In addition, there was the considerable problem of what might be causing the problem. Connectors on the CTD itself were checked with nothing obvious being found. The problem didn't always happen at the same depth thereby suggesting that it wasn't caused by a damaged portion of the cable running through the winch (also the problem didn't seem to be getting any worse, which if it was either the cable or termination most certainly would).

If I were to have to make a guess (and that's what it would be) then I'd suspect the swivel. I recommend that during the summer it is returned to the manufacturers for service and see what they say.

OCEANLOGGER

The oceanlogger performed without problem for the entire cruise.

XBT

The XBT system worked well throughout the cruise. There was a little confusion to start with as the 'usual' first choice launcher (the white one) could not be found. The spare (orange) launcher was located but it was found to have the wrong connector (?) This was changed and tested. Mean whist the white launcher was found and used throughout the cruise without problem.

EK60

The EK 60 worked well throughout the whole of the cruise, however it did demonstrate one problem, and that was that at intervals between 3 and 5 hours communications between the main processor in the UIC and the three GPT's in the gravimeter room would fail. An email was sent to Simrad asking for assistance.

Simrad produced a new file called GPTprog.hex and instructions for installing it which had cured a similar problem on another vessel.

When working on a system like this there is always a chance that if you make changes you could make things worse rather than better. For this reason the installation of the new file was left untill all the 'real' acoustic work had been completed.

The order of events are listed below:

- Copy the original GPTprog.hex file and back it up.
- Copy ther new file inplace of the old
- Re-start the software. This then detects that the file is new and asks if the operator want to upgrade the GPT's
- 'Yes' was selected. This upgraded the 38 KHz and said that the upgrade had been sucessful.
- The same happened for the 120KHz
- The 200KHz reported a failure in the upgrade.
- On going to the 'install' menu both the 120 and 200 KHz GPT's were shown in red, indicating problem with both.
- 'None' was selected as the transducer for both of these, the idea being that when the correct transducer was re-sellected than the installation of the file would be re-requested. This did not happen. What did happen was that the GPT's dissapeared from the list entirely.
- About two minutes later the 120KHz GPT re-appeared in the list and appeared to work correctly, although the power had to be cycled to get it to work properly.
- The 200KHz was still dead.
- The spare 200KHz was installed and appeared in the list immediately.
- The software detected this new GPT, adding it to the list but it could not be made to 'ping'. It was assumed that this was due to the GPTprog.hex being different from the other two units. Its software was upgraded and according to the message displayed was done successfully.
- We appeared to have all three channels back again.
- After power cycling the system while racks were closed up and screws tightened ther 200 was again missing.
- 'pinging' it's IP address had no effect and neither ther 'S1' or 'S2' lights were on.
- Simrad was emailed and at the time of writing this a response is still to be forthcoming.
- The 200KHz GPT that is currently installed was the spare. The original unit is in the Ele/Ws awaiting further investigations.

OTHER

LHPR

D Bone found that a modification to the internals of the LHPR motor housing was necessary. Adding a relay 'strategically' did this, which seemed to work OK. A more permanent solution may be deemed necessary.

WHALE ACOUSTICS

The whale acoustics team brought with then some severely abused equipment, damaged RF cables, poor connections and no spares holding whatsoever. Their acoustic command unit was shattered inside, some components hanging off boards by their leads, a transformer with shattered ferrite core etc. By extreme good luck, the thing still performed to some degree after a bit of intensive care.

ITS REPORT

JR82

PERSONAL COMPUTERS

SOPHOS UPDATE

Sophos updated to v3.64. Virus software had not been updated since the refit 4 months ago. Half the PC's could not be accessed via SAVADMIN because the sweepupd password was set incorrectly. Bugbear-A, Elkern-C and Klez-H were rife. Netware login scripts were used to remove bugbear from memory and sweep the local drives. Each machine was then visited and all infected files removed. Machines clean and reasonably up to date. (Note: Signy also at v3.64, all machines clean)

NETWARE

GROUPWISE INTERNET AGENT

The GWIA settings were changed to send problem or undeliverable messages to the postmaster (JRCOMMS) rather than the GWPROB directory. These settings can be found in NWADMIN under `Groupwise View`. Select `SMTP | details | SMTP/MIME Settings | Undeliverables`

Log settings were also changed. The logs are now kept for 60 days to aid the tracing of user problems. The logs are kept in daily files under

```
y:\wpdomain\wpgate\gwia\000.prc\
```

DSREPAIR

This was run following the power problems and crash on 13th December 2003. No errors encountered.

VOLUMES

Both POSTO and SHARED1 volumes reporting more space in use than files on the disk. This again caused by power problems from 13th December 2003. Vrepair could have been used to attempt a fix, but preferred to delete the effected volumes, recreate and restore from backup.

UNIX

JRUF

Following power fluctuations on the 13th December 2002, various problems have arisen and been dealt with (See JR81 report). A problem remains preventing users from logging in using CDE (only the root user logs in as normal). The message received is shown below:

```
The DT messaging system could not be started

To correct the problem:

Choose [ok] to return to the login screen

Select Failsafe Session from the login screens option menu and log
in.

Check to see that the hostname is correct in these locations:

   /etc/src.sh

   /etc/hosts

   /usr/adm/inetd.sec


For additional information, see the DT Users Guide
```

A solution for this has not been found, but the benefits of not allowing users access to jruf mean we should probably not fix it. Jruf is currently the level C logging machine and rebooting requires considerable time and effort spent in managing the SCS and ADCP data streams. It is better that jruf not execute user processes which have caused instability and crashes in the past.

SCS LOGGING SYSTEM

MINIPACK

This device replaces the UOR and Aquashut from previous cruises. It requires a GPS feed from the SCS (Trimble NMEA stream) and logging of $MINIPACK data which contains 26 variables. This was found to exceed the limit for a NMEA parent variable so two of the variables frrffo and frrffm were dropped (variable positions 23 and 24). Note that unlike most data streams ending with {CR}{LF} this data stream is terminated with a {CR} only; check the termination field in the SCS configuration file.

The Minipack PC has an NTP client installed as a service which is started automatically at bootup. This NTP client can be found on the Tardis 1.2 cd and has two configuration files found in c:\winnt. They are ntp.conf and ntp.drift. The file ntp.drift should not be edited, but the ntp.conf file contains the IP address of the NTP server, in this case 193.61.88.60, the SCS server using Trimble GPS time.

Refer to Appendix A for a list of Minipack variables and to Appendix B for a wiring schematic diagram.

LEVELC

Two variables were removed from the Minipack levelc data definition form, frrffo and frrffm, before creating the data stream. The scs2levc.xml files also needed these variables removed and the field positions renumbered. When these modifications were made the scs data started to flow cleanly to the levelc via the scs2levc program.

The scs2levc data stream for the net monitor stopped updating so a rebuild of the data file was used as the fix for the problem. This involved stopping the scs2levc processes on jruf and resetting the streamstates flag for the minipack. To reset the streamstates flag the wfset command was used. ("`wfset net-monitor`") This sets the write flag back to "n" in the streamstates file and enables the credat command to be run again to create a new datafile. Once this was complete, the scs2levc command was run and the stream rebuilt from the SCS data files.

INSTALLATION OF AN SCS REMOTE CLIENT PC

This is simple, but the instructions in the manual are incorrect. Follow this procedure on the JCR:

This works for Windows NT 4.0 Workstation, but may well work for another OS. If you have problems revert to a clean install of NT4.0 Workstation. Basic Windows networking is required only (if you install to a machine with a Novell client the mapped drives will have to be changed and the SCS.CFG edited to reflect the changes). Install the IPX/SPX, NetBios and TCP/IP protocols. Join the workgroup JCRDAS and give the PC a name like JCR-SCS-x, where x is the next number in the sequence.

1. Install Service Pack 6a.

2. Login as the user SCS (basic user access is best, not Admin, although SCSMenu can be executed by any user.

3. Map drives to:

   a. `X:  //JCR-NOAA-S1/SCSExe`

   b. `Y: //JCR-NOAA-S1/SCSLog`

   c. `Z: //JCR-NOAA-S1/SCSShip`

4. Copy the file `C:\SCS.CFG` from another remote client PC, it should be identical to the one shown in Appendix C. Careful to note the ";" at the end of each line and directories must always end in a forward slash "/" (if installing under Win95 change all the forward slashes "/" for back slashes "\"). Place it in the root of C:\.

5. Copy ALL the files from `OlectraChartInstallFiles` and `SCSInstallFiles` directories, found under `AllSCS` directory on the v3.0 cdrom to `C:\WINNT\SYSTEM32`. Overwrite files even if they are newer (one file `OLEAUT32.DLL` does not copy because the file is open, ignore this). These files are also found under (Z:) `SCSShip\JCR\RemoteSCS\.`

6. Run the command `REGSVR32 C:\WINNT\SYSTEM32\OLCH2X32.OCX`

7. Make a shortcut to `X:\SCSMenu.exe`

NETWORK

Nothing to report.

OTHER

EMAIL

We have received a number of disinfected emails from Cambridge since the email gateway was modified to look at the south.nerc-bas.ac.uk domain. This has highlighted the number of virus threats we receive on the ship. In the week following the change, the Master received five disinfected emails that contained the W32/Klez-H virus and the third engineer received one that had contained a copy of Bugbear.

EK60

During the cruise, the EK60 experienced an intermittent fault communicating with the GPT units. Simrad was consulted and they sent an upgrade file that needed installing on the GPTs. To install perform the steps below:

1. Make a copy of the existing file C:\EK60\GPTprog.hex

2. Place the new file in the C:\EK60 directory overwriting the existing file

3. Restart the EK60 software. The software detects the new software and prompts the operator asking if it should be installed in each GPT. Answer yes for each GPT and the software is copied to the GPT.

During the install of the software the 200kHz GPT experienced a fault with the new software and is now no longer responding on the network. This has been reported to Simrad and we are waiting a response.

WORK TO BE DONE/RECOMMENDATIONS

1. The KVM Extender power supply for the Helmsman display failed and needs replacing.

2. The A3 scanner power supply failed and needs replacing.

3. Order several generic PSU's on next years indent.

4. The LaserJet 4m plus fuser unit has failed and needs replacing.

5. Order a duplexing unit for the HP 4500 on next years indent.

6. Jruf X windows problem to be solved.

7. Win32 version of listit and other RVS utils to be written.

8. SCS; RAW to ACO and LAB file converter program required. This could be lifted from the source available on the NOAA v3.0 cdrom.

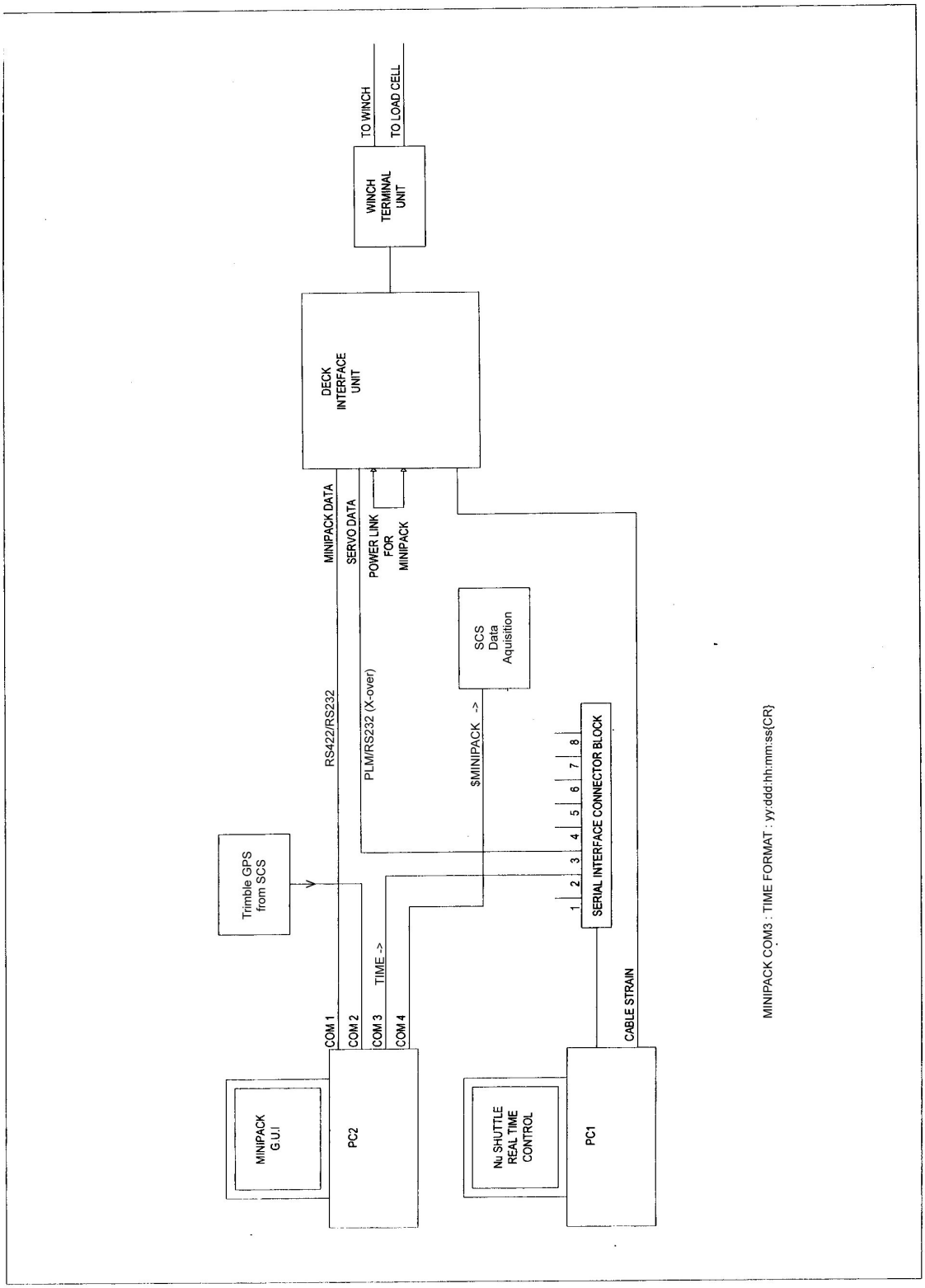
9. Automatic AMOS import/export system to be installed on JCR-AMOS-D1.

APPENDIX A – MINIPACK VARIABLES

Field	Comment	Data Type	Units	Data fieldposition	Length	Units Field Position	Units
cond	Conductivity	ASCII		1	10		
temp	Temp	ASCII	Degree C	2	10		
press	Pressure	ASCII	milibar	3	10		
fluor		ASCII		4	10		
battv		ASCII	volts	5	10		
batti		ASCII	bat current	6	10		
deltatemp		ASCII	degrees C	7	10		
chan8		ASCII		8	10		
swdn1		ASCII		9	10		
swdn2		ASCII		10	10		
swdn3		ASCII		11	10		
swdn4		ASCII		12	10		
swdn5		ASCII		13	10		
swdn6		ASCII		14	10		
alphatraka		ASCII		15	10		
par		ASCII	par	16	10		
swup1		ASCII		17	10		
swup2		ASCII		18	10		
swup3		ASCII		19	10		
swup4		ASCII		20	10		
swup5		ASCII		21	10		
swup6		ASCII		22	10		
frrffo		ASCII		23	10	removed from SCS	
frrffm		ASCII		24	10	removed from SCS	
calcsal		ASCII		25	10		
calcsv		ASCII		26	10		

Terminator for a line of data is CR not LF.

APPENDIX B - MINIPACK WIRING SCHEMATIC



APPENDIX C – FILE CONTENTS C:\SCS.CFG

```
SCSAcqEnv=0;                used to signal the ACQ machine [1] or remote [0]

SCSAcqServer=JCR-NOAA-S1;           PC running ACQ

SCSDisplay=Z:/JCR/Display/;

SCSExe=X:/;

SCSLog=Y:/;

SCSShip=Z:/JCR/;

SCSCompress=Y:/Compress/;

SCSEventData=Z:/JCR/EventTemplates/;

SCSEventLog=Y:/EventData/;

SCSMerge=Y:/MergeData/;              used for Merge SCS Data app

SCSSounds=Z:/JCR/Sounds/;            where sound (*.WAV) files are located

ARCDIR=S:/Arcview/;                  where ArcView scripts and projects are loaded
```

DATA MANAGEMENT

NATHAN CUNNINGHAM

Data management was carried out in much the same way as on previous cruises. The SCS system, RVS system and level C all performed their function in logging the data. The UOR $minipack SCS data stream was set up and functioned well. Progress on logging metadata was made with consideration and the initial implementation of XML schemas for the underway and station data. This is the start of the implementation of the two years metadata strategy. Exploratory work was undertaken for developing the RDBMS for the underway data collected by the SCS.

One of the ambiguities currently experienced with the JCR logging system is level of pre-processing and smoothing that some data streams undergo before being centrally logged. The clarity of the "data state" in terms of raw data, processed data, pre-processed data needs formulising and documenting in the high level metadata. Special consideration is required by each of the research groups working on the JCR with the development of a coherent and integrated data encapsulation system encompassing the underway data, transect data and station event data, resulting in a complete RDBMS for each unique spatial-temporal observation.

The processing of the oceanographic data needs consideration concerning the availability of experienced users of the PSTAR software. Strategic decisions are required on how we proceed with PSTAR and MATLAB and what human and technical resources that will be allocated to it.

MATLAB requires more than one user license.

Web page development software would be useful such as DreamWeaver.

The installation and licensing ArcGis is required onboard the JCR PC network.

The installation and licensing Oracle is required onboard the JCR. There are issues with the Oracle server and potential lack of computing resources.

ACKNOWLEDGEMENTS

This cruise was a real team effort, and I must thank not only every person on the ship for their professionalism but also the logistics and personnel sections back at BAS. In particular, Chris Hindley gave great support and guidance. The planning also benefited from numerous discussions with Jon Watkins and Eugene Murphy. There was a very friendly and cooperative from the shipside, and ours thanks go to the Captain, Chris Elliot, and all the officers, the stewards and the catering staff for looking after us so well, and to the crew and all the engineers.

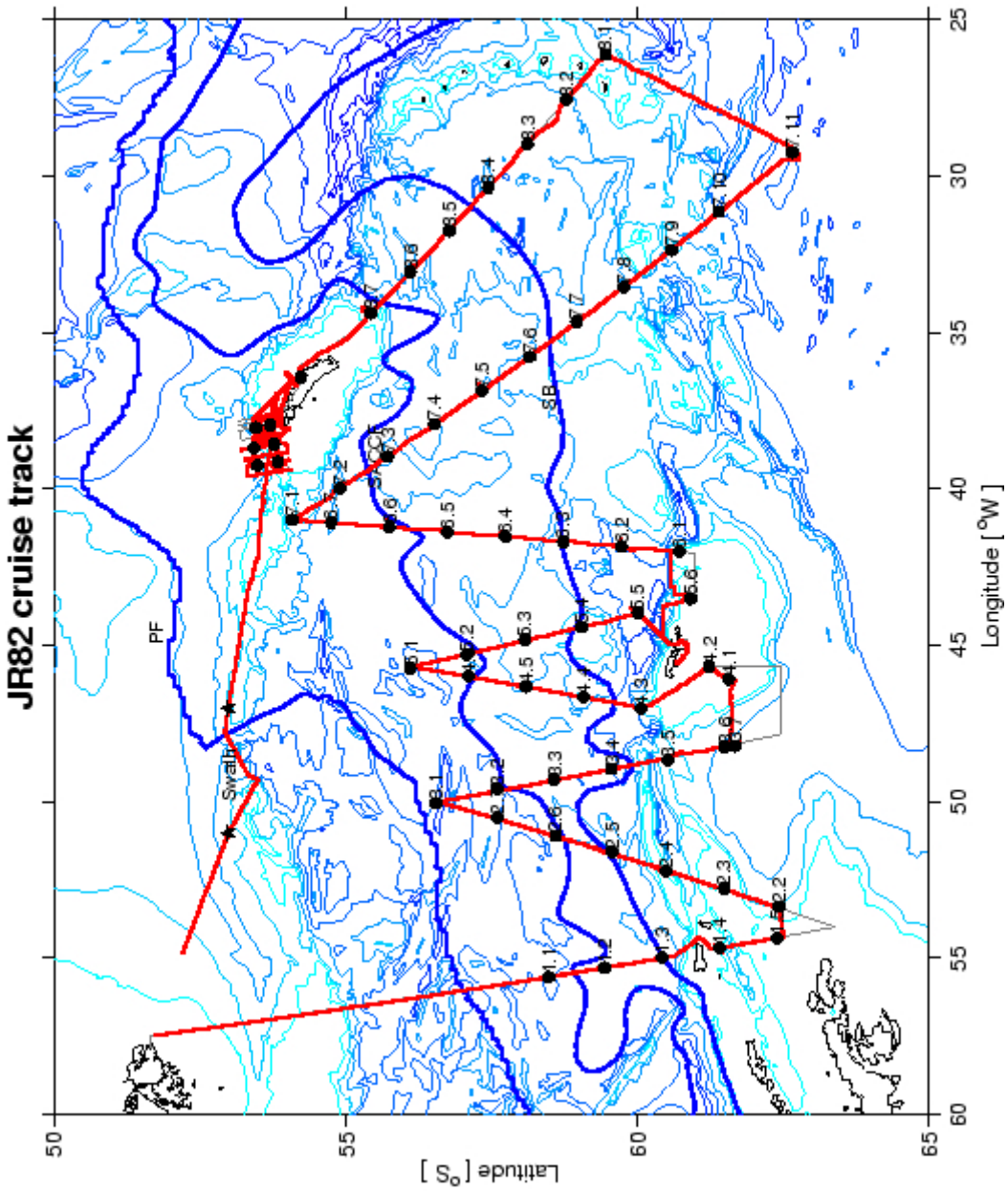
It was a long cruise and all the scientific party stuck to their tasks and helped each other out. I am particularly grateful to those who helped for the overall good of the science. These include Mark Preston, Pete Lens and Doug Willis from ITS and ETS, and Doug Bone who as always kept the show on the road. The six watch leaders, namely Nathan Cunningham, Tony North, Cathy Goss, Sally Thorpe, Pablo Glorioso and Peter Enderlein did a great job and took much of the weight off my shoulders. Kate Arnold and Min Gordon also supported other people's sampling and were invaluable.

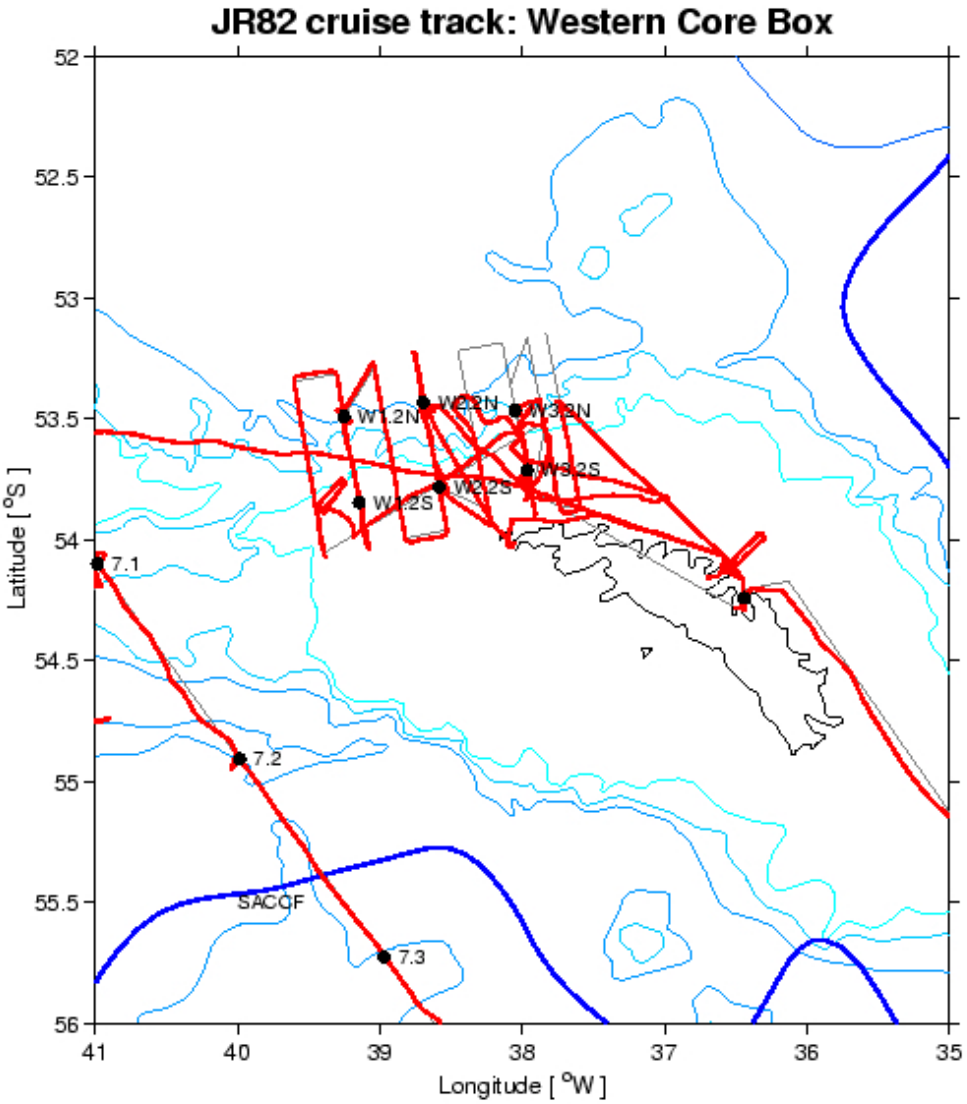
GENERAL RECOMMENDATIONS

The ship worked very well. The only general comment concerns eating arrangements.

The duty mess is not only one of the smallest spaces on the ship, it is also one of the heavily used. This is a bad combination and people were frequently having to stand up to eat etc. It is not an option for scientists to change to eat upstairs when they are in the middle of work. The idea of a single mess room with cafeteria-style service seems a popular one on the ship. At the very least, extra seating in the duty mess is one of several short-term solutions. Extending the bench seats so that they are the same lengths as the tables would immediately allow 4 more people to sit in comfort. I cannot imagine that this is too expensive.

CRUISE TRACK SCOTIA SEA




JR82 cruise track: Western Core Box
Latitude [°S]
Longitude [°W]
52
52.5
53
53.5
54
54.5
55
55.5
56
41
40
39
38
37
36
35
W1.2N
W2.2N
W3.2N
W3.2S
W2.2S
W1.2S
7.1
7.2
7.3
SACQF

6.5

7.5

EVENT LOG AND TRANSECT LOG

Event log

Transect log